
Office of Vocational and Adult Education (ED), Washington, DC.; National Science Foundation, Arlington, VA. Div. of Undergraduate Education.

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Guides - Classroom - Learner (051) -- Guides - Classroom - Teacher (052)

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Behavioral Objectives; Competency Based Education; Course Descriptions; Curriculum Design; Curriculum Guides; Educational Certificates; *Equipment Maintenance; *Industry; Instructional Materials; Job Skills; Job Training; Learning Activities; Learning Modules; *Machine Repairers; *Machine Tool Operators; Machine Tools; Postsecondary Education; Student Certification; Student Evaluation; Teaching Methods; *Technical Education

This package consists of course syllabi, an instructor's handbook, and a student laboratory manual for a 1-year vocational training program to prepare students for entry-level employment as industrial maintenance technicians. The program was developed through a modification of the DACUM (Developing a Curriculum) technique. The course syllabi volume begins with the MASTER (Machine Tool Advanced Skills Technology Educational Resources) Program Consortium competency profile with 19 duties (and supporting technical workplace competencies): practice safety; apply mathematical concepts; interpret engineering drawings and control documents; use measuring tools; use hand tools; operate machine tools; perform welding operations; maintain/troubleshoot equipment and systems; repair power transmission systems; fabricate/install sheet metal parts; piping operations; basic rigging; bearing maintenance; use computers; align shafts; install/align machines; maintain electrical devices; basic mechanical concepts; and fasteners and preloading. The first volume contains the justification, documentation, and course syllabi for the courses. Each syllabus contains the following: course description; prerequisites; course objectives; required course materials; methods of instruction; lecture outline; lab outline; Secretary's Commission on Achieving Necessary Skills competencies taught; and appropriate reference materials. The two-volume instructor's handbook consists of technical training modules that include some or all of the following: time required; duty; task; objective(s); instructional materials list; references; student preparation; introduction; presentation outline; practical application; evaluation; summary; and attachments, including handouts, laboratory worksheets, and self-assessment.
with answer key. The handbook is arranged by duty grouping, with technical modules developed for each task box on the competency profile. The student laboratory manual contains a DACUM chart and learning modules. Each module in the student manual includes some or all of the following: objectives, outline, laboratory exercises, laboratory aids, and handouts. (YLB)
EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY

Industrial Maintenance Series
COURSE SYLLABI

BEST COPY AVAILABLE

Supported by the National Science Foundation’s Advanced Technological Education Program
a consortium of educators and industry

EDUCATIONAL RESOURCES
FOR THE
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Industrial Maintenance Series
COURSE SYLLABI

Supported by the National Science Foundation's Advanced Technological Education Program
This material is based upon work supported by the National Science Foundation under Grant No. DUE-9553716

National Science Foundation
Advanced Technological Education Program

"Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Foundation."
ACKNOWLEDGEMENTS

This project was made possible by the cooperation and direct support of the following organizations:

National Science Foundation - Division of Undergraduate Education
MASTER Consortia of Employers and Educators

MASTER has built upon the foundation which was laid by the Machine Tool Advanced Skills Technology (MAST) Program. The MAST Program was supported by the U.S. Department of Education - Office of Vocational and Adult Education. Without this prior support MASTER could not have reached the level of quality and quantity that is contained in these project deliverables.

MASTER DEVELOPMENT CENTERS
Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES

COLLEGE AFFILIATES

FEDERAL LABS
Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS
Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -
Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS
American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS
Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS
The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.
Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION
Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.
Manufacturing in the Augusta Region
Augusta is the second largest city in Georgia and manufacturing represents the largest sector of the Augusta economy. The region is home to 810 manufacturers employing 89,717 people, an industrial base consisting of about 75% process control and 25% discrete parts production facilities. Major areas of emphasis for industry include technology transfer, factory floor training, and job certification programs. Growth of manufacturing in the region has been driven by Augusta's high tech development in electronics, process control, telecommunications, computers, medical services and instrumentation.

Augusta Technical Institute and Center for Advanced Technology (CADTEC)
Augusta Technical Institute (ATI) is part of Georgia's Department of Technical and Adult Education system, serving a large percentage of the two-state Central Savannah River area through its main campus and satellite facilities. The student body includes vocational-technical and college prep students, as well as current workers seeking retraining or skills upgrade; ATI has long emphasized outreach and special attention to the needs of low income, rural and disadvantaged residents, as well as displaced workers, single parents, women in non-traditional fields, and the disabled. In 1983, the Institute used the opportunity to host one of Georgia's new regional advanced technology centers (ATC's) to streamline its technical programs and thereby help to ensure the future employability of its students. ATI's Center for Advanced Technology (CADTEC) is designed to provide technology research and demonstration, industry assessments, technical consulting, and industry-specific contract training for the many established and emerging high tech companies in the Augusta region.

Development Team
- **Project Director**: Mr. Ray Center, Director of CADTEC, served as program director for the MASTER project.
- **Subject Matter Expert**: Ronnie Lambert, MS, MASTER Site Coordinator, had program responsibility for developing skill standards based on the industry skills verification process, as well as developing course curricula and program materials for the MASTER pilot program in Industrial Maintenance Mechanic and Instrumentation Technician. Mr. Lambert has taught Industrial Maintenance Mechanic and Instrumentation for 32 years in colleges and industry across the Southeast.
Introduction

MASTER research indicates that a minimum of one year of occupational study and training will prepare students with the entry-level skills necessary for the industrial maintenance trade. These findings led us to structure our pilot program to a one-year schedule.

In this one-year program, the students progress through a series of industrial maintenance courses designed to both educate and train students with knowledge and skills in areas ranging from industrial mechanics and refrigeration fundamentals to an introduction to microcomputer operations and electrical systems. Students receive a wide range of training which enables them to seek jobs in many different areas. The Industrial Maintenance Program at Augusta Technical Institute (ATI) has been training Industrial Maintenance Mechanics for many years and works closely with advisory committee members to make sure that the skills being taught are the skills needed in industry. Students who graduate from this course of study receive certificates of completion from ATI. The Industrial Maintenance Department worked closely with the MASTER staff, made every effort to assist the MASTER staff with research, and currently seek adoption of the recommended MASTER materials for their Industrial Maintenance students. The Industrial Maintenance Department at ATI is recognized throughout Georgia by large and small manufacturing companies as a premier source for entry-level technicians. Upon graduation, students are able to understand general operation of all machines, mechanical or electrical, conventional or computer controlled, that contribute to the manufacturing process. The curriculum has been designed to prepare students to enter the workforce as entry-level Industrial Maintenance Mechanics. Laboratory work is emphasized with actual industrial equipment in order to prepare students for interesting, rewarding work in a wide variety of industries. The Industrial Maintenance department has a unique blend of theoretical knowledge and practical application which directly corresponds to modern uses in industrial maintenance.

After many interviews with practitioners from industry and discussions with educators, managers, supervisors, and others involved with machine-related occupations (specifically industrial maintenance), the MASTER Consortium Partners have agreed to present our definition of an industrial maintenance mechanic as follows:

**INDUSTRIAL MAINTENANCE MECHANIC** - uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.
This volume contains the justification, documentation, and course syllabi for the courses which we recommend as minimum training for individuals desiring to become industrial maintenance mechanics.

The first and most important task of the MASTER program was the development of a foundation upon which all other works could be built. The MASTER Competency Profile is this foundation.
The MASTER Competency Profile

Development of Competency Profiles at each of the MASTER sites began with visits to representative companies for the purpose of surveying expert workers within the industry and occupational areas under investigation. Each site began the survey process by asking a subject matter expert in the targeted technical area, generally a member of its faculty, to employ a modified version of the generally accepted DACUM (Developing A Curriculum) method to categorize the major skills needed to work in the selected occupation. As source materials, the college instructors drew on their professional knowledge and experience of current industry requirements and trends. The initial skill standards developed by the subject matter experts underwent numerous internal reviews and revisions within each site, assuming final form as a series of structured survey and interview questions designed to elicit a simple yes or no response.

To determine an appropriate survey sample, each site compiled a database of its region's small and medium-sized manufacturers and searched for companies likely to employ workers in the targeted occupational area. The resulting cross-industry samples were sorted further to achieve a balance of technological capability and workforce size; the sample companies within each region were then asked to participate in the project. Willing respondents were scheduled for interviews.

During the company interviews, the MASTER staff asked expert workers to identify the primary duties and tasks performed by a typical worker and to consider the special skills and knowledge, traits and attitudes, and industry trends that would have an impact on worker training, employability, and performance both now and in the future. The interview results were analyzed to create individual profiles identifying the most common duties and skills required of workers at each company. These individual company Competency Profiles served two purposes. First, they showed, in a format that could be easily understood by both industries and educators, a picture of the occupational specialty at a given company at that particular time. Second, these individual company Competency Profiles furnished the company with a document over which they could claim ownership. This, in effect, made them real partners in the work of MASTER.

Data for all companies were then aggregated to develop a composite Competency Profile of industry skill standards within the selected occupational specialty area of Industrial Maintenance, as shown on the following page.

These same duties and tasks were then included in both the Texas and National Surveys for further validation. As a result of the surveys, additional refinements were made in the Competency Profiles. These changes were incorporated into the individual course syllabi which were used for the pilot program.

The MASTER Competency Profile for Industrial Maintenance Mechanic has been included on the following page.
Industrial Maintenance Mechanic Competency Profile

Job Analysis conducted and prepared by

MASTER
Machine Tool Advanced Skills Technology Educational Resources Program Consortium
<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A Practice Safety</strong></td>
<td>A-1 Use protective equipment</td>
</tr>
<tr>
<td></td>
<td>A-2 Accident prevention</td>
</tr>
<tr>
<td></td>
<td>A-3 Working aloft</td>
</tr>
<tr>
<td></td>
<td>A-4 Fire safety</td>
</tr>
<tr>
<td></td>
<td>A-5 Lifting safety</td>
</tr>
<tr>
<td></td>
<td>A-6 Lockout/tagout</td>
</tr>
<tr>
<td><strong>B Apply Mathematical Concepts</strong></td>
<td>B-1 Perform basic arithmetic functions</td>
</tr>
<tr>
<td></td>
<td>B-2 Convert fractions/decimals</td>
</tr>
<tr>
<td></td>
<td>B-3 Convert Metric/English measurements</td>
</tr>
<tr>
<td></td>
<td>B-4 Perform basic algebraic operations</td>
</tr>
<tr>
<td></td>
<td>B-5 Perform basic trigonometric functions</td>
</tr>
<tr>
<td></td>
<td>B-6 Perform basic geometric calculations</td>
</tr>
<tr>
<td><strong>C Interpret Engineering Drawings and Control Documents</strong></td>
<td>C-1 Identify basic types of drawings</td>
</tr>
<tr>
<td></td>
<td>C-2 Identify basic layout of drawings</td>
</tr>
<tr>
<td></td>
<td>C-3 Review blueprint notes and dimensions</td>
</tr>
<tr>
<td><strong>D Use Measuring Tools</strong></td>
<td>D-1 Use non-precision measuring tools</td>
</tr>
<tr>
<td></td>
<td>D-2 Use precision measuring tools</td>
</tr>
<tr>
<td><strong>E Use Hand Tools</strong></td>
<td>E-1 Identify and use maintenance technician’s hand tools</td>
</tr>
<tr>
<td></td>
<td>E-2 Identify and use hand held power tools</td>
</tr>
<tr>
<td><strong>F Operate Machine Tools</strong></td>
<td>F-1 Use and care of milling machines</td>
</tr>
<tr>
<td></td>
<td>F-2 Use and care of horizontal and vertical band saws</td>
</tr>
<tr>
<td></td>
<td>F-3 Use and care of pedestal grinder</td>
</tr>
<tr>
<td></td>
<td>F-4 Use and care of surface grinder</td>
</tr>
<tr>
<td></td>
<td>F-5 Operate lathes</td>
</tr>
<tr>
<td></td>
<td>F-6 Use and care of drill presses</td>
</tr>
</tbody>
</table>
**Industrial Maintenance Mechanic**

**Technical Workplace Competencies**

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>G</strong></td>
<td><strong>Perform Welding Operations</strong></td>
</tr>
<tr>
<td>G-1 Weld with shielded metal arc welding (SMAW) process</td>
<td>G-2 Weld/cut with oxyacetylene</td>
</tr>
<tr>
<td><strong>H</strong></td>
<td><strong>Maintain/ Troubleshoot Equipment and Systems</strong></td>
</tr>
<tr>
<td>H-1 Maintain air conditioning systems</td>
<td>H-2 Maintain pneumatic control circuits</td>
</tr>
<tr>
<td>H-5 Maintain gate, globe, ball, plug, and butterfly valves</td>
<td>H-6 Maintain check valves and relief valves</td>
</tr>
<tr>
<td>H-9 Troubleshoot, maintain, and repair pneumatic systems</td>
<td></td>
</tr>
<tr>
<td><strong>I</strong></td>
<td><strong>Repair Power Transmission Systems</strong></td>
</tr>
<tr>
<td>I-1 Maintain and troubleshoot belt drive systems</td>
<td>I-2 Maintain and troubleshoot gear power transmission drives</td>
</tr>
<tr>
<td>I-4 Maintain and troubleshoot clutches</td>
<td></td>
</tr>
<tr>
<td><strong>J</strong></td>
<td><strong>Fabricate/Install Sheet Metal Parts</strong></td>
</tr>
<tr>
<td>J-1 Layout sheet metal parts</td>
<td>J-2 Form and/or bend sheet metal parts</td>
</tr>
<tr>
<td><strong>K</strong></td>
<td><strong>Piping Operations</strong></td>
</tr>
<tr>
<td>K-1 Perform basic pipefitting calculations</td>
<td>K-2 Cut, thread, and ream pipe</td>
</tr>
<tr>
<td>K-4 Install and adjust pipe support</td>
<td>K-5 Tubing</td>
</tr>
<tr>
<td>K-7 Plastic pipe</td>
<td></td>
</tr>
<tr>
<td><strong>L</strong></td>
<td><strong>Basic Rigging</strong></td>
</tr>
<tr>
<td>L-1 Rigging fundamentals</td>
<td>L-2 Demonstrate basic rigging skills</td>
</tr>
</tbody>
</table>
# Industrial Maintenance Mechanic

## Technical Workplace Competencies

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M</strong></td>
<td><strong>N-1</strong> Perform basic word processing</td>
</tr>
<tr>
<td><strong>M</strong></td>
<td><strong>N-2</strong> Perform basic spreadsheet operations</td>
</tr>
<tr>
<td><strong>O</strong></td>
<td><strong>N-2</strong> Perform basic word processing</td>
</tr>
<tr>
<td><strong>O</strong></td>
<td><strong>N-2</strong> Perform basic spreadsheet operations</td>
</tr>
<tr>
<td><strong>P</strong></td>
<td><strong>P-1</strong> Install electrical connections</td>
</tr>
<tr>
<td><strong>P</strong></td>
<td><strong>P-2</strong> Setting and leveling</td>
</tr>
<tr>
<td><strong>Q</strong></td>
<td><strong>P-3</strong> Grouting</td>
</tr>
<tr>
<td><strong>Q</strong></td>
<td><strong>P-4</strong> Special mountings</td>
</tr>
<tr>
<td><strong>R</strong></td>
<td><strong>Q-1</strong> Use electrical test equipment</td>
</tr>
<tr>
<td><strong>R</strong></td>
<td><strong>Q-2</strong> Apply basic terms to electrical circuits</td>
</tr>
<tr>
<td><strong>R</strong></td>
<td><strong>Q-3</strong> Analyze series, parallel, and complex AC/DC circuits</td>
</tr>
<tr>
<td><strong>R</strong></td>
<td><strong>Q-4</strong> Check AC and DC motors</td>
</tr>
<tr>
<td><strong>R</strong></td>
<td><strong>Q-5</strong> Troubleshoot electrical devices</td>
</tr>
<tr>
<td><strong>S</strong></td>
<td><strong>R-1</strong> Force</td>
</tr>
<tr>
<td><strong>S</strong></td>
<td><strong>R-2</strong> Work</td>
</tr>
<tr>
<td><strong>S</strong></td>
<td><strong>R-3</strong> Mechanical motion and rate</td>
</tr>
<tr>
<td><strong>S</strong></td>
<td><strong>R-4</strong> Simple machines</td>
</tr>
<tr>
<td><strong>S</strong></td>
<td><strong>R-5</strong> Power</td>
</tr>
<tr>
<td><strong>S</strong></td>
<td><strong>S-1</strong> Fasteners and nomenclature</td>
</tr>
<tr>
<td><strong>S</strong></td>
<td><strong>S-2</strong> Application for various fasteners</td>
</tr>
<tr>
<td><strong>S</strong></td>
<td><strong>S-3</strong> Techniques for removing damaged fasteners</td>
</tr>
<tr>
<td><strong>S</strong></td>
<td><strong>S-4</strong> Cleaning and restoring threaded fasteners</td>
</tr>
<tr>
<td>Duties</td>
<td>Tasks</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>S-5 Fasteners and Preloading</td>
<td>S-5 Torque/preload theory</td>
</tr>
<tr>
<td>S-6 Effects of lubricating</td>
<td>S-6 Effects of lubricating threads prior to</td>
</tr>
<tr>
<td>S-7 Demonstrate appropriate</td>
<td>torquing</td>
</tr>
<tr>
<td>technique</td>
<td></td>
</tr>
</tbody>
</table>
Industrial Maintenance Mechanic
Skills, Traits and Trends

Skills and Knowledge
Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

Traits and Attitudes
Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientiousness
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

Tool/Equipment Proficiency
Mechanic's Tools (e.g., toolbox, wrenches, sockets, hammers, etc.)
Measuring Tools
Power Tools
Drill Presses
Power Saws
Power Drills
Hydraulic Presses
Welding Equipment (SMAW, GMAW)
Alignment/Calibration Tools
Computer
Personal Safety Equipment
Oxyacetylene Equipment
Vises
Pedestal Grinders
Pipe Threading Dies
Pipe/Conduit Bending Equipment
AC Service Equipment
Power Transmission Devices
Hydraulic Training Equipment
Electrical Testing Equipment
Air Compressor
Air Powered Tools
Rigging Equipment

Current Trends
Statistical Process Control
Composites
Laser Alignment
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
More Sophisticated Computer Controls
Hazardous Materials Handling
The MASTER Pilot Program  
Curriculum and Course Descriptions

After completing the Competency Profile for each occupational specialty area, each MASTER partner reviewed its existing curriculum against the industry-verified skill standards in order to identify a suitable foundation for new pilot training programs. Because each college had to comply with the requirements of its respective college system and appropriate state agency, the resulting pilot curricula for occupational specialty areas tended to vary in format and academic requirements (e.g., some programs were based on the semester system, others on the quarter system). Despite differences in the curricula developed at the partner colleges, each of the pilot programs was designed to achieve the following two goals mandated in the MASTER grant proposal:

Pilot Program: "Conduct a one year pilot program with 25 or more selected applicants at each college or advanced technology center to evaluate laboratory content and effectiveness, as measured by demonstrated competencies and indicators of each program area."

Student Assessment: "Identify global skills competencies of program applicants both at point of entrance and point of exit for entry-level and already-employed technicians."

(Note: Not all occupational specialty areas were pilot-tested at all Development Centers; however, all partner colleges conducted one or more pilot programs.)

Included on the following page is the curriculum listing for the pilot program which was used to validate course syllabi for this occupational specialty area. The curriculum also shows the number of hours assigned to each of the courses (lecture, laboratory and credit hours). Also included is a description of each of the courses.
MASTER Curriculum  
**INDUSTRIAL MAINTENANCE**  
(One Year Certificate Program)

**FIRST QUARTER***

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>LEC</th>
<th>LAB</th>
<th>CR</th>
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<tbody>
<tr>
<td>MATH 103</td>
<td>Algebraic Concepts</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>ELC 106</td>
<td>Direct Current Circuits I</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>IMM 101</td>
<td>Industrial Maintenance Safety Procedures</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>IMM 108</td>
<td>Industrial Mechanics I</td>
<td>5</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>CMP 101</td>
<td>Introduction to Microcomputers</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16</td>
<td>12</td>
<td>21</td>
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**SECOND QUARTER***

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<th>Title</th>
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<th>LAB</th>
<th>CR</th>
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<tr>
<td>ENGL 101</td>
<td>English</td>
<td>5</td>
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<td>5</td>
</tr>
<tr>
<td>ELC 109</td>
<td>Alternating Current I</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>ELC 110</td>
<td>Alternating Current II</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>IMM 128</td>
<td>Pumps &amp; Piping Systems</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>IMM 113</td>
<td>Industrial Hydraulics</td>
<td>6</td>
<td>4</td>
<td>8</td>
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<tr>
<td></td>
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<td>18</td>
<td>12</td>
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</table>

**THIRD QUARTER***

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<th>Title</th>
<th>LEC</th>
<th>LAB</th>
<th>CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSY 100</td>
<td>Interpersonal Relations and Professional</td>
<td>3</td>
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<td>IMM 110</td>
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<td>3</td>
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<td>IMM 115</td>
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**FOURTH QUARTER***

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<td>WLD 133</td>
<td>Metal Welding and Cutting Techniques</td>
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<td>IMM 109</td>
<td>Lathe Operations I</td>
<td>4</td>
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<td>IMM 133</td>
<td>Industrial Maintenance-Mechanical Review</td>
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*Each quarter is 10 weeks in length.
# First Quarter

**MATH 103** Algebraic Concepts (5-0-5) Introduces concepts and operations which can be applied to the study of algebra. Topics include: use of variables, manipulation of algebraic expressions, solution of linear and quadratic equations, evaluation and graphing of linear and quadratic functions, and solution of systems of linear equations. Class includes lecture, applications, and homework to reinforce learning. (Prerequisite: MATH 098, Pre-Algebra, or entrance math score)

**ELC 106** Direct Current Circuits I (3-2-4) Introduces direct current (DC) concepts and applications. Topics include: fundamental electrical principles and laws; direct current test equipment; series, parallel, and combination circuits; and basic laboratory procedures and safety practices. (Prerequisites: MATH 103, Algebraic Concepts)

**IMM 101** Industrial Maintenance Safety Procedures (2-1-2) Provides an in-depth study of the health and safety practices required for maintaining industrial production equipment. Topics include: traffic safety, ladder safety, fire safety, safe work in confined spaces, electrical safety, emergency procedures, an introduction to OSHA regulations, MSDS Right-To-Know Law, hazardous materials safety, and safety equipment.

**IMM 108** Industrial Mechanics I (5-5-7) Provides instruction in those basic physics concepts which are applicable to mechanics of industrial production equipment; teaches basic industrial application of mechanical principles with emphasis on power transmission and specific mechanical components. Topics include: mechanical tools, fasteners, basic mechanics, lubrication, bearings, and packings and seals.

**CMP 101** Introduction to Microcomputers (1-4-3) Introduces fundamental concepts and operations necessary to utilize microcomputers. Emphasis is placed on basic functions and familiarity with computer use. Topics include: computer terminology; computer operating systems; data storage; file management; equipment care and operation; and an introduction to work processing, database, and spreadsheet application. (Prerequisite: Provisional admission)

# Second Quarter

**ENGL 101** English (5-0-5) Emphasizes the development and improvement of written and oral communication abilities. Topics include: analysis of writing techniques used in selected readings, writing practice, editing and proofreading, research skills, and oral presentation skills. Homework assignments reinforce classroom learning. (Prerequisite: ENGL 097, English III and RAG 097, Reading III, or the equivalent)
ELC 109 Alternating Current I (3-2-4) Introduces the theory and application of varying sine wave voltages and current. Topics include: AC wave generation, oscilloscope operation, inductance, and capacitance. (Prerequisites/Corequisite: ELC 108, Direct Current Circuits, II, MATH 104, Geometry and Trigonometry, or MATH 105, Trigonometry)

ELC 110 Alternating Current II (3-2-4) Continues development of AC concepts with emphasis on constructing, verifying, and troubleshooting reactive circuits using RLC theory and oscilloscopes. Topics include: simple RLC circuits, AC circuit resonance, passive filters, transformer theory and applications, and non-sinusoidal wave forms. (Prerequisite/Corequisite: ELC 109, Alternating Current II)

IMM 128 Pumps and Piping Systems (1-4-2) Provides instruction in the operation of industrial pumps, valves, and piping/delivery systems with emphasis on installation procedures, maintenance and repair. Topics include: pump identification, pump operation, pump installation, maintenance, troubleshooting, piping systems, and installation and repair of piping systems.

IMM 113 Industrial Hydraulics (6-4-8) Provides instruction in fundamental concepts and theories for the safe operation of hydraulic components and systems. Topics include: hydraulic theory, suction side of pumps, actuators, valves, pumps/motors, accumulators, symbols and circuitry, types of fluids, filters, servicing safety, preventative maintenance, and troubleshooting.

Third Quarter

PSY 100 Interpersonal Relations and Professional Development (3-0-3) Provides a study of human relations and professional development in today's rapidly changing world to prepare students for living and working in a complex society. Topics include: personal skills required for an understanding of self and others; projecting a professional image; job acquisition skills such as conducting a job search, interviewing techniques, job applications, and resume preparation; and desirable job performance skills and attitudes necessary for job retention and advancement. (Prerequisite: Provisional admission)

IMM 110 Industrial Mechanics II (3-7-6) Continues the application of mechanical principles to industrial production equipment with emphasis on power transmission and mechanical components. Emphasis is placed on alignment and tension. Topics include: mechanical drive systems, couplings and alignment, clutches and brakes, linkage and levers, mechanical troubleshooting, and preventative maintenance.

IMM 115 Industrial Pneumatics (3-2-4) Provides instruction in fundamental concepts and theories for the safe operation of pneumatic components and systems. Topics include: pneumatic theory, preventative maintenance, compressors, regulators, pneumatic valves, actuators, servicing safety, and troubleshooting.
IMM 100  Refrigeration Fundamentals (3-2-4) Introduces basic concepts and theories of refrigeration. Topics include: the laws of thermodynamics, pressure and temperature relationships, heat transfer, the refrigeration cycle, and safety.

Fourth Quarter

WLD 133  Metal Welding and Cutting Techniques (2-3-3) Provides instruction in the fundamental use of the electric arc welder and the oxyacetylene cutting outfit. Emphasis is placed on safe setup and use of equipment. Topics include: safety practices, arc welding equipment and setup, oxyfuel welding, flame cutting equipment and setup, and welding and cutting procedures. (Prerequisite: Provisional admission)

IMM 109  Lathe Operations I (4-6-7) Provides opportunities for students to develop skill in the use of bench grinders and lathes. Topics include: lathes, bench grinders, bench grinder operations, lathe calculations, lathe setup, and lathe operations. (Prerequisite: Provisional admission)

IMM 133  Industrial Maintenance-Mechanical Review (1-4-3) Summarizes and integrates all previous CMP, ELC, and IMM courses to assist Industrial Maintenance Technology students in assembly, troubleshooting, and repair of multi-system machinery and devices. Topics include: electrical, mechanical, and fluidic interfacing in complex and industrial equipment.
The MASTER
Technical Workplace Competencies
and
Course Crosswalk

After development of appropriate curricula for the pilot programs, each MASTER college began to develop individual course outlines for its assigned specialty area. The skill standards identified in the Competency Profile were cross walked against the technical competencies of the courses in the pilot curriculum. The resulting matrix provided a valuable tool for assessing whether current course content was sufficient or needed to be modified to ensure mastery of entry-level technical competencies. Exit proficiency levels for each of the technical competencies were further validated through industry wide surveys both in Texas and across the nation.

The Technical Workplace Competencies and Course Crosswalk on the following pages presents the match between industry—identified duties and tasks and the pilot curriculum for Industrial Maintenance. Course titles are shown in columns; duties and tasks, in rows. The Exit Proficiency Level Scale (see Figure 1), an ascending scale with 5 as the highest level of proficiency, includes marked boxes indicating whether the task is covered by the instructor during the course; the numbers 1–5 indicate the degree of attention given to the task and the corresponding proficiency expected on the part of the student upon completion of the course of studies. The crosswalk is intended to serve as an aide to other instructional designers and faculty in community college programs across the nation.

<table>
<thead>
<tr>
<th>Technical Workplace Competency</th>
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<tr>
<td>Rarely</td>
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<td>Routinely with Supervision</td>
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<td>Routinely with Limited Supervision</td>
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<td>Routinely Without Supervision</td>
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<td>Initiates/Improves/Modifies and Supervises Others</td>
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Figure 1

Included on the following pages is the Technical Workplace Competencies and Course Crosswalk for the pilot program curriculum. This crosswalk validates the fact that the duties and tasks which were identified by industry as being necessary for entry-level employees have been incorporated into the development of the course syllabi.
### A. PRACTICE SAFETY

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<tbody>
<tr>
<td>A-1 Use Protective Equipment</td>
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<td>A-2 Accident Prevention</td>
<td>I R I R R R R R R R R R R</td>
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<td>A-3 Working Afloat</td>
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<td>A-4 Fire Safety</td>
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<td>A-5 Lifting Safety</td>
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<td>A-6 Lockout/Tagout</td>
<td>I M I R R R R R R R R R M</td>
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### B. APPLY MATHEMATICAL CONCEPTS

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<td>B-2 Convert Fractions/Decimals</td>
<td>I I I R R R R R R R R R</td>
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<td>B-3 Convert Metric/English Measurements</td>
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<td>B-4 Perform Basic Algebraic Operations</td>
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<td>B-6 Perform Basic Geometric Calculations</td>
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### C. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS

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<td>C-1 Identify Basic Types of Drawings</td>
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<td>C-2 Identify Basic Layout of Drawings</td>
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<td>C-3 Review Blueprint Notes and Dimensions</td>
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### D. USE MEASURING TOOLS

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<td>D-1 Use Non-Precision Measuring Tools</td>
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<td>D-2 Use Precision Measuring Tools</td>
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### E. USE HAND TOOLS

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<td>E-2 Identify and Use Hand Held Power Tools</td>
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**Note:**
- I = Introduced and Taught
- R = Repeated and Reinforced
- M = Mastered

**BEST COPY AVAILABLE:** 24
### F. OPERATE MACHINE TOOLS

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<tbody>
<tr>
<td>F-1 Use and Care of Milling Machines</td>
<td>I R</td>
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<tr>
<td>F-2 Use and Care of Horizontal and Vertical Band Saws</td>
<td>I R</td>
<td></td>
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<tr>
<td>F-3 Use and Care of Pedestal Grinder</td>
<td>I R</td>
<td></td>
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<tr>
<td>F-4 Use and Care of Surface Grinder</td>
<td>I R</td>
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<tr>
<td>F-5 Operate Lathes</td>
<td>I R</td>
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<tr>
<td>F-6 Use and Care of Drill Presses</td>
<td>I R</td>
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### G. PERFORM WELDING OPERATIONS

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<tr>
<td>G-1 Weld With Shielded Metal Arc Welding (SMAW) Process</td>
<td>I R</td>
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<td>G-2 Weld/Cut With Oxyacetylene</td>
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<tr>
<td>G-3 Perform Gas Soldering</td>
<td>I R</td>
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### H. MAINTAIN/TROUBLESHOOT EQUIPMENT AND SYSTEMS

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<tr>
<td>H-1 Maintain Air Conditioning Systems</td>
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<tr>
<td>H-2 Maintain Pneumatic Control Circuits</td>
<td>I R</td>
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<td></td>
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<tr>
<td>H-3 Troubleshoot Centrifugal Pumps</td>
<td>I R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>H-4 Troubleshoot Positive Displacement Pumps</td>
<td>I R</td>
<td>R</td>
<td>R</td>
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<tr>
<td>H-5 Maintain Gate, Globe, Ball, Plug, and Butterfly Valves</td>
<td>I R R R R</td>
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<tr>
<td>H-6 Maintain Check Valves and Relief Valves</td>
<td>I R R R M</td>
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<tr>
<td>H-7 Troubleshoot and Repair Blowers</td>
<td>I R R R R R R</td>
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<tr>
<td>H-8 Troubleshoot, Maintain, and Repair Hydraulic Systems</td>
<td>I R R R</td>
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<tr>
<td>H-9 Troubleshoot, Maintain, and Repair Pneumatic Systems</td>
<td>I R R R</td>
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### I. REPAIR POWER TRANSMISSION SYSTEMS

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<tr>
<td>I-1 Maintain and Troubleshoot Belt Drive Systems</td>
<td>I R M</td>
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<tr>
<td>I-2 Maintain and Troubleshoot Gear Power Transmission Drives</td>
<td>I R M</td>
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<tr>
<td>I-3 Maintain and Troubleshoot Chain Power Transmission Drives</td>
<td>I R M</td>
<td></td>
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<tr>
<td>I-4 Maintain and Troubleshoot Clutches</td>
<td>I R</td>
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</table>
### J. FABRICATE/INSTALL SHEET METAL PARTS

| J-1 Layout Sheet Metal Parts | I | R | R | M | 4 |
| J-2 Form and/or Bend Sheet Metal Parts | I | R | R | M | 4 |
| J-3 Fasten Sheet Metal Parts Together | I | R | R | M | 4 |

### K. PIPING OPERATIONS

| K-1 Perform Basic Pipefitting Calculations | I | R | R | M | 4 |
| K-2 Cut, Thread, and Ream Pipe | I | R | R | M | 4 |
| K-3 Pipe Assembly | I | R | R | M | 4 |
| K-4 Install and Adjust Pipe Support | I | R | R | M | 4 |
| K-5 Tubing | I | R | R | M | 4 |
| K-6 Fittings | I | R | R | M | 4 |
| K-7 Plastic Pipe | I | R | R | M | 4 |

### L. BASIC RIGGING

| L-1 Rigging Fundamentals | I | R | R | M | 4 |
| L-2 Demonstrate Basic Rigging Skills | I | R | R | M | 4 |

### M. BEARING MAINTENANCE

| M-1 Plain Bearings | I | R | R | R | M | 4 |
| M-2 Rolling Element Bearings | I | R | R | R | M | 4 |

### N. USE COMPUTERS

| N-1 Perform Basic Word Processing | I | R | R | 2 |
| N-2 Perform Basic Spreadsheet Operations | I | R | R | 2 |

### O. ALIGN SHAFTS

| O-1 Principles of Alignment | I | R | R | M | 4 |
| O-2 Methods of Alignment | I | R | R | M | 4 |
### INDUSTRIAL MAINTENANCE TECHNOLOGY

#### Technical Workplace Competencies and Course Crosswalk

#### P. INSTALL/ALIGN MACHINES

| Task                           | Algebra-Geometric | Direct Current | Indirect Current | Intro to Electronics | Industrial Mechanics I | Industrial Mechanics II | Altering Current I | Altering Current II | Pumps & Fluid Systems | Industrial Hydraulics | Industrial Pneumatics | Refining/Petro-Engle | Metal Working/Cutting | Machining | Drafting | Review |
|--------------------------------|-------------------|---------------|------------------|----------------------|------------------------|------------------------|---------------------|---------------------|----------------------|----------------------|---------------------|----------------------|----------------------|----------------------|
| P-1 Install Electrical Connections | I                  | R             | R                | R                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| P-2 Setting and Leveling       | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| P-3 Grouting                    | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| P-4 Special Mountings           | I                  | R             | R                | R                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |

#### Q. MAINTAIN ELECTRICAL DEVICES

| Task                           | Algebra-Geometric | Direct Current | Indirect Current | Intro to Electronics | Industrial Mechanics I | Industrial Mechanics II | Altering Current I | Altering Current II | Pumps & Fluid Systems | Industrial Hydraulics | Industrial Pneumatics | Refining/Petro-Engle | Metal Working/Cutting | Machining | Drafting | Review |
|--------------------------------|-------------------|---------------|------------------|----------------------|------------------------|------------------------|---------------------|---------------------|----------------------|----------------------|---------------------|----------------------|----------------------|----------------------|
| Q-1 Use Electrical Test Equipment | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| Q-2 Apply Basic Terms to Electrical Circuits | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| Q-3 Analyze Series, Parallel, and Complex AC/DC Circuits | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| Q-4 Check AC and DC Motors     | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| Q-5 Troubleshoot Electrical Devices | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |

#### R. BASIC MECHANICAL CONCEPTS

| Task                           | Algebra-Geometric | Direct Current | Indirect Current | Intro to Electronics | Industrial Mechanics I | Industrial Mechanics II | Altering Current I | Altering Current II | Pumps & Fluid Systems | Industrial Hydraulics | Industrial Pneumatics | Refining/Petro-Engle | Metal Working/Cutting | Machining | Drafting | Review |
|--------------------------------|-------------------|---------------|------------------|----------------------|------------------------|------------------------|---------------------|---------------------|----------------------|----------------------|---------------------|----------------------|----------------------|----------------------|
| R-1 Force                       | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| R-2 Work                        | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| R-3 Mechanical Motion and Rate   | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| R-4 Simple Machines             | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| R-5 Power                       | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |

#### S. FASTENERS AND PRELOADING

| Task                           | Algebra-Geometric | Direct Current | Indirect Current | Intro to Electronics | Industrial Mechanics I | Industrial Mechanics II | Altering Current I | Altering Current II | Pumps & Fluid Systems | Industrial Hydraulics | Industrial Pneumatics | Refining/Petro-Engle | Metal Working/Cutting | Machining | Drafting | Review |
|--------------------------------|-------------------|---------------|------------------|----------------------|------------------------|------------------------|---------------------|---------------------|----------------------|----------------------|---------------------|----------------------|----------------------|----------------------|
| S-1 Fasteners and Nomenclature | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| S-2 Application for Various Fasteners | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| S-3 Techniques for Removing Damaged Fasteners | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| S-4 Cleaning and Restoring Threaded Fasteners | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| S-5 Torque/Preload Theory       | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| S-6 Effects of Lubricating Threads Prior to Torquing | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
| S-7 Demonstrate Appropriate Torquing Technique | I                  | R             | R                | M                    | M                      | M                      | M                   | M                   | M                    | M                    | M                   | M                    | M                    | M                    |
The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" the following five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance:

**COMPETENCIES:**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resources</td>
<td>Identifies, organizes, plans, and allocates resources</td>
</tr>
<tr>
<td>Interpersonal</td>
<td>Works with others</td>
</tr>
<tr>
<td>Information</td>
<td>Acquires and uses information</td>
</tr>
<tr>
<td>Systems</td>
<td>Understands complex inter-relationships</td>
</tr>
<tr>
<td>Technology</td>
<td>Works with a variety of technologies</td>
</tr>
</tbody>
</table>

**FOUNDATION SKILLS:**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Skills</td>
<td>Reads, writes, performs arithmetic and mathematical operations, listens, and speaks well</td>
</tr>
<tr>
<td>Thinking Skills</td>
<td>Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn, and reasons</td>
</tr>
<tr>
<td>Personal Qualities</td>
<td>Displays responsibility, self-esteem, sociability, self-management, integrity, and honesty</td>
</tr>
</tbody>
</table>

Recognizing the value of SCANS proficiencies to job performance as well as the growing mandate in many states to include SCANS activities in course curricula, MASTER asked survey respondents to review the SCANS skill sets in the context of the draft skill standards for each occupational specialty area. MASTER also incorporated an evaluation of SCANS competencies and foundation skills into its assessment of the pilot training curricula. The results were summarized in a crosswalk that allowed the MASTER staff to modify course contents where needed to strengthen the achievement of SCANS competencies.

As soft skills, the SCANS competencies are inherently difficult to quantify. MASTER realizes that some faculty will emphasize the SCANS more or less than others. In time, faculty will learn to make these types of SCANS activities an integral and important part of the teaching process.
# MASTER Curriculum
## INDUSTRIAL MAINTENANCE
(One Year Certificate Program)

### FIRST QUARTER*

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>LEC</th>
<th>LAB</th>
<th>CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 103</td>
<td>Algebraic Concepts</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>ELC 106</td>
<td>Direct Current Circuits I</td>
<td>3</td>
<td>2</td>
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<tr>
<td>IMM 101</td>
<td>Industrial Maintenance Safety Procedures</td>
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<td>IMM 108</td>
<td>Industrial Mechanics I</td>
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<tr>
<td>CMP 101</td>
<td>Introduction to Microcomputers</td>
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<td>4</td>
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### SECOND QUARTER*

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<td>ENGL 101</td>
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<td>ELC 109</td>
<td>Alternating Current I</td>
<td>3</td>
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<td>4</td>
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<tr>
<td>ELC 110</td>
<td>Alternating Current II</td>
<td>3</td>
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<tr>
<td>IMM 128</td>
<td>Pumps &amp; Piping Systems</td>
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<td>4</td>
<td>2</td>
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<tr>
<td>IMM 113</td>
<td>Industrial Hydraulics</td>
<td>6</td>
<td>4</td>
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### THIRD QUARTER*

<table>
<thead>
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<tr>
<td>PSY 100</td>
<td>Interpersonal Relations and Professional Development</td>
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<tr>
<td>IMM 110</td>
<td>Industrial Mechanics II</td>
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<td>7</td>
<td>6</td>
</tr>
<tr>
<td>IMM 115</td>
<td>Industrial Pneumatics</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>IMM 100</td>
<td>Refrigeration Fundamentals</td>
<td>3</td>
<td>2</td>
<td>4</td>
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<tr>
<td>XXX ###</td>
<td>Elective</td>
<td>-</td>
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### FOURTH QUARTER*

<table>
<thead>
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<th>Course Title</th>
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<tr>
<td>WLD 133</td>
<td>Metal Welding and Cutting Techniques</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>IMM 109</td>
<td>Lathe Operations I</td>
<td>4</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>IMM 133</td>
<td>Industrial Maintenance-Mechanical Review</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>XXX ###</td>
<td>Elective</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
</tbody>
</table>

*Each quarter is 10 weeks in length.
MATH 103
MASTER PROGRAM
Algebraic Concepts
COURSE SYLLABUS

Total lecture hours: 50 Total lab hours: 0 Credit hours: 5

COURSE DESCRIPTION:

Introduces concepts and operations which can be applied to the study of algebra. Topics include: use of variables, manipulation of algebraic expressions, solution of linear and quadratic equations, evaluation and graphing of linear and quadratic functions, and solution of systems of linear equations. Class includes lecture, applications, and homework to reinforce learning.

PREREQUISITE: Pre-Algebra, or entrance math scores in accordance with approved DTAE admission score levels

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:
1. Basic mathematical concepts;
2. Basic algebraic concepts; and,
3. Intermediate algebraic concepts.

REQUIRED COURSE MATERIALS:


Materials: Scientific calculator
Graph paper
Pencils
Straight edge

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and discussions.
Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Satisfactorily perform on written, oral, and practical examinations;
2. Satisfactorily perform on outside assignments including writing assignments;
3. Contribute to class discussions; and,
4. Maintain attendance per current policy.

LECTURE OUTLINE:

<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Contact Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arithmetic Operations and Order of Operations</td>
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</tr>
<tr>
<td>Units of Measurement and Approximate Numbers</td>
<td></td>
</tr>
<tr>
<td>Signed numbers</td>
<td></td>
</tr>
<tr>
<td>TEST 1</td>
<td></td>
</tr>
<tr>
<td>Exponents, Roots, and Radicals</td>
<td></td>
</tr>
<tr>
<td>Introduction to Algebra, Simple Equations and Inequalities</td>
<td></td>
</tr>
<tr>
<td>Basic Algebraic Operations</td>
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<tr>
<td>TEST 2</td>
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<tr>
<td>Factoring</td>
<td></td>
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<tr>
<td>Algebraic Operations</td>
<td></td>
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<tr>
<td>Quadratic Equations</td>
<td></td>
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<tr>
<td>TEST 3</td>
<td></td>
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<tr>
<td>Graphs</td>
<td></td>
</tr>
<tr>
<td>Simultaneous Linear Equations</td>
<td></td>
</tr>
<tr>
<td>TEST 5</td>
<td></td>
</tr>
<tr>
<td>FINAL EXAM - Cumulative</td>
<td></td>
</tr>
</tbody>
</table>

Total Lecture Hours 50

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."
The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. Resources: Identifies, organizes, plans, and allocates resources
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   B. Interpersonal: Works with others
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.
      5. Negotiates resources in order to accomplish objectives
      6. Works well with all members of the class
   C. Information: Acquires and uses information
      1. Acquires and evaluates information
      2. Organizes and maintains information
      3. Interprets and communicates information
   D. Systems: Understands complex inter-relationships
      1. Understands and works well with social, organizational, and technological systems
      2. Monitors and corrects performance of system during operation
      3. Recommends modifications to system to improve performance
   E. Technology: Works with a variety of technologies
      1. Chooses relevant procedures, tools, and equipment
      2. Applies appropriate procedures and techniques to accomplish tasks
      3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
   A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks
      I. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
         a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect
a sequence, locate answers, find facts, and infer from written texts
b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques
a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. Demonstrates ability to understand and perform multi-step computations
d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. Listening: Receives, attends to, interprets, and responds to verbal messages and other cues
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

5. Speaking: Organizes ideas and communicates orally
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and/or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. **Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions

2. **Problem Solving:** Recognizes problems and devises and implements plan of action
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. **Seeing Things In the Mind’s Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual
imagery and meet safety requirements for necessary machinery

b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. Demonstrates ability to visually discriminate in gross and fine imagery
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied tasks

4. Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills
a. Demonstrates mastery of basic reading, math, and language skills through application
b. Demonstrates ability to translate abstract theory into practical application
c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
d. Demonstrates knowledge of good study skills and learning habits

5. Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem
a. Demonstrates use of simple logic
b. Demonstrates ability to distinguish relationships
c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. Personal Qualities: Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. Responsibility: Exerts a high level of effort and perseveres towards goal attainment
a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time

e. Demonstrates maturity to take responsibility for actions

f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. **Self-Esteem:** Believes in own self-worth and maintains a positive view of self

   a. Presents a positive attitude toward tasks

   b. Demonstrates ability to separate work and personal behaviors

   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors

   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors

   e. Demonstrates ability to accept and use constructive criticism

   f. Accepts positive reinforcement in an appropriate manner

3. **Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings

   a. Demonstrates appropriate and acceptable social behaviors in interactions

   b. Demonstrates ability to work cooperatively in individual, team, or group situations

   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner

   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. **Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control

   a. Accepts personal strengths and weaknesses and uses the same for positive advancement

   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner

   c. Demonstrates ability to formulate and follow personal schedules

   d. Demonstrates ability to wisely use classroom time

   e. Demonstrates use of good study habits and skills

   f. Demonstrates maturity to take responsibility for own actions

5. **Integrity/Honesty:** Chooses ethical courses of action
a. Knows and demonstrates ability to distinguish between positive and negative behaviors
b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   IMM-B1 through IMM-B2; and,
   IMM-B4.
COURSE SYLLABUS

Total lecture hours: 30  Total lab hours: 20  Credit hours: 4

COURSE DESCRIPTION:

Introduces direct current (DC) concepts and applications. Topics include: fundamental electrical principles and laws; direct current test equipment; series, parallel, and combination circuits; and basic laboratory and safety practices.

PREREQUISITE:  Algebraic Concepts

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:
1. Electrical principles and laws;
2. DC test equipment;
3. Series, parallel, and combination circuits; and,
4. Laboratory procedures and safety practices.

REQUIRED COURSE MATERIALS:


Hand Tools/Quantity Required:
- Calculator
- Tool box
- Volt-Ohm meter
- Safety shoes
- Classroom supplies
- Safety glasses

METHODS OF INSTRUCTION:

Lecture:  Didactic presentations will include lecture and demonstrations.

Laboratory:  Laboratory will be a hands-on process.
Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Contact Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review Basic Math</td>
<td>3</td>
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<tr>
<td>Electron Theory and Ohm's Law</td>
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<td>Energy and Power</td>
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<td>Circuits, Symbols and Diagrams</td>
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<td>Measuring Electricity</td>
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<td>Series Circuits</td>
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<td>Parallel Circuits</td>
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<td>Test 4</td>
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<td>Series-Parallel Circuits</td>
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<td>Unit 10 Review</td>
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<td>Conductors and Wire Sizes</td>
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<td>Voltage Drop</td>
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<td>Test 6</td>
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<td>Batteries; Magnetics</td>
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<td>Unit 15 Review</td>
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<td>Test 7</td>
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<td>DC Motors - Shunt, Series</td>
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<td>Test 8</td>
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<td>DC Motors - Compound</td>
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<td>Test 9</td>
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<td>Unit 20</td>
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<td>Final Review; Final Exam</td>
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Total Lecture Hours 30
LAB OUTLINE:

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<tr>
<th>Lab Topics</th>
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<tr>
<td>Ohm's Law Problems</td>
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<td>Circuit with Source and Load</td>
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<tr>
<td>Series Circuits-Build and Measure Voltages and Circuits</td>
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<tr>
<td>Parallel Circuits-Build and Measure, Voltages and Currents</td>
<td>2</td>
</tr>
<tr>
<td>Series-Parallel Circuit-Build and Measure, Voltages and Currents</td>
<td>2</td>
</tr>
<tr>
<td>Voltage Drop Circuit</td>
<td>2</td>
</tr>
<tr>
<td>Charge and Test Battery</td>
<td>2</td>
</tr>
<tr>
<td>Wire and Run Shunt and Series Motor</td>
<td>2</td>
</tr>
<tr>
<td>Wire and Run Compound Motor</td>
<td>2</td>
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<tr>
<td>Complete all Labs</td>
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<td><strong>Total Lab Hours</strong></td>
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COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its “AMERICA 2000 REPORT” that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from “What Work Requires of Schools: A SCANS Report for America 2000.”

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   
   A. **Resources:** Identifies, organizes, plans, and allocates resources
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback

   B. **Interpersonal:** Works with others
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. Information: Acquires and uses information
1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. Systems: Understands complex inter-relationships
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks
   I. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
      e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. **Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. **Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
b. Demonstrates ability to hear, comprehend, and appropriately follow directions

c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately

e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. Speaking: Organizes ideas and communicates orally

a. Demonstrates appropriate listening and speaking skills in personal conversations

b. Demonstrates ability to choose and organize appropriate words to effectively communicate

c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation

d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and/or assessment purposes

e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups

f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations

g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative

a. Demonstrates ability to objectively assess personal strengths and weaknesses

b. Demonstrates ability to set realistic short-term and long-term goals

c. Demonstrates ability to recognize and distinguish between positive and negative alternatives

d. Demonstrates ability to identify potential pitfalls and take evasive actions

e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives

g. Demonstrates maturity in taking responsibility for decisions

2. **Problem Solving:** Recognizes problems and devises and implements plan of action
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. **Seeing Things In the Mind’s Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. **Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. **Reasoning:** Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. **Responsibility:** Exerts a high level of effort and perseveres towards goal attainment
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. **Self-Esteem:** Believes in own self-worth and maintains a positive view of self
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. **Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. **Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. **Integrity/Honesty:** Chooses ethical courses of action
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

**Appropriate Reference Materials:**

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B4;
   IMM-E1 through IMM-E2;
   IMM-P1; and
   IMM-Q1 through IMM-Q5.
TOTAL LECTURE HOURS: 20     TOTAL LAB HOURS: 10     CREDIT HOURS: 2

COURSE DESCRIPTION:

Provides an in-depth study of the health and safety practices required for maintaining industrial production equipment. Topics include: traffic safety, ladder safety, fire safety, safe work in confined spaces, electrical safety, emergency procedures, an introduction to OSHA regulations, MSDS Right-To-Know Law, hazardous materials safety, and safety equipment.

PREREQUISITE: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:
1. Traffic safety;
2. Ladder safety;
3. Fire safety;
4. Safe work in confined spaces;
5. Electrical safety;
6. Emergency procedures
7. Introduction to OSHA regulations;
8. MSDS Right-to-Know Law and hazardous materials safety; and,
9. Safety equipment.

REQUIRED COURSE MATERIALS:


Hand Tools/Quantity Required:
- Safety Glasses 1 pair
- Classroom Supplies 1
- Calculator 1
METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:
1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

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<td>Information Sheet 100-1 Safety First</td>
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<tr>
<td>Introduction to Safety</td>
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<td>Video 101-1 - “Introduction to Safety”</td>
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<td>Video 101-3 - “Government Safety Regulations”</td>
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<td>Video 101-4 - “OSHA Permit-Required Confined Spaces”</td>
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<td>Video 101-5 - “Personal Protective Equipment”</td>
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<td>Video 101-6 - “Selection and Use of Personal Protective Equipment”</td>
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<td>Video 101-7 - “Eye Care and Safety”</td>
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Chemical Safety 2
Tool Safety
Video 101-8 - “Hand & Power Tool Safety”
Safe Material Handling
TEST FOUR, FIVE, SIX
Review all lesson material 2
MIDTERM EXAM
Machine Safety
Video 101-19 - “Lock-Out and Tag-Out”
Lab 4
TEST SEVEN
Electrical Safety 2
Video 101-17 - “Our Invisible Friend - Electricity”
Video 101-18 - “Electricity Safety”
Electrical Protection
Lab 5
TESTS EIGHT AND NINE
Fire Protection 2
Video 101-20 - “Fire Protection”
Handout 101-2 - Types of Fire Extinguishers
Lab 6
TEST TEN
Health Protection 2
Video 101-9 - “Hand, Wrist and Finger Safety”
Video 101-13 - “Back Care and Safety”
Lab 7
TEST ELEVEN
Safe Work Practices 2
Video 101-10 - “Working Safely”
Video 101-2 - “Safety Attitudes and Practices”
Lab 8
TEST TWELVE
Complete all assignments 2
Review all lessons
FINAL EXAM

Total Lecture Hours 20
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Total Lab Hours 10

COURSE OBJECTIVES: SCANS COMPETENCIES

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The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. **Resources**: Identifies, organizes, plans, and allocates resources
   1. Allocates time to complete assigned tasks on schedule
   2. Determines and allocates required materials and resources for meeting objectives
   3. Evaluates skills, performance, and quality of work and provides feedback

B. **Interpersonal**: Works with others
   1. Participates as a member of the team, contributing to group effort
   2. Provides individual assistance/direction to peers as requested
   3. Determines and meets expectations
   4. Exercises leadership qualities to effectively communicate ideas and make decisions.
   5. Negotiates resources in order to accomplish objectives
   6. Works well with all members of the class
C. **Information: Acquires and uses information**
   1. Acquires and evaluates information
   2. Organizes and maintains information
   3. Interprets and communicates information

D. **Systems: Understands complex inter-relationships**
   1. Understands and works well with social, organizational, and technological systems
   2. Monitors and corrects performance of system during operation
   3. Recommends modifications to system to improve performance

E. **Technology: Works with a variety of technologies**
   1. Chooses relevant procedures, tools, and equipment
   2. Applies appropriate procedures and techniques to accomplish tasks
   3. Identifies or solves problems to maintain equipment

II. **FOUNDATION SKILLS**

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
   1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
      e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
   2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
      a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted
grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. **Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques

   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems

   c. Demonstrates ability to understand and perform multi-step computations

   d. Demonstrates ability to read, interpret, and use standard measuring devices

   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively

   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. **Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues

   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery

   b. Demonstrates ability to hear, comprehend, and appropriately follow directions

   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately

e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. **Speaking:** Organizes ideas and communicates orally

   a. Demonstrates appropriate listening and speaking skills in personal conversations

   b. Demonstrates ability to choose and organize appropriate words to effectively communicate

   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation

   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and/or assessment purposes

   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups

   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations

   g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

   1. **Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative

      a. Demonstrates ability to objectively assess personal strengths and weaknesses

      b. Demonstrates ability to set realistic short-term and long-term goals

      c. Demonstrates ability to recognize and distinguish between positive and negative alternatives

      d. Demonstrates ability to identify potential pitfalls and take evasive actions

      e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response

      f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives

      g. Demonstrates maturity in taking responsibility for decisions
2. **Problem Solving**: Recognizes problems and devises and implements plan of action
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. **Seeing Things In the Mind’s Eye**: Organizes, and processes symbols, pictures, graphs, objects, and other information
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. **Knowing How to Learn**: Use efficient learning techniques to acquire and apply new knowledge and skills
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. **Reasoning**: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. **Responsibility:** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. **Self-Esteem:** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner

3. **Sociability:** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. **Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
d. Demonstrates ability to wisely use classroom time
e. Demonstrates use of good study habits and skills
f. Demonstrates maturity to take responsibility for own actions

5. **Integrity/Honesty:** Chooses ethical courses of action
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

**Appropriate Reference Materials:**

1. MASTER Technical Modules:
MASTER PROGRAM
Industrial Mechanics I
COURSE SYLLABUS

Total lecture hours: 50      Total lab hours: 50      Credit hours: 7

COURSE DESCRIPTION:

Provides instruction in those basic physics concepts which are applicable to mechanics of industrial production equipment; teaches basic industrial application of mechanical principles with emphasis on power transmission and specific mechanical components. Topics include: mechanical tools, fasteners, basic mechanics, lubrication, bearings, and packings and seals.

PREREQUISITE:        NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Mechanical tools;
2. Fasteners;
3. Basic mechanics;
4. Lubrication;
5. Bearings; and,
6. Packings and seals.

REQUIRED COURSE MATERIALS:


Hand Tools/Quantity Required:

- Safety Glasses 1 pair
- Classroom Supplies 1
- Calculator 1

METHOD OF INSTRUCTION:

Lecture:       Didactic presentations will include lecture and demonstrations.
Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:
1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Contact Hrs.</th>
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<tbody>
<tr>
<td>Drawings, Sketching, Machinery</td>
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<tr>
<td>Instructions, Power Transmission</td>
<td>5</td>
</tr>
<tr>
<td>V-Belt Drives, Flat Belts</td>
<td>5</td>
</tr>
<tr>
<td>Chains, Couplings, Bearings</td>
<td>5</td>
</tr>
<tr>
<td>Packing and Seals</td>
<td>5</td>
</tr>
<tr>
<td>Mechanical Fasteners</td>
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</tr>
<tr>
<td>Wood Fasteners</td>
<td>5</td>
</tr>
<tr>
<td>Gears</td>
<td>5</td>
</tr>
<tr>
<td>Screw Threads</td>
<td>5</td>
</tr>
<tr>
<td>Lubrication</td>
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<td><strong>Total Lecture Hours</strong></td>
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LAB OUTLINE:

<table>
<thead>
<tr>
<th>Lab Topics</th>
<th>Contact Hrs.</th>
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</thead>
<tbody>
<tr>
<td>Sketch Pillow Block, Label Drawing</td>
<td>5</td>
</tr>
<tr>
<td>Connect V-Belt Drive, Connect Flat Belt Drive</td>
<td>5</td>
</tr>
<tr>
<td>Demonstrate Chain Replacement</td>
<td>5</td>
</tr>
<tr>
<td>Demonstrate Removal and Installation of Mechanical Seals</td>
<td>5</td>
</tr>
<tr>
<td>Demonstrate Tightening Threaded Fasteners</td>
<td>5</td>
</tr>
<tr>
<td>Demonstrate Proper Installation of Nails, Wood Screws and Lag Screws</td>
<td>5</td>
</tr>
<tr>
<td>Demonstrate Installation of Spur, Helical</td>
<td>5</td>
</tr>
</tbody>
</table>
and Worm Gears
Demonstrate Thread Tapping
(English and Metric)
Demonstrate Lubrication Using Grease
and Oil
Complete all Labs, Review

Total Lab Hours

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. **Resources: Identifies, organizes, plans, and allocates resources**
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   B. **Interpersonal: Works with others**
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.
      5. Negotiates resources in order to accomplish objectives
      6. Works well with all members of the class
   C. **Information: Acquires and uses information**
      1. Acquires and evaluates information
      2. Organizes and maintains information
      3. Interprets and communicates information
D. **Systems**: Understands complex inter-relationships
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. **Technology**: Works with a variety of technologies
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. **FOUNDATION SKILLS**
A. **Basic Skills**: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

I. **Reading**: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
   a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
   b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. **Writing**: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. **Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems

c. Demonstrates ability to understand and perform multi-step computations

d. Demonstrates ability to read, interpret, and use standard measuring devices

e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively

f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. **Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues

a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery

b. Demonstrates ability to hear, comprehend, and appropriately follow directions

c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately

e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. Speaking: Organizes ideas and communicates orally

a. Demonstrates appropriate listening and speaking skills in personal conversations

b. Demonstrates ability to choose and organize appropriate words to effectively communicate

c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation

d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and/or assessment purposes

e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups

f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations

g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

I. Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative

a. Demonstrates ability to objectively assess personal strengths and weaknesses

b. Demonstrates ability to set realistic short-term and long-term goals

c. Demonstrates ability to recognize and distinguish between positive and negative alternatives

d. Demonstrates ability to identify potential pitfalls and take evasive actions

e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response

f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives

g. Demonstrates maturity in taking responsibility for decisions
2. **Problem Solving**: Recognizes problems and devises and implements plan of action  
   a. Demonstrates ability to detect problem through observation, inquiry, or directive  
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation  
   c. Demonstrates ability to generate alternatives or options for problem solution  
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution  
   e. Demonstrates ability to initiate and effect solution  
   f. Demonstrates ability to take responsibility for outcomes  
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations  
3. **Seeing Things In the Mind's Eye**: Organizes, and processes symbols, pictures, graphs, objects, and other information  
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery  
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues  
   c. Demonstrates ability to visually discriminate in gross and fine imagery  
   d. Demonstrates ability to visualize abstractly  
   e. Demonstrates ability to apply visual imagery to applied tasks  
4. **Knowing How to Learn**: Use efficient learning techniques to acquire and apply new knowledge and skills  
   a. Demonstrates mastery of basic reading, math, and language skills through application  
   b. Demonstrates ability to translate abstract theory into practical application  
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process  
   d. Demonstrates knowledge of good study skills and learning habits  
5. **Reasoning**: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem  
   a. Demonstrates use of simple logic  
   b. Demonstrates ability to distinguish relationships
c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. **Responsibility:** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. **Self-Esteem:** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner

3. **Sociability:** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. **Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. **Integrity/Honesty:** Chooses ethical courses of action
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

**Appropriate Reference Materials:**

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B3;
   IMM-C1 through IMM-C3;
   IMM-D1;
   IMM-E1 through IMM-E2;
   IMM-I1 through IMM-I4
   IMM-K1 through IMM-K7;
   IMM-L1 through IMM-L2;
   IMM-M1 through IMM-M2;
   IMM-O1 through IMM-O2;
   IMM-P2;
IMM-P4; and
IMM-R1 through IMM-R5.
Introduction to Microcomputers

COURSE SYLLABUS

Total lecture hours: 10
Total lab hours: 40
Credit hours: 3

COURSE DESCRIPTION:

Introduces fundamental concepts and operations necessary to utilize microcomputers. Emphasis is placed on basic functions and familiarity with computer use. Topics include: computer terminology; computer operating systems; data storage; file management; equipment care and operation; and an introduction to word processing, database, and spreadsheet applications.

PREREQUISITE: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:
1. Computer terminology;
2. Disk operating systems;
3. Data storage;
4. File management;
5. Hardware and software care and operation; and,
6. Introductory word processing, database, and spreadsheet applications.

REQUIRED COURSE MATERIALS:


Materials/Quantity Required:
- Classroom Supplies 1
- Computer 1
METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:
1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Contact Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Computers</td>
<td>1</td>
</tr>
<tr>
<td>TEST 1</td>
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<tr>
<td>Working With Files on a Disk</td>
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<tr>
<td>Managing and Organizing Files on Disks</td>
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<tr>
<td>TEST 2</td>
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<tr>
<td>Word Processing Using WordPerfect</td>
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<tr>
<td>The Keyboard</td>
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<td>TEST 3</td>
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<tr>
<td>Formatting Text</td>
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<tr>
<td>TEST 4</td>
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<tr>
<td>Review</td>
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<tr>
<td>Intro to Internet</td>
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<tr>
<td>Moving, Searching and Replacing Text</td>
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<td>TEST 5</td>
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<td>Formatting a Document</td>
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<td>TEST 6</td>
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<td>Merging Documents</td>
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<td>TEST 7</td>
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LAB OUTLINE:

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<tr>
<td>Hardware and Software</td>
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<tr>
<td>Format, Directory, and Rename Commands</td>
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<tr>
<td>Root Directory, MD and CD Commands</td>
<td>4</td>
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<tr>
<td>Creating and Editing a Document</td>
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<tr>
<td>Deleting and Blocking Text</td>
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<tr>
<td>Printing Multiple Pages and Spell Check</td>
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<tr>
<td>Identify, Text, Save a Document</td>
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<tr>
<td>Page Format Menu, Line Format Menu</td>
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<tr>
<td>Merging, Creating a Primary File, Creating a Secondary File</td>
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<tr>
<td>Complete All Labs</td>
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<td><strong>Total Lab Hours</strong></td>
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</tbody>
</table>

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. Resources: Identifies, organizes, plans, and allocates resources
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   B. Interpersonal: Works with others
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. **Information: Acquires and uses information**
   1. Acquires and evaluates information
   2. Organizes and maintains information
   3. Interprets and communicates information

D. **Systems: Understands complex inter-relationships**
   1. Understands and works well with social, organizational, and technological systems
   2. Monitors and corrects performance of system during operation
   3. Recommends modifications to system to improve performance

E. **Technology: Works with a variety of technologies**
   1. Chooses relevant procedures, tools, and equipment
   2. Applies appropriate procedures and techniques to accomplish tasks
   3. Identifies or solves problems to maintain equipment

II. **FOUNDATION SKILLS**

A. **Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks**
   1. **Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules**
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
      e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. **Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. **Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery

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b. Demonstrates ability to hear, comprehend, and appropriately follow directions

c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately

e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. Speaking: Organizes ideas and communicates orally

a. Demonstrates appropriate listening and speaking skills in personal conversations

b. Demonstrates ability to choose and organize appropriate words to effectively communicate

c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation

d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and/or assessment purposes

e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups

f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations

g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative

a. Demonstrates ability to objectively assess personal strengths and weaknesses

b. Demonstrates ability to set realistic short-term and long-term goals

c. Demonstrates ability to recognize and distinguish between positive and negative alternatives

d. Demonstrates ability to identify potential pitfalls and take evasive actions

e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives

g. Demonstrates maturity in taking responsibility for decisions

2. **Problem Solving:** Recognizes problems and devises and implements plan of action

   a. Demonstrates ability to detect problem through observation, inquiry, or directive

   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation

   c. Demonstrates ability to generate alternatives or options for problem solution

   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

   e. Demonstrates ability to initiate and effect solution

   f. Demonstrates ability to take responsibility for outcomes

   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. **Seeing Things In the Mind’s Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information

   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery

   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues

   c. Demonstrates ability to visually discriminate in gross and fine imagery

   d. Demonstrates ability to visualize abstractly

   e. Demonstrates ability to apply visual imagery to applied tasks

4. **Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills

   a. Demonstrates mastery of basic reading, math, and language skills through application

   b. Demonstrates ability to translate abstract theory into practical application

   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process

   d. Demonstrates knowledge of good study skills and learning habits
5. **Reasoning:** Discover a rule or principle underlying the relationship between two or more objects and applies it when solving a problem
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. **Responsibility:** Exerts a high level of effort and perseveres towards goal attainment
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. **Self-Esteem:** Believes in own self-worth and maintains a positive view of self
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. **Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings  
   a. Demonstrates appropriate and acceptable social behaviors in interactions  
   b. Demonstrates ability to work cooperatively in individual, team, or group situations  
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner  
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly  

4. **Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control  
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement  
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner  
   c. Demonstrates ability to formulate and follow personal schedules  
   d. Demonstrates ability to wisely use classroom time  
   e. Demonstrates use of good study habits and skills  
   f. Demonstrates maturity to take responsibility for own actions  

5. **Integrity/Honesty:** Chooses ethical courses of action  
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors  
   b. Demonstrates honesty and integrity in working with peers and supervisors  
   c. Takes full responsibility for personal actions  
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable  
   e. Demonstrates positive work and social ethics in undertakings  

**Appropriate Reference Materials:**  

1. MASTER Technical Modules:  
   IMM-N1 through IMM-N2.
### MASTER Curriculum

**INDUSTRIAL MAINTENANCE**  
(One Year Certificate Program)

#### FIRST QUARTER*

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>LEC</th>
<th>LAB</th>
<th>CR</th>
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<tbody>
<tr>
<td>MATH 103</td>
<td>Algebraic Concepts</td>
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<tr>
<td>ELC 106</td>
<td>Direct Current Circuits I</td>
<td>3</td>
<td>2</td>
<td>4</td>
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<tr>
<td>IMM 101</td>
<td>Industrial Maintenance Safety Procedures</td>
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<td>1</td>
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<tr>
<td>IMM 108</td>
<td>Industrial Mechanics I</td>
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**Total: 16 LEC, 12 LAB, 21 CR**

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<td>Pumps &amp; Piping Systems</td>
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**Total: 18 LEC, 12 LAB, 23 CR**

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<td>Development</td>
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<tr>
<td>IMM 110</td>
<td>Industrial Mechanics II</td>
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<td>IMM 115</td>
<td>Industrial Pneumatics</td>
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<td>IMM 100</td>
<td>Refrigeration Fundamentals</td>
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**Total: 12 LEC, 11 LAB, 20 CR**

#### FOURTH QUARTER*

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<td>IMM 109</td>
<td>Lathe Operations I</td>
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<td>IMM 133</td>
<td>Industrial Maintenance-Mechanical Review</td>
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**Total: 7 LEC, 13 LAB, 16 CR**

*Each quarter is 10 weeks in length.
Master Program

English

Course Syllabus

Total lecture hours: 50  Total lab hours: 0  Credit hours: 5

Course Description:

Emphasizes the development and improvement of written and oral communication abilities. Topics include: analysis of writing techniques used in selected readings, writing practice, editing and proofreading, research skills, and oral presentation skills. Homework assignments reinforce classroom learning.

Prerequisite/Corequisite: English III and Reading III, or the equivalent.

Course Objectives:

After successful completion of this course, the students will be able to study, understand, and solve problems in:
1. Analysis of writing techniques used in selected readings;
2. Writing practice;
3. Editing and proofreading;
4. Research skills; and,
5. Oral presentation skills.

Required Course Materials:


Materials: Loose leaf paper
           Loose leaf binder
           Blue or black pen
           Pencil
           Highlighter

Method of Instruction:

Lecture: Didactic presentations will include lecture and discussions.
Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:
1. Satisfactorily perform on written, oral, and practical examinations;
2. Satisfactorily perform on outside assignments including writing assignments;
3. Contribute to class discussions; and,
4. Maintain attendance per current policy.

LECTURE OUTLINE:

<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Contact Hrs.</th>
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<tbody>
<tr>
<td>Grammar Pretest and Paragraph</td>
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<tr>
<td>Introduction to the Course</td>
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<tr>
<td>The Computer Grammar Project</td>
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<td>One-minute Introductory Speech: “Who Am I?”</td>
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<td><strong>Introduction to the Paragraph</strong></td>
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<tr>
<td>The Evaluation of a Paragraph</td>
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<tr>
<td>“The Paper Format”</td>
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<td><strong>Introduction to the Portfolio or Journal Notebook (Entries will be evaluated throughout the quarter at the instructor's discretion)</strong></td>
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<td>Example Paragraph</td>
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<td>“Important Factors in Writing”</td>
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<tr>
<td><strong>Narrative Paragraph</strong></td>
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<td><strong>Library Orientation and Library Project</strong></td>
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<tr>
<td>The Abstract</td>
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<td>Grammar and Mechanics Skills as Needed</td>
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<td>“Speaking One to One Thousand”</td>
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<td><strong>Listening Skills</strong></td>
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<td>Spelling Test #4 (Words 150-200)</td>
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<td>“The Third and Fourth Steps in Writing”</td>
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<td><strong>Description Paragraph</strong></td>
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<td>Dividing and Classifying Paragraph</td>
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COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. Resources: Identifies, organizes, plans, and allocates resources
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides
feedback

B. **Interpersonal: Works with others**
   1. Participates as a member of the team, contributing to group effort
   2. Provides individual assistance/direction to peers as requested
   3. Determines and meets expectations
   4. Exercises leadership qualities to effectively communicate ideas and make decisions.
   5. Negotiates resources in order to accomplish objectives
   6. Works well with all members of the class

C. **Information: Acquires and uses information**
   1. Acquires and evaluates information
   2. Organizes and maintains information
   3. Interprets and communicates information

D. **Systems: Understands complex inter-relationships**
   1. Understands and works well with social, organizational, and technological systems
   2. Monitors and corrects performance of system during operation
   3. Recommends modifications to system to improve performance

E. **Technology: Works with a variety of technologies**
   1. Chooses relevant procedures, tools, and equipment
   2. Applies appropriate procedures and techniques to accomplish tasks
   3. Identifies or solves problems to maintain equipment

II. **FOUNDATION SKILLS**

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks
   1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      d. Demonstrates ability to read, interpret, and follow
schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. **Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. **Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. **Speaking:** Organizes ideas and communicates orally
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and/or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. **Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions

e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response

f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives

g. Demonstrates maturity in taking responsibility for decisions

2. Problem Solving: Recognizes problems and devises and implements plan of action

a. Demonstrates ability to detect problem through observation, inquiry, or directive

b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation

c. Demonstrates ability to generate alternatives or options for problem solution

d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

e. Demonstrates ability to initiate and effect solution

f. Demonstrates ability to take responsibility for outcomes

g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. Seeing Things In the Mind's Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information

a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery

b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues

c. Demonstrates ability to visually discriminate in gross and fine imagery

d. Demonstrates ability to visualize abstractly

e. Demonstrates ability to apply visual imagery to applied tasks

4. Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills

a. Demonstrates mastery of basic reading, math, and language skills through application

b. Demonstrates ability to translate abstract theory into
practical application

c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
d. Demonstrates knowledge of good study skills and learning habits

5. **Reasoning:** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
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f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. **Responsibility:** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. **Self-Esteem:** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. Demonstrates ability to accept personal strengths and
weaknesses and builds on positive behaviors

e. Demonstrates ability to accept and use constructive criticism

f. Accepts positive reinforcement in an appropriate manner

3. **Sociability**: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

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   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. **Integrity/Honesty**: Chooses ethical courses of action
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings
MASTER PROGRAM
Alternating Current I
COURSE SYLLABUS

Total lecture hours: 30    Total lab hours: 20    Credit hours: 4

COURSE DESCRIPTION:

Introduces the theory and application of varying sine wave voltages and current. Topics include: AC wave generation, oscilloscope operation, inductance, and capacitance.

PREREQUISITE:
Direct Current Circuits I

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:
1. AC wave generation;
2. Oscilloscope operation;
3. Inductance; and,

REQUIRED COURSE MATERIALS:


Lab Manual: Lab Manuals are issued as a text and must be returned before Final Exam is taken.

Hand Tools/Quantity Required:
Safety Glasses
Classroom Supplies
Calculator
Volt-Ohm Meter w/Test Leads

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.
Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:
1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

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<thead>
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<tr>
<td>Wheatstone Bridge</td>
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<tr>
<td>Electronic Charges</td>
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<td>Filmstrip 802-6, &quot;Magnetism and Electro-Magnetism&quot;, Bergwall</td>
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<td>Capacitors</td>
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<td>Inductors</td>
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<td>Oscilloscope</td>
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<td>Inductive Circuits</td>
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<td>Capacitive Circuits</td>
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<td>Reactive Circuits</td>
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LAB OUTLINE:

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<tr>
<td>Construct Wheatstone Bridge</td>
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<tr>
<td>Electrostatic Charges</td>
<td>2</td>
</tr>
<tr>
<td>Build Capacitor Circuit</td>
<td>2</td>
</tr>
<tr>
<td>Build Inductor Circuit</td>
<td>2</td>
</tr>
<tr>
<td>Oscilloscope to Measure Voltage</td>
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Frequency
Inductive Circuits - Measure Voltage  2
Capacitive Circuits - Measure Voltage  2
Reactive Circuits - Measure Current  2
Complete all Labs  2
Total Lab Hours  20

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. Resources: Identifies, organizes, plans, and allocates resources
   1. Allocates time to complete assigned tasks on schedule
   2. Determines and allocates required materials and resources for meeting objectives
   3. Evaluates skills, performance, and quality of work and provides feedback

B. Interpersonal: Works with others
   1. Participates as a member of the team, contributing to group effort
   2. Provides individual assistance/direction to peers as requested
   3. Determines and meets expectations
   4. Exercises leadership qualities to effectively communicate ideas and make decisions.
   5. Negotiates resources in order to accomplish objectives
   6. Works well with all members of the class

C. Information: Acquires and uses information
   1. Acquires and evaluates information
   2. Organizes and maintains information
   3. Interprets and communicates information

D. Systems: Understands complex inter-relationships
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

**E. Technology: Works with a variety of technologies**
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

**II. FOUNDATION SKILLS**

**A. Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
   a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
   b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. **Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques

   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems

   c. Demonstrates ability to understand and perform multi-step computations

   d. Demonstrates ability to read, interpret, and use standard measuring devices

   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively

   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. **Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues

   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery

   b. Demonstrates ability to hear, comprehend, and appropriately follow directions

   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately

   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. **Speaking**: Organizes ideas and communicates orally  
   a. Demonstrates appropriate listening and speaking skills in personal conversations  
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate  
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation  
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and/or assessment purposes  
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups  
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations  
   g. Demonstrates ability to take responsibility for presentations  

B. **Thinking Skills**: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons  
   1. **Decision Making**: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative  
      a. Demonstrates ability to objectively assess personal strengths and weaknesses  
      b. Demonstrates ability to set realistic short-term and long-term goals  
      c. Demonstrates ability to recognize and distinguish between positive and negative alternatives  
      d. Demonstrates ability to identify potential pitfalls and take evasive actions  
      e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response  
      f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives  
      g. Demonstrates maturity in taking responsibility for decisions  
   2. **Problem Solving**: Recognizes problems and devises and implements plan of action  
      a. Demonstrates ability to detect problem through observation, inquiry, or directive
b. Demonstrates ability to grasp appropriate overview and
degree of seriousness of problem and to behave
responsibly in situation
c. Demonstrates ability to generate alternatives or options
for problem solution
d. Demonstrates ability to research options, assess and
evaluate options, and determine appropriate and best
solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in
individual, team, or group situations

3. Seeing Things In the Mind’s Eye: Organizes, and processes
symbols, pictures, graphs, objects, and other information
a. Functions at minimum or above required visual levels in
order to see, interpret, attend and respond to visual
imagery and meet safety requirements for necessary
machinery
b. Demonstrates ability to read, interpret, and act upon
signs, symbols, and other visual cues
c. Demonstrates ability to visually discriminate in gross and
fine imagery
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied
tasks

4. Knowing How to Learn: Use efficient learning techniques to
acquire and apply new knowledge and skills
a. Demonstrates mastery of basic reading, math, and
language skills through application
b. Demonstrates ability to translate abstract theory into
practical application
c. Demonstrates ability to incorporate and generalize new
learning into a sequential learning process
d. Demonstrates knowledge of good study skills and
learning habits

5. Reasoning: Discovers a rule or principle underlying the
relationship between two or more objects and applies it when
solving a problem.
a. Demonstrates use of simple logic
b. Demonstrates ability to distinguish relationships
c. Demonstrates ability to determine and isolate factors in
relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. **Responsibility:** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. **Self-Esteem:** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner

3. **Sociability:** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. **Self-Management**: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. **Integrity/Honesty**: Chooses ethical courses of action
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

**Appropriate Reference Materials:**

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B4;
   IMM-C1 through IMM-C3;
   IMM-E1 through IMM-E2;
   IMM-P1; and,
   IMM-Q1 through IMM-Q5.
MASTER PROGRAM
Alternating Current II
COURSE SYLLABUS

Total lecture hours: 30          Total lab hours: 20          Credit hours: 4

COURSE DESCRIPTION:
Continues development of AC concepts with emphasis on constructing, verifying, and troubleshooting reactive circuits using RLC theory and oscilloscopes. Topics include: simple RLC circuits, AC circuit resonance, passive filters, transformer theory, and applications, and non-sinusoidal wave forms.

PREREQUISITE:          Alternating Current I

COURSE OBJECTIVES:
After successful completion of this course, the students will be able to study, understand, and solve problems in:
1. Simple RLC circuits;
2. AC circuit resonance;
3. Passive filters;
4. Transformer theory and applications; and,
5. Non-sinusoidal wave form.

REQUIRED COURSE MATERIALS:


Lab Manual:  Lab Manuals are issued as a text and must be returned before Final Exam is taken.

Hand Tools/Quantity Required:
Tools
Safety Glasses
Classroom Supplies
Calculator
Volt-Ohm Meter w/test leads
METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Contact Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Power—Single Phase</td>
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</tr>
<tr>
<td>Resonance—Series and Parallel</td>
<td>3</td>
</tr>
<tr>
<td>AC Power—Three Phase</td>
<td>3</td>
</tr>
<tr>
<td>Impedance Matching</td>
<td>3</td>
</tr>
<tr>
<td>Transformer—Single Phase</td>
<td>3</td>
</tr>
<tr>
<td>Filmstrip #802d-8, &quot;Transformer&quot;, Bergwall</td>
<td></td>
</tr>
<tr>
<td>Transformer—Three Phase</td>
<td>3</td>
</tr>
<tr>
<td>Motors—Single Phase</td>
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<tr>
<td>Motors—Three Phase</td>
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<tr>
<td>Generators—Three Phase</td>
<td>3</td>
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<tr>
<td>Final Exam</td>
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<td>Total Lecture Hours</td>
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</table>

LAB OUTLINE:

<table>
<thead>
<tr>
<th>Lab Topics</th>
<th>Contact Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connect Single Phase Power Circuit and Measure Power</td>
<td>2</td>
</tr>
<tr>
<td>Connect Series and Parallel Resonance Circuits and Measure Impedance</td>
<td>2</td>
</tr>
<tr>
<td>Connect Three Phase Circuits; Measure</td>
<td></td>
</tr>
</tbody>
</table>
Voltages 2
Connect Impedance Matching Circuit and Measure Impedance 2
Connect Transformer; Measure Voltage 2
Connect Delta and Wye Three Phase Transformers 2
Wire Single Phase Motors, Start and Run, Measure Torque 2
Wire Three Phase Motors, Start and Run 2
Wire Three Phase Generator to Supply Three Phase Load 2
Complete All Labs 2
Total Lab Hours 20

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. Resources: Identifies, organizes, plans, and allocates resources
      1. Allocates time to complete assigned tasks on schedule
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      1. Participates as a member of the team, contributing to group effort
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5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. Information: Acquires and uses information
1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. Systems: Understands complex inter-relationships
1. Understands and works well with social, organizational, and technological systems
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E. Technology: Works with a variety of technologies
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
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b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems

c. Demonstrates ability to understand and perform multi-step computations

d. Demonstrates ability to read, interpret, and use standard measuring devices

e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively

f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. Listening: Receives, attends to, interprets, and responds to verbal messages and other cues

a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery

b. Demonstrates ability to hear, comprehend, and appropriately follow directions
c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. **Speaking:** Organizes ideas and communicates orally
a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and/or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. **Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative
a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives

g. Demonstrates maturity in taking responsibility for decisions

2. **Problem Solving: Recognizes problems and devises and implements plan of action**
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. **Seeing Things In the Mind’s Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information**
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. **Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills**
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. **Reasoning**: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
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   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities**: Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. **Responsibility**: Exerts a high level of effort and perseveres towards goal attainment
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
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2. **Self-Esteem**: Believes in own self-worth and maintains a positive view of self
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
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   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
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   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. **Integrity/Honesty:** Chooses ethical courses of action
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

**Appropriate Reference Materials:**

1. MASTER Technical Modules:
   - IMM-A1 through IMM-A6;
   - IMM-B1 through IMM-B4;
   - IMM-C1 through IMM-C3;
   - IMM-E1 through IMM-E2
   - IMM-H7;
IMM-P1; and
IMM-Q1 through IMM-Q5.
MASTER PROGRAM
Pumps and Piping Systems
COURSE SYLLABUS

Total lecture hours: 10  Total lab hours: 40  Credit hours: 2

COURSE DESCRIPTION:

Provides instruction in the operation of industrial pumps, valves, and piping/delivery systems with emphasis on installation procedures, maintenance and repair. Topics include: pump identification, pump operations, pump installation, maintenance, troubleshooting, piping systems, and installation and repair of piping systems.

PREREQUISITES:  Industrial Mechanics I; Industrial Pneumatics

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:
1. Pump identification;
2. Pump operation;
3. Pump installation, maintenance, and troubleshooting;
4. Piping systems; and,
5. Installation of piping systems.

REQUIRED COURSE MATERIALS:


Lab manuals are issued as a text and must be returned before Final Exam is taken.

Hand Tools/Quantity Required:

- Safety Glasses  1 pair
- Classroom Supplies  1
- Calculator  1
METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Contact Hrs.</th>
</tr>
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<tbody>
<tr>
<td>Gear Pumps</td>
<td>1</td>
</tr>
<tr>
<td>Vane Pumps</td>
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</tr>
<tr>
<td>Rotary Piston Pumps</td>
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</tr>
<tr>
<td>Reciprocating Piston Pumps</td>
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</tr>
<tr>
<td>Bent Axis Piston Pump</td>
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<tr>
<td>Axial Piston Pump</td>
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</tr>
<tr>
<td>Filters - Intake and Sump</td>
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<tr>
<td>Rigid Pipe</td>
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<tr>
<td>Flexible Piping</td>
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</tr>
<tr>
<td>Plan Piping Installation</td>
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Total Lecture Hours 10

LAB OUTLINE:

<table>
<thead>
<tr>
<th>Lab Topics</th>
<th>Contact Hrs.</th>
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<tbody>
<tr>
<td>Rebuild Gear Pump</td>
<td>4</td>
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<tr>
<td>Rebuild Vane Pump</td>
<td>4</td>
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<tr>
<td>Rebuild Rotary Piston Pump</td>
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<tr>
<td>Rebuild Reciprocating Piston Pump</td>
<td>4</td>
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<tr>
<td>Rebuild Bent Axis Piston Pump</td>
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<td>Rebuild Axial Piston Pump</td>
<td>4</td>
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<tr>
<td>Remove and Install Filters</td>
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</table>
Install Rigid Piping System  4
Install Flexible Piping System  4
Plan Piping Installation  4
Total Lab Hours  40

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. Resources: Identifies, organizes, plans, and allocates resources
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   B. Interpersonal: Works with others
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.
      5. Negotiates resources in order to accomplish objectives
      6. Works well with all members of the class
   C. Information: Acquires and uses information
      1. Acquires and evaluates information
      2. Organizes and maintains information
      3. Interprets and communicates information
   D. Systems: Understands complex inter-relationships
      1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
   a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
   b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. **Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. Demonstrates ability to understand and perform multi-step computations
d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. **Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues

a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
b. Demonstrates ability to hear, comprehend, and appropriately follow directions
c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. **Speaking**: Organizes ideas and communicates orally
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and/or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills**: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. **Decision Making**: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions

2. **Problem Solving**: Recognizes problems and devises and implements plan of action
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. Seeing Things In the Mind’s Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied tasks

4. Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
d. Demonstrates knowledge of good study skills and learning habits

5. Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. Personal Qualities: Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. Responsibility: Exerts a high level of effort and perseveres towards goal attainment
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. Self-Esteem: Believes in own self-worth and maintains a positive view of self
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner

3. Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. **Self-Management**: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. **Integrity/Honesty**: Chooses ethical courses of action
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

**Appropriate Reference Materials:**

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B3;
   IMM-E1 through IMM-E2;
   IMM-H2 through IMM-H6;
   IMM-H8 through IMM-H9
   IMM-K1 through IMM-K7;
   IMM-M1 through IMM-M2; and,
   IMM-P3 through IMM-P4.
Total lecture hours: 60  Total lab hours: 40  Credit hours: 8

COURSE DESCRIPTION:

Provides instruction in fundamental concepts and theories for the safe operation of hydraulic components and systems. Topics include: hydraulic theory, suction side of pumps, actuators, valves, pumps/motors, accumulators, symbols and circuitry, types of fluids, filters, servicing safety, preventative maintenance, and troubleshooting.

PREREQUISITE:  NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:
1. Hydraulic theory;
2. Suction side of pumps;
3. Actuators;
4. Valves;
5. Pumps/motors;
6. Accumulators;
7. Symbols and circuitry;
8. Types of fluids;
9. Filters;
10. Servicing safety;
11. Preventive maintenance; and,
12. Troubleshooting.

REQUIRED COURSE MATERIALS:


Lab Manuals are issued as a text and must be returned before Final Exam is taken.
Hand Tools/Quantity Required:

- Tools
  Safety Glasses: 1 pair
  Classroom Supplies: 1
  Calculator: 1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

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Pressure
Flow Rate
Null Procedure
Replacement and Adjustment
Pumps/Motors
Inspection Accumulators
Testing
Replacement
Symbols and Circuitry
Component Identification
Types of Fluids
Composition of Fluids
Types
Selection of Oil
Filters
Verification
Cleaning and Replacement
Servicing Safety
Protective Clothing
Repair and Replacement
Preventive Maintenance
Program Elements
Program Selection
Fluid Checks
Replacement
Alignment
Lines
Troubleshooting
Application

Total Lecture Hours 60

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<td>Filters</td>
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<td>Troubleshooting</td>
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II. FOUNDATION SKILLS
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3. **Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques
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   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

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   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
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   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
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   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. **Speaking:** Organizes ideas and communicates orally
   a. Demonstrates appropriate listening and speaking skills in personal conversations
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f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
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2. Problem Solving: Recognizes problems and devises and implements plan of action
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
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   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
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   a. Demonstrates mastery of basic reading, math, and language skills through application
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   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
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   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities: Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty**

1. **Responsibility: Exerts a high level of effort and perseveres towards goal attainment**

**122**
a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. **Self-Esteem**: Believes in own self-worth and maintains a positive view of self

a. Presents a positive attitude toward tasks
b. Demonstrates ability to separate work and personal behaviors
c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
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f. Accepts positive reinforcement in an appropriate manner

3. **Sociability**: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings

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a. Knows and demonstrates ability to distinguish between positive and negative behaviors

b. Demonstrates honesty and integrity in working with peers and supervisors

c. Takes full responsibility for personal actions

d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable

e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B4
   IMM-C1 through IMM-C3;
   IMM-D1;
   IMM-E1 through IMM-E2;
   IMM-H3 through IMM-H8;
   IMM-M1 through IMM-M2;
   IMM-O1 through IMM-O2; and,
   IMM-P4.
# MASTER Curriculum

## INDUSTRIAL MAINTENANCE

(One Year Certificate Program)

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*Each quarter is 10 weeks in length.*
1. Satisfactory perform on written, oral examinations;
2. Satisfactory perform on outside assignments including writing assignments;
3. Contribute to class discussions; and,
4. Maintain attendance per current policy.

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<thead>
<tr>
<th>Lecture Topics</th>
<th>Contact Hrs.</th>
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<td>Human Relations Skills</td>
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<td>Goal Setting</td>
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<td>Behavior Problems</td>
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<td>Job Search</td>
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<td>Employment Documents</td>
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<td>Interviewing</td>
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<td>Job Retention Skills</td>
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<td>Office Relationship</td>
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<td>Time Management</td>
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<td>Job Advancement Skills</td>
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<td>Performance Appraisal</td>
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<td>Professional Image Skills</td>
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<td>Image</td>
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<td>Attitude</td>
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</table>

Total Lecture Hours 30

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:
I. COMPETENCIES

A. Resources: Identifies, organizes, plans, and allocates resources
   1. Allocates time to complete assigned tasks on schedule
   2. Determines and allocates required materials and resources for meeting objectives
   3. Evaluates skills, performance, and quality of work and provides feedback

B. Interpersonal: Works with others
   1. Participates as a member of the team, contributing to group effort
   2. Provides individual assistance/direction to peers as requested
   3. Determines and meets expectations
   4. Exercises leadership qualities to effectively communicate ideas and make decisions.
   5. Negotiates resources in order to accomplish objectives
   6. Works well with all members of the class

C. Information: Acquires and uses information
   1. Acquires and evaluates information
   2. Organizes and maintains information
   3. Interprets and communicates information

D. Systems: Understands complex inter-relationships
   1. Understands and works well with social, organizational, and technological systems
   2. Monitors and corrects performance of system during operation
   3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies
   1. Chooses relevant procedures, tools, and equipment
   2. Applies appropriate procedures and techniques to accomplish tasks
   3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks
   1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information
from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts

   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. **Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques

   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems

   c. Demonstrates ability to understand and perform multi-step computations

   d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. Listening: Receives, attends to, interprets, and responds to verbal messages and other cues
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. Speaking: Organizes ideas and communicates orally
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and/or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
1. **Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions

2. **Problem Solving:** Recognizes problems and devises and implements plan of action
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. **Seeing Things In the Mind’s Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. Demonstrates ability to visually discriminate in gross and fine imagery
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied tasks

4. **Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
d. Demonstrates knowledge of good study skills and learning habits

5. **Reasoning:** Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. **Responsibility:** Exerts a high level of effort and perseveres towards goal attainment
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. **Self-Esteem: Believes in own self-worth and maintains a positive view of self**
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner

3. **Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings**
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. **Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control**
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. **Integrity/Honesty: Chooses ethical courses of action**
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions

d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable

e. Demonstrates positive work and social ethics in undertakings
COURSE DESCRIPTION:
Continues the application of mechanical principles to industrial production equipment with emphasis on power transmission and mechanical components. Emphasis is placed on alignment and tension. Topics include: mechanical drive systems, couplings and alignment, clutches and brakes, linkage and levers, mechanical troubleshooting, and preventative maintenance.

PREREQUISITE:             Industrial Mechanics I

COURSE OBJECTIVES:
After successful completion of this course, the students will be able to study, understand, and solve problems in:
1. Mechanical drive systems;
2. Couplings and alignment;
3. Clutches and brakes;
4. Linkage and levers;
5. Mechanical troubleshooting; and,
6. Preventive maintenance.

REQUIRED COURSE MATERIALS:


Lab Manual:           Lab Manuals are issued as a text and must be returned before Final Exam is taken.

Hand Tools/Quantity Required:
Tools
Safety Glasses     1 pair
Classroom Supplies 1
Calculator         1
METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

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<td>Mechanical Drive Systems—Belts</td>
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<td>Couplings-Alignment</td>
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<td>Portable Power Tools</td>
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<td>Clutches and Brakes</td>
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<td>Linkage and Levers</td>
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<td>Preventive Maintenance</td>
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<td>Test 4</td>
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<td>Rigging</td>
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<td>Mechanical Troubleshooting</td>
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LAB OUTLINE:

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<tr>
<td>Belt Drive System Lab</td>
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COURSE OBJECTIVES: SCANS COMPETENCIES

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1. Acquires and evaluates information
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2. Monitors and corrects performance of system during operation
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1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
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c. Demonstrates technical writing skills in preparing
outlines, summaries, time lines, flow charts, diagrams,
etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in
a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the
organization and presentation of answers to required
written assessments

3. Arithmetic/Mathematics: Perform basic computations and
approaches practical problems by choosing appropriately from a
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a. Demonstrates proficiency in basic arithmetic functions
including ability to add, subtract, multiply, and divide
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problems
c. Demonstrates ability to understand and perform
multi-step computations
d. Demonstrates ability to read, interpret, and use standard
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and instructions and to safely operate machinery
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appropriately follow directions
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utilize verbal classroom as well as other auditory
instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately

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f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. Speaking: Organizes ideas and communicates orally
   a. Demonstrates appropriate listening and speaking skills in personal conversations
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   g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
   1. Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative
      a. Demonstrates ability to objectively assess personal strengths and weaknesses
      b. Demonstrates ability to set realistic short-term and long-term goals
      c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
      d. Demonstrates ability to identify potential pitfalls and take evasive actions
      e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
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   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation  
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   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery  
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues  
   c. Demonstrates ability to visually discriminate in gross and fine imagery  
   d. Demonstrates ability to visualize abstractly  
   e. Demonstrates ability to apply visual imagery to applied tasks  

4. **Knowing How to Learn**: Use efficient learning techniques to acquire and apply new knowledge and skills  
   a. Demonstrates mastery of basic reading, math, and language skills through application  
   b. Demonstrates ability to translate abstract theory into practical application  
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process  
   d. Demonstrates knowledge of good study skills and learning habits  

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   a. Demonstrates use of simple logic  
   b. Demonstrates ability to distinguish relationships
c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. Personal Qualities: Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. Responsibility: Exerts a high level of effort and perseveres towards goal attainment
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
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2. Self-Esteem: Believes in own self-worth and maintains a positive view of self
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
e. Demonstrates ability to accept and use constructive criticism
f. Accepts positive reinforcement in an appropriate manner

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   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
c. Demonstrates active interest in peers by offering 
   assistance, sharing resources, and sharing knowledge in a 
   professional and acceptable manner 

d. Demonstrates professional work ethic by separating work 
   and personal social behaviors and acting accordingly 

4. **Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control 
   a. Accepts personal strengths and weaknesses and uses the 
      same for positive advancement 
   b. Demonstrates ability to continuously set, assess, choose, 
      and modify objectives as the situation demands in an 
      appropriate manner 
   c. Demonstrates ability to formulate and follow personal 
      schedules 
   d. Demonstrates ability to wisely use classroom time 
   e. Demonstrates use of good study habits and skills 
   f. Demonstrates maturity to take responsibility for own 
      actions 

5. **Integrity/Honesty:** Chooses ethical courses of action 
   a. Knows and demonstrates ability to distinguish between 
      positive and negative behaviors 
   b. Demonstrates honesty and integrity in working with 
      peers and supervisors 
   c. Takes full responsibility for personal actions 
   d. Demonstrates understanding of consequences for negative 
      ethical behaviors and accepts responsibility for same 
      when applicable 
   e. Demonstrates positive work and social ethics in 
      undertakings 

**Appropriate Reference Materials:**

1. **MASTER Technical Modules:**
   IMM-A1 through IMM-A6; 
   IMM-B1 through IMM-B3; 
   IMM-C1 through IMM-C3; 
   IMM-D1 through IMM-D2; 
   IMM-E1 through IMM-E2; 
   IMM-H7; 
   IMM-I1 through IMM-I4; 
   IMM-K1 through IMM-K7; 
   IMM-L1 through IMM-L2; 
   IMM-M1 through IMM-M2; 
   IMM-O1 through IMM-O2;
IMM-P2; IMM-P4; IMM-R1 through IMM-R5; and, IMM-S1 through IMM-S7.
MASTER PROGRAM
Industrial Pneumatics
COURSE SYLLABUS

Total lecture hours: 30     Total lab hours: 20     Credit hours: 4

COURSE DESCRIPTION:

Provides instruction in fundamental concepts and theories for the safe operation of pneumatic components and systems. Topics include: pneumatic theory, preventative maintenance, compressors, regulators, pneumatic valves, actuators, servicing safety, and troubleshooting.

PREREQUISITE: Industrial Hydraulics

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:
1. Pneumatic theory;
2. Preventive maintenance;
3. Compressors;
4. Regulators;
5. Pneumatic valves;
6. Actuators;
7. Servicing safety; and,
8. Troubleshooting.

REQUIRED COURSE MATERIALS:


Lab Manuals are issued as a text and must be returned before Final Exam is taken.
Hand Tools/Quantity Required:
- Tool Box 1
- Safety Glasses 1 pair
- Classroom Supplies 1
- Calculator 1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:
1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Contact Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evolution of Compressed Air</td>
<td></td>
</tr>
<tr>
<td>Force Transmission</td>
<td>3</td>
</tr>
<tr>
<td>Energy Transmission Using a</td>
<td></td>
</tr>
<tr>
<td>Pneumatic System</td>
<td>3</td>
</tr>
<tr>
<td>Control of Pneumatic Energy</td>
<td></td>
</tr>
<tr>
<td>Test 1</td>
<td></td>
</tr>
<tr>
<td>Compressors</td>
<td>3</td>
</tr>
<tr>
<td>Test 2</td>
<td></td>
</tr>
<tr>
<td>Aftercoolers, Dryers, Receives-Air</td>
<td></td>
</tr>
<tr>
<td>Distribution System</td>
<td>3</td>
</tr>
<tr>
<td>Check Valves, Cylinders, Motors</td>
<td>3</td>
</tr>
<tr>
<td>Directional Control Valves</td>
<td>3</td>
</tr>
<tr>
<td>Test 3</td>
<td></td>
</tr>
<tr>
<td>Flow Control Valves, Silencers, Quick Exhaust</td>
<td>3</td>
</tr>
</tbody>
</table>
Test 4
Regulators, Boosters and Sequence Valves 3
Air Preparation 3
Final Exam 3
Total Lecture Hours 30

LAB OUTLINE:

<table>
<thead>
<tr>
<th>Lab Topics</th>
<th>Contact Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force Transmission</td>
<td>2</td>
</tr>
<tr>
<td>Control of Pneumatic Energy</td>
<td>2</td>
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<tr>
<td>Compressors</td>
<td>2</td>
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<tr>
<td>Air Distribution System</td>
<td>2</td>
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<tr>
<td>Cylinders</td>
<td>2</td>
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<tr>
<td>Directional Control Valves</td>
<td>2</td>
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<tr>
<td>Sequence Valves</td>
<td>2</td>
</tr>
<tr>
<td>Air Preparation</td>
<td>2</td>
</tr>
</tbody>
</table>

Total Lab Hours 20

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. Resources: Identifies, organizes, plans, and allocates resources
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   B. Interpersonal: Works with others
1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. Information: Acquires and uses information
1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. Systems: Understands complex inter-relationships
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks
   1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. Listening: Receives, attends to, interprets, and responds to verbal messages and other cues
a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
b. Demonstrates ability to hear, comprehend, and appropriately follow directions
c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. Speaking: Organizes ideas and communicates orally
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and/or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
   1. Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative
      a. Demonstrates ability to objectively assess personal strengths and weaknesses
      b. Demonstrates ability to set realistic short-term and long-term goals
      c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
      d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. **Problem Solving:** Recognizes problems and devises and implements plan of action
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. **Seeing Things In the Mind’s Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. Demonstrates ability to visually discriminate in gross and fine imagery.
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied tasks

4. **Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
d. Demonstrates knowledge of good study skills and learning habits

5. **Reasoning:** \textit{Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem}
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. **Responsibility:** \textit{Exerts a high level of effort and perseveres towards goal attainment}
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. **Self-Esteem:** \textit{Believes in own self-worth and maintains a positive view of self}
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
3. **Sociability**: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. **Self-Management**: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. **Integrity/Honesty**: Chooses ethical courses of action
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

**Appropriate Reference Materials:**

1. MASTER Technical Modules:
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B3;
IMM-C1 through IMM-C3;
IMM-D1;
IMM-E1 through IMM-E2;
IMM-H2;
IMM-H5 through IMM-H6; and,
IMM-H9.
MASTER PROGRAM
Refrigeration Fundamentals
COURSE SYLLABUS

Total lecture hours: 30       Total lab hours: 20       Credit hours: 4

COURSE DESCRIPTION:

Introduces basic concepts and theories of refrigeration. Topics include: the laws of thermodynamics, pressure and temperature relationships, heat transfer, the refrigeration cycle and safety.

PREREQUISITE: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:
1. Laws of thermodynamics;
2. Pressure and temperature relationships;
3. Heat transfer;
4. Refrigeration cycle; and,
5. Safety.

REQUIRED COURSE MATERIALS:

Textbook 1  Modern Refrigeration and Air Conditioning, Althouse et al., Latest Edition

Textbook 2  Study Guide for Modern Refrigeration and Air Conditioning, Althouse et al., Latest Edition

Hand Tools/Quantity Required:
3 ring notebook
#2 pencil
Goggles—flexible fitting
Hooded ventilation
Pocket thermometer—40 to 60 degrees Fahrenheit
METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:
1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Contact Hrs.</th>
</tr>
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<tbody>
<tr>
<td>Laws of Thermodynamics</td>
<td>7</td>
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<tr>
<td>First law of thermodynamics</td>
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</tr>
<tr>
<td>Second law of thermodynamics</td>
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</tr>
<tr>
<td>Definition of refrigeration terms and purposes</td>
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<tr>
<td>Pressure and Temperature Relationships</td>
<td>6</td>
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<tr>
<td>Definition of pressure</td>
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<tr>
<td>Relationship of pressure and temperature -</td>
<td></td>
</tr>
<tr>
<td>P.T. chart</td>
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</tr>
<tr>
<td>Pressure - Atmospheric, gauge and absolute</td>
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<tr>
<td>Gas laws</td>
<td></td>
</tr>
<tr>
<td>Heat and Heat Transfer</td>
<td>6</td>
</tr>
<tr>
<td>Definitions of heat and temperature</td>
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</tr>
<tr>
<td>Temperatures - Fahrenheit, Celsius, and absolute</td>
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<tr>
<td>Heat - Specific, sensible and latent</td>
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</tr>
<tr>
<td>Refrigeration Cycle</td>
<td>8</td>
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<tr>
<td>Condensation</td>
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<tr>
<td>Evaporation</td>
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<tr>
<td>System Components</td>
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<td>Basic refrigeration cycle</td>
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<td>Safety</td>
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<tr>
<td>General shop safety</td>
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<td>Emergency procedures</td>
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Total Lecture Hours 30

LAB OUTLINE:

<table>
<thead>
<tr>
<th>Lab Topics</th>
<th>Contact Hrs.</th>
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<tbody>
<tr>
<td>Laws of Thermodynamics</td>
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<tr>
<td>Pressure and Temperature Relationships</td>
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<tr>
<td>Heat and Heat Transfer</td>
<td>5</td>
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<tr>
<td>Refrigeration Cycle</td>
<td>5</td>
</tr>
</tbody>
</table>

Total Lab Hours 20

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its “AMERICA 2000 REPORT” that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from “What Work Requires of Schools: A SCANS Report for America 2000.”

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. Resources: Identifies, organizes, plans, and allocates resources
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   B. Interpersonal: Works with others
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.
      5. Negotiates resources in order to accomplish objectives
      6. Works well with all members of the class
   C. Information: Acquires and uses information
      1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. Systems: Understands complex inter-relationships
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks
1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
   a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
   b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
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   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. **Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems

c. Demonstrates ability to understand and perform multi-step computations

d. Demonstrates ability to read, interpret, and use standard measuring devices

e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively

f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. **Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues

a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery

b. Demonstrates ability to hear, comprehend, and appropriately follow directions

c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. Speaking: Organizes ideas and communicates orally
a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and/or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative
a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. Problem Solving: Recognizes problems and devises and implements plan of action
a. Demonstrates ability to detect problem through observation, inquiry, or directive
b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. Seeing Things In the Mind’s Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information
a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. Demonstrates ability to visually discriminate in gross and fine imagery
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied tasks

4. Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills
a. Demonstrates mastery of basic reading, math, and language skills through application
b. Demonstrates ability to translate abstract theory into practical application
c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
d. Demonstrates knowledge of good study skills and learning habits

5. Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem
a. Demonstrates use of simple logic
b. Demonstrates ability to distinguish relationships
c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. Personal Qualities: Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. Responsibility: Exerts a high level of effort and perseveres towards goal attainment
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. Self-Esteem: Believes in own self-worth and maintains a positive view of self
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner

3. Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. **Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. **Integrity/Honesty:** Chooses ethical courses of action
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

**Appropriate Reference Materials:**

1. **MASTER Technical Modules:**
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B4;
   IMM-C1 through IMM-C3;
   IMM-D1;
   IMM-E1 through IMM-E2;
   IMM-H1;
   IMM-H3 through IMM-H8;
   IMM-J1 through IMM-J3;
   IMM-P1; and,
   IMM-Q1 through IMM-Q5.
### MASTER Curriculum
#### INDUSTRIAL MAINTENANCE
*(One Year Certificate Program)*

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Course Code</th>
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<td>Algebraic Concepts</td>
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<td>Direct Current Circuits I</td>
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<td>Industrial Maintenance Safety Procedures</td>
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<td>IMM 108</td>
<td>Industrial Mechanics I</td>
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<td>CMP 101</td>
<td>Introduction to Microcomputers</td>
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|         |             |                                                         | 16  | 12  | 21 |
| **SECOND QUARTER*** | ENGL 101  | English                                                 | 5   | 0   | 5  |
|         | ELC 109    | Alternating Current I                                   | 3   | 2   | 4  |
|         | ELC 110    | Alternating Current II                                  | 3   | 2   | 4  |
|         | IMM 128    | Pumps & Piping Systems                                  | 1   | 4   | 2  |
|         | IMM 113    | Industrial Hydraulics                                   | 6   | 4   | 8  |

|         |             |                                                         | 18  | 12  | 23 |
| **THIRD QUARTER*** | PSY 100    | Interpersonal Relations and Professional Development    | 3   | 0   | 3  |
|         | IMM 110    | Industrial Mechanics II                                 | 3   | 7   | 6  |
|         | IMM 115    | Industrial Pneumatics                                   | 3   | 2   | 4  |
|         | IMM 100    | Refrigeration Fundamentals                              | 3   | 2   | 4  |
|         | XXX ###   | Elective                                                | -   | -   | 3  |

|         |             |                                                         | 12  | 11  | 20 |
| **FOURTH QUARTER*** | WLD 133    | Metal Welding and Cutting Techniques                    | 2   | 3   | 3  |
|         | IMM 109    | Lathe Operations I                                      | 4   | 6   | 7  |
|         | IMM 133    | Industrial Maintenance-Mechanical Review               | 1   | 4   | 3  |
|         | XXX ###   | Elective                                                | -   | -   | 3  |

|         |             |                                                         | 7   | 13  | 16 |

*Each quarter is 10 weeks in length.*
MASTER PROGRAM

Metal Welding and Cutting Techniques

COURSE SYLLABUS

Total lecture hours: 20  Total lab hours: 30  Credit hours: 3

COURSE DESCRIPTION:

Provides instruction in the fundamental use of the electric arc welder and the oxyacetylene cutting outfit. Emphasis is placed on safe setup and use of equipment. Topics include: safety practices, arc welding equipment and setup, oxyfuel welding, flame cutting equipment and setup, and welding and cutting procedures.

PREREQUISITE: Provisional Admission

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:
1. Arc welding;
2. Flame cutting;
3. Safety practices;
4. Oxyfuel welding; and,
5. Brazing.

REQUIRED COURSE MATERIALS:

Textbook:  


Hand Tools/Quantity Required:
  Welding Hood
  Safety Gloves for Welding
  Safety Vest for Welding

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands-on process.
Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

<table>
<thead>
<tr>
<th>Lecture Topics</th>
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<tbody>
<tr>
<td>Arc Welding</td>
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<tr>
<td>Principles and Terminology</td>
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<tr>
<td>Applications</td>
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<tr>
<td>Safe Operating Procedures</td>
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<td>Metal Joints and Preparation</td>
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<td>Arc Weld</td>
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<td>Flame Cutting</td>
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<td>Principles and Terminology</td>
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<td>Applications</td>
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<td>Safe Operating Procedures</td>
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<td>Work Preparation</td>
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<td>Safety Practices</td>
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<tr>
<td>General</td>
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<tr>
<td>Arc Welding Applications</td>
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<tr>
<td>First Aid</td>
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<td>Oxyfuel Welding</td>
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<td>Principles and Terminology</td>
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<td>Applications</td>
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<td>Metal Joints and Preparation</td>
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<td>Oxyfuel Weld</td>
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<td>Brazing</td>
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<td>Principles and Terminology</td>
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<td>Metal Joints and Preparation</td>
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<td>Braze Metal</td>
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Total Lecture Hours 20
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<td>Safety Practices</td>
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<td><strong>Total Lab Hours</strong></td>
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COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its “AMERICA 2000 REPORT” that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from “What Work Requires of Schools: A SCANS Report for America 2000.”

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. **Resources:** Identifies, organizes, plans, and allocates resources
   1. Allocates time to complete assigned tasks on schedule
   2. Determines and allocates required materials and resources for meeting objectives
   3. Evaluates skills, performance, and quality of work and provides feedback

B. **Interpersonal:** Works with others
   1. Participates as a member of the team, contributing to group effort
   2. Provides individual assistance/direction to peers as requested
   3. Determines and meets expectations
   4. Exercises leadership qualities to effectively communicate ideas and make decisions.
   5. Negotiates resources in order to accomplish objectives
   6. Works well with all members of the class

C. **Information:** Acquires and uses information
   1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. Systems: Understands complex inter-relationships
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
   a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
   b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. **Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems

c. Demonstrates ability to understand and perform multi-step computations

d. Demonstrates ability to read, interpret, and use standard measuring devices

e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively

f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. **Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues

a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery

b. Demonstrates ability to hear, comprehend, and appropriately follow directions

c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately

e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. Speaking: Organizes ideas and communicates orally

a. Demonstrates appropriate listening and speaking skills in personal conversations

b. Demonstrates ability to choose and organize appropriate words to effectively communicate

c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation

d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and/or assessment purposes

e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups

f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations

g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative

a. Demonstrates ability to objectively assess personal strengths and weaknesses

b. Demonstrates ability to set realistic short-term and long-term goals

c. Demonstrates ability to recognize and distinguish between positive and negative alternatives

d. Demonstrates ability to identify potential pitfalls and take evasive actions

e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response

f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives

g. Demonstrates maturity in taking responsibility for decisions
2. **Problem Solving**: Recognizes problems and devises and implements plan of action
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. **Seeing Things In the Mind's Eye**: Organizes, and processes symbols, pictures, graphs, objects, and other information
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. **Knowing How to Learn**: Use efficient learning techniques to acquire and apply new knowledge and skills
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. **Reasoning**: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities**: Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. **Responsibility**: *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. **Self-Esteem**: *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner

3. **Sociability**: *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. **Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. **Integrity/Honesty:** Chooses ethical courses of action
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

**Appropriate Reference Materials:**

1. **MASTER Technical Modules:**
   - IMM-A1 through IMM-A6;
   - IMM-B1 through IMM-B2;
   - IMM-B4 through IMM-B6;
   - IMM-C1 through IMM-C3;
   - IMM-D1;
   - IMM-E1 through IMM-E2; and,
   - IMM-G1 through IMM-G3.
Master Program
Lathe Operations I
Course Syllabus

Total lecture hours: 40  Total lab hours: 60  Credit hours: 7

Course Description:
Provides opportunities for students to develop skill in the use of bench grinders and lathes. Topics include: lathes, bench grinders, bench grinder operations, lathe calculations, lathe setup, and lathe operations.

Prerequisite: Provisional Admission

Course Objectives:
After successful completion of this course, the students will be able to study, understand, and solve problems in:
1. Lathes;
2. Bench grinders;
3. Bench grinder operations;
4. Lathe calculations;
5. Lathe setup; and,

Required Course Materials:

Hand Tools/Quantity Required:
Hand Tools
Calculator

Method of Instruction:
Lecture: Didactic presentations will include lecture, video and demonstrations.
Laboratory: Laboratory will be a hands-on process.
Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

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<th>Lecture Topics</th>
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<td>Lathe Parts</td>
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<td>Lathe Lubrication System</td>
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<td>Lathe Maintenance</td>
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<td>Sharpening</td>
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<td>Grinding</td>
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<td>Speeds and Feeds</td>
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<td>Other Calculations (Tapers, Threads, Drilling)</td>
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Total Lecture Hours 40

LAB OUTLINE:

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COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its “AMERICA 2000 REPORT” that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from “What Work Requires of Schools: A SCANS Report for America 2000.”

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. Resources: Identifies, organizes, plans, and allocates resources
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   B. Interpersonal: Works with others
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations
      4. Exercises leadership qualities to effectively communicate ideas and make decisions.
      5. Negotiates resources in order to accomplish objectives
      6. Works well with all members of the class
   C. Information: Acquires and uses information
      1. Acquires and evaluates information
      2. Organizes and maintains information
      3. Interprets and communicates information
   D. Systems: Understands complex inter-relationships
      1. Understands and works well with social, organizational, and technological systems
      2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
   a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
   b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. **Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. Demonstrates ability to understand and perform multi-step computations
d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively

4. **Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. **Speaking:** Organizes ideas and communicates orally
a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and/or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

I. Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative
a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. Problem Solving: Recognizes problems and devises and implements plan of action
a. Demonstrates ability to detect problem through observation, inquiry, or directive
b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. Seeing Things In the Mind's Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information
a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. Demonstrates ability to visually discriminate in gross and fine imagery
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied tasks

4. Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills
a. Demonstrates mastery of basic reading, math, and language skills through application
b. Demonstrates ability to translate abstract theory into practical application
c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
d. Demonstrates knowledge of good study skills and learning habits

5. Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem
a. Demonstrates use of simple logic
b. Demonstrates ability to distinguish relationships
c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly
C. **Personal Qualities**: Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. **Responsibility**: Exerts a high level of effort and perseveres towards goal attainment
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. **Self-Esteem**: Believes in own self-worth and maintains a positive view of self
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner

3. **Sociability**: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. **Self-Management**: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control
a. Accepts personal strengths and weaknesses and uses the same for positive advancement
b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
c. Demonstrates ability to formulate and follow personal schedules
d. Demonstrates ability to wisely use classroom time
e. Demonstrates use of good study habits and skills
f. Demonstrates maturity to take responsibility for own actions

5. **Integrity/Honesty: Chooses ethical courses of action**
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

**Appropriate Reference Materials:**

1. **MASTER Technical Modules:**
   IMM-A1 through IMM-A6;
   IMM-B1 through IMM-B6;
   IMM-C1 through IMM-C3;
   IMM-D1 through IMM-D2;
   IMM-E1 through IMM-E2; and,
   IMM-F1 through IMM-F6.
MASTER PROGRAM
Industrial Maintenance–Mechanical Review
COURSE SYLLABUS

Total lecture hours: 10       Total lab hours: 40       Credit hours: 3

COURSE DESCRIPTION:

Summarizes and integrates all previous CMP, ELC, and IMM courses designed to assist Industrial Maintenance Technology students in assembly, troubleshooting, and repair of multi-system machinery and devices. Topics include: electrical, mechanical, and fluidic interfacing in complex and industrial equipment.

PREREQUISITE/COREQUISITE: All Program Courses

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:
1. Math;
2. Alternating current;
3. Direct current;
4. AC/DC motors;
5. Refrigeration;
6. Pumps and piping systems;
7. Industrial hydraulics;
8. Industrial pneumatics;
9. Lathe operations;
10. Industrial mechanics;
11. Welding; and,
12. Safety.

REQUIRED COURSE MATERIALS:

Textbook: All previous books
Lab Manual: All previous books
Hand Tools/Quantity Required:
- Tools: 1 set
- Safety Glasses: 1 pair
- Classroom Supplies: 1
- Calculator: 1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands-on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:
1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Contact Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic Test, Safety, AC and DC Circuits</td>
<td>1</td>
</tr>
<tr>
<td>Math, Motor Controls</td>
<td>1</td>
</tr>
<tr>
<td>Pneumatics, Pumps and Piping Systems</td>
<td>1</td>
</tr>
<tr>
<td>Test 1</td>
<td></td>
</tr>
<tr>
<td>Rebuild Air Compressor (Project 1)</td>
<td>1</td>
</tr>
<tr>
<td>Rebuild Air Compressor (Project 1) (continued)</td>
<td>1</td>
</tr>
<tr>
<td>Test 2</td>
<td></td>
</tr>
<tr>
<td>Complete All Assignments and Project 1</td>
<td>1</td>
</tr>
<tr>
<td>Mechanics</td>
<td>1</td>
</tr>
<tr>
<td>Hydraulics</td>
<td>1</td>
</tr>
<tr>
<td>Test 3</td>
<td></td>
</tr>
<tr>
<td>Lathe Operations, Welding</td>
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</tr>
</tbody>
</table>
Refrigeration
Complete All Assignments
Final Exam

Total Lecture Hours 10

LAB OUTLINE:

<table>
<thead>
<tr>
<th>Lab Topics</th>
<th>Contact Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rebuild Air Compressor</td>
<td>12</td>
</tr>
<tr>
<td>Rebuild Pump</td>
<td>12</td>
</tr>
<tr>
<td>Troubleshoot Motor Control</td>
<td>8</td>
</tr>
<tr>
<td>Troubleshoot Lathe</td>
<td>4</td>
</tr>
<tr>
<td>Troubleshoot Refrigeration System</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Total Lab Hours 40</td>
</tr>
</tbody>
</table>

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. Resources: Identifies, organizes, plans, and allocates resources
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   
   B. Interpersonal: Works with others
      1. Participates as a member of the team, contributing to group effort
      2. Provides individual assistance/direction to peers as requested
      3. Determines and meets expectations

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4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. Information: Acquires and uses information
1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. Systems: Understands complex inter-relationships
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks
   1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
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   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. **Listening**: Receives, attends to, interprets, and responds to verbal messages and other cues
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
b. Demonstrates ability to hear, comprehend, and appropriately follow directions
c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
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   d. Demonstrates ability to wisely use classroom time
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   IMM-E1 through IMM-E2;
IMM-F1 through IMM-F6;
IMM-G1 through IMM-G3;
IMM-H1 through IMM-H9;
IMM-I1 through IMM-I4;
IMM-J1 through IMM-J3;
IMM-K1 through IMM-K7;
IMM-L1 through IMM-L2;
IMM-M1 through IMM-M2;
IMM-N1 through IMM-N2;
IMM-O1 through IMM-O2;
IMM-P1 through IMM-P4;
IMM-Q1 through IMM-Q5;
IMM-R1 through IMM-R5; and,
IMM-S1 through IMM-S7.
MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

a consortium of educators and industry

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY

Industrial Maintenance Series
INSTRUCTOR'S HANDBOOK
DUTIES A THROUGH H

Supported by the National Science Foundation's Advanced Technological Education Program
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Supported by the National Science Foundation's Advanced Technological Education Program
ACKNOWLEDGEMENTS

This project was made possible by the cooperation and direct support of the following organizations:

National Science Foundation - Division of Undergraduate Education
MASTER Consortia of Employers and Educators

MASTER has built upon the foundation which was laid by the Machine Tool Advanced Skills Technology (MAST) Program. The MAST Program was supported by the U.S. Department of Education - Office of Vocational and Adult Education. Without this prior support MASTER could not have reached the level of quality and quantity that is contained in these project deliverables.

MASTER DEVELOPMENT CENTERS
Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES

COLLEGE AFFILIATES

FEDERAL LABS
Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS
Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -
Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS
American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS
Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS
The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.
Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION
Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.
Manufacturing in the Augusta Region
Augusta is the second largest city in Georgia and manufacturing represents the largest sector of the Augusta economy. The region is home to 810 manufacturers employing 89,717 people, an industrial base consisting of about 75% process control and 25% discrete parts production facilities. Major areas of emphasis for industry include technology transfer, factory floor training, and job certification programs. Growth of manufacturing in the region has been driven by Augusta’s high tech development in electronics, process control, telecommunications, computers, medical services and instrumentation.

Augusta Technical Institute and Center for Advanced Technology (CADTEC)
Augusta Technical Institute (ATI) is part of Georgia’s Department of Technical and Adult Education system, serving a large percentage of the two-state Central Savannah River area through its main campus and satellite facilities. The student body includes vocational-technical and college prep students, as well as current workers seeking retraining or skills upgrade; ATI has long emphasized outreach and special attention to the needs of low income, rural and disadvantaged residents, as well as displaced workers, single parents, women in non-traditional fields, and the disabled. In 1983, the Institute used the opportunity to host one of Georgia’s new regional advanced technology centers (ATC’s) to streamline its technical programs and thereby help to ensure the future employability of its students. ATI’s Center for Advanced Technology (CADTEC) is designed to provide technology research and demonstration, industry assessments, technical consulting, and industry-specific contract training for the many established and emerging high tech companies in the Augusta region.

Development Team
- **Project Director:** Mr. Ray Center, Director of CADTEC, served as program director for the MASTER project.
- **Subject Matter Expert:** Ronnie Lambert, MS, MASTER Site Coordinator, had program responsibility for developing skill standards based on the industry skills verification process, as well as developing course curricula and program materials for the MASTER pilot program in Industrial Maintenance Mechanic and Instrumentation Technician. Mr. Lambert has taught Industrial Maintenance Mechanic and Instrumentation for 32 years in colleges and industry across the Southeast.
Introduction:
INSTRUCTOR'S HANDBOOK

Prior to the development of this Instructor's Handbook, MASTER project staff visited over 150 companies, conducted interviews with over 500 expert workers, and analyzed data from a national survey involving over 2800 participating companies. These investigations led to the development of a series of Instructor Handbooks, with each being fully industry-driven and specific to one of the technologies shown below.

Advanced CNC and CAM
Automated Equipment Repair
Computer Aided Design & Drafting
Conventional Machining
Industrial Maintenance
Instrumentation
LASER Machining
Manufacturing Technology
Mold Making
Tool And Die
Welding

Each Instructor's Handbook contains a collection of Technical Training Modules which are built around a Competency Profile for the specific occupation. The Competency Profile which is the basis for this Instructor's Handbook, may be found on the following page (and on each of the tab pages of this book).

Each Technical Training Module has been designed to be:

* Based on skill standards specified by industry. There must be a direct correlation between what industry needs and what is taught in the classroom and in the laboratory. For many years this type of training has been known as “competency-based training”.

* Generic in nature. The training materials may then be customized by the trainer, for any given training situation based on the training need.

* Modular in design, to allow trainers to select lessons which are applicable to their training needs.

* Comprehensive, include training for advanced and emerging, highly-specialized manufacturing technologies.
Self-contained, including all the components which might be needed by an experienced trainer. These components might include any or all of the following:

- a standardized lesson plan,
- an assessment instrument,
- a listing of commercially available resources (e.g., recommended textbooks, instructor guides, student manuals, and videos),
- new training materials, when suitable existing materials are not available (e.g., classroom handouts, transparency masters, and laboratory exercises).

This Instructor's Handbook is arranged by Duty groupings (Duty A, Duty B, etc.) with technical modules developed for each Task Box on the Competency Profile. Trainers are free to choose modules for a specific training need and combine modules to build individualized training programs.

This Instructor's Handbook is being offered with an accompanying Student Laboratory Manual for use by the students enrolled in the training program.
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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INDUSTRIAL MAINTENANCE MECHANIC uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<td>Maintain/ Troubleshoot Equipment and Systems</td>
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<td>Maintain/ Troubleshoot Equipment and Systems</td>
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<td>Maintain/ Troubleshoot Equipment and Systems</td>
<td>H-7 Troubleshoot, maintain, and repair hydraulic systems</td>
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<td>H-8 Troubleshoot, maintain, and repair hydraulic systems</td>
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<td>Repair Power Transmission Systems</td>
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INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-A1

Subject: Industrial Maintenance

Duty: Practice Safety
Task: Use Protective Equipment

Objective(s):

Upon completion of this module the student will be able to:

a. Identify safety equipment appropriate to protect the eyes from flying particulate matter or chemicals;
b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
c. Identify equipment appropriate to protect against high level of noise;
d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials; and,
e. Identify safety equipment appropriate to protect the lungs from chemicals or particles.

Instructional Materials:

Overhead Projector;
Gloves
Safety Goggles
Dust Mask
Hearing Protection (ear plugs and ear muffs)
Face Shields
Handout Reading Assignments
MASTER Handout (IMM-A1-HO)
Copy of 29 CFR 1910 Regulations
MASTER Laboratory Aid (IMM-A1-LA)
MASTER Laboratory Worksheet (IMM-A1-LW)
MASTER Self-Assessment

References:

Complete Text of OSHA Guidelines - 29 CFR 1910
First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; and Loss Prevention Data, Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston-Providence Turnpike, Norwood, MA 02062, Latest Editions


Encyclopedia of Occupational Health and Safety; and Loss Control, International Labor Organization, 666 11th St. NW., Washington, DC 20001, Latest Editions


Air Purifying Respirators, - 30m - Video Tape - NUS Training Corp., 910 Clopper Rd., Gaithensbury, MD 20878, Latest Edition

Personal Protection, - 20m - Video Tape - NUS Training Corp., 910 Clopper Rd., Gaithensbury, MD 20878, Latest Edition

Using Respirators In Hazardous Environments, - 30m - Video Tape - NUS Training Corp., 910 Clopper Rd., Gaithensbury, MD 20878, Latest Edition

Four Elements of Respiratory, - 11m - Video Tape, Latest Edition
Student Preparation:

All students must prepare themselves to enhance their attitudes toward safety. Such preparation may begin by the students asking themselves the following basic questions daily:

1. Is my hair properly stowed to prevent accidents?
2. Am I wearing any jewelry?
3. Do I have the proper shoes?
4. Do I have my eye shields (safety glasses)?
5. Is my work area free of debris and clean?
6. Does my machine have all its safeguards?
7. Is my machine working properly?
8. Do I know where the nearest fire extinguisher is?

Introduction:

Working safely should be the concern of every individual. Safety includes protecting yourself and others from injury. While others — your employer, your family, governmental agencies, and insurance companies — are concerned for your well-being, you have the final responsibility for your safety in the workplace. Being aware of your surrounding and selecting and using correct safety equipment is your responsibility.

Presentation Outline:

I. Describe Types of Conditions That Would Require the Use of Protective Equipment Due to Air Borne Partials
   A. Grinding operations
   B. Any time while in an active production environment
   C. Near welding operations
D. Near high pressure water, air, or other mediums, i.e., oil
E. Possibility of splashing chemicals

II. Identify Condition That Would Require the Use of a Hard Hat
A. Generally anytime while in a construction or manufacturing environment
B. In areas with low overhead clearances

III. Review Conditions That Would Require Use of Hearing Protection
A. Ear plugs
B. Ear muffs
C. OSHA requirements

IV. Describe Typical Conditions That Would Warrant Use of Gloves to Protect the Hands
A. Grinding
B. Working with rough metals
C. Working with multi strand steel cables
D. Electrical (special insulated gloves may be required for certain voltages)

V. Identify How Lungs Are Protected from Harmful Chemicals/Particles
A. Plant engineering/ventilation
B. Use of respirators or bubble suits
C. Review OSHA requirements for fiber glass, asbestos and chemical protection

Practical Application:

1. Instructor will demonstrate selection and proper use of safety equipment.
2. Students will be allowed to practice the use of safety equipment.

Evaluation and/or Verification:

Successful completion of this Technical Module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objective as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-A2) dealing with accident prevention.
Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
- Using OSHA required safety equipment for the shop;
- Safety glasses;
- Hearing protection;
- Face shields;
- Gloves;
- Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
- Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify safety equipment appropriate to protect the eyes from flying particle matter or chemicals;

b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;

c. Identify equipment appropriate to protect against high level of noise;

d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials; and,

e. Identify safety equipment appropriate to protect the lungs from chemicals or particles.

Reading Assignments:

The following chapters are assigned to read from Supervisor’s Safety Manual textbook, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Controlling Hazards; Protecting the Eyes: Equipment Types, Face Protection, Overcoming Employee Complaints; Protecting the Head: Fabrication, Auxiliary Features, Overcoming Objections; Ear Protection: Amount of Protection, Insert-Type Protectors, Muff Types; Protecting Fingers, Palms, and Hands; Protecting the Torso; Respiratory Protective Equipment: Selecting the Respirator, Overcoming Employee Complaints; Safety Belts and Harnesses: Fabrication, Lifelines, Inspection</td>
</tr>
</tbody>
</table>
Module Outline:

I. Describe Types of Conditions That Would Require the Use of Protective Equipment Due to Air Borne Partials
   A. Grinding operations
   B. Any time while in an active production environment
   C. Near welding operations
   D. Near high pressure water, air, or other medians, i.e., oil
   E. Possibility of splashing chemicals

II. Identify Condition That Would Require the Use of a Hard Hat
   A. Generally anytime while in a construction or manufacturing environment
   B. In areas with low overhead clearances

III. Review Conditions That Would Require Use of Hearing Protection
   A. Ear plugs
   B. Ear muffs
   C. OSHA requirements

IV. Describe Typical Conditions That Would Warrant Use of Gloves to Protect the Hands
   A. Grinding
   B. Working with rough metals
   C. Working with multi strand steel cables
   D. Electrical (special insulated gloves may be required for certain voltages)

V. Identify How Lungs Are Protected from Harmful Chemicals/particles
   A. Plant engineering/ventilation
   B. Use of respirators or bubble suits
   C. Review OSHA requirements for fiber glass, asbestos and chemical protection
Standards of Performance Safety:

Student shall demonstrate safe attitude by:
- Using OSHA required safety equipment for the shop;
- Safety glasses;
- Hearing protection;
- Face shields;
- Gloves;
- Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
- Not participating in horse play or practical joking.

Conduct:

1. There will be no horse play or practical joking; and,
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.
1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   Ear plugs
   Ear muffs

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercise inserting and removing ear plugs.

5. Practice using ear plugs.

6. Practice exercise using ear muffs.
IMM-A1
Use Protective Equipment
Self-Assessment

1. What should not be worn around rotating or other movable-parts machinery?

2. Name two types of devices which provide protection to the eye.

3. There are three types of coverings that provide protection from objects striking the head. Name two of them.

4. How do you determine if a pair of glasses are safety glasses?

5. Of the two types of ear protection, which generally gives the best protection?

6. What type of safety devices and apparel should be worn when you use solvents to clean parts or surfaces?

7. List all types of hearing protection.

8. List all types of safety glasses.
9. What is purpose of eyewash equipment?

10. What is FDA?
1. Loose clothing

2. a. Safety glasses
   b. Goggles

3. a. Hard hat
   b. Bump hat
   c. Skull hat

4. Manufacture's symbol on lens and frames

5. Ear muffs

6. Rubber or plastic covered gloves and apron plus safety glasses

7. Ear muffs, ear plugs

8. Goggles, safety glasses

9. Dilute toxic chemical in eye(s)

10. Food and drug administration
INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-A2

Subject: Industrial Maintenance               Time: 4 Hrs.

Duty: Practice Safety
Task: Accident Prevention

Objective(s):
Upon completion of this module the student will be able to:

a. Identify the two major factors in working safely;
b. List four steps you can take prior to performing work that will insure a safe outcome;
c. Identify the employee's responsibility if a potential accident or unsafe condition exists; and,
d. Select specific tasks that have the potential to cause an injury.

Instructional Materials:

Reading Assignment
MASTER Handout (IMM-A2-HO)
Paper
Pencil
Chalkboard
Overhead Projector
MASTER Self-Assessment

References:

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; and Loss Prevention Data, Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston - Providence Turnpike, Norwood, MA 02062, Latest Editions


Encyclopedia of Occupational Health and Safety; and Loss Control, International Labor Organization, 666 11th St. NW., Washington, DC 20001, Latest Editions


Supervisors Development Program - 10m - Video Tape - National Safety Council, Latest Edition


Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-A1 “Use Protective Equipment”

Introduction:

Accident prevention is the responsibility of management and every employee. You must continually be alert for potential or actual unsafe conditions. An attitude of safety will prevent injury, protect your job, and reduce operating costs for your employer. Relate the word accident to terms like broken back, blindness, and death to get it in perspective.
Presentation Outline:

I. Major Factors in Working Safely
   A. Knowing what the records are
   B. Recognizing when things are not as they should be
   C. Attitude towards safety
      1. A state of mind that requires you to accept responsibility for your own and your co-workers safety
      2. A state of mind that does not compromise safety for production or speed
      3. A state of mind that would stop production rather than put an employee at unnecessary risk

II. Four Steps That Help Insure a Safe Job
    A. Preparing to do the job
       1. Research task to insure it can be performed
       2. Appropriate tools and help are available
       3. Proper lockout procedure
    B. Select appropriate safety equipment
    C. Once the job starts, maintain a clean work place
    D. Avoid unsafe practices
       1. Failing to use safety equipment
       2. Performing task you are not qualified to perform
       3. Rushing
       4. Practical joking
       5. Making do with a tool rather than getting the right tool

III. Employee Responsibility
    A. Assume responsibility for your own safety
    B. Notify crew and supervision of an unsafe condition
    C. Stop work if unsafe condition is identified

IV. Task That Have the Potential to Cause Injury
    A. Working with electricity
    B. Working near rotating equipment
    C. Working with chemicals and solvents
    D. Using pneumatic or hydraulic equipment
    E. Using ladders
    F. Lifting heavy objects
    G. Working in areas with harmful fumes

Evaluation and/or Verification:

Successful completion of this Technical Module will be based on the student's successful completion of the written evaluation.
Summary:

Review the main lesson points using the objective as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-A3) dealing with working aloft.
Objective(s):

Upon completion of this module the student will be able to:

a. Identify the two major factors in working safely;

b. List four steps you can take prior to performing work that will insure a safe outcome;

c. Identify the employees responsibility if a potential accident or unsafe condition exist; and,

d. Select specific task that have the potential to cause an injury.

Reading Assignments:

The following chapters are assigned to read from Supervisor's Safety Manual textbook, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
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</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Giving Instructions: Importance of Job Instruction, Starting the New Man; On-the-Job Training: Over-the-Shoulder Coaching; Job Safety Analysis: Select the Job, Break the Job Down, Identify Hazards and Potential Accidents, Develop Solutions, Benefits of JSA; Job Instruction Training: Step 1-Preparations, Step 2-Presentation, Step 3-Application, Step 4-Testing Follow-up; Other Methods of Instruction: The Lesson Plan, Programmed Instruction, Independent Study, Closed-Circuit TV, Summary.</td>
</tr>
</tbody>
</table>
FIRE PREVENTION CHECK LIST

ELECTRICAL EQUIPMENT

☐ No make shift wiring
☐ Extension cords serviceable
☐ Motors and tools free of dirt and grease
☐ Lights clear of combustible materials
☐ Safest cleaning solvents used
☐ Fuse and control boxes clean and closed
☐ Circuits properly fused
☐ Equipment approved for use in hazardous areas (if required)
☐ Ground connection clean and tight

FRICTION

☐ Machinery properly lubricated
☐ Machinery properly adjusted and aligned

SPECIAL FIRE-HAZARD MATERIALS

☐ Special isolation of flammable materials
☐ Nonmetal stock free of tramp metal

WELDING AND CUTTING

☐ Areas surveyed for fire safety
☐ Combustibles removed or covered
☐ Permit issued

OPEN FLAMES

☐ Kept away form spray rooms and booths
☐ Portable torches clear of flammable surfaces
☐ No gas leaks

PORTABLE HEATERS

☐ Set up with ample horizontal and overhead clearances
☐ Secured against tipping or upset
☐ Combustibles removed or covered
☐ Safely mounted on noncombustible surface
☐ Not used as rubbish burners

HOT SURFACES

☐ Hot pipes clear of combustible materials
☐ Ample clearance around boilers and furnaces
☐ Soldering irons kept off combustible surfaces
☐ Ashes in metal containers
SMOKING AND MATCHES
- "No smoking" and "smoking" areas clearly marked
- Butt containers available and serviceable
- No discarded smoking materials in prohibited areas

SPONTANEOUS IGNITION
- Flammable waste material in closed metal containers
- Flammable waste material containers emptied frequently
- Piled material cool, dry, and well ventilated
- Trash receptacles emptied daily

STATIC ELECTRICITY
- Flammable liquid dispensing vessels grounded or banded
- Moving machinery grounded
- Proper humidity maintained

HOUSEKEEPING
- No accumulations of rubbish
- Safe storage of flammables
- Passageways clear of obstacles
- Premises free of unnecessary combustible materials
- No leaks or dripping of flammables and floor free of spills
- Fire doors unblocked and operating freely with fusible links intact

EXTINGUISHING EQUIPMENT
- Proper type
- In proper location
- Unobstructed
- Clearly marked
- In working order
- Service date current
- Personnel trained in use of equipment
Module Outline:

I. Major Factors in Working Safely
   A. Knowing what the records are
      1. Recognizing when things are not as they should be
   B. Attitude towards safety
      1. A state of mind that requires you to accept responsibility for your own and your coworkers’ safety
      2. A state of mind that does not compromise safety for production or speed
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      1. Failing to use safety equipment
      2. Performing task you are not qualified to perform
      3. Rushing
      4. Practical joking
      5. Making do with a tool rather than getting the right tool

III. Employee Responsibility
   A. Assure responsibility for your own safety
   B. Notify crew and supervision of an unsafe condition
   C. Stop work if unsafe condition is identified

IV. Task That Have the Potential to Cause Injury
   A. Working with electricity
   B. Working near rotating equipment
   C. Working with chemicals and solvents
   D. Using pneumatic or hydraulic equipment
   E. Using ladders
   F. Lifting heavy objects
   G. Working in areas with harmful fumes
IMM-A2
Accident Prevention
Self-Assessment

1. List two major factors in working safely.
   ____________________________________________
   ____________________________________________

2. List four steps that help insure a safe job.
   ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________

3. Safety is ________________ responsibility.

4. List four tasks that have the potential to cause injury.
   ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________

5. One of the most important factors in personal safety is
   ________________________.
1. Knowing what the hazards are and how to avoid them. Right attitude towards safety.

2. a. Be alert to unsafe condition  
b. Observe and recognize unsafe condition  
c. Decide how to handle situation safely  
d. Take necessary precaution to avoid injury

3. Your

4. a. Not right safety attitude  
b. Not obeying safety rules  
c. Not following safety procedure  
d. Not using PPE

5. Attitude
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-A3

Subject: Industrial Maintenance
Time: 5 Hrs.

Duty: Practice Safety
Task: Working Aloft

Objective(s):

Upon completion of this module the student will be able to:

a. Describe typical safety equipment used when working aloft;
b. Describe how to set up a portable ladder for use;
c. Define basic safety concerns while working from scaffolding;
d. Identify the safety concerns to be addressed while working from a personal man basket;
e. Demonstrate use of a safety belt/harness; and,
f. Demonstrate proper set up and use of a portable ladder.

Instructional Materials:

Safety Belt
Extension Ladder
Hard Hat (Instructor's Discretion)
Safety Glasses
MASTER Handout (IMM-A3-HO)
MASTER Laboratory Aid (IMM-A3-LA)
MASTER Laboratory Worksheet (IMM-A3-LW)
MASTER Self-Assessment

References:

29 CFR 1910.25,26
29 CFR 1910.66

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; Loss Prevention Data, Factory Mutual Engineering Corporation of the Factory Mutual
System, 1151 Boston - Providence Turnpike, Norwood, MA 02062, Latest Editions


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**Student Preparation:**

Students should have previously completed the following Technical Modules:

- IMM-A1  "Use Protective Equipment"
- IMM-A2  "Accident Prevention"

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**Introduction:**

All maintenance technicians have to work aloft occasionally. This may be safely done if the technician is familiar with industry and OSHA regulations. An attitude of safety, the correct safety equipment, and proper training are all essential.
Presentation Outline:

I. Identify Safety Equipment Used When Working Aloft
   
   Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA's rules
   
   A. Equipment common to most personnel when working aloft
      1. Safety glasses
      2. Hard hat
      3. Safety belt or harness

II. Describe How to Set up a Portable Ladder for Use
   
   A. Portable ladder are broken down in the CFRs as metal and wood ladders
      B. Wood ladders see 29 CFR 1910.25
         1. Single section ladder
         2. Two section ladder
         3. Special use wood ladders
         4. Step ladder
      C. Metal ladders see 29 CFR 1910.26
      D. Set up 29 CFR 1910.26
         1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall for all sectional ladders

III. Basic Safety Concerns While Working from Scaffolding
     
     Note: This module does not address scaffolding erection because special training is required
     
     A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
     B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
     C. Never lean over the handrails to perform work

IV. Concerns While Working from a Manlift or Personnel Lift (see 29 CFR 1910.68)
    
    A. Use basket or lift for employees and tools only, not freight
    B. If basket has integral test weights insure weights are removed prior to lifting personnel
    C. Hands must be inside basket while basket is moving
    D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
    E. Always inspect basket rigging prior to entry
    F. Once the basket is in position it must be tied off if egress from the basket is required

V. Demonstrate Proper Set up and Use of an Extension Ladder
    
    A. Determine wall to base of ladder distance
    B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder
Practical Application:

Students will practice in the lab. Each student will complete the MASTER Laboratory Worksheet (IMM-A3-LW) and turn in to the instructor for checking.

Evaluation and/or Verification:

Successful completion of this Technical Module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objective as a guide. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-A4) dealing with fire safety.
Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Describe typical safety equipment used when working aloft;
b. Describe how to set up a portable ladder for use;
c. Define basic safety concerns while working from scaffolding;
d. Identify the safety concerns to be addressed while working from a personal man basket;
e. Demonstrate use of a safety belt/harness; and,
f. Demonstrate proper set up and use of a portable ladder.

Reading Assignments:

The following chapters are assigned to read from textbook:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Manual Handling Methods; Lifting and Carrying; Equipment for Handling; Hand Trucks, Ropes, Chains and Slings; Fiber Ropes; Rope Slings</td>
</tr>
</tbody>
</table>

Module Outline:

I. Identify Safety Equipment Used When Working Aloft

   Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA

   A. Equipment common to most personnel when working aloft
       1. Safety glasses
2. Hard hat
3. Safety belt or harness

II. Describe How to Set up a Portable Ladder for Use
A. Portable ladder are broken down in the CFRs as metal and wood ladders
B. Wood ladders see 29 CFR 1910.25
   1. Single section ladder
   2. Two section ladder
   3. Special use wood ladders
   4. Step ladder
C. Metal ladders see 29 CFR 1910.26
D. Set up 29 CFR 1910.26
   1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall

III. Basic Safety Concerns While Working from Scaffolding
   Note: This module does not address scaffolding erection because special training is required
A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
C. Never lean over the handrails to perform work

IV. Concerns While Working from a Man Basket or Personnel Lift
A. Use basket or lift for employees and tools only, not freight
B. If basket has integral test weights insure weights are removed prior to lifting personnel
C. Hands must be inside basket while basket is moving
D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
E. Always inspect basket rigging prior to entry
F. Once the basket is in position it must be tied off if egress from the basket is required

V. Demonstrate Proper Set up and Use of an Extension Ladder
A. Determine wall to base of ladder distance
B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder
IMM-A3-LA
Working Aloft
Attachment 2: MASTER Laboratory Aid

Standards of Performance Safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Conduct:

1. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.
I. Identify Safety Equipment Used When Working Aloft

   Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA

   A. Equipment common to most personnel when working aloft
      1. Safety glasses
      2. Hard hat
      3. Safety belt or harness

II. Describe How to Set up a Portable Ladder for Use

   A. Portable ladder are broken down in the CFRs as metal and wood ladders
   B. Wood ladders see 29 CFR 1910.25
      1. Single section ladder
      2. Two section ladder
      3. Special use wood ladders
      4. Step ladder
   C. Metal ladders see 29 CFR 1910.26
   D. Set up 29 CFR 1910.26
      1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall

III. Basic Safety Concerns While Working from Scaffolding

   Note: This module does not address scaffolding erection because special training is required

   A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
   B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
   C. Never lean over the handrails to perform work

IV. Concerns While Working from a Man Basket or Personnel Lift

   A. Use basket or lift for employees and tools only, not freight
   B. If basket has integral test weights insure weights are removed prior to lifting personnel
   C. Hands must be inside basket while basket is moving
   D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
   E. Always inspect basket rigging prior to entry
   F. Once the basket is in position it must be tied off if egress from the basket is required

V. Demonstrate Proper Set up and Use of an Extension Ladder

   A. Determine wall to base of ladder distance
B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder
IMM-A3
Working Aloft
Self-Assessment

1. A ladder with a 250 lb. weight capacity for heavy duty use is considered:
   a. Type IA
   b. Type I
   c. Type II
   d. Type III

2. An aluminum ladder can be used near electrical sources if it has rubber feet on the bottom.
   a. True
   b. False

3. How far must a ladder extend beyond the roof line if you are going to climb onto the structure?
   a. 1 foot
   b. 3 feet
   c. 10 feet
   d. None of the above

4. The base of a ladder should be placed so that it is one foot away from the structure for every four feet of height to the point where the ladder rests against the building?
   a. True
   b. False

5. A ladder whose top support points is 12 feet high should be how far from the structure?
   a. 2 feet
   b. 3 feet
   c. 4 feet
   d. None of the above

6. A step ladder can be leaned against a structure if it is secured at the bottom.
   a. True
   b. False
7. How often should a ladder be inspected?
   a. Once a month by maintenance personnel only
   b. Only if it has been dropped
   c. Before each use
   d. None of the above
IMM-A3
Working Aloft
Self-Assessment Answer Key

1. b
2. b
3. b
4. a
5. b
6. a
7. c
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-A4

Subject: Industrial Maintenance  Time: 4 Hrs.

Duty: Practice Safety
Task: Fire Safety

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the technician's responsibilities relative to fire safety;
b. List conditions required for fire to exist;
c. Name four classes of fires;
d. List four typical causes of industrial fires described in the lesson;
e. Match the correct class extinguishers to a given fuel source; and,
f. Demonstrate proper use of a fire extinguisher.

Instructional Materials:

Dust Mask
Gloves
Face Shields
Side Shields
Outside space appropriate for controlled fire
Adequate extinguishers to use for practice
Emergency extinguishers for correct class of the fire
MASTER Handout (IMM-A4-HO)
MASTER Laboratory Aid (IMM-A4-LA)
MASTER Laboratory Worksheet (IMM-A4-LW)
MASTER Self-Assessment

References:

29 CFR 1910.155
29 CFR-1910.157

First Aid Textbook, American National Red Cross, 17th and D Sts. NW.,
Washington DC 20006, Latest Edition
Approval Guide; Handbook of Property Conservation; and Loss Prevention Data, Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston-Providence Turnpike, Norwood, MA 02062, Latest Editions


Fire Fighting Equipment - 15m - Video Tape - (Akron), Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-A1 "Use Protective Equipment"
IMM-A2 "Accident Prevention"
IMM-A3 "Working Aloft"

Introduction:

This module will provide you with the knowledge to prevent fires, and teach you how to react in the event of a fire and how to operate an extinguisher. It is not intended to make you a fire fighter. Each industry has its own procedure for handling fires and that procedure should become part of this module prior to teaching.
Working in Areas With Harmful Fumes:

In the operation of welding and cutting, toxic materials are given off in the form of smoke and other gases. Work areas in which this type of work is done must be well ventilated to prevent inhalation of toxic fumes and to prevent the possibility of oxygen deficiency. Certain metals, fluxes, and cleaning compounds are inhalation hazards. These include fluorine, lead, zinc, iron oxide, beryllium, cadmium, and mercury. If you doubt that ventilation is adequate, discontinue welding or cutting which involves these materials.

Presentation Outline:

I. Technician's Responsibility
   A. Each employer will have company specific rules
   B. Unless the technician is part of the company fire fighting crew or fire brigade
      1. Notify every one in the area to evacuate
      2. Get to a phone and notify appropriate department
      3. Something as simple as an ash tray or trash can can start fire that may be easily and safely extinguished. Appropriate department must be notified of the event
      4. Employees are responsible for keeping the workplace safe and for reporting unsafe conditions

II. Identify Conditions Required for a Fire to Exist
    A. Fuel
    B. Oxygen
    C. Heat

III. Four Classes of Fire
    A. Ordinary combustibles
    B. Flammable liquids
    C. Electrical
    D. Combustible metals

IV. List Four Typical Causes of Workplace Fires
    A. Careless smokers
    B. Electrical overloads
    C. Inadequate fire watch for welding and cutting operations
    D. Combustible dust in the atmosphere

V. Demonstrate to Class How to Match the Correct Extinguishers for the Class of Fire

VI. Demonstrate Proper Use of a Fire Extinguisher
Practical Application:

Students will practice under instructor supervision using the correct extinguisher and extinguishing a fire. Each student will select, check, and use the appropriate extinguisher to put out a fire.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the readout (IMM-A4-HO). Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-A5) dealing with lifting safety.
Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the technicians responsibilities relative to fire safety;
b. List conditions required for fire to exist;
c. Name four classes of fires;
d. List four typical causes of industrial fires described in the lesson;
e. Match the correct class extinguishers to a given fuel source; and,
f. Demonstrate proper use of a fire extinguisher.

Reading Assignments:

The following chapters are assigned to read from textbook.

<table>
<thead>
<tr>
<th>Chapter</th>
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<tbody>
<tr>
<td>12</td>
<td>Basic Principles; Understanding Fire Chemistry;</td>
</tr>
<tr>
<td></td>
<td>Determining Fire Hazards; Informing the Working Force;</td>
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<td></td>
<td>Causes of Fire: Electric Equipment, Friction; Special Fire-Hazard Materials; Welding and Cutting; Open Flames; Portable Heaters; Hot Surfaces; Smoking and Matches; Spontaneous Ignition; Static Electricity; Fire-Safe Housekeeping; Alarms; Equipment; Evacuation; Fire Alarms; What About Extinguishers?; Follow Up for Fire Safety; Fire Brigades; Special Fire Protection Problems</td>
</tr>
</tbody>
</table>

Module Outline:

I. Technician's Responsibility
A. Each employer will have company specific rules
B. Unless the technician is part of the company fire fighting crew or fire brigade
   1. Notify everyone in the area to evacuate
   2. Get to a phone and notify appropriate department
   3. Something as simple as an ash tray or trash can can start fire that may be easily and safely extinguished. Appropriate department must be notified of the event
   4. Employees are responsible for keeping the workplace safe and for reporting unsafe conditions

II. Identify Conditions Required for a Fire to Exist
   A. Fuel
   B. Oxygen
   C. Heat

III. Four Classes of Fire
   A. Ordinary combustibles
   B. Flammable liquids
   C. Electrical
   D. Combustible metals

IV. List Four Typical Causes of Workplace Fires
   A. Careless smokers
   B. Electrical overloads
   C. Inadequate fire watch for welding and cutting operations
   D. Combustible dust in the atmosphere

V. Demonstrate to Class How to Match the Correct Extinguishers for the Class of Fire

VI. Demonstrate Proper Use of a Fire Extinguisher
Suitable for use on what type of fire: B C

Agent Characteristics:
- Regular or Ordinary Dry Chemical
- Basically Sodium Bicarbonate
- Discharges a white cloud
- Leaves residue
- Non-freezing

Average Size - 1 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.

Suitable for use on what type of fire: ABC or BC

Agent Characteristics:
- Multipurpose Dry Chemical
- Basically Ammonium Phosphate
- Discharges a yellow cloud
- Leaves residue
- Non-freezing
- Some extinguishers utilizing this agent do not have an “A” rating; however, they are designated as having “A” capability.

Average Size - 2 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.

Suitable for use on what type of fire: B C

Agent Characteristics:
- Purple-K Dry Chemical
- Basically Potassium Bicarbonate
- Discharges a bluish cloud
- Leaves residue
- Non-freezing

Average Size - 2 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.
Suitable for use on what type of fire: B C

Agent Characteristics:
- KCL Dry Chemical
- Basically Potassium Chloride
- Discharges a white cloud
- Leaves residue
- Non-freezing
- Potassium Chloride/Urea

Average Size - 2 to 30 lbs. (11 to 23)
Horizontal Range - 5 to 20 ft. (15 to 30)
Discharge Time - 8 to 25 sec. (20 to 31)

Suitable for use on what type of fire: B C

Agent Characteristics:
- Carbon Dioxide
- Basically an inert gas that discharges a cold white cloud
- Leaves no residue
- Non-freezing

Average Size - 2 ½ to 20 lbs.
Horizontal Range - 3 to 8 ft.
Discharge Time - 8 to 30 sec.

Suitable for use on what type of fire: B C

Agent Characteristics:
- Halogenated Agent
- Basically halogenated hydrocarbons
- Discharges a white vapor
- Leaves no residue
- Non-freezing

Average Size - 2 ½ lbs.
Horizontal Range - 4 to 8 ft.
Discharge Time - 8 to 10 sec.
0 Suitable for use on what type of fire: A

Agent Characteristics:
- Water
- Basically tap water
- Discharges in a solid or spray stream
- May contain corrosion inhibitor which leaves a yellow residue
- Protect from freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute

Suitable for use on what type of fire: A

Agent Characteristics:
- Anti-Freeze Solution
- Basically a Calcium Chloride solution to prevent freezing
- Discharges a solid or spray stream
- Leaves residue
- Non freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute

Suitable for use on what type of fire: A B

Agent Characteristics:
- Loaded Stream
- Basically an alkali-metal-salt solution to prevent freezing
- Discharges a solid or spray stream
- Leaves residue
- Non freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute
Suitable for use on what type of fire: B

Agent Characteristics:
- Foam
- Basically a water and detergent
- Discharges a foamy solution
- After evaporation, leaves a powder residue
- Protect from freezing

Average Size - 18 oz.
Horizontal Range - 10 to 15 ft.
Discharge Time - 24 sec.

Suitable for use on what type of fire: D

Agent Characteristics:
- Dry Powder Special Compound
- Basically Sodium Chloride or Graphite materials
- Agent is discharged from an extinguisher in a solid stream or is applied with a scoop or shovel to smother combustible metal
- Leaves residue
- Non-freezing

Average Size - 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 25 to 30 sec.
Standards of performance:

Student shall demonstrate safe work habits in the workshop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Conduct:

1. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.
Standard of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Worksheet:

1. Established standards for safety and conduct shall be followed

2. Equipment required:
   Dust Mask;
   Gloves;
   Fire extinguishers;
   Face shield; and,
   Side shields.

3. Instructor must confirm proficiency prior to student progressing

4. Practice exercises
   A. Instructor will demonstrate proper usage of fire extinguishers
   B. Student shall practice using fire extinguishers
Answer the following questions by circling the correct answer.

1. Conditions required for a fire to exist:
   a. Fuel, Hydrogen, Heat
   b. Hydrogen, Oxygen, Fuel
   c. Heat, Hydrogen, Oxygen
   d. Fuel, Oxygen, Heat

2. Four classes of fire are:
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

3. List four typical causes of workplace fires:
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

4. A Class _________ fire extinguisher is used for electrical fires.

5. A Class _________ fire extinguisher is used for ordering combustibles fires.
1. b

2. Four classes of fire are:
   a
   b
   c
   d

3. List four typical causes of workplace fires:
   combustibles
   flammable liquids
   electrical equipment
   combustible metals

4. C

5. A
Subject: Industrial Maintenance  Time: 3 Hrs.

Duty: Practice Safety

Task: Lifting Safety

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the consequences of improper lifting techniques;
b. Recognize when it is unsafe to lift an object alone;
c. Demonstrate proper lifting techniques;
d. Identify safety concerns to be addressed when lifting rough, sharp or fragile items;
e. State formula for dealing with center of gravity;
f. Identify parts of hoist;
g. Safely demonstrate using a hoist; and,
h. Move a load using a hoist.

Instructional Materials:

- Large Empty Cardboard Box
- Pencil
- Paper
- Gloves
- Safety Glasses
- Hand Truck
- Conveyor
- Chains
- Sling
- Face Shield
- Side Shield
- MASTER Handout (IMM-A5-HO)
- MASTER Laboratory Worksheet (IMM-A5-LW)
- MASTER Laboratory Aid (IMM-A5-LA)
- Copy of 29 CFR 1910 Regulations
References:


*Approval Guide; Handbook of Property Conservation; and Loss Prevention Data*, Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston-Providence Turnpike, Norwood, MA 02062, Latest Editions


*Supervisor’s Safety Manual*, Latest Edition


*Lifting, Eye Protection and Hand Tool Safety*, - 20m - Video Tape - BBP, Latest Edition
Student Preparation:

Students should have previously completed the following Technical Modules:
- IMM-A1 "Use Protective Equipment"
- IMM-A2 "Accident Prevention"
- IMM-A3 "Working Aloft"
- IMM-A4 "Fire Safety"

Introduction:

Injuries resulting from improper lifting probably are the number one cause of employee injury. A strong physically fit body is not enough to ensure you won't have back problems. Following time proven lifting methods and getting help when you need it is your best assurance. Remember you are responsible for your own safety. Furthermore, moving a load safely to protect the load, hoist, person operating the hoist, and other people is very important.

Presentation Outline:

I. Discuss the Importance of Lifting Safely
   A. Give each student a copy of the following attachments:
      1. Laboratory Aid
      2. Objectives, Reading Assignments, and Module Outline
      3. Laboratory Worksheet

II. Identify the Steps to Manually Lift Safely
   A. Estimate the load to be lifted. If it is heavier than one person should attempt, get help.
   B. Place feet properly. Spread your feet slightly (comfortably), with one foot slightly ahead of the other and alongside the object.
   C. Bend knees, kneel, or squat. Get close enough to the load to reach under it without bending the back.
   D. Use blocking under objects to get a handhold and to prevent crushed fingers.
   E. Get a good grip. Be sure you can maintain your grip on the object. Use gloves when handling sharp or rough objects.
   F. Let the legs do the lifting. To rise, straighten your legs, letting the powerful leg, arm, and shoulder muscles do the lifting.
   G. Do not turn the body at the waist while carrying a load.
H. Lower the load to the floor from the carrying position by bending the knees while keeping the back straight. This keeps the load on the leg and arm muscles. Keep fingers and toes clear as the load is set.

III. Consequences of Improper Lifting
   A. Injury
   B. Loss time
   C. Possibility of becoming unemployed

IV. When Is It Unsafe to Lift an Object Alone
   A. Bulked load that restricts view
   B. When you would have to lift with your back rather than your legs
   C. When the object is too large to get a good grip

V. Discuss Handling Specific Shapes
   A. Locate center of gravity and use this area to lift
   B. Place as much weight as possible as close to lifting mechanism
   C. Place flat weight on button

VI. Safety Concerns When Lifting Rough, Sharp, or Fragile Objects
   A. Gloves
   B. Safety glasses
   C. Is the object being lifted a hazardous material?

VII. Discuss Equipment for Material Handling
   A. Hand trucks
   B. Powered trucks
   C. Conveyers
   D. Hoists

VIII. Discuss and Demonstrate Safe Use of Hand Trucks
   A. Place most of the weight on bed of hand truck
   B. May require two people if one object is difficult to lift on side
   C. Hold object tightly as handle is pulled back
   D. Adjust handle position so more weight is on hand end
   E. After movement, hold object tightly as handle is moved upward
   F. Lift object on one side so bed of truck can be moved away from object

IX. Discuss and Demonstrate Use of Powered Hand Trucks
   A. Watch out for people
   B. Drive unit slowly
   C. Use manual lifting rules

X. Discuss and Demonstrate Safe Use of Conveyers
   A. Watch for pinch points
   B. Exercise caution when loading and unloading objects
   C. Do not overload conveyers. Rollers may not move freely

XI. Discuss and Demonstrate Safe Use of Hoists
   A. Formula for dealing with center of gravity
   B. Identify parts of hoist
   C. Safely demonstrate using a hoist
   D. Identify types of loads
   E. Discuss and demonstrate lifting techniques
F. Discuss and demonstrate moving techniques
XII. Discuss and Demonstrate Safe Use of Chains and Slings
   A. Storage area should be clean and dry
   B. Watch for pinch points
   C. Inspect for defects before using:
      1. Chains
         a. Wear
         b. Stretch
         c. Distortion
         d. Nicks
         e. Cracks
         f. Gauges
      2. Slings
         a. Wear
         b. Stretch
         c. Distortion
         d. Flat, Sling Spots
   D. Types
      1. Slings
         a. Choker
         b. Double Choker
         c. Bridle
         d. Basket
         e. Double Basket

Practical Application:

1. Basic laws of physics will be analyzed.
2. Physical characteristics of materials will be analyzed.
3. Students will practice correct lifting techniques.
4. Each student will then complete the Laboratory exercise where he will be graded on demonstrating proper lifting techniques.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the practical evaluation.

Summary:

Review the main lesson points using the Handout (IMM-A5-HO) as a guide for discussion and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (IMM-A6) dealing with lockout/tagout.
Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face-shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the consequences of improper lifting techniques;
b. Recognize when it is unsafe to lift an object alone;
c. Demonstrate proper lifting techniques;
d. Identify safety concerns to be addressed when lifting rough, sharp or fragile items;
e. State formula for dealing with center of gravity;
f. Identify parts of hoist;
g. Safely demonstrate using a hoist; and,
h. Move a load using a hoist.

Reading Assignments:

The following chapters are assigned to read from Supervisor’s Safety Manual textbook, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
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<tbody>
<tr>
<td>9</td>
<td>Material Handling Problems; Manual Handling Methods; Lifting and Carrying; Handling Specific Shapes; Equipment for Handling; Hand Trucks; Powered Hand Trucks; Powered Industrial Trucks; Conveyors; Chains and Slings</td>
</tr>
</tbody>
</table>

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Module Outline:

I. Discuss the Importance of Lifting Safely
   A. Give each student a copy of the following attachments:
      1. Laboratory Aid
      2. Objectives, Reading Assignments, and Module Outline
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II. Identify the Steps to Manually Lift Safely
    A. Estimate the load to be lifted. If it is heavier than one person should attempt, get help.
    B. Place feet properly. Spread your feet slightly (comfortably), with one foot slightly ahead of the other and alongside the object.
    C. Bend knees, kneel, or squat. Get close enough to the load to reach under it without bending the back.
    D. Use blocking under objects to get a handhold and to prevent crushed fingers.
    E. Get a good grip. Be sure you can maintain your grip on the object. Use gloves when handling sharp or rough objects.
    F. Let the legs do the lifting. To rise, straighten your legs, letting the powerful leg, arm, and shoulder muscles do the lifting.
    G. Do not turn the body at the waist while carrying a load.
    H. Lower the load to the floor from the carrying position by bending the knees while keeping the back straight. This keeps the load on the leg and arm muscles. Keep fingers and toes clear as the load is set.

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     A. Injury
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E. Discuss and demonstrate lifting techniques
F. Discuss and demonstrate moving techniques

XII. Discuss and Demonstrate Safe Use of Chains and Slings
A. Storage area should be clean and dry
B. Watch for pinch points
C. Inspect for defects before using:
   1. Chains
      a. Wear
      b. Stretch
      c. Distortion
      d. Nicks
      e. Cracks
      f. Gauges
   2. Slings
      a. Wear
      b. Stretch
      c. Distortion
      d. Flat, Sling Spots
D. Types
   1. Slings
      a. Choker
b. Double Choker

c. Bridle

d. Basket

e. Double Basket
IMM-A5-LA
Lifting Safety
Attachment 2: MASTER Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horseplay or practical joking.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.
Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Worksheet:

1. Established standards for safety and conduct shall be followed.
2. Equipment required:
   Hand truck
   Conveyor
   Chains
   Sling
   Face shield
   Side shields
3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student’s progressing to next exercise.
4. Practice manual lifting.
5. Practice using hand truck to carry objects.
6. Practice using powered truck to carry objects.
7. Practice using hoist to move objects.
8. Practice handling specific shapes.
9. Practice lifting with slings.
10. Practice lifting with chains.
11. Instructor will guide each exercise.
12. Instructor will grade each exercise.
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-A6

Subject: Industrial Maintenance

Duty: Practice Safety
Task: Lockout/Tagout

Time: 5 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Recognize the benefits of an effective Lockout/Tagout procedure;
b. Identify who is allowed to remove or install a Lockout/Tagout tag or lock;
c. Recognize who is responsible for assuring equipment is properly locked out or tagged out prior to performing maintenance; and,
d. Determine if all emergency conditions are cleared for maintenance.

Instructional Materials:

- Lock (Designed for Lockout)
- Safety Tags
- Lockout Hasp
- Safety Switch
- MASTER Handout (IMM-A6-HO)
- Relief Valve
- Hydraulic Actuated Valve
- Safety Sign (caution-lockout for safety before you start)
- Valve Lockout
- MASTER Self-Assessment
- MASTER Laboratory Worksheet (IMM-A6-LW)
- MASTER Laboratory Aid (IMM-A6-LA)
- Copy of 29 CFR 1910.147 Regulations

References:

OSHA Lockout/Tagout Guidelines, 29 CFR 1910.147

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition
Approval Guide; Handbook of Property Conservation; and Loss Prevention Data, Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston-Providence Turnpike, Norwood, MA 02062, Latest Editions


Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-A1 "Use Protective Equipment"
IMM-A2 "Accident Prevention"
IMM-A3 "Working Aloft"
IMM-A4 "Fire Safety"
IMM-A5 "Lifting Safety"

Introduction:

This module is designed to teach the purpose and importance of ensuring that the concepts of personal and group safety are not just concepts. Safety must be a way of life if work is to be performed without injury or loss. Think of Lockout/Tagout as life and health assurance. Lockout/Tagout procedures are required by OSHA.
Presentation Outline:

I. Benefits of an Effective Lockout/Tagout Program
   A. Reduced employee injuries and death
   B. Reduced down time
   C. Increased awareness of the employees' role in insuring safety in the work environment
   D. Less regulatory involvement
   E. Review 29 CFR 910.147

II. Who May Hang, Remove a Lockout or Tagout Tag or Lock
   A. Identify when a lockout is needed
   B. Identify when a tagout is appropriate. This will vary among industrial clearance procedures.

III. Responsibility for Lockout/Tagout
   A. Typically it is the work crew leader who is responsible for briefing the crew as to the clearance boundaries and what is locked out

IV. Locking out or Clearing a Piping, Mechanical System, or Component for Maintenance
   A. Identify typical sources of force that may be present in a typical piping system
      1. Static head pressure or induced thermal pressure
      2. In-line accumulators
      3. Non-insulated automatic actuating valves, motors, or relief
      4. System pressure
      5. Stress that any or all of these forces have the ability to injure or kill if not properly cleared and depressurized prior to maintenance
   B. Methods of relieving trapped pressure from a system or component
      1. Vent and drain valves
      2. Carefully loosen a flange and break the seal (never remove the bolts). Only loosen slightly.
      3. Open system relief valve
   C. Identify typical methods of disabling components prior to maintenance
      1. Manual valves
      2. Pneumatic valves (fail-open or closed)
      3. Hydraulic valves
      4. Relief valves
      5. Fans
      6. Rollers
   D. Energy sources can take many forms, including:
      1. Electrical
      2. Pneumatic
      3. Hydraulic
      4. Mechanical
5. Fluid and gas
6. Thermal
7. Pressurized water
8. Gravity

E. Accidental start-up or release of stored energy can sometimes be controlled with safety devices. Some examples are:
1. Machine guards
2. Electrical disconnects
3. Mechanical stops
4. Point-of-operation guards

Practical Application:

Students will practice correct lockout/tagout procedures. Each student will complete the laboratory exercise and will be graded on demonstrating proper lockout/tagout procedure.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluations.

Summary:

Review the main lesson points using the Handout (IMM-A6-HO) as a guide for discussion and practice lockout/tagout procedures.

Next Lesson Assignment:

MASTER Technical Module (IMM-B1) dealing with performing basic arithmetic functions.

Glossary:

Affected Employee
An employee whose job requires him/her to operate or use a machine or equipment on which service or maintenance is being performed under lockout/tagout, or whose job requires him/her to work in an area in which such service or maintenance is being performed. Affected employees must be informed when lockout/tagout is being performed.
Authorized Employee
A person who locks and tags machines or equipment in order to perform service or maintenance on that machine or equipment.

Blanks
Typically, a metal disk that is inserted into the space between two pipe flanges. The blank is then bolted in place and forms a solid block to prevent the passage of liquids or gases through the pipe. “Blanking” (the insertion of blanks) is an important step to assure the safe entry into tanks or vessels if the materials in the pipes pose a hazard to employees working inside.

Bleed
Releasing stored hydraulic, electrical or pneumatic energy.

Block-Out
Physically preventing the movement of machinery or equipment using mechanical devices such as blocks, chains, cribbing or timbers.

Capable of Being Locked Out
An energy isolating device is capable of being out if it has a hasp or other means of attachment to which, or through which, a lock can be affixed, or it has a locking mechanism built into it. Other energy isolating devices are capable of being locked out if lockout can be achieved without the need to dismantle, rebuild or replace the energy isolating device or permanently alter its energy control capability.

Energized
Connected to an energy source or containing residual or stored energy.

Energy
All sources of power to a given piece of machinery or equipment. These can be electrical, pneumatic, hydraulic, process fluids and gases and mechanical.

Energy Control
The use of energy isolating devices to block or isolate energy sources, as well as Lockout/Tagout procedures to prevent unexpected start-up and release of stored energy during maintenance or installation.

Energy Isolating Device
A mechanical device that physically prevents the transmission or release of energy, including a manually operated electrical circuit breaker, a disconnect switch, a line valve, a block or any similar device used to block or isolate energy.
Energy Source
Any source of electrical, pneumatic, hydraulic, mechanical, thermal, chemical or other energy.

Lockout
The process used to identify, cut off and secure all energy sources before beginning repairs, adjustments or maintenance. A lockout device is used to secure equipment or machinery in the off position, ensuring that the equipment or machinery cannot be operated.

Lockout Device
A lock (either key or combination type) that holds an energy isolating device in a safe position and prevents the machine or equipment or machinery from being operated.

Normal Production Operations
The use of a machine or equipment to perform its intended production function.

Servicing and/or Maintenance
Workplace activities that require lockout/tagout on the equipment before beginning the activity because employees may be exposed to the unexpected energized or startup of the equipment or the release of hazardous energy. Servicing and/or maintenance includes constructing, installing, setting up, adjusting, inspecting, modifying, lubricating, cleaning and making tool changes.

Setting Up
Any work performed to prepare a machine or equipment to perform its normal production operation.

Tagout
Attaching a tag to the lock on the power source that has been shut off, indicating the time, reason for the lockout and the name of the person doing the work. The tag acts as a warning not to restore energy to the equipment or machinery.

Tagout Device
A prominent warning tag which can be surely fastened to an energy isolating device to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

Written Energy Control Program
This is the main requirement of the OSHA Standard. The written program provides details about:
1. The hazards of uncontrolled energy;
2. Energy control and lockout/tagout procedures in the workplace;
3. Employee training;
4. Inspections; and,
5. Complete records of all inspection and training that applies to energy control and lockout/tagout.

**Zero Energy State**

All energy has been controlled in machinery or equipment.
Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Recognize the benefits of an effective lockout/tagout procedure;
b. Identify who is allowed to remove or install a lockout/tagout tag or
   lock;
c. Recognize who is responsible for assuring equipment is properly locked
   out or tagged-out prior to performing maintenance; and,
d. Determine if all emergency condition are cleared for maintenance.

Module Outline:

I. Benefits of an Effective Lockout/Tagout Program
   A. Reduce employee injuries and death
   B. Reduce down time
   C. Increased awareness pf employees role in insuring safety in the work
      environment
   D. Less regulatory involvement
   E. Review 29 CFR 1910.147
II. Who May Hang, Remove a Lockout or Tagout Tag or Lock
   A. Identify when a lockout is needed
   B. Identify when a tagout is appropriate. This will also vary between
      industry clearance procedures.
III. Responsibility for Lockout/Tagout
   A. Typically it is the work crew leader who is also responsible for briefing
      the crew as to the clearance boundaries and what is locked out
   B. Carefully loosen a flange and break the seal (never remove the bolts).
      Only loosen slightly.
C. Open system relief valve

IV. Locking out or Clearing a Piping, Mechanical System or Component for Maintenance

A. Identify typical sources of force that may be present in a typical piping system
   1. Static head pressure or induced thermal pressure
   2. Incline accumulators
   3. Unisolated automatic actuating valves, motors or relief
   4. System pressure
   5. Stress that any or all of these forces have the ability to injure or kill is not properly cleared lockout and depressurized prior to maintenance

B. Methods of relieving trapped pressure from a system or component
   1. Vent and drain valves
   2. Carefully loosen a flange and break the seal (never remove the bolts). Only loosen slightly.
   3. Open system relief valve

C. Identify typical methods of disabling components prior to maintenance
   1. Manual operated valves
   2. Pneumatic operated valves (fail open or closed)
   3. Hydraulic actuated valve
   4. Relief valves
   5. Fans
   6. Rollers

Reading Assignments:

Read the handout titled “Lockout and Tagout Procedures.”
Lockout and Tagout Procedures

Lockout and tagout procedures are designed to prevent equipment from being energized while maintenance is taking place. The types and uses are defined by the Occupational Safety and Health Administration, CFR 1910.147.

To lockout is to place a locking device on an energy-isolating device — a manually operated circuit breaker, for instance. The energy-isolating device and the equipment being controlled cannot be operated until the lockout device is removed. See Figure 1.

Remote or interlocking switches may not be used to control circuits. The use of emergency stops are prohibited for lockout-tagout by OSHA. They do not offer positive protection.

Tagouts are placed on an energy-isolating device. They indicate that the energy-isolating device and the equipment being controlled may not be operated. Tagouts are red and have black lettering. A tag must be signed and dated by the individual who placed it. OSHA has two additional requirements for these tags. The purpose of the lockout/tagout (the procedure performed) must be written on the tag. Most companies put this information on the back of a tag. See Figure 2.
2 – Tagout

When more than one person is involved, each individual must place a lockout/tagout device on the isolation device. If a lockout device is used, it should be capable of accepting multiple locks. This is so each individual can place a lock on the device. Each lock should have a tag similar to the one used in the tagout procedure. The individual who puts the lock in place signs the tag. See Figure 3.
3 – Multiple-Lock Lockout Device

The lockout physically prohibits the operation of a piece of equipment. The tagout relies on those who read it. They must recognize its significance.

Wherever lockout/tagouts are used, there must be an established procedure for all to follow. All personnel must understand the importance and the use of the lockout/tagout system. The lockout/tagout devices used within an organization are standardized. So, anyone within the organization will recognize what they are.

The restrictions indicated by lockouts and tagouts remain in force until they are removed. The person putting the tagout or lockout in place is the person who has the authority to remove it.

The Occupational Safety and Health Act sets standards that are administered by the Occupational Safety and Health Administration (OSHA). OSHA has standard lockout/tagout procedures. The lockout/tagout procedures apply to all energy systems — air, hydraulic, mechanical, and electrical.
Zero-Energy Concept

Your job may be to maintain electrical circuits and equipment. However, many of them are connected to mechanical, hydraulic, or pneumatic devices. So, the equipment you work on may involve other types of energy in addition to electricity. Zero energy means all forms of energy are neutralized.

There may be hydraulic or pneumatic pressure in hoses or lines. There may be stored energy in weights or springs. There may be the potential for movement, as when air might blow through a turbine or fan. All these forms of energy must be recognized and neutralized. They have the potential to injure you or damage equipment.

Before working on any type of equipment, release or neutralize all energy which might affect that equipment. This means taking whatever action is necessary — turning a valve or putting a jack under a weight, for instance. This is the zero-energy concept.
Standards of performance safety:

Student shall demonstrate safe work habits in the workshop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. The project will require the student to demonstrate skills and knowledge in the following:
   A. Practice safety
   B. Use approved eye protection.
   C. Remove energy source
   D. Place tag
   E. Place lock
   F. Sign tag
   G. Remove lock
   H. Remove tag

2. Established standards for safety and conduct shall be followed.

3. Equipment required:
   A. Lock
   B. Tag
   C. Safety Switch

4. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

5. Practice exercises:
   A. Use lock to lock energy supply. Instructor must demonstrate placing lock on energy supply.
   B. Use tag to tag energy supply. Instructor must demonstrate placing tag on energy supply.

6. Practice exercise:
   A. Student shall practice placing tag on energy source.
   B. Student shall practice placing lock on energy source.
1. The term Lockout is best defined as:
   a. Blocking the flow of energy from a power source to a piece of equipment.
   b. Shutting down a piece of equipment for service or maintenance work.
   c. Applying a lock to a piece of equipment to show that it should not be used.
   d. Applying a tag to a piece of equipment to show that it should not be used.

2. A Lockout procedure is used whenever:
   a. The servicing or repair work to be done places an employee in danger.
   b. An equipment guard must be removed for servicing.
   c. A power source can be locked out for servicing.
   d. All of the above.

3. Tagout refers to:
   a. The warning tag attached to a power source or piece of machinery telling others not to restart.
   b. The process of blocking energy form reaching a piece of equipment.
   c. Signing off that a certain piece of machinery has been serviced.
   d. A device that physically prevents others from restarting equipment.

4. An authorized employee is one who:
   a. Works on machinery that is subject to lockout.
   b. Services machinery that is subject to lockout.
   c. Actually locks out equipment for servicing.
   d. Both b and c.

5. An affected employee is one who:
   a. Works on machinery that is subject to lockout.
   b. Works in an area where lockout is used.
   c. Services machinery that is subject to lockout.
   d. Both a and b.

6. Zero energy state refers to:
   a. A power source that is locked out for servicing.
   b. A power source that is locked out and tagged for servicing.
   c. The release of all stored energy from a power source.
   d. The release of all locks and tags so that energy can be restored.
7. It is all right to lend your lock to a co-worker if:
   a. The co-worker's lock is in another part of the building.
   b. The co-worker's lock is in another building miles away from where he is working.
   c. You know you won't be using your lock.
   d. None of the above.

8. If you come across a piece of equipment that is turned off but not locked out, you would:
   a. Ask someone working in the area if it could be turned back on.
   b. Notify someone who is authorized to perform lockout.
   c. Never restart the equipment.
   d. Both b and c.

9. A lockout audit must be performed by:
   a. An authorized person who works with the lockout procedure to be inspected.
   b. An authorized person who doesn't work with the lockout procedure to be inspected.
   c. A person from the Health and Safety department.
   d. None of the above.

10. Lockout/Tagout procedures are in place to:
    a. Prevent the accident start-up of equipment.
    b. Prevent workers from taking short-cuts while servicing equipment.
    c. To be used when startup occurs.
    d. To be used when the machine is stopped.

11. The _______ physically prohibits the operation of a piece of equipment.
    a. GFCI
    b. tagout device
    c. lockout device
    d. a, b, and c

12. The _______ does not physically prohibit operation of equipment; it relies on those who read it.
    a. GFCI
    b. tagout device
    c. lockout device
    d. a, b, and c

13. Zero energy means all forms of energy (electrical, mechanical, fluid, and thermal) are neutralized.
    a. true
    b. false
14. Under normal operating conditions, in addition to you, who is allowed to remove your padlock from a machine's power source after a power lockout?
   a. no one
   b. The maintenance supervisor
   c. the safety engineer
   d. your supervisor

15. This organization establishes, implements, and enforces safe workplace guidelines.
   a. NEC
   b. ANSI
   c. OSHA
   d. NEMA
   e. UL
   f. UAW
IMM-A6
Lockout/Tagout
Self-Assessment Answer Key

1. b
2. d
3. a
4. d
5. b
6. c
7. d
8. d
9. a
10. a
11. c
12. b
13. a
14. a
15. c
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<td><strong>C</strong> Interpret Engineering Drawings and Control Documents</td>
<td>C-1 Identify basic types of drawings</td>
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<td><strong>D</strong> Use Measuring Tools</td>
<td>D-1 Use non-precision measuring tools</td>
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<td>E-1 Identify and use maintenance technician's hand tools</td>
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<td>G-1 Weld with shielded metal arc welding (SMAW) process</td>
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**Tasks**
- Apply Mathematical Concepts
- Perform Welding Operations
- Troubleshoot Equipment and Systems
- A-1 Use protective equipment
- A-2 Accident prevention
- A-3 Working shift
- A-4 Fire safety
- A-5 Lifting safety
- A-6 Lockout
- A-7 Copy available
INDUSTRIAL MAINTENANCE MECHANIC uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<td>O Align Shafts</td>
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<td>P Install/Align Machines</td>
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<td>Q Maintain Electrical Devices</td>
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<td>S Fasteners and Preloading</td>
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</tr>
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**BEST COPY AVAILABLE**
Subject: Industrial Maintenance

Duty: Apply Mathematical Concepts

Task: Perform Basic Arithmetic Functions

Objective(s):

Upon completion of this unit the student will be able to:

a. Add whole numbers;
b. Subtract whole numbers;
c. Divide whole numbers;
d. Multiply whole numbers;
e. Add decimals;
f. Subtract decimals;
g. Multiply decimals; and,
h. Divide decimals.

Instructional Materials:

Paper
Pencil
Overhead Projector
Chalkboard
MASTER Handout (IMM-B1-HO)
MASTER Laboratory Worksheet (IMM-B1-LW)
MASTER Self-Assessment

References:


*Applied Math*, Avi C. Bajpai, Rodney M. Bond; adapted by Jerry W. Jones, Latest Edition

Basic Business Math, Robert L. Dansby, Latest Edition


Becoming A Mental Math Wizard, Jerry Lucas, Latest Edition

Building Success In Math, Carol R. Langbort, Virginia H. Thompson, Latest Edition


Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-A6 "Lockout/Tagout"

Introduction:

Basic math skills are used daily in many areas of our lives. These skills are used in work and home. This area of math is the most popular area used today.

Presentation Outline:

I. Add Whole Numbers
II. Subtract Whole Numbers
III. Multiply Whole Numbers
IV. Divide Whole Numbers
V. Add Decimals
VI. Subtract Decimals
VII. Multiply Decimals
IX. Divide Decimals

Practical Application:

Students will practice working math problems. Each student will complete the MASTER Laboratory Worksheet (IMM-B1-LW) and turn it in to the instructor for checking.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.
Summary:

Review the main lesson points using the objections as a guide and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-B2) dealing with the conversion of fractions and decimals.
Standards of performance safety:

Student shall demonstrate math skills acquired in this module by:
Actively participating in class; and,
Working problems in this module;

Objectives:

Upon completion of this unit the student will be able to:

a. Add whole numbers;
b. Subtract whole numbers;
c. Divide whole numbers;
d. Multiply whole numbers;
e. Add decimals;
f. Subtract decimals;
g. Multiply decimals;
h. Divide decimals;
i. Locate any decimal place to the millionths;
j. Read numbers containing decimals;
k. Write numbers containing decimals;
l. Round off a decimal to a specified place value;
m. Align decimal points before computation;
n. Add numbers containing decimals;
o. Subtract numbers containing decimals;
p. Multiply numbers containing decimals; and,
q. Divide numbers containing decimals.

Module Outline:

I. Add Whole Numbers
II. Subtract Whole Numbers
III. Multiply Whole Numbers
IV. Divide Whole Numbers
V. Decimal System Place Value
VI. Add Decimals
VII. Subtract Decimals
VIII. Multiply Decimals
IX. Divide Decimals
Worksheet:

Give the place value of the 5 in the numbers below:

1. 16.53  
2. 0.4565  
3. 51,345  

Write the numbers below in words:

4. 0.000052  
5. 0.013  
6. 0.0008  
7. 15,248  

Write the numbers that are indicated by the following phrases:

8. Three thousandths  
9. Seventy-five and sixty seven hundredths  
10. Eighty-six hundred ten-thousandths  

Round these numbers to the specified place value:

<table>
<thead>
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<th></th>
<th>Thousandths</th>
<th>Tenths</th>
<th>Hundredths</th>
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</thead>
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<tr>
<td>11. 2.75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. 18.613</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. 0.22</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
14. 14.2343

15. When adding or subtracting decimals, be sure the decimal points are __________.

Add or subtract the following:

16. 0.7 + 14 + 16.2 = _________________

17. 74 + 890 + 0.0057 - 46.72 = _________________

18. 42.6 + 0.0131 = _________________

19. It is not necessary to align the ____________ ____________ in a multiplication problem.

20. The number of digits behind a decimal point in the ____________ equals the number of digits behind decimal points in the ____________ ____________ in a multiplication problem.

Solve the problems below. Use zeros as place holders if necessary.

21. 254.8 x 14 = _________________

22. 6,000 x 0.021 = _________________

23. 152.33 x 3.5 = _________________

24. 16.8 x 101.6 = _________________

25. To multiply a number by a multiple of 10, simply count the number of zeros in the ____________ and move the decimal point in the ____________ the same number of places.

Use the short cut method to solve the following problems:

26. 15.1 x 10,001 = __________

27. 0.44 x 102 = __________
Solve the following problems, using zeros as place holders if necessary:

28. 6099.6 divided by 16.5 = _________

29. 1509.04 divided by 2.3 = _________

30. When dividing by a multiple of 10, move the decimal point to the _________ the same number if spaces as there are zeros in the _________.

Use the short cut method of dividing by multiples of 10 to solve the following problems:

31. 0.053 divided by 1000 = _________

32. 14.954 divided by 10 = _________

33. 110 divided by 1000 = _________

34. 436.89 divided by 100 = _________
IMM-B1
Perform Basic Arithmetic Functions
Self-Assessment

Give the place value of the 5 in the numbers below:
1. 16.52
2. 0.4566
3. 51,346

Write the numbers below in words:
4. 0.000051
5. 0.011
6. 0.0007
7. 15,247

Write the numbers that are indicated by the following phrases:
8. Two thousandths
9. Sixty-five and sixty seven hundredths
10. Eighty-seven hundred ten-thousandths

Round these numbers to the specified place value:
11. 2.76
12. 18.614
13. 0.23
14. 14.2345
15. When adding or subtracting decimals, be sure the decimal points are _________.

Add or subtract the following:

16. \[0.7 + 14 + 16.1 = \] ______________

17. \[74 + 890 + 0.0051 - 46.72 = \] ______________

18. \[42.6 + 0.0132 = \] ______________

19. It is not necessary to align the ___________ in a multiplication problem.

Solve the problems below. Use zeros as place holders if necessary.

20. \[254.8 \times 13 = \] ______________

21. \[6,000 \times 0.020 = \] ______________

22. \[152.33 \times 3.6 = \] ______________

23. \[16.8 \times 101.7 = \] ______________

24. To multiply a number by a multiple of 10, simply count the number of zeros in the ___________ and move the decimal point to the ___________ the same number of places.

Use the short cut method to solve the following problems:

25. \[15.1 \times 10,0000 = \] ______________

26. \[0.44 \times 100 = \] ______________

Solve the following problems, using zeros as place holders if necessary:

27. \[6099.6 \text{ divided by } 16.6 = \] ______________

28. \[1509.04 \text{ divided by } 2.4 = \] ______________
29. When dividing by a multiple of 10, move the decimal point to the ________
   the same number if spaces as there are zeros in the ________.

Use the short cut method of dividing by multiples of 10 to solve the following
problems:

30. 0.052 divided by 1000 = __________
31. 14.953 divided by 10 = __________
32. 100 divided by 1000 = __________
33. 436.86 divided by 100 = __________
IMM-B1
Perform Basic Arithmetic Functions
Self-Assessment Answer Key

1. Tenths
2. Hundredths
3. Ten thousandths
4. Fifty one millionths
5. Eleven thousandths
6. Seven ten thousandths
7. Fifteen thousand, two hundred forty seven
8. .002
9. 65.67
10. .8700
11. 2.760 (thousandths)
   2.8 (tenths)
   2.76 (hundredths)
12. 18.614 (thousandths)
   18.6 (tenths)
   18.61 (hundredths)
13. 0.230 (thousandths)
   0.2 (tenths)
   0.23 (hundredths)
14. 14.235 (thousandths)
   14.2 (tenths)
   14.23 (hundredths)
15. In a vertical line
16. 30.8
17. 917.2851
18. 42.6132
19. Numbers
20. 3312.4
21. 120
22. 548.388
23. 1708.56
24. Number, right
25. 151,000
26. 44
27. 367.44578
28. 628.76666
29. Left, number
30. .000052
31. 1.4953
32. 0.1
33. 4.3686
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-B2

Subject: Industrial Maintenance

Duty: Apply Mathematical Concepts

Task: Convert Fractions/Decimals

Time: 6 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Define a fraction and its parts;
b. Reduce fractions to their lowest terms;c. Define prime number and composite number;
d. Define common fractions and uncommon fractions;
e. Add fractions;
f. Find the common denominator of a number of fractions;
g. Subtract fractions;
h. Define mixed number;
i. Define improper fractions;
j. Change mixed numbers to improper fractions;
k. Change improper fractions to mixed numbers;
l. Reduce improper fractions to their lowest terms;
m. Add improper fractions;
n. Subtract improper fractions;
o. Multiply fractions; and,
p. Divide fractions.

Instructional Materials:

Paper
Pencil
Chalkboard
Overhead Projector
MASTER Handout (IMM-B2-HO)
MASTER Laboratory Worksheet (IMM-B2-LW)
MASTER Self-Assessment
Textbook
References:


**Applied Math**, Avi C. Bajpai, Rodney M. Bond; adapted by Jerry W. Jones, Latest Edition

**Applied Math for Technicians**, Claude S. Moore, Bennie L. Griffin, Edward C. Polhamus, Jr.; {drawings, George E. Morris.}, Latest Edition


**Becoming a Mental Math Wizard**, Jerry Lucas, Latest Edition

**Building Success in Math**, Carol R. Langbort, Virginia H. Thompson, Latest Edition


Student Preparation:

Students should have previously completed the following Technical Modules:

**IMM-B1** "Perform Basic Arithmetic Functions"

Introduction:

This module prepares you to use fractions. Many calculations made in industrial plants use fractions. Fractions allow you to measure and adjust tolerances on machinery parts. Working with blueprints or machine parts specifications also requires an understanding of fractions.

In this module you will learn how to add, subtract, multiply and divide fractions. Also, you will learn how to work with mixed numbers that combine whole numbers and fractions. Fractions are converted to decimals and decimals are converted to fractions.

Presentation Outline:

I. Introduction - Define Fractions
II. Reducing a Fraction
III. Adding Fractions
IV. Subtracting Fractions
V. Improper Fractions
VI. Multiplying Fractions
VII. Dividing Fractions
VIII. Converting Fractions to Decimals
IX. Converting Decimals to Fractions

Practical Application:

Students will practice in the lab. Each student will complete the MASTER Laboratory Worksheet (IMM-B2-LW) and turn it into the instructor for checking.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written evaluation.

Summary:

Review the main lesson points and practice laboratory worksheet as a guide.

Next Lesson Assignment:

MASTER Technical Module (IMM-B3) dealing with the conversion of Metric/English measurements.
Standards of performance safety:

Student shall demonstrate ability to work with fractions, convert fractions to decimals, and decimals to fractions.

Objective(s):

Upon completion of this module the student will be able to:

a. Define a fraction and its parts;
b. Reduce fractions to their lowest terms;
c. Define prime number and composite number;
d. Define common fractions and uncommon fractions;
e. Add fractions;
f. Find the common denominator of a number of fractions;
g. Subtract fractions;
h. Define mixed number;
i. Define improper fractions;
j. Change mixed numbers to improper fractions;
k. Change improper fractions to mixed numbers;
l. Reduce improper fractions to their lowest terms;
m. Add improper fractions;
n. Subtract improper fractions;
o. Multiply fractions; and,
p. Divide fractions.

Reading Assignments:

The following chapters are assigned to read from *Math for Consumers*, by D.S. Kaine and L.S. Kaine, Addison-Wesley Pub. Co., Latest Edition:

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<th>Title</th>
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<tr>
<td></td>
<td>Fractions and Operations</td>
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Module Outline:

I. Introduction - Define Fractions
II. Reducing Fractions
III. Adding Fractions
IV. Subtracting Fractions
V. Improper Fractions
VI. Multiplying Fractions
VII. Dividing Fractions
VIII. Converting Fractions to Decimals
IX. Converting Decimals to Fractions

Glossary:

Composite Number
A number greater than one and divisible by one, itself, and other numbers.

Denominator
The number below (or to the right of) the fraction line for any proper or improper fraction.

Equivalent
Means "equal to" but not necessarily "identical to."

Fraction
A number that represents a part of a whole.

Improper Fraction
Any fraction whose value is equal to or greater than one. The numerator of an improper fraction is always equal to or greater than the denominator.

Mixed Number
A mixed number is a combination of a whole number and a fraction.

Numerator
The number above (or to the left of) the fraction line for any proper or improper fraction.

Prime Number
A number greater than one and divisible only by one and itself.

Proper Fraction
Any fraction whose value is less than one. The numerator of a proper fraction is always less than the denominator.

Reduced Fraction
A fraction in its simplest form, whose numerator and denominator contain no common factors other than 1.
Worksheet:

Reduce the following fractions to their lowest terms:

1. \( \frac{4}{24} = \) 
2. \( \frac{8}{32} = \) 
3. \( \frac{2}{18} = \) 
4. \( \frac{36}{72} = \) 
5. \( \frac{10}{16} = \)

Change the mixed numbers to improper fractions.

1. \( 9 \frac{3}{4} = \) 
2. \( 5 \frac{7}{8} = \) 
3. \( 4 \frac{9}{32} = \)

Solve the following problems.

1. \( \frac{2}{7} \times \frac{6}{11} = \) 
2. \( \frac{5}{9} \times \frac{8}{3} = \) 
3. \( \frac{2}{3} \times \frac{1}{10} = \) 
4. \( \frac{5}{7} \) divided by \( \frac{2}{3} = \) 
5. \( \frac{7}{8} \) divided by \( \frac{1}{4} = \) 
6. \( \frac{3}{4} \) divided by \( \frac{2}{9} = \)
Convert decimals to fractions or fractions to decimals.

1. $12/15 = \underline{\hspace{2cm}}$
2. $3/5 = \underline{\hspace{2cm}}$
3. $11/17 = \underline{\hspace{2cm}}$
4. $0.6 = \underline{\hspace{2cm}}$
5. $0.875 = \underline{\hspace{2cm}}$
6. $0.88 = \underline{\hspace{2cm}}$
Reduce fractions to lowest terms.

1. \( 0.375 = \) ____
2. \( \frac{13}{15} = \) ____
3. \( \frac{6}{8} = \) ____
4. \( \frac{31}{37} = \) ____
5. \( 0.667 = \) ____

Change mixed numbers to improper fractions.

6. \( 3 \frac{15}{16} = \) ____
7. \( 6 \frac{5}{6} = \) ____
8. \( 1 \frac{19}{20} = \) ____
9. \( 9 \frac{2}{5} = \) ____
10. \( 4 \frac{14}{15} = \) ____

Solve the following problems.

11. \( \frac{2}{3} + \frac{4}{5} = \) ____
12. \( 4 \frac{1}{3} - 1 \frac{8}{9} = \) ____
13. \( \frac{14}{15} \times \frac{15}{42} = \) ____
14. \( 1 \frac{9}{15} \text{ divide by } 6 \frac{32}{45} = \) ____
15. \( 1 \frac{7}{8} \times 3 \frac{7}{9} = \) __________
Convert decimals to fractions or fractions to decimals.

16. \( \frac{7}{8} = \) ________

17. \( \frac{31}{32} = \) ________

18. \( \frac{14}{16} = \) ________

19. \( 0.12 = \) ________

20. \( 2.875 = \) ________
IMM-B2
Convert Fractions/Decimals
Self-Assessment Answer Key

1. 0.375
2. 0.867
3. 0.75
4. 0.838
5. 0.667
6. 63/16
7. 41/6
8. 39/20
9. 47/5
10. 74/15
11. 22/15
12. 2 4/9
13. 1/3
14. 36/151
15. 85/12
16. 0.875
17. 0.969
18. 0.875
19. 1/8
20. 2 7/8
INDUSTRIAL MAINTENANCE
MECHANIC SERIES
MASTER Technical Module No. IMM-B3

Subject: Industrial Maintenance

Duty: Apply Mathematical Concepts

Task: Convert Metric/English Measurements

Time: 4 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Name the three basic units of metric-system measurement;
b. Match the six most commonly used metric-system prefixes with their meaning;
c. Determine where to place the decimal when writing the numerical equivalent of a metric measurement;
d. Add and subtract metric-system units;
e. Convert Celsius degrees to Fahrenheit and Fahrenheit to Celsius; and
f. Convert metric units to English units and English units to metric units.

Instructional Materials:

Paper
Pencil
Chalkboard
Overhead Projector
MASTER Handout (IMM-B3-HO)
MASTER Laboratory Worksheet (IMM-B3-LW)
MASTER Self Assessment

References:

*Applied Electronic Math, with Calculators*, Tontsch, John W., Latest Edition


*Applied Math for Technicians*, Moore, Claude S.; Griffin, Bennie L.; Polhamus, Edward C., Jr.; {drawings, George E. Morris.}, Latest Edition
Introduction:

In today's world economy maintenance mechanics will see more and more equipment and drawings that require use of the metric numbering system. You must be able to convert dimensions from metric to English or English to metric. This study will help keep you above the rest of the skills needed by the modern maintenance technician.

Presentation Outline:

I. English System  
II. Metric System  
III. Metric Prefixes  
IV. Moving Decimal  
V. Metric Length  
VI. Metric Weight  
VII. Metric Volume  
VIII. Metric Temperature  
IX. Converting English to Metric Units  
X. Converting Metric to English

Practical Application:

Students will practice in the lab. Each student will complete the MASTER Laboratory Worksheet (IMM-B3-LW) and turn it in to the instructor for checking.
Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written evaluation.

Summary:

Review the main lesson points using the objective as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-B4) dealing with performing basic algebraic operations.
Standards of Performance:

Student shall demonstrate ability to convert English units to metric units and convert metric units to English units.

Objectives:

Upon completion of this module the student will be able to:

a. Name the three basic units of metric system measurement;
b. Match the six most commonly used metric system prefixes with their meaning;
c. Determine where to place the decimal when writing the numerical equivalent of a metric measurement;
d. Add and subtract metric-system units;
e. Convert Celsius degrees to Fahrenheit and Fahrenheit to Celsius; and,
f. Convert metric units to English units and English units to metric units.

Conversion Chart:

<table>
<thead>
<tr>
<th>Metric to English</th>
<th>English To Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td></td>
</tr>
<tr>
<td>1 mm = 0.04 in</td>
<td>1 in = 2.54 cm</td>
</tr>
<tr>
<td>1 cm = 0.39 in</td>
<td>1 ft = 30.48 cm = 0.305</td>
</tr>
<tr>
<td>1 m = 39.37 in = 3.28 ft</td>
<td>1 yd = 0.914 m</td>
</tr>
<tr>
<td>1 m = 1.09 yd</td>
<td>1 km = 0.62 mi</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td></td>
</tr>
<tr>
<td>1 g = 0.035 oz</td>
<td>1 oz = 31.103 g</td>
</tr>
<tr>
<td>1 kg = 2.2 lb</td>
<td>1 lb = 0.453 kg</td>
</tr>
<tr>
<td><strong>Volume</strong></td>
<td></td>
</tr>
<tr>
<td>1 ml = 0.2 tsp</td>
<td>1 tsp = 5 ml</td>
</tr>
<tr>
<td>1 l = 1.057 qt</td>
<td>1 c = 284 ml</td>
</tr>
<tr>
<td></td>
<td>1 qt = 0.946 l</td>
</tr>
<tr>
<td></td>
<td>1 gal = 3.785 l</td>
</tr>
</tbody>
</table>
Common abbreviations used above:

c = cup
cm = centimeter
ft = foot
g = gram
gal = gallon
in = inch
kg = kilogram
km = kilometer
l = liter
lb = pound
m = meter
mi = mile
ml = milliliter
mm = millimeter
oz = ounce
qt = quart
tsp = teaspoon
yd = yard

Reading Assignments:

The following chapters are assigned to read from Math for Consumers, by D.S. Kaine and L.S. Kaine, Advisor-Wesley Pub. Co., Latest Edition

Subject - Metric System

Module Outline:

I. English System
II. Metric System
III. Metric Prefixes
IV. Moving Decimal
V. Metric Length
VI. Metric Weight
VII. Metric Volume
VIII. Metric Temperature
IX. Converting English to Metric Units
X. Converting Metric to English
Glossary:

**Composite Number**
A number greater than one and divisible by one, itself, and other numbers.

**Denominator**
The number below (or to the right of) the fraction line for any proper or improper fraction.

**Equivalent**
Means "equal to" but not necessarily "identical to".

**Fraction**
A number that represents a part of a whole.

**Improper Fraction**
Any fraction whose value is equal to or greater than one. The numerator of an improper fraction is always equal to or greater than the denominator.

**Mixed Number**
A mixed number is a combination of a whole number and a fraction.

**Numerator**
The number above (or to the left of) the fraction line for any proper or improper fraction.

**Prime Number**
A number greater than one and divisible only by one and itself.

**Proper Fraction**
Any fraction whose value is less than one. The numerator of a proper fraction is always less than the denominator.

**Reduced Fraction**
A fraction in its simplest form, whose numerator and denominator contain no common factors other than 1.
Perform operations, as indicated.

1. There are _____ kilograms in a metric ton.
2. 100.9 g - 74.99 g = _____ g
3. 93.6 cg + 1,189 cg = _____ cg

Perform the conversions. Round your answer to two places.

1. 34 g = _____ oz
2. 92 cm = _____ ft
3. 890 l = _____ gal
4. 15 cm = _____ in
5. 58.5 kg = _____ lbs
Compute these metric measurements, then convert into English units. Use the conversion chart.

1. \(1.2 \text{ kg} + 849 \text{ g} = \underline{\text{kg}} = \underline{\text{lb}}\)
2. \(84.2 \text{ 1} - 2,145 \text{ ml} \underline{\text{l}} = \underline{\text{gal}}\)
3. \(9.3 \text{ m} \times 490 \text{ mm} = \underline{\text{km}} = \underline{\text{mi}}\)
4. \(2,600 \text{ hg} \div 456.3 \text{ kg} = \underline{\text{g}} = \underline{\text{oz}}\)
5. \(493 \text{ ml} \times 0.33 \text{ 1} = \underline{\text{ml}} = \underline{\text{qt}}\)
6. \(43.8 \text{ cm} + 248 \text{ mm} = \underline{\text{m}} = \underline{\text{ft}}\)
7. \(492 \text{ g} \div 2.2 \text{ kg} = \underline{\text{mg}} = \underline{\text{oz}}\)

Convert these English units into metric units. Use the conversion chart.

8. \(154 \text{ mi} = \underline{\text{km}}\)
9. \(14.5 \text{ c} = \underline{\text{ml}}\)
10. \(1,983 \text{ lb} = \underline{\text{kg}}\)
11. \(154 \text{ yd} = \underline{\text{m}}\)
12. \(98.5 \text{ gal} \underline{\text{l}}\)

Convert the following measurements and temperatures.

13. \(85^\circ \text{ C} = \underline{\text{F}}\)
14. \(120 \text{ mm} = \underline{\text{m}}\)
15. \(14 \text{ kg} = \underline{\text{g}}\)
16. \(59^\circ C = \underline{\quad} ^\circ F\)
17. \(2.4 \text{ t} = \underline{\quad} \text{kg}\)
18. \(6.25 \text{ l} = \underline{\quad} \text{ml}\)
19. \(27^\circ F = \underline{\quad} ^\circ C\)
20. \(0.89 \text{ km} = \underline{\quad} \text{cm}\)
1. 2.049 kg = 4.51 lb
2. 82.06 l = 21.7 gal
3. .0000049 km = .0049 m
4. .5698 g = 16.28 oz
5. 162,690 ml = 171.96 qt
6. 0.69 m = 2.26 ft
7. 223.6 mg = .0078 oz
8. 247.8 km
9. 4,118 ml
10. 898.3 kg
11. 140.8 m
12. 372.75 l
13. 185 F
14. 0.12 m
15. 14,000 g
16. 138.2 F
17. 2,400 kg
18. 6.250 ml
19. -2.8 C
20. 89,000 cm
Subject: Industrial Maintenance

Duty: Apply Mathematical Concepts
Task: Perform Basic Algebraic Operations

Time: 6 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Define formula;
b. Define equation;
c. Define term;
d. Demonstrate that you understand what combinations of letters and numbers or letters indicate in formulas;
e. Demonstrate that you understand what parentheses or brackets indicate in formulas;
f. Change certain sentences about mathematical relationships into formulas; and,
g. Demonstrate that you can rearrange formulas in order to find various unknowns.

Instructional Materials:

- Paper
- Pencil
- Chalkboard
- Overhead Projector
- MASTER Handout (IMM-B4-HO)
- MASTER Laboratory Worksheet (IMM-B4-LW)
- MASTER Self-Assessment

References:

Applied Electronic Math, with Calculators, John W. Tontsch, Latest Edition

Applied Math, Avi C. Bajpai, Rodney M. Bond; adapted by Jerry W. Jones, Latest Edition
Applied Math for Technicians, Claude S. Moore, Bennie L. Griffin, Edward C. Polhamus, Jr.; {drawings, George E. Morris.}, Latest Edition

Basic Business Math, Robert L. Dansby, Latest Edition


Becoming a Mental Math Wizard, Jerry Lucas, Latest Edition

Building Success in Math, Carol R. Langbort, Virginia H. Thompson, Latest Edition


Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-B3   “Convert Metric/English Measurements”

Introduction:

This module includes basic techniques used in working with formulas. In this module, you will consider approaches to working formulas. These are methods you can apply whenever you have to use formulas. In this module, you will learn how to substitute values in formulas. You will learn how to use formulas to find various unknowns. You will practice what you learn by working some practical formulas.

Presentation Outline:

I. Formula Components
   Terms, brackets, parentheses, letters, number
II. What a Formula Does
   State relationships
III. Principles for Solving Formulas
IV. Ratio for Solving Formulas
V. Practice Using Formulas

Practical Application:

Students will practice in the lab. Each student will complete the MASTER Laboratory Worksheet (IMM-B4-LW) and turn it in to the instructor for checking.
Evaluation and/or Verification:
Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:
Review the main lesson points using the objective as a guide for discussion and work problems on MASTER laboratory worksheet.

Next Lesson Assignment:
MASTER Technical Module (IMM-B5) dealing with performing basic trigonometric functions.
Standards of performance safety:

Student shall demonstrate ability to use formulas to solve mathematical problems.

Objectives:

Upon completion of this module the student will be able to:

a. Define formula;
b. Define equation;
c. Define term;
d. Demonstrate that you understand what combinations of letters and numbers or letters indicate in formulas;
e. Demonstrate that you understand what parentheses or brackets indicate in formulas;
f. Change certain sentences about mathematical relationships into formulas; and,
g. Demonstrate that you can rearrange formulas in order to find various unknowns.

Rules for Dealing with Formulas:

1. A formula is a way of briefly expressing a rule, fact, or principle by the use of symbols or letters.

2. Formulas are equations. An equation is a statement that the quantities on each side of the equal sign equal the same thing.

3. Combinations of letters and/or numbers indicate multiplication.

4. Parentheses ( ) or brackets [ ] are grouping symbols. They indicate that the quantities within them are to be grouped together, and are to be considered as one quantity. When working with formulas that have parentheses, first do the operation indicated within the parentheses. When both brackets and parentheses are present work within the brackets.

5. Formulas state relationships that have been tested and proven to be true. A formula is a sentence where letters, symbols, and numbers substitute for words.
6. Sometimes, you know the value of the quantity to the left of the equal sign, but not all the values to the right. You can still work the formula by reattaching it.

7. There are some rules of procedure you must follow when you rearrange equations. One important principle is cancellation. Cancellation removes a common element from a fraction's numerator and denominator on one side of an equation.

8. Another important principle states that what is done to one side an equation, must be done to the other side. Another principle used in solving formula is transposition. This states that when you move quantity form one side of an equation to the other, you change its sign or operation.

Reading Assignments:

The following chapters are assigned to read from *Math for Consumers*, D.S. Kaine and L.S. Kaine, Advisor-Wesley Pub. Co., Latest Edition

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
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<tr>
<td></td>
<td>Equation Solving</td>
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</tbody>
</table>

Module Outline:

I. Formula Components
   Terms, brackets, parentheses, letters, number
II. What a Formula Does
    State Relationships
III. Principles for Solving Formulas
IV. Ratio for Solving Formulas
V. Practice Using Formulas

Glossary:

Cancellation
   Removing a common element from a numerator and a denominator of a fraction on one side of an equation.

Equation
   A statement that two quantities are equal.
Formula
A way of briefly expressing a rule, fact, or principle by the use of symbols or letters. A formula is an equation.

Term
Numbers or symbols combined by multiplication, division, addition, or subtraction.

Transportation
The process of moving a quantity from one side of an equation to the other by changing its sign of operation.
Worksheet:

1. Formulas:
   a. are equations.
   b. show how some quantities are related to each other.
   c. state relationships which have been tested and proven to be true.
   d. all of the above.

2. In a formula terms are:
   a. numbers or symbols combined by addition or subtraction.
   b. numbers or symbols combined by addition, subtraction, multiplication, or division.
   c. numbers or symbols.
   d. none of the above.

3. Parentheses or brackets in a formula mean:
   a. quantities within them are to be grouped together.
   b. quantities within them are to be considered one quantity.
   c. first do the work indicated within the parentheses.
   d. all of the above.

4. Write the formula for the following sentence. Profit (P) equals the margin (M) minus the overhead (O).

5. Write the formula for the following sentence. The amperage (A) of an electrical circuit is equal to the wattage (W) divided by the voltage (V).

6. Write the sentence for the following formula. I=PRT (I is interest on money, P is principal, R is rate, and T is time).

7. Write the sentence for the following formula. HP=VA/746 horsepower on an electric motor, V is volts, and a amperes.
IMM-B4
Perform Basic Algebraic Operations
Self-Assessment

1. Rearrange the formula $F_1 \times D_1 = F_0 \times D_0$ to solve for $D_1$. (Show all steps.)

   ____________________________
   ____________________________

2. Rearrange the formula $A = L \times W$ to solve for $W$. (Show all steps.)

   ____________________________
   ____________________________

3. Write the sentence that is the equivalent of the formula $A = L \times W$. ($A =$ area of a rectangle, $L =$ Length, and $W =$ width.)

   ____________________________
   ____________________________

4. Assume that $W$ represents work, $F$ represents force, and $D$ represents distance. Write a formula that shows distance multiplied by force equals work.

   ____________________________
   ____________________________

5. In a formula, a combination of a number and a letter or two letters, like $3A$ or $BC$ indicates:
   a. addition
   b. multiplication
   c. either of the above, depending on the sign in the equation.
   d. none of the above
6. Equations are:
   a. formulas
   b. statements of principles
   c. statements that two quantities are equal
   d. all of the above

7. Formulas:
   a. are equations
   b. show how some quantities are related to each other
   c. state relationships which have been tested and proven to be true
   d. all of the above
IMM-B4
Perform Basic Algebraic Operations
Self-Assessment Answer Key

1. $F_1 \times D_1 = F_0 \times D_0$; therefore, $D_1 = \frac{(F_0 \times D_0)}{F_1}$

2. $A = L \times W$; therefore, $\frac{A}{L} = W$

3. Area of a rectangle = Length time width

4. Distance multiplied by force = Work; therefore $D \times F = W$

5. b

6. d

7. d
Subject: Industrial Maintenance

Duty: Apply Mathematical Concepts

Task: Perform Basic Trigonometric Functions

Objective(s):

Upon completion of this module the student will be able to:

a. Solve trigonometric functions using a sin equation;
b. Solve trigonometric functions using a cos equation;
c. Solve trigonometric functions using a csc equation;
d. Solve trigonometric functions using a tan equation;
e. Solve trigonometric functions using a cot equation;
f. Solve trigonometric functions using a sec equation;
g. Solve for unknown sides, angles or radians for a right triangle;
h. Convert radians to degrees; and,
i. Convert degrees to radians.

Instructional Materials:

- MASTER Handout (IMM-B5-HO)
- MASTER Laboratory Worksheet (IMM-B5-LW)
- MASTER Self-Assessment
- Paper
- Pencil
- Chalk Board
- Overhead Projector

References:


- Applied Math, Avi C. Bajpai, Rodney M. Bond; adapted by Jerry W. Jones, Latest Edition

- Applied Math for Technicians, Claude S. Moore, Bennie L. Griffin, Edward C. Polhamus, Jr.; {drawings, George E. Morris.}, Latest Edition
Introduction:

Trigonometry in a study of right triangles. The right triangle is useful in studying angles, arcs, and distances. Proportional control is also a valuable asset.

Presentation Outline:

I. Solve Trigonometric Functions Use a Sin Equation
II. Solve Trigonometric Functions Use a Cos Equation
III. Solve Trigonometric Functions Use a Csc Equation
IV. Solve Trigonometric Functions Use a Tan Equation
V. Solve Trigonometric Functions Use a Cot Equation
VI. Solve Trigonometric Functions Use a Sec Equation
VII. Solve For Unknown Sides, Angles or Radians For a Right Triangle
VIII. Convert Radians to Degrees
IX. Convert Degrees to Radians

Practical Application:

Students will practice working math problems. Each student will complete the MASTER Laboratory Worksheet (IMM-B5-LW) and turn it in to the instructor for checking.
Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of written evaluation.

Summary:

Review the main lesson points using the MASTER Handout (IMM-B5-HO) as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-B6) dealing with basic geometric calculations.
Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Solve trigonometric functions use a sin equation.;
b. Solve trigonometric functions use a cos equation;
c. Solve trigonometric functions use a csc equation;
d. Solve trigonometric functions use a tan equation;
e. Solve trigonometric functions use a cot equation;
f. Solve trigonometric functions use a sec equation;
g. Solve for unknown sides, angles or radians for a right triangle;
h. Convert radians to degrees; and,
i. Convert degrees to radians.

Reading Assignments:

The following chapters are assigned to read from *Mathematics for Technicians* by Edward Tronaas, Prentice Hall Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Trigonometry</td>
</tr>
</tbody>
</table>

Module Outline:

I. Solve Trigonometric Functions Use a Sin Equation
II. Solve Trigonometric Functions Use a Cos Equation
III. Solve Trigonometric Functions Use a Csc Equation
IV. Solve Trigonometric Functions Use a Tan Equation
V. Solve Trigonometric Functions Use a Cot Equation
VI. Solve Trigonometric Functions Use a Sec Equation
VII. Solve For Unknown Sides, Angles or Radians For a Right Triangle
VIII. Convert Radians to Degrees
IX. Convert Degrees to Radians
Worksheet:

(Use Trig Function Tables)

Solve:

1. Sin 22° 18' =
2. Cot 22° 18' =
3. Sec 22° 18' =
4. Tan 22° 18' =
5. Csc 22° 18' =
6. Cos 22° 18' =
7. Cos A = 0.69675
8. Cot A = 1.1340
9. Sin A = 0.98531
10. Sec A = 1.5753
11. Tan A = 0.50587
12. 2π Radians = Degrees
13. 180 Degrees = Radians
14. π Radians = Degrees
IMM-B5
Perform Basic Trigonometric Functions
Self-Assessment

(Use Trig Function Tables)

Solve:

1. 97 Degrees = ___________ Radians
2. 1.5 [\pi] Radians = ___________ Degrees
3. Sin 37° 14' = ______________
4. Cos 156° 16' = ______________
5. Tan 41° 11' = ______________
6. Sec 18° 9' = ______________
7. Csc 8° 8' = ______________
8. Cot 21° 8' = ______________
9. Sec A = 1.5753 ______________
10. Sin A = 0.98531 ______________
<p>| | |</p>
<table>
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<tr>
<th></th>
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<tbody>
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<td>2</td>
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<td>0.5871</td>
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<td>9</td>
<td>50° 36°</td>
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<td>10</td>
<td>79° 50°</td>
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</tbody>
</table>
INDUSTRIAL MAINTENANCE
MECHANIC SERIES
MASTER Technical Module No. IMM-B6

Subject: Industrial Maintenance
Duty: Apply Mathematical Concepts
Task: Perform Basic Geometric Calculations

Objective(s):
Upon completion of this module the student will be able to demonstrate how to:

a. Calculate angles;
b. Calculate length of triangle sides;
c. Calculate radius, diameter, circumference, and area of a circle;
d. Calculate length of sphere;
e. Calculate area of a cone;
f. Calculate volume of a solid;
g. Calculate volume and area of a cylinder;
h. Calculate polygon dimension; and,
i. Calculate prism dimensions.

Instructional Materials:
MASTER Handout (IMM-B6-HO)
MASTER Laboratory Worksheet (IMM-B6-LW)
MASTER Self-Assessment
Paper
Pencil
Chalk Board
Overhead Projector
Various Geometric Objects

References:

*Applied Electronic Math, with Calculators*, Tontsch, John W., Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

- IMM-B1 “Perform Basic Arithmetic Functions”
- IMM-B4 “Perform Basic Algebraic Operations”

Introduction:

Geometry is used to calculate lengths, angles, arcs, area and volumes of various shapes and objects.

Presentation Outline:

I. Angles
II. Triangle
III. Circle
IV. Sphere
V. Cone
VI. Solid
VII. Cylindrical
VIII. Polygon
IX. Prism

Practical Application:

Students will practice working math problems. Each student will complete the MASTER Laboratory Worksheet (IMM-B6-LW) and turn it in to the instructor for checking.
Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the handout (IMM-B6-HO) as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-C1) dealing with identifying basic layout of drawings.
Standards of Performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Calculate angles;
b. Calculate length of triangle sides;
c. Calculate radius, diameter, circumference, and area of a circle;
d. Calculate length of sphere;
e. Calculate area of a cone;
f. Calculate volume of a solid;
g. Calculate volume and area of a cylinder;
h. Calculate polygon dimension; and,
i. Calculate prism dimensions.
Objective(s):

Upon completion of this module the student will be able to:

a. Calculate angles;
b. Calculate length of triangle sides;
c. Calculate radius, diameter, circumference, and area of a circle;
d. Calculate length of sphere;
e. Calculate area of a cone;
f. Calculate volume of a solid;
g. Calculate volume and area of a cylinder;
h. Calculate polygon dimension; and,
i. Calculate prism dimensions.

Reading Assignments:

The following chapters are assigned to read from Math for Technician, by Edward Trunaas, Prentice Hall Publishers, Latest Edition:

Chapter Title
8 Fundamentals of Geometry

Module Outline:

I. Angles
II. Triangle
III. Circle
IV. Sphere
V. Cone
VI. Solid
VII. Cylindrical
VIII. Polygon
IX. Prism
IMM-B6-LW
Perform Basic Geometric Calculations
Attachment 3: MASTER Laboratory Worksheet

Practice Working Problems In The Following Areas:
   a. Angles;
   b. Triangle;
   c. Circle;
   d. Sphere;
   e. Cone;
   f. Solid;
   g. Cylindrical;
   h. Polygon; and,
   i. Prism.
IMM-B6
Perform Basic Geometric Calculations
Self-Assessment

Solve:

1. If a triangle has a side equal to 3 inches and another side equal to 4 inches, calculate the length of the third side.

2. \( \pi \) Radius = __________ degrees.

3. Calculate the diameter of a circle. Radius equals 6 inches.

4. Calculate the area of a circle. Radius equals 6 inches.

5. Calculate the volume of a cone. The cone has a 6 inch radius and is 6 inches high.
1. \( c^2 = a^2 + b^2 \); therefore, \( c^2 = \sqrt{3^2 + 4^2} = \sqrt{9 + 16} = \sqrt{25} \); therefore, \( c = 5 \)

2. \( 360^\circ \)

3. \( 6 \times 2 = 12 \) inches

4. \( \pi r^2 = A = 3.14 (36) = 113.04 \) sq. inches

5. \( \frac{1}{3} \pi r^2 h = \left( \frac{1}{3} \right) (113.04) (6) = 223.8 \) cubic inches
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

### Duties

| A | Practice Safety |
| B | Apply Mathematical Concepts |
| C | Interpret Engineering Drawings and Control Documents |
| D | Use Measuring Tools |
| E | Use Hand Tools |
| F | Operate Machine Tools |
| G | Perform Welding Operations |
| H | Maintain Troubleshoot Equipment and Systems |
| I | Repair Power Transmission Systems |
| J | Fabricate Install Sheet Metal Parts |

### Tasks

| B-1 Perform basic arithmetic functions | B-2 Convert fractions/decimals | B-3 Convert Metric/English measurements | B-4 Perform basic algebraic operations | B-5 Perform basic trigonometric functions | B-6 Perform basic geometric calculations |
| C-1 Identify basic types of drawings | C-2 Identify basic layout of drawings | C-3 Review blueprint notes and dimensions |
| D-1 Use non-precision measuring tools | D-2 Use precision measuring tools |
| E-1 Identify and use maintenance technician's hand tools | E-2 Identify and use hand held power tools |
| F-1 Use and care of milling machines | F-2 Use and care of horizontal and vertical band saws | F-3 Use and care of grinders |
| G-1 Weld with shielded metal arc welding (SMAW) process | G-2 Weld/cut with oxyacetylene | G-3 Perform gas soldering |
| H-1 Maintain air conditioning systems | H-2 Maintain pneumatic control circuits | H-3 Troubleshoot centrifugal pumps | H-4 Troubleshoot positive displacement pumps | H-5 Maintain gate, globe, ball, plug, and butterfly valves | H-6 Maintain check valves and relief valves | H-7 Troubleshoot and repair blowers | H-8 Troubleshoot, maintain, and repair hydraulic systems | H-9 Troubleshoot, maintain, and repair pneumatic systems |
| I-1 Maintain and troubleshoot bell drive systems | I-2 Maintain and troubleshoot gear power transmission drives | I-3 Maintain and troubleshoot chain power transmission drives | I-4 Maintain and troubleshoot clutches |
| J-1 Layout and/or bend sheet metal parts | J-2 Form sheet metal parts | J-3 Fasten sheet metal parts together | J-4 Install sheet metal parts together |
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<td>L-1 Rigging fundamentals</td>
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<td>M</td>
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<td>N</td>
<td>N-1 Perform basic pipefitting calculations</td>
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<td>O</td>
<td>O-1 Principles of alignment</td>
</tr>
<tr>
<td>P</td>
<td>P-1 Install electrical connections</td>
</tr>
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<td>Q</td>
<td>Q-1 Use electrical test equipment</td>
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<td>R</td>
<td>R-1 Force</td>
</tr>
<tr>
<td>S</td>
<td>S-1 Fasteners and nomenclature</td>
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</tbody>
</table>
INDUSTRIAL MAINTENANCE
MECHANIC SERIES
MASTER Technical Module No. IMM-C1

Subject: Industrial Maintenance  Time: 7 Hrs.
Duty: Interpret Engineering Drawings and Control Documents
Task: Identify Basic Types of Drawings

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify basic types of drawings;
b. Identify mechanical blueprints;
c. Identify electrical blueprints;
d. Identify process blueprints; and,
e. Identify welding blueprints.

Instructional Materials:

MASTER Handout (IMM-C1-HO)
MASTER Self-Assessment
Drawings

References:

*Blueprint Reading*, TPC Publishers, Latest Edition

*Basic Blueprint Reading and Sketching*, Olivo and Olivo, Delmar Publishers, Latest Edition

*Reading Blueprints*, Industrial Media, Inc., Latest Edition


Student Preparation:
Introduction:

Drawings are an important vehicle of communication for technical personnel. Being able to work with different types of drawings is critical for a technician.

Presentation Outline:

I. Basic Types of Drawings
II. Mechanical Blueprints
III. Electrical Blueprints
IV. Process Blueprints
V. Welding Blueprints

Practical Application:

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-C2) dealing with identifying basic layout of drawings.
Standards of performance:

Student shall demonstrate how to identify basic types of drawings within 85% accuracy.

Objectives:

Upon completion of this module the student will be able to:

a. Identify mechanical drawings;
b. Identify electrical drawings;
c. Identify process drawings;
d. Identify welding drawings; and,
e. HVAC drawings.

Reading Assignments:

The following chapters are assigned to read from Industrial Blueprint Reading and Sketching, Kirk Patrick, Latest Edition:

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<tr>
<th>Chapter</th>
<th>Title</th>
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<td>2</td>
<td>Drawing Formula</td>
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<td>21</td>
<td>Welding Assemblies</td>
</tr>
<tr>
<td>24</td>
<td>Reading Electrical and Electronics Schematic Diagrams</td>
</tr>
</tbody>
</table>

Module Outline:

I. Basic Types of Drawings.
   A. Mechanical
   B. Electrical
   C. Process
   D. Welding
   E. Sketch
   F. Plot plans
   G. Floor plans
   H. Contour maps
   I. Elevations
   J. Architectural
   K. Engineering Drawings

II. Mechanical
A. One view drawings
B. Two view drawings
C. Three view drawings
D. Auxiliary views
E. Isometric views
F. Orthographic views
G. Pictorial views
H. Oblique views
I. GD&T
J. Assembly
K. Hydraulic drawings
L. Pneumatic drawings
M. Machine drawings
N. Parts
O. Explored views

III. Electrical
A. Schematic diagrams
B. Single line diagrams
C. Wiring diagrams
D. Pictorial diagrams
E. Block diagrams
F. Symbols
G. Distribution
H. Plant wiring diagram

IV. Process
A. Block diagram
B. Flow diagram
C. P&ID or EFG diagram
D. Symbols
E. Piping diagrams

V. Welding
A. Symbols
B. Assembly
C. Views

VI. HVAC
A. Sheet metal
B. Ducts, duct sections
C. Diffusers
D. Triangulation
IMM-C1
Identify Basic Types of Drawings
Self-Assessment

Circle the letter preceding the correct answer.

1. Oblique drawings are used in _________________ areas.
   A. Mechanic
   B. Electrical
   C. Welding
   D. Process

2. Isometric drawings are used in _________________ areas.
   A. Mechanical
   B. Electrical
   C. Welding
   D. Process

3. Single line drawings are used in _________________ areas.
   A. Mechanical
   B. Electrical
   C. Welding
   D. Process

4. GD&T are considered part of _________________ drawings.
   A. Mechanical
   B. Electrical
   C. Welding
   D. Process

5. EFD's are considered as part of _________________ drawings.
   A. Mechanical
   B. Electrical
   C. Welding
   D. Process
IMM-C1
Identify Basic Types of Drawings
Self-Assessment Answer Key

1. A
2. A
3. B
4. A
5. B
Subject: Industrial Maintenance

Duty: Interpret Engineering Drawings and Control Documents
Task: Identify Basic Layout of Drawings

Objective(s):

Upon completion of this unit the student will be able to:

a. Draw a simple isometric sketch;
b. Using drawing ledger, draw a simple three dimensional drawing; and,
c. Draw a simple orthographic view.

Instructional Materials:

Drawings
MASTER Handout (IMM-C2-HO)
MASTER Self-Assessment
MASTER Laboratory Worksheet (IMM-C2-LW)

References:

*Blueprint Reading*, TPC Publishers, Latest Edition

*Basic Blueprint Reading and Sketching*, Olivo and Olivo, Delmar Publishers, Latest Edition

*Reading Blueprints*, Industrial Media, Inc., Latest Edition


Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-C1 "Identify Basic Types of Drawings"
Introduction:

Drawings are a means of communicating technical information so all technical people understand. Pictures are easier to understand than written descriptions.

Presentation Outline:

I. Drawing Lines Nomenclature
II. Two Dimensional Drawings
III. Sectional Views
IV. Auxiliary Views
V. Areas of a Drawing

Practical Application:

The student will be able to identify the basic components of the title block and other notation blocks on a blueprint.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-C3) dealing with reviewing blueprint notes and dimensions.
Objectives:

Upon completion of this module the student will be able to:

a. Draw a simple isometric sketch;
b. Using drawing ledger, draw a simple three dimensional drawing; and,
c. Draw a simple orthographic view.

Reading Assignments:

The following chapters are assigned to read from *Industrial Blueprint Reading & Sketching*, Kirk Patrick, Latest Edition:

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<th>Chapter</th>
<th>Title</th>
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<td>12</td>
<td>Reading Two Dimensioning Drawings</td>
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<tr>
<td>15</td>
<td>Sectional Views</td>
</tr>
<tr>
<td>16</td>
<td>Auxiliary Views</td>
</tr>
</tbody>
</table>

Module Outline:

I. Drawing Lines Nomenclature
II. Two Dimensional Drawings
III. Sectional Views
IV. Auxiliary Views
V. Areas of a Drawing
Worksheet:

1. Draw an isometric sketch of an object furnished by instructor.
2. Draw a three dimensional sketch of an object furnished by instructor.
3. Draw an orthographic sketch of an object furnished by instructor.
Instructor will grade these exercises.

1. Draw an isometric sketch of an object furnished by instructor.

2. Draw a three dimensional sketch of an object furnished by instructor.

3. Draw an orthographic sketch of an object furnished by instructor.
Industrial Maintenance

MECHANIC SERIES
MASTER Technical Module No. IMM-C3

Subject: Industrial Maintenance

Duty: Interpret Engineering Drawings and Control Documents

Task: Review Blueprint Notes and Dimensions

Objective(s):

Upon completion of this unit the student will be able to:

a. Interpret notes on prints or mechanical drawings;
b. Identify scale on a print or mechanical drawing;
c. Demonstrate method of dimensioning a drawing;
d. Define tolerance assured in interpretation of drawings;
e. Identify document identification code;
f. Interpret drawing abbreviations and acronyms; and,
g. Interpret symbols used to illustrate surface finish.

Instructional Materials:

MASTER Handout (IMM-C3-HO)
MASTER Self-Assessment
Mechanical Blueprints

References:

Blueprint Reading, TPC Publishers, Latest Edition

Basic Blueprint Reading and Sketching, Olivo and Olivo, Delmar Publishers, Latest Edition

Reading Blueprints, Industrial Media, Inc., Latest Edition

Technology of Machine Tools, Delmar, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-C1 "Identify Basic Types of Drawings"
IMM-C2 "Identify Basic Layout of Drawings"
Introduction:

Mechanical drawings allow people to communicate with each other.

Presentation Outline:

I. Master Types of Drawings
II. Major Areas on Blueprint Mechanical Drawing
III. Scales Used for Drawings
IV. Dimension
V. Tolerances
VI. Document Identification Codes

Practical Application:

Student will demonstrate how to review blueprint notes and dimensions.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-D1) dealing with the use of non-precision measuring tools.
IMM-C3-HO
Review Blueprint Notes and Dimensions
Attachment 1: MASTER Handout

Objectives:

Upon completion of this module the student will be able to:

a. Interpret notes on prints or mechanical drawings;
b. Identify scale on a print or mechanical drawing;
c. Demonstrate method of dimensioning a drawing;
d. Define tolerance assured in interpretation of drawings;
e. Identify document identification code;
f. Interpret drawing abbreviations and acronyms; and,
g. Interpret symbols used to illustrate surface finish.

Reading Assignments:

The following chapters are assigned to read from Industrial Blueprint Reading and Sketching, Kirk Patrick, Latest Edition:

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<td>17</td>
<td>Dimensioning</td>
</tr>
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<td>18</td>
<td>Tolerances</td>
</tr>
</tbody>
</table>

Module Outline:

I. Major Types of Drawings
II. Major Areas on Blueprint Mechanical Drawing
III. Scales Used for Drawings
IV. Dimension
V. Tolerances
VI. Document Identification Codes
IMM-C3
Review Blueprint Notes and Dimensions
Self-Assessment

Circle the letter preceding the correct answer.

1. The two types of notes shown on engineering drawings are _____________.
   A. Assembly and detail
   B. Personal and business
   C. Detail and field
   D. General and specific

2. The three numbering systems used to show size and location dimensions are _____________.
   A. Fractions, numbers, and letters
   B. Fractions, decimals, and metric
   C. Fractions, tolerances, and decimals
   D. Decimals, limits, and tolerance
   E. Metric, English, and decimals

3. A drawing change is begun with a form called _____________.
   A. A change letter document
   B. A revision document notice
   C. An engineering revision
   D. A revision notice
   E. A document change notice

4. Which of the following does not appear in the title block?
   A. Drawing title
   B. Drawing size
   C. Revision letter
   D. Revision Descriptions
   E. None of the above

5. Half scale is correctly written as _____________.
   A. 2x
   B. 2"=1
   C. 1:2
   D. 1=2
6. The first sheet of a drawing with 22 sheets is identified as ____________.
   A. Sheet 1
   B. Sheet A
   C. Sheet 1 of 22

7. The abbreviation for National Taper Pipe (thread).
   A. NPT
   B. NTPT
   C. NT
   D. NTP

8. The complete finish symbol includes ____________.
   A. Waviness height
   B. Waviness width
   C. Roughness width
   D. All of the above

9. A tolerance is ________________.
   A. The amount of clearance shown on a drawing
   B. The amount of space between making parts
   C. The fineness of a finish
   D. The amount a part can vary from the dimension shown on the drawing

10. Document numbers ______________________________.
    A. Is usually assigned form a drawing log
    B. Always includes the size
    C. Always includes tolerances
    D. Always includes drawing title
IMM-C3
Review Blueprint Notes and Dimensions
Self-Assessment Answer Key

1. D
2. C
3. E
4. E
5. D
6. C
7. A
8. D
9. D
10. A
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<td>A-1 Use protective equipment</td>
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<td>A-2 Accident prevention</td>
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<td>A-3 Working aloft</td>
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<td>A-4 Fire safety</td>
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<td>A-5 Lifting safety</td>
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<td>A-6 Lockout/Tagout</td>
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<tr>
<td>Apply Mathematical Concepts</td>
<td>B-1 Perform basic arithmetic functions</td>
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<tr>
<td>B-2 Convert fractions/decimals</td>
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<td>B-3 Convert Metric/English measurements</td>
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<tr>
<td>B-4 Perform basic algebraic operations</td>
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<td>B-5 Perform basic trigonometric functions</td>
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<td></td>
</tr>
<tr>
<td>Interpret Engineering Drawings and Control Documents</td>
<td>C-1 Identify basic types of drawings</td>
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<tr>
<td>C-2 Identify basic layout of drawings</td>
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<tr>
<td>C-3 Review blueprint notes and dimensions</td>
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<tr>
<td>Use Measuring Tools</td>
<td>D-1 Use non-precision measuring tools</td>
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<td>D-2 Use precision measuring tools</td>
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<td>Use Hand Tools</td>
<td>E-1 Identify and use maintenance technician's hand tools</td>
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<td>H-5 Maintain and repair blowers</td>
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<tr>
<td>H-6 Maintain and repair hydraulic systems</td>
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<tr>
<td>H-7 Troubleshoot, maintain, and repair hydraulic systems</td>
<td></td>
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<tr>
<td>H-8 Troubleshoot, maintain, and repair pneumatic systems</td>
<td></td>
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<tr>
<td>Maintain/Troubleshoot Equipment and Systems</td>
<td>I-1 Maintain and troubleshoot belt drive systems</td>
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<td>I-2 Maintain and troubleshoot gear power transmission drives</td>
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<td>I-4 Maintain and troubleshoot clutches</td>
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<td>Repair Power Transmission Systems</td>
<td>J-1 Layout sheet metal parts</td>
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<td>J-2 Form and/or bend sheet metal parts</td>
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<tr>
<td>J-3 Fasten sheet metal parts together</td>
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</tr>
<tr>
<td></td>
<td>K-2 Cut, thread, and ream pipe</td>
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<tr>
<td></td>
<td>K-3 Pipe assembly</td>
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<td></td>
<td>K-4 Install and adjust pipe support</td>
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<td>K-5 Tubing</td>
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<td>L-2 Demonstrate basic rigging skills</td>
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<td>M</td>
<td>M-1 Plain bearings</td>
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<td></td>
<td>M-2 Rolling element bearings</td>
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<td>N-1 Perform basic pipefitting calculations</td>
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<td>N-2 Perform basic piping operations</td>
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<td>O-1 Principles of alignment</td>
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<td>O-2 Methods of alignment</td>
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<td>P-2 Setting and leveling</td>
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<td>P-3 Grouting</td>
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<td>P-4 Special mountings</td>
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<td>Q</td>
<td>Q-1 Use electrical test equipment</td>
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<td>Q-2 Apply basic terms to electrical circuits</td>
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<td></td>
<td>Q-3 Analyze series, parallel, and complex AC/DC circuits</td>
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<td></td>
<td>Q-4 Check AC and DC motors</td>
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<td>Q-5 Troubleshoot electrical devices</td>
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<td>R</td>
<td>R-1 Force</td>
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<td>R-2 Work</td>
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<td>R-4 Simple machines</td>
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<td>R-5 Power</td>
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<td>S-2 Application for various fasteners</td>
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<td>S-6 Effects of lubricating threads prior to torquing</td>
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<td>S-7 Demonstrate appropriate torqueing technique</td>
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</tbody>
</table>
INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-D1

Subject: Industrial Maintenance Time: 4 Hrs.
Duty: Use Measuring Tools
Task: Use Non-Precision Measuring Tools

Objective(s):

Upon completion of this module the student will be able to use the following non-precision measuring tools to 1/32" accuracy:

a. Steel Rule
b. Folding Rule
c. Steel Tape
d. Outside Calipers
e. Inside Calipers

Instructional Materials:

MASTER Handout (IMM-D1-HO)
MASTER Self-Assessment
MASTER Laboratory Aid (IMM-D1-LA)
MASTER Laboratory Worksheet (IMM-D1-LW)
Steel Rule
Folding Rule
Steel Tape
Outside Calipers
Inside Calipers

References:


Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-C3 "Review Blueprint Notes and Dimensions"
Introduction:

Measuring is an important tool for accurate construction of mechanical parts.

Presentation Outline:

I. Introduction
II. Folding Rule
III. Steel Rule
IV. Steel Tape
V. Outside and Inside Calipers

Practical Application:

1. Instructor will demonstrate proper use of non-precision measuring tools.
2. Student will demonstrate proper use of non-precision measuring tools.

Evaluation and/or Verification:

Successful completion of this Technical Module will be based on the student’s successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-D2) dealing with the use of precision measuring tools.
Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
  a. Properly use steel rule;
  b. Properly use folding rule;
  c. Properly use steel tape;
  d. Properly use outside calipers; and,
  e. Properly use inside calipers.

Reading Assignments:

The following chapters are assigned to read from Technology of Machine Tools,
by Krar, McGraw-Hill Company, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Measurement</td>
</tr>
</tbody>
</table>

Module Outline:

I. Introduction
II. Steel Rule
III. Folding Rule
IV. Steel Tape
V. Outside Calipers
VI. Inside Calipers
Standards of performance:

- Student shall demonstrate safe work habits in the work shop by:
  - Using OSHA required safety equipment for the shop;
  - Safety glasses;
  - Hearing protection;
  - Face shields;
  - Gloves;
  - Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
  - Not participating in horse play or practical joking.
IMM-D1-LW
Use Non-Precision Measuring Tools
Attachment 3: MASTER Laboratory Worksheet

1. Instructor will demonstrate use of the following non precision measuring tools:
   a. Steel Rule
   b. Folding Rule
   c. Steel Tape
   d. Outside Calipers
   e. Inside Calipers

2. Instructor will grade the student's use of the following non precision measuring tools:
   a. Steel Rule
   b. Folding Rule
   c. Steel Tape
   d. Outside Calipers
   e. Inside Calipers
1. A vernier caliper gives a more precise measurement than a slide caliper because it has ____________.
   a. Projecting teeth  
   b. A vernier scale  
   c. An L-shaped frame  
   d. Both inside and outside scale

2. What is the reading on the vernier caliper below?
   a. .642  
   b. 1.642  
   c. 1.645  
   d. 1.64
3. What is the reading on the vernier caliper below?
a. 0.415
b. 3.125
c. 3.405
d. 3.412

4. What is the reading on the vernier caliper below?
a. 4.575
b. 4.250
c. 4.570
d. 4.275
5. What is the reading on this vernier caliper?
   a. 3.785
   b. 3.800
   c. 3.473
   d. 3.793
IMM-D1
Use Non-Precision Measuring Tools
Self Assessment Answer Key

1. b
2. b
3. d
4. a
5. d
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-D2

Subject: Industrial Maintenance  
Duty: Use Measuring Tools  
Task: Use Precision Measuring Tools  
Time: 10 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Measure to an accuracy of 0.001;
b. Properly use vernier calipers;
c. Properly use outside micrometers;
d. Properly use depth gauges; and,
e. Properly use inside micrometers.

Instructional Materials:

- Vernier Calipers
- Outside Micrometer
- Inside Micrometer
- MASTER Handout (IMM-D2-HO)
- MASTER Self-Assessment
- MASTER Laboratory Aid (IMM-D2-LA)
- MASTER Laboratory Worksheet (IMM-D2-LW)

References:


Student Preparation:

Students should have previously completed the following Technical Modules:

- IMM-D1  “Use Non-Precision Measuring Tools”

Introduction:

Precision tools are often used to measure angular or linear distances when accuracy is very important in order to make parts for smooth operation.
Presentation Outline:

I. Vernier Calipers
II. Outside Micrometer
III. Inside Micrometer
IV. Depth Gauge

Practical Application:

Student will demonstrate proper use of precision measuring tools. The accuracy will be held to plus or minus 0.001.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-E1) dealing with identification and use of maintenance technician’s hand tools.
Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Properly use vernier calipers;
b. Properly use outside and inside micrometers;
c. Properly use depth gauges; and,
d. Properly use dial indicators.

Reading Assignments:

The following chapters are assigned to read from Technology of Machine Tools,
by Krar, McGraw-Hill, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
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<td>Micrometer</td>
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<tr>
<td>10</td>
<td>Vernier Calipers</td>
</tr>
<tr>
<td>11</td>
<td>Inside, Depth and Height Measuring Instruments</td>
</tr>
</tbody>
</table>

Module Outline:

I. Vernier Calipers
II. Outside Micrometer
III. Inside Micrometer
IV. Depth Gauge
Standards of performance safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves; and,
Not wearing rings, watches, jewelry, or loose clothing while operating equipment.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.
Worksheet:

1. Instructor will demonstrate how to use the following precision measuring tools:
   a. Vernier Calipers
   b. Inside Micrometers
   c. Outside Micrometers
   d. Depth Gages
   e. Dial Indicators

2. Student will demonstrate how to use the following precision measuring tools:
   a. Vernier Calipers
   b. Inside Micrometers
   c. Outside Micrometers
   d. Depth Gages
   e. Dial Indicators

3. Instructor will grade student's ability to use the following precision measuring tools:
   a. Vernier Calipers
   b. Inside Micrometers
   c. Outside Micrometers
   d. Depth Gauges
   e. Dial Indicators
IMM-D2
Use Precision Measuring Tools
Self-Assessment

1. The outside and inside caliper must be read or set with a _____.
   A. Height gage
   B. Solid square
   C. Gage block
   D. Steel rule

2. The outside caliper legs:
   A. Curve outward
   B. Curve inward
   C. Have one point and one curved
   D. Have two points

3. The inside caliper legs:
   A. Curve outward
   B. Curve inward
   C. Have one point one curved
   D. Have two points

4. When checking the measurement of an outside caliper have one leg:
   A. Hooked on the end of a steel rule
   B. On the 1" mark of a steel rule
   C. On the 32nd scale of a steel rule
   D. And the steel rule on a flat surface

5. When checking the measurement of an inside caliper, have one leg of the caliper:
   A. Hooked on the end of a steel rule
   B. On the 1" mark of a steel rule
   C. On the 32nd scale of a steel rule
   D. And the steel rule on a flat surface

6. How many numbered lines are there on the sleeve of an outside micrometer caliper?
   A. 40
   B. 30
   C. 20
   D. 10
7. What is the value or each numbered line on the sleeve?
   A. .010
   B. .025
   C. .100
   D. .0001

8. What is the total number of lines on the sleeve of an outside micrometer caliper?
   A. 25
   B. 30
   C. 35
   D. 40

9. What is the value of each line on the sleeve?
   A. .010
   B. .025
   C. .100
   D. .0001

10. How many lines are there on the thimble?
    A. 25
    B. 50
    C. 100
    D. 1000

11. What is the value of each line on the thimble?
    A. .100
    B. .050
    C. .025
    D. .001

12. How many threads per inch are there on the spindle of a micrometer?
    A. 25
    B. .40
    C. 100
    D. 1000

13. One turn of the thimble advances the spindle of a micrometer:
    A. .001
    B. .010
    C. .025
    D. .100
14. What should be used to check a 2" micrometer for accuracy?
   A. Spindle to anvil
   B. 1" standard
   C. ½" standard
   D. 1" hot roll steel

15. After the telescoping gauge is set to size, it must be read with an:
   A. Outside caliper
   B. Inside caliper
   C. Outside micrometer
   D. Inside micrometer

16. Some vernier caliper and dial calipers will measure:
   A. Depth
   B. Outside diameters
   C. Inside diameters
   D. All of the above
IMM-D2
Use Precision Measuring Tools
Self-Assessment Answer Key

1. D
2. B
3. A
4. A
5. D
6. D
7. C
8. D
9. B
10. A
11. D
12. B
13. C
14. B
15. C
16. D
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

**Tasks**

**A-1** Use protective equipment
**A-2** Apply mathematical concepts
**A-3** Interpret engineering drawings and control documents
**A-4** Use measuring tools
**A-5** Use hand tools
**A-6** Operate machine tools
**A-7** Perform welding operations
**A-8** Maintain and troubleshoot equipment and systems
**A-9** Repair power transmission systems
**A-10** Fabricate/Install sheet metal parts

**Duties**

**A**  Practice safety:
**B**  Apply mathematical concepts:
**C**  Interpret engineering drawings and control documents:
**D**  Use measuring tools:
**E**  Use hand tools:
**F**  Operate machine tools:
**G**  Perform welding operations:
**H**  Maintain/Troubleshoot equipment and systems:
**I**  Repair power transmission systems:
**J**  Fabricate/Install sheet metal parts:
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
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</table>
| K Piping Operations | K-1 Perform basic pipefitting calculations  
K-2 Cut, thread, and ream pipe  
K-3 Pipe assembly  
K-4 Install and adjust pipe support  
K-5 Tubing  
K-6 Fittings  
K-7 Plastic pipe |
| L Basic Rigging      | L-1 Rigging fundamentals  
L-2 Demonstrate basic rigging skills |
| M Bearing Maintenance | M-1 Plain bearings  
M-2 Rolling element bearings |
| N Use Computers       | N-1 Perform basic word processing  
N-2 Perform basic spreadsheet operations |
| O Align Shafts        | O-1 Principles of alignment  
O-2 Methods of alignment |
| P Install/Align Machines | P-1 Install electrical connections  
P-2 Setting and leveling  
P-3 Grouting  
P-4 Special mountings |
| Q Maintain Electrical Devices | Q-1 Use electrical test equipment  
Q-2 Apply basic terms to electrical circuits  
Q-3 Analyze series, parallel, and complex AC/DC circuits  
Q-4 Check AC and DC motors  
Q-5 Troubleshoot electrical devices |
| R Basic Mechanical Concepts | R-1 Force  
R-2 Work  
R-3 Mechanical motion and rate  
R-4 Simple machines  
R-5 Power |
| S Fasteners and Preloading | S-1 Fasteners and nomenclature  
S-2 Applications for various fasteners  
S-3 Techniques for removing damaged fasteners  
S-4 Cleaning and restoring threaded fasteners  
S-5 Torque preload theory  
S-6 Effects of lubricating threads prior to torquing  
S-7 Demonstrate appropriate torquing technique |
INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-E1

Subject: Industrial Maintenance

Time: 6 Hrs.

Duty: Use Hand Tools
Task: Identify and Use Maintenance Technician’s Hand Tools

Objective(s):

Upon completion of this module the student will be able to:

a. Proper use of pliers;
b. Proper use of hammers;
c. Proper use of punches;
d. Proper use of wrenches;
e. Proper use of chisels;
f. Proper use of bars; and,
g. Proper use of screwdrivers.

Instructional Materials:

MASTER Handout (IMM-E1-HO)
MASTER Laboratory Aid (IMM-E1-LA)
MASTER Laboratory Worksheet (IMM-E1-LW)
MASTER Self-Assessment
Pliers
Hammers
Punches
Wrenches
Chisels
Bars
Screwdrivers

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
Introduction:

Hand tools serve as an extension of a maintenance mechanic's mind. These tools allow the mechanic to gain torque and leverage.

Presentation Outline:

I. Proper Use of Pliers
II. Proper Use of Hammers
III. Proper Use of Punches
IV. Proper Use of Wrenches
V. Proper Use of Chisels
VI. Proper Use of Bars
VII. Proper Use of Screwdrivers

Practical Application:

1. Instructor will demonstrate how to safely and correctly use hand tools.
2. Student will demonstrate how to safely and correctly use hand tools.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-E2) identifying and using hand held power tools.
Standards of performance:

Student shall identify the two major factors in working safely by:
Listing four steps you can take prior to performing work that will insure a
safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe
condition exist; and,
Selecting specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will demonstrate the:
a. Proper use of pliers;
b. Proper use of hammers;
c. Proper use of punches;
d. Proper use of wrenches;
e. Proper use of chisels;
f. Proper use of bars; and,
g. Proper use of screwdrivers.

Module Outline:

I. Proper Use of Pliers
II. Proper Use of Hammers
III. Proper Use of Punches
IV. Proper Use of Wrenches
V. Proper Use of Chisels
VI. Proper Use of Bars
VII. Proper Use of Screwdrivers
Standards of performance safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves; and,
Not wearing rings, watches, jewelry, or loose clothing while operating equipment.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.
Worksheet:

1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   - Ear Plugs
   - Ear Muffs

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercise inserting and removing ear plugs.

5. Practice using ear plugs.

6. Practice exercise using ear muffs.
IMM-E1
Identify and Use Maintenance Technician’s Hand Tools
Self-Assessment

1. The size of any wrench is determined by the ________________.
   A. Overall length
   B. Opening between its jaws
   C. Clearance on the nut and bolt
   D. Diameter of the shank

2. What type of screwdriver has square shanks?
   A. Phillips
   B. Cabinet
   C. Wide tip
   D. Heavy duty

3. A hammer that has a rubber face is called a _____________ hammer.
   A. Mallet
   B. Claw
   C. Ball peen
   D. Sledge

4. A plier that has a long bill is called a ________________ plier.
   A. Combination
   B. Long nose
   C. Needle nose
   D. Reversible pliers

5. This tool is used to remove nails.
   A. Nail claw
   B. Pry bar
   C. Nipping tool
   D. Wrecking bar
IMM-E1
Identify and Use Maintenance Technician's Hand Tools
Self-Assessment Answer Key

1. B
2. D
3. A
4. B
5. A
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-E2

Subject: Industrial Maintenance
Duty: Use Hand Tools
Task: Identify and Use Hand Held Power Tools

Time: 4 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify typical use and application of a hand drill and a hand power screwdriver;
b. Identify typical use and application of a reciprocating saw;
c. Identify typical use and application of a circular saw;
d. Identify typical use and application of hand held high-speed pneumatic tools;
e. Identify typical use and application of a hand held electric or pneumatic side grinder;
f. Identify typical use and application of electric or pneumatic impact tools; and,
g. Demonstrate safe operation of hand held power tools to established performance measures.

Instructional Materials:

MASTER Handout (IMM-E2-HO)
MASTER Laboratory Aid (IMM-E2-LA)
MASTER Laboratory Worksheet (IMM-E2-LW)
MASTER Self-Assessment

Lab Equipment:

Hand drill and power screwdriver
   Assorted drill bits
   Assorted screwdriver bits
   Chuck key
   Material suitable for drilling practice and demonstration
Reciprocating saw
   Assorted blades
   Material suitable for practice and demonstration
   Allen wrench
Circular saw
Assorted blades
Material suitable for practice and demonstration
Wrench appropriate to install blade
Hand held high-speed pneumatic pencil/peewee grinder
Assorted cut off, grinding and polishing wheels
Assorted carbide burrs
Hand held electric or pneumatic side grinder
Assorted grit grinding wheels
Electric/pneumatic impact tools
Material suitable for practice and demonstration
Impact socked set
Impact chisel

References:


Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-E1 “Identify and Use Maintenance Technician’s Hand Tools”

Introduction:

Powered hand tools are used to supply higher torque and at a higher speed of movement than hand tools. This reduces the manual labor and allows one to accomplish more in the same amount of time.

Presentation Outline:

I. Identify Typical Use and Application of a Hand Drill and a Hand Power Screwdriver
   A. Safety
   B. Selecting proper bits
   C. Operation
D. Application

II. Identify Typical Use and Application for a Reciprocating Saw
A. Safety
B. Selecting proper blade
C. Operation
D. Application

III. Identify Typical Use and Application of a Circular Saw
A. Safety
B. Selecting proper blade
C. Operation
D. Application

IV. Identify Typical Use and Application of Hand Held High-Speed Pneumatic Tools
A. Safety
B. Selecting proper tool bits
C. Operation
D. Application

V. Identify Typical Use and Application of a Hand Held Electric or Pneumatic Side Grinder
A. Safety
B. Selecting proper grit wheel
C. Operation
D. Application

VI. Identify Typical Use and Application of Electric or Pneumatic Impact Tools
A. Safety
B. Selecting proper blade
C. Operation
D. Application

VII. Demonstrate Correct Setup and Operation of Hand Held Power Tools and Accessories to Established Lab Exercise and Performance Measures

Practical Application:

Instructor will demonstrate proper and safe use of portable power tools. Student will observe instructor and demonstrate proper and safe use of portable power tools.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.
Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-F1) dealing with the use and care of milling machines.
Identify and Use Hand Held Power Tools
Attachment 1: MASTER Handout

Standards of performance:

Student shall identify the two major factors in working safely by:

- Listing four steps you can take prior to performing work that will insure a safe outcome;
- Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
- Selecting specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to:

- Identify typical use and application of a hand drill and a hand power screwdriver;
- Identify typical use and application of a reciprocating saw;
- Identify typical use and application of a circular saw;
- Identify typical use and application of hand held high-speed pneumatic tools;
- Identify typical use and application of a hand held electric or pneumatic side grinder;
- Identify typical use and application of electric or pneumatic impact tools; and,
- Demonstrate safe operation of hand held power tools to established performance measures.

Module Outline:

I. Identify Typical Use and Application of a Hand Drill and a Hand Power Screwdriver
   A. Safety
   B. Selecting proper bits
   C. Operation
   D. Application

II. Identify Typical Use and Application for a Reciprocating Saw
   A. Safety
   B. Selecting proper blade
   C. Operation
   D. Application

III. Identify Typical Use and Application of a Circular Saw
   A. Safety
B. Selecting proper blade
C. Operation
D. Application

IV. Identify Typical Use and Application of Hand Held High-Speed Pneumatic Tools
   A. Safety
   B. Selecting proper tool bits
   C. Operation
   D. Application

V. Identify Typical Use and Application of a Hand Held Electric or Pneumatic Side Grinder
   A. Safety
   B. Selecting proper grit wheel
   C. Operation
   D. Application

VI. Identify Typical Use and Application of Electric or Pneumatic Impact Tools
   A. Safety
   B. Selecting proper blade
   C. Operation
   D. Application

VII. Demonstrate Correct Setup and Operation of Hand Held Power Tools and Accessories to Established Lab Exercise and Performance Measures
Standards of performance safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves; and,
Not wearing rings, watches, jewelry, or loose clothing while operating equipment.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.
Worksheet:

1. Established standards for safety and conduct shall be followed.

2. Safety glasses
   Leather gloves
   Face shields
   Ground fault protector
   Safety curtains lab equipment

3. Lab Equipment:
   Hand drill and power screwdriver
     Assorted drill bits
     Assorted screwdriver bits
     Chuck key
     Material suitable for practice and demonstration
   Reciprocating saw.
     Assorted blades
     Material suitable for practice and demonstration
     Allen wrench
   Circular saw.
     Assorted blades
     Material suitable for practice and demonstration
     Wrench appropriate to install blade
   Hand held electric-speed pneumatic pencil/pewee grinder
     Assorted cut off, grinding and polishing wheels
     Assorted carbide burrs
   Hand held electric or pneumatic side grinder.
     Assorted grit grinding wheels
   Electric/pneumatic impact tools.
     Material suitable for practice and demonstration
     Impact socket set
     Impact chisel

4. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

5. Practice exercise using each tool in No. 3 above.
IMM-E2

Identify and Use Hand Held Power Tools
Self-Assessment

The student will be evaluated on the following performances and standards:

1. Use a hand drill and a power screwdriver for the task assigned.
   A. Select proper bits
   B. Safety install bit and drill hole in designated stock in such a manner as not to damage equipment or endanger personnel.
   C. Safety install bit and drive a screw using a power screw-driver in such a manner as not to damage equipment or endanger personnel.

2. Use a reciprocating saw to cut material to within 1/16" of designated dimension.
   A. Select proper blade
   B. Safely install the correct blade and cut a board to within 1/16" of designated dimension

3. Use a circular saw to cut a board to within 1/16" of designated dimension.
   A. Select proper blade
   B. Safely install the correct blade and cut a board to within 1/16" of designated dimension

4. Use hand held high-speed pneumatic tools.
   A. Select proper tool bits
   B. Install the correct bit and operate the equipment tool in such a manner as not to damage equipment or endanger personnel.

5. Use a hand held electric or pneumatic side grinder.
   A. Setup curtains for grinding
   B. Select proper grit wheel
   C. Install the correct wheel and operate the equipment in such a manner as not to damage equipment or endanger personnel.

6. Use electric or pneumatic impact tools.
   A. Select proper socket or chisel for the task assigned
   B. Install the tool and operate the equipment in such a manner as not to damage equipment or endanger personnel.
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-F1

Subject: Industrial Maintenance
Duty: Operate Machine Tools
Task: Use and Care of Milling Machines

Time: 40 Hrs.

Objective(s):

Upon completion of this module the student will be able to demonstrate proper use of milling machine to include:

a. Milling cutters;
b. Milling machine setups;
c. Milling machine operations (horizontal);
d. Indexing operation;
e. Gear cutting;
f. Helical milling; and,
g. Vertical milling machine operation.

Instructional Materials:

MASTER Handout (IMM-F1-HO)
MASTER Laboratory Aid (IMM-F1-LA)
MASTER Laboratory Worksheet (IMM-F1-LW)
MASTER Self-Assessment
Milling Machine (Horizontal and Vertical)

References:

Major Process Equipment Maintenance and Repair by Fred Geitner,

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-E2 "Identify and Use Hand Held Power Tools"
Introduction:

Milling machines are used for many machining operation. These include cutting, planning, and shaping of metals. Many parts must be made and milling machines.

Presentation Outline:

I. Milling Machine and Accessories
II. Milling Cutters
III. Speeds, Feeds and Depth of Cut
IV. Setups
V. Operations (Horizontal)
VI. Indexing
VII. Gear Cutting
VIII. Helical Milling
IX. Cam, Worm Milling
X. Vertical Milling Machine

Practical Application:

1. Instructor will demonstrate how to properly use milling machines.
2. Student will demonstrate how to properly use milling machines.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-F2) dealing with the use and care of horizontal and vertical band saws.
Standards of performance:

Student shall:
1. Identify the two major factors in working safely;
2. List four steps you can take prior to performing work that will insure a safe outcome;
3. Identify the employees responsibility if a potential accident or unsafe condition exist; and,
4. Select specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to demonstrate proper use of milling machines to include:
a. Milling cutters;
b. Milling machine setups;
c. Milling machine operations (horizontal);
d. Indexing operation;
e. Gear cutting;
f. Helical milling; and,
g. Vertical milling machine operation.

Reading Assignments:

The following chapters are assigned to read from Technology of Machine Tools, by Krar, McGraw-Hill Pub., Latest Edition:

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<tr>
<th>Chapter</th>
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<tr>
<td>12</td>
<td>Milling Machine</td>
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Module Outline:

I. Milling Machine and Accessories
II. Milling Cutters
III. Speeds, Feeds and Dept of Cut
IV. Setups
V. Operations (Horizontal)
VI. Indexing
VII. Gear Cutting
VIII. Helical Milling
IX. Cam, Worm Milling
X. Vertical Milling Machine
Standards of performance:

Student shall identify the two major factors in working safely by:
Listing four steps you can take prior to performing work that will insure a 
safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe 
condition exist; and,
Selecting specific task that have the potential to cause an injury.
IMM-F1-LW
Use and Care of Milling Machines
Attachment 3: MASTER Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate:
   A. Milling Machine and Accessories
   B. Milling Cutters
   C. Speeds, Feeds and Dept of Cut
   D. Setups
   E. Operations (Horizontal)
   F. Indexing
   G. Gear Cutting
   H. Helical Milling
   I. Cam, Worm Milling
   J. Vertical Milling Machine

2. Student will be graded on proper operation and part fabrication by milling machine.
1. List three variety of surfaces that a milling machine can mill.

2. Briefly describe the function of a milling machine.

3. Why should the knee clamps and saddle clamps be tightened when milling?

4. List three directions the table can be adjusted on a column and knee milling machine.

5. The two basic types of milling machines are the ____________ and the ____________.

6. Compare the horizontal milling machine to the vertical milling machine.

7. The crossfeed handwheel is used to ________________.

8. The table traverse handwheel is used to ________________.

9. What is the purpose of a backlash eliminator? ________________.
10. The arbor support is used to ____________________________

______________________________
IMM-F1
Use and Care of Milling Machine
Self-Assessment Answer Key

1. Horizontal, vertical and angular.

2. The milling machine cuts metal with a multi tooth cutting tool.

3. Lock knee to column, reduce table vibration.

4. Horizontal, traverse and vertical.

5. Column and knee, bed

6. The horizontal types have the milling cutter mounted on a horizontal arbor, whereas, the vertical types have a spindle in a vertical position.

7. Move the table either away from or toward the column.


9. The work piece must be clamped securely in order to compensate for wear or backlash.

10. Milling cutter(s) are mounted on the arbor.
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-F2

Subject: Industrial Maintenance
Time: 16 Hrs.

Duty: Operate Machine Tools
Task: Use and Care of Horizontal and Vertical Band Saws

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the component parts of horizontal and vertical band saw;
b. Describe the purpose and operation of the components of a horizontal and vertical band saw;
c. Demonstrate how to remove, install and adjust the blade of a horizontal and vertical band saw;
d. Demonstrate how to adjust the blade guards and guides of a horizontal and vertical band saw;
e. Identify the safety concerns associated with band saw operation;
f. Setup and operate a band saw to a designated tolerance without endangering personnel or equipment; and,
g. Weld saw blade (if saw has a welder attachment).

Instructional Materials:

MASTER Handout (IMM-F2-HO)
MASTER Laboratory Aid (IMM-F2-LA)
MASTER Laboratory Worksheet (IMM-F2-LW)
MASTER Self-Assessment
Horizontal band saw
Vertical band saw
Replacement blades for metal and wood
Safety glasses
Heavy gloves
Stock suitable for practice
Hand tools as needed for adjustments
Ruler
References:


Student Preparation:

Students should have previously completed the following Technical Modules:

**IMM-F1**  "Use and Care of Milling Machines"

Introduction:

One of the most basic types of machine shop equipment is the category of power saws. The machinist will need to be very familiar with the setup and operation of all the types of saws commonly found in the machine shop. Power saws fall into classifications: cutoff saws and the contour bandsaw. This lesson discusses the topics which pertain to the blade selection, setting of blade surface feet per minute and safe operation of these saws.

Presentation Outline:

I. Identify the Component Parts of a Horizontal and Vertical Band Saw
   A. Blade
   B. Blade guard
   C. coolant system (if used)
   D. Work clamp (if used)
   E. Blade tensioning device
   F. On/off and feed controls

II. Describe the Purpose and Operation of the Components of a Horizontal and Vertical Band Saw
   A. Blade
      1. Different types
   B. Blade guard
      1. Adjustment techniques
   C. Coolant system (if used)
      1. Types of coolant
      2. When coolant is needed
      3. Adjusting flow control
   D. Work clamp (if used)
      1. Purpose
      2. How to adjust
E. Blade tensioning device
   1. How to tighten and loosen
   2. Recognizing proper tension
F. On/off and feed controls
   1. On-off and remote power switches
   2. Setting feed by adjusting spring tension (typically for cutoff saw)

III. Demonstrate How to Remove, Install and Adjust the Blade Tension of a Horizontal and Vertical Band Saw

IV. Demonstrate How to Adjust the Blade Guards and Guides of a Horizontal and Vertical Band Saw
   A. How to loosen
   B. Correct operating position
   C. How to tighten

V. Identify the Safety Concerns Associated with Band Saw Operation
   A. Airborne derbies
   B. Exposed cutting surface
   C. Sharp edges

VI. Demonstrate How to Setup and Operate a Band Saw to a Designated Tolerance Without Endangering Personnel or Equipment

VII. Demonstrate How to Use Weld Saw Blades

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Practical Application:

1. Practice removing, installing and adjusting the blade tension of a horizontal and vertical band saw.
2. Practice adjusting the blade guards and guides of a horizontal and vertical band saw.
   A. Loosen
   B. Correct operating position
   C. Tighten
3. Identify the safety concerns associated with band saw operation.
   A. Airborne debris
   B. Exposed cutting surface
   C. Sharp edges
4. Practice setup and operating a band saw to a designated tolerance without endangering personnel or equipment.
5. Demonstrate how to use weld saw blades.

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Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written evaluation.
Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-F3) dealing with the use and care of pedestal grinders.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
- Using OSHA required safety equipment for the shop;
- Safety glasses;
- Hearing protection;
- Face shields;
- Gloves;
- Not wearing rings, watches, jewelry, or loose clothing while operating equipment;
- Not participating in horse play or practical joking;
- Identifying the two major factors in working safely;
- Listing four steps you can take prior to performing work that will insure a safe outcome;
- Identifying the employee's responsibility if a potential accident or unsafe condition exists; and,
- Selecting specific tasks that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to:

a. Demonstrate proper use and care of horizontal band saw; and,
b. Demonstrate proper use and care of vertical band saw.

Reading Assignments:

The following chapters are assigned to read from Technology of Machine Tools, by Krar, McGraw-Hill Publishing, Latest Edition:

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<td>Bandsaw Parts and Accessories</td>
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<td>37</td>
<td>Bandsaw Operations</td>
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Module Outline:

I. Identify the Component Parts of a Horizontal and Vertical Band Saw
   A. Blade
   B. Blade guard
   C. Coolant system (if used)
II. Describe the Purpose and Operation of the Components of a Horizontal and Vertical Band Saw
   A. Blade
      1. Different types
   B. Blade guard
      1. Adjustment techniques
   C. Coolant system (if used)
      1. Types of coolant
      2. When coolant is needed
      3. Adjusting flow control
   D. Work clamp (if used)
      1. Purpose
      2. How to adjust
   E. Blade tensioning device
      1. How to tighten and loosen
      2. Recognizing proper tension
   F. On/off and feed controls
      1. On-off and remote power switches
      2. Setting feed by adjusting spring tension (typically for cutoff saw)

III. Demonstrate How to Remove, Install and Adjust the Blade Tension of a Horizontal and Vertical Band Saw

IV. Demonstrate How to Adjust the Blade Guards and Guides of a Horizontal and Vertical Band Saw
   A. How to loosen
   B. Correct operating position
   C. How to tighten

V. Identify the Safety Concerns Associated with Band Saw Operation
   A. Airborne derbies
   B. Exposed cutting surface
   C. Sharp edges

VI. Demonstrate How to Setup and Operate a Band Saw to a Designated Tolerance Without Endangering Personnel or Equipment

VII. Demonstrate How to Use Weld Saw Blades
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment;
Not participating in horse play or practical joking;
Identifying the two major factors in working safely;
Listing four steps you can take prior to performing work that will insure a safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe condition exists; and,
Selecting specific tasks that have the potential to cause an injury.
Worksheet:

1. Instructor will demonstrate how to setup and operate a band saw to a designated tolerance without endangering personnel or equipment by:
   A. Selecting proper blade;
   B. Installing and properly adjusting the blade;
   C. Adjusting the blade guides and guard;
   D. Adjusting the coolant flow if or as appropriate;
   E. Adjusting feed control (if applicable);
   F. Properly securing the work and making a cut to specified tolerances; and,
   G. Shutting down the machine and cleaning up work area.

2. Student will demonstrate how to setup and operate a band saw to a designated tolerance without endangering personnel or equipment by:
   A. Selecting proper blade;
   B. Installing and properly adjusting the blade;
   C. Adjusting the blade guides and guard;
   D. Adjusting the coolant flow if or as appropriate;
   E. Adjusting feed control (if applicable);
   F. Properly securing the work and making a cut to specified tolerances; and,
   G. Shutting down the machine and cleaning up work area.

3. Instructor will grade student's performance.
IMM-F2
Use and Care of Horizontal and Vertical Band Saws
Self-Assessment

Circle the letter preceding the correct answer.

1. Which of the following is not normally classified as a cutoff saw?
   A. Horizontal bandsaw
   B. Contour bandsaw
   C. Power hacksaw
   D. Abrasive

2. Which type of saw is most productive when preparing bar stock for machining operations?
   A. Horizontal bandsaw
   B. Contour bandsaw
   C. Power hacksaw
   D. Abrasive saw

3. Which type of saw is most useful for sawing parts having unusual angles and radii?
   A. Horizontal bandsaw
   B. Contour bandsaw
   C. Power hacksaw
   D. Abrasive saw

4. Which of the following refers to the number of teeth per inch for a saw blade?
   A. Set
   B. Gage
   C. TPI
   D. Pitch

5. Using your answer to question 4, which is best for general purpose sawing?
   A. 4
   B. 6
   C. 10
   D. 14

6. Which type of sawing can be done using a blade with no teeth?
   A. Precision
   B. Soft materials
   C. Abrasive
   D. Friction
7. What happens if too fast a blade speed is used?
   A. You finish the job sooner
   B. You burn up the saw blade
   C. You increase production
   D. You injure yourself

8. What do you do if the saw blade dulls or breaks before the cut is completed?
   A. Stop the saw
   B. Replace the blade with a new one
   C. Re-start the cut in a new location
   D. All of the above

9. How is the blade speed adjusted on a contour bandsaw?
   A. Change the belts
   B. Change the blade
   C. Adjust the handwheel
   D. Adjust the blade supports and guides

10. Which of the following is not a requirement of a sawing job?
    A. Color
    B. Safety
    C. Tool life
    D. Accuracy
Use and Care of Horizontal and Vertical Band Saws

Self-Assessment Answer Key

1. B
2. A
3. A
4. D
5. C
6. D
7. B
8. D
9. A and C
10. A
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-F3

Subject: Industrial Maintenance  
Time: 3 Hrs.

Duty: Operate Machine Tools  
Task: Use and Care of Pedestal Grinder

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate proper use and care of pedestal grinder;
b. Identify the component parts of a pedestal grinder;
c. Describe the correct method of dressing a grinding wheel;
d. Describe the relationship between feed speed and surface quality;
e. Describe the correct method of adjusting the tool rest of a pedestal grinder;
f. Describe the correct method of removing, testing and installing a grinding wheel on a pedestal grinder;
g. Identify the safety concerns relative to operation of a pedestal grinder; and,
h. Set up and operate a pedestal grinder without endangering personnel or equipment.

Instructional Materials:

MASTER Handout (IMM-F3-HO)  
MASTER Laboratory Aid (IMM-F3-LA)  
MASTER Laboratory Worksheet (IMM-F3-LW)  
MASTER Self-Assessment  
Pedestal grinder  
Assorted wheels  
Stock suitable for practice  
Face shield  
Safety glasses  
Wheel dresser  
Hand tools as required to maintain the grinder
References:


Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-F2  “Use and Care of Horizontal and Vertical Band Saws”

Introduction:

Pedestal grinding are made for less rugged use than the surface grinder. The grinders are not as precise as the surface grinder also.

Presentation Outline:

I. Identify the Component Parts of a Pedestal Grinder
   A. Pedestal
   B. Motor
   C. Spindle
   D. Toolrest (guard)
   E. Grinding wheel and vibration pads
   F. Coolant supply

II. Describe the Correct Method of Dressing a Grinding Wheel
    A. Different types of dressing tools
    B. Distinction between a properly and an improperly dressed wheel

III. Describe the Relationship Between Feed Speed and Surface Quality
    A. Fast feed-rapid metal abrasion with course finish
    B. Slow feed-slower metal removal and finer finish

IV. Describe the Correct Method of Adjusting the Tool Rest of a Pedestal Grinder
    A. Distance from wheel position in relation to horizontal axis of the spindle

V. Describe the Correct Method of Removing, Testing and Installing a Grinding Wheel on a Pedestal Grinder
    A. Blocking spindle rotation
    B. Removing guards
    C. Removing mounting nut and washers
    D. Sounding a wheel for flaws
E. Mounting the wheel, vibration pads, washer and nut
F. Replacing guards

VI. Identify the Safety Concerns Relative to Operation of a Pedestal Grinder
A. Flying grinding dust
B. Disintegrating wheel
C. Wheel may throw small parts
E. Danger of hand or fingers being pulled into wheel if small parts are improperly secured

VII. Set up and Operate a Pedestal Grinder Without Endangering Personnel or Equipment (This will be performed in the lab.)

Practical Application:

Practice identifying the component parts of a pedestal grinder:
   Pedestal;
   Motor;
   Spindle;
   Toolrest (guard);
   Grinding wheel and vibration pads; and,
   Coolant supply.

Practice dressing a grinding wheel:
   Different types of dressing tools; and,
   Distinction between a properly and an improperly dressed wheel.

Practice feeding stock at different speeds and examine the resulting surface quality:
   Fast feed-rapid metal abrasion with course finish; and,
   Slow feed-slower metal removal and finer finish.

Practice adjusting the tool rest of a pedestal grinder:
   Distance from wheel; and,
   Position in relation to horizontal axis of the spindle.

Practice removing, testing and installing a grinding wheel on a pedestal grinder:
   Blocking spindle rotation;
   Removing guards;
   Removing mounting nut and washers;
   Sounding a wheel for flaws;
   Mounting the wheel, vibration pads, washer and nut; and,
   Replacing guards.

Identify the safety concerns relative to operation of a pedestal grinder:
   Flying grinding dust;
   Disintegrating wheel;
Wheel may throw small parts; and,
Danger of hand or fingers being pulled into wheel if small parts are improperly secured.

Set up and operate a pedestal grinder without endangering personnel or equipment.

**Evaluation and/or Verification:**

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

**Summary:**

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

**Next Lesson Assignment:**

MASTER Technical Module (IMM-F4) dealing with the use and care of surface grinders.
Standards of performance:

Student shall identify the two major factors in working safely by:
1. Listing four steps you can take prior to performing work that will insure a safe outcome;
2. Identifying the employee’s responsibility if a potential accident or unsafe condition exist; and,
3. Selecting specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to:
a. Demonstrate proper use and care of pedestal grinder;
b. Identify the component parts of a pedestal grinder;
c. Describe the correct method of dressing a grinding wheel;
d. Describe the relationship between feed speed and surface quality;
e. Describe the correct method of adjusting the tool rest of a pedestal grinder;
f. Describe the correct method of removing, testing and installing a grinding wheel on a pedestal grinder;
g. Identify the safety concerns relative to operation of a pedestal grinder; and,
h. Set up and operate a pedestal grinder without endangering personnel or equipment.

Reading Assignments:

The following chapters are assigned to read from Technology of Machine Tools, by Krar, McGraw-Hill Publications, Latest Edition

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<th>Topic</th>
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<td>Cylinder Grinder</td>
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Module Outline:

I. Identify the Component Parts of a Pedestal Grinder
   A. Pedestal
   B. Motor
   C. Spindle
   D. Toolrest (guard)
E. Grinding wheel and vibration pads
F. Coolant supply

II. Describe the Correct Method of Dressing a Grinding Wheel
A. Different types of dressing tools
B. Distinction between a properly and an improperly dressed wheel

III. Describe the Relationship Between Feed Speed and Surface Quality
A. Fast feed-rapid metal abrasion with course finish
B. Slow feed-slower metal removal and finer finish

IV. Describe the Correct Method of Adjusting the Tool Rest of a Pedestal Grinder
A. Distance from wheel position in relation to horizontal axis of the spindle

V. Describe the Correct Method of Removing, Testing and Installing a Grinding Wheel on a Pedestal Grinder
A. Blocking spindle rotation
B. Removing guards
C. Removing mounting nut and washers
D. Sounding a wheel for flaws
E. Mounting the wheel, vibration pads, washer and nut
F. Replacing guards

VI. Identify the Safety Concerns Relative to Operation of a Pedestal Grinder
A. Flying grinding dust
B. Disintegrating wheel
C. Wheel may throw small parts
D. Danger of hand or fingers being pulled into wheel if small parts are improperly secured

VII. Set up and Operate a Pedestal Grinder Without Endangering Personnel or Equipment (This will be performed in the lab.)
Standards of performance:

Student shall identify the two major factors in working safely by:
1. Listing four steps you can take prior to performing work that will insure a safe outcome;
2. Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
3. Selecting specific task that have the potential to cause an injury.
Worksheet:

1. **Instructor will:**
   A. Demonstrate proper use and care of pedestal grinder; and,
   B. Set up and operate a pedestal grinder without endangering personnel or equipment.

2. **Student will:**
   A. Demonstrate proper use and care of pedestal grinder; and,
   B. Set up and operate a pedestal grinder without endangering personnel or equipment.

3. **Instructor will grade student's performance on:**
   A. Demonstrating proper use and care of pedestal grinder; and,
   B. Set up and operating a pedestal grinder without endangering personnel or equipment.
IMM-F3
Use and Care of Pedestal Grinder
Self-Assessment

1. What are three reasons for grinding?
   

2. Briefly describe grades of wheels used for a pedestal grinder.

   

3. Grinding wheel faces are known by different _______________.

4. When ordering grinding wheels, what information is needed?

   

5. The standard marking system for wheels includes _______________

   

6. Describe the tool rest adjustment for a pedestal grinder.

   

7. Describe the correct method of mounting a grinding wheel on a pedestal grinder.

   

8. What is dressing a grinding wheel?

   

1. Sharpen cutting edges on tools, make surfaces smoother, and cut metal to desired shape.
2. Grades range from soft to hard.
3. Letters
4. Speed of machine, Diameter of hole, Shape of wheel, Type of wheel face, Diameter of wheel, and Thickness of wheel.
5. Abrasive type, grain size, bond type, grade and structure.
6. The tool rest should be set as close as possible to the wheel without touching the wheel.
7. Precaution! Since grinding wheels are abrasive, the wheels are easy to break, be careful. Never force the wheel onto a shaft! Place washers slightly larger than diameter of the flanges should be placed between the sides of the wheels and flanges. Tighten nut only enough to hold wheel firmly. Start grinder and true wheel with a grinding wheel dresser.
8. Sharpening a wheel.
INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-F4

Subject: Industrial Maintenance Time: 3 Hrs.
Duty: Operate Machine Tools
Task: Use and Care of Surface Grinder

Objective(s):

Upon completion of this module the student will be able to:
a. Identify the importance of the surface grinder to the maintenance mechanic;
b. Identify the component parts of a surface grinder;
c. Describe the purpose and operation of the major components of a surface grinder;
d. Identify how to mount a part for grinding, using a magnetic base and using dog clamps;
e. Describe the relationship between speed, feed and surface quality;
f. Identify safety concerns relative to using a surface grinder; and,
g. Setup and operate a surface grinder to a tolerance of .002 without endangering personnel of equipment.

Instructional Materials:

MASTER Handout (IMM-F4-HO)
MASTER Laboratory Aid (IMM-F4-LA)
MASTER Laboratory Worksheet (IMM-F4-LW)
MASTER Self-Assessment
Surface grinder
Instrumentation material
2" bar stock for practice
Safety glasses/side shields
Face shields
Micrometer or dial caliper
Basic hand tools for wheel replacement
Wheel dresser
References:


Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-F3  “Use and Care of Pedestal Grinder”

Introduction:

Grinders enable a maintenance mechanic to turn a surface or edge of materials from a rough surface into a smooth surface.

Presentation Outline:

I. Identify the Importance of the Surface Grinder to the Maintenance Mechanic
   A. Removes small predetermined amount of metal
   B. Makes surfaces parallel
   C. Makes surface flat

II. Identify the Component Parts of a Surface Grinder
    A. Control levers
    B. Bed table
    C. Compound rest
    D. Wheel grinding
    E. Coolant system

III. Describe the Purpose and Operation of the Major Components of a Surface Grinder
    A. Control levers
    B. Bed table
    C. Compound rest
    D. Wheel grinding
    E. Coolant system

IV. Identify How to Mount a Part for Grinding, Using a Magnetic Base and Using Dog Clamps
    A. Clamping using a magnetic base
    B. Clamping using dogs
V. Describe the Relationship Between Speed, Feed and Surface Quality
   A. Typical speed and feed charts
   B. Setting speed and feed controls
   C. Light cut at high feed speed
   D. Heavy cut at high feed speed
   E. Heavy cut at low feed speed

VI. Identify Safety Concerns Relative to Using a Surface Grinder
   A. Work coming loose
   B. Flying derbies
   C. Wheel disintegrating
   D. Moving parts

VII. Setup and Operate a Surface Grinder to a Tolerance of .002” Without Endangering Personnel or Equipment

Practical Application:

I. Practice the operation of the power, feed and speed controls of a surface grinder
   A. Control levers
   B. Wheel
   C. Coolant system

II. Practice mounting a part using a magnetic base and using dog clamps
   A. Clamping using a magnetic base
   B. Clamping using dogs

III. Practice operating the grinder at different speed and feed and compare the surface qualities
   A. Typical speed and feed charts
   B. Setting speed and feed controls
   C. Light cut at high feed speed
   D. Heavy cut at high feed speed
   E. Heavy cut at low feed speed

IV. Point out safety concerns relative to using a surface grinder
   A. Work coming loose
   B. Flying debris
   C. Wheel disintegrating
   D. Moving parts

V. Practice setup and operating a surface grinder to a tolerance of .002 without endangering personnel or equipment

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.
Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-F5) dealing with operation of lathes.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify the importance of the surface grinder to the maintenance mechanic;
b. Identify the component parts of a surface grinder;
c. Describe the purpose and operation of the major components of a surface grinder;
d. Identify how to mount a part for grinding, using a magnetic base and using dog clamps;
e. Describe the relationship between speed, feed and surface quality;
f. Identify safety concerns relative to using a surface grinder; and,
g. Setup and operate a surface grinder to a tolerance of .002 without endangering personnel of equipment.

Reading Assignments:

The following chapters are assigned to read from *Technology of Machine Tools* by Krar, McGraw-Hill Publisher, Latest Edition:

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<th>Unit</th>
<th>Title</th>
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<td>Types of Abrasives</td>
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<td>83</td>
<td>Surface Grinders and Accessories</td>
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<td>84</td>
<td>Surface Grinding Operations</td>
</tr>
</tbody>
</table>
Module Outline:

I. Identify the Importance of the Surface Grinder to the Maintenance Mechanic
   A. Removes small predetermined amount of metal
   B. Makes surfaces parallel
   C. Makes surface flat

II. Identify the Component Parts of a Surface Grinder
    A. Control levers
    B. Bed table
    C. Compound rest
    D. Wheel grinding
    E. Coolant system

III. Describe the Purpose and Operation of the Major Components of a Surface Grinder
     A. Control levers
     B. Bed table
     C. Compound rest
     D. Wheel grinding
     E. Coolant system

IV. Identify How to Mount a Part for Grinding, Using a Magnetic Base and Using Dog Clamps
    A. Clamping using a magnetic base
    B. Clamping using dogs

V. Describe the Relationship Between Speed, Feed and Surface Quality.
   A. Typical speed and feed charts
   B. Setting speed and feed controls
   C. Light cut at high feed speed
   D. Heavy cut at high feed speed
   E. Heavy cut at low feed speed

VI. Identify Safety Concerns Relative to Using a Surface Grinder
    A. Work coming loose
    B. Flying debris
    C. Wheel disintegrating
    D. Moving parts

VII. Setup and Operate a Surface Grinder to a Tolerance of .002" Without Endangering Personnel or Equipment
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. Instructor will demonstrate how to setup and operate a surface grinder to a tolerance of .002 without endangering personnel of equipment.

2. Student will demonstrate how to setup and operate a surface grinder to a tolerance of .002 without endangering personnel of equipment.

3. Instructor will grade student’s performance on setup and operating a surface grinder to a tolerance of .002 without endangering personnel of equipment.
IMM-F4
Use and Care of Surface Grinder
Self-Assessment

1. The ________ is located in the wheel head and provides for the mounting of the grinding wheel.
   a. Saddle or cross slide
   b. Table
   c. Base
   d. Spindle

2. The surface grinder table has accessories bolted on it by means of a:
   a. Dove tail
   b. Flat way
   c. V-ways
   d. T-slot

3. The spindle of a surface grinder has a:
   a. Key-seat
   b. Straight shank
   c. Taper
   d. V-grove

4. The grinding wheel is mounted on the:
   a. Adapter
   b. Spindle
   c. Column
   d. Wheelhead hand wheel

5. To make a hard grinding wheel act softer:
   a. Decrease the work feed
   b. Decrease the wheel speed
   c. Increase the wheel speed
   d. Increase the coolant flow

6. The most common toolroom surface grinder has:
   a. Horizontal spindle and a reciprocating table
   b. Horizontal spindle and a rotary table
   c. Vertical spindle and a reciprocating table
   d. Vertical spindle and a rotary table
7. An excessive amount of imbalance of the grinding wheel will damage the:
   a. Work surface
   b. Grinding wheel
   c. Table
   d. Spindle bearings

8. Before balancing a grinding wheel it must be:
   a. Sprayed
   b. Dressed
   c. Trued
   d. Reversed

9. The wheel is balanced by counterbalances located in the:
   a. Flange
   b. Spindle
   c. Grinding wheel
   d. Motor

10. To rough dress the wheel take .001-.002 in. at a:
    a. High feed rate
    b. Higher speed rate of the wheel
    c. Slow feed rate
    d. 450 angle

11. Most ferrous metal is held on a surface grinder by:
    a. Bolting to the table
    b. A vise
    c. A magnetic chuck
    d. V-blocks

12. Grinding fluids are used on surface grinders to reduce heat, remove swarf, control dust, and
    a. Lubricate the work
    b. Easy removal of work
    c. Lubricate the chuck
    d. Cool the table bearings

13. Before grinding a flat workpiece be sure to:
    a. Machine to finished size
    b. Remove all burrs
    c. Dip in oil to help lubrication
    d. Heat treat
14. When blocking short workpiece, to be held securely, with parallels or steel pieces they must be _________ than the finished workpiece.
   a. Harder
   b. Thinner
   c. Thicker
   d. Clearer

15. The grinding wheel should clear the end of the workpiece when setting the trip dogs by approximately:
   a. 1"
   b. 3"
   c. 5"
   d. 7"

16. After the wheel just sparks the workpiece, in set-up, raise the wheel .005" and move the table slowly by hand over the entire surface to locate the:
   a. Start position
   b. End position
   c. High point
   d. Low point

17. When making a roughing cut, on the surface grinder, the depth should be _________ of an inch.
   a. .00005-.0001
   b. .0005-.001
   c. .001-.003
   d. .005-.010

18. When a work holding device is not used to grind an angle an angular cut may be made by:
   a. Swiveling the table
   b. Tilting the table
   c. Dressing the wheel to the desired angle
   d. Tilting the head

19. Some surface grinders may not be used for crush-forming because:
   a. The table is too small
   b. The wheel is too soft
   c. The spindle bearings may be damaged
   d. The table will not tilt
20. To cut-off a large workpiece on a surface grinder, the table is:
   a. Reciprocated
   b. Stationary
   c. Turned to 45 degrees
   d. Raised
1. D
2. D
3. C
4. A
5. B
6. A
7. D
8. C
9. A
10. A
11. C
12. A
13. B
14. B
15. A
16. C
17. C
18. C
19. C
20. A
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-F5

Subject: Industrial Maintenance
Duty: Operate Machine Tools
Task: Operate Lathes

Time: 68 Hrs.

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify major component parts of an engine lathe;
b. Properly set up and use lathe accessories required for basic lathe operation;
c. Determine correct speed and feed for a given metal;
d. Identify safety concerns relative to lathe operation;
e. Demonstrate set up and use of lathe operation;
f. Identify and use different types of lathe cutting tools;
g. Face cut and turn stock between centers to a specified tolerance; and,
h. Demonstrate method of drilling, boring and reaming a hole to obtain specified tolerance.

Instructional Materials:

- Tool grinder
- Instructional material
- Hand tools
- Assortment of outside micrometers up to 3"
- Lab standards, MASTER Laboratory Aid (IMM-F5-LA)
- Depth gage
- Telescoping gage
- Dial calipers
- Tool stock
- Handout reading assignments in textbook, objectives, and outlines
- MASTER Handout (IMM-F5-HO)
- Side shield and face shield
- 2" Stock for practice and evaluation
- Engine lathe

- MASTER Video Tape (IMM-F5-VT1)
MASTER Laboratory worksheets (IMM-F5-LW1 and IMM-F5-LW2)

References:


The following video tapes available from Bergwall Productions in series 501 (Lathe), Latest Edition:

1. "Basic Parts," #501.01X-1 VHS
2. "Setting Up Work," #501.02X-2 VHS
3. "Accessories," #501.03X-1 VHS
5. "Three Ways To Taper," #501.04X-1 VHS
6. "Cutting A Thread," #501.06X-1 VHS

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-A1 through IMM-A6 "Practice Safety"
IMM-B1 through IMM-B6 "Apply Mathematical Concepts"
IMM-C1 through IMM-C3 "Interpret Engineering Drawings and Control Documents"
IMM-D-1 through IMM-D2 "Use Measuring Tools"
IMM-E1 through IMM-E2 "Use Hand Tools"
IMM-F1 "Use and Care of Milling Machines"
IMM-F2 "Use and Care of Horizontal and Vertical Band Saws"
IMM-F3 "Use and Care of Pedestal Grinder"
IMM-F4 "Use and Care of Surface Grinder"

Introduction:

The lathe is a powered machine capable of producing many cylindrical devices used in many everyday and industrial applications. Usually the raw product is a piece of rolled solid stock. A maintenance mechanic may need to fabricate a part from a raw product or repair an existing part. The lathe is one of the most common powered tools found in
a machine shop or maintenance shop in an industrial plant. If a part is cylindrical, the lathe was probably used to produced the part. Using the lathe to some degree of expertise is important to a maintenance mechanic.

Presentation Outline:

I. Discuss the Importance of the Lathe to the Maintenance Mechanic
   A. Give each student a copy of the following attachments:
      1. Laboratory aid and required video tapes
      2. Objectives, reading assignments, and module outline
      3. Laboratory worksheet 1 and 2
      4. Project 2 drawing and duties/tasks profile

II. Identify and Discuss Component Parts of an Engine Lathe
    A. Control panel
    B. Bed & ways
    C. Head stock
    D. Gear box
    E. Carriage
    F. Tailstock

III. Identify, Setup and Demonstrate Use of Lathe Accessories
     A. Centers
     B. Chucks
     C. Faceplates
     D. Mandrels
     E. Steady and follower rest
     F. Lathe dogs
     G. Driver plates
     H. Tool holders
     I. Boring bars

IV. Discuss and Demonstrate How to Select the Correct Speed and Feed for Various Metals
    A. Steel
    B. Aluminum
    C. Brass

V. Discuss Lathe Safety
   A. Clamping of work
   B. Watches & rings
   C. Housekeeping
   D. Chuck wrenches
   E. Removing chips
   F. Measurements

VI. Discuss and Demonstrate Use of Lathe Centers
    A. Mounting
B. Removing  
C. Aligning  

VII. Discuss and Demonstrate Use of Cutting Tools  
A. Grinding a toolbit  
B. Conditioning point of bits  
C. Types of cutting tools  

VIII. Discuss and Demonstrate Turning Between Centers  
A. Why face cut  
B. Center drill  
C. Using a tailstock center  
E. Using steady rest  
F. Using chucks  

IX. Discuss and Demonstrate Method of Drilling, Boring and Reaming Using a Lathe  

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Practical Application:  

Students will practice in the lab using the lathe. Each student will complete the laboratory exercise prior to preceding to the performance evaluation.  

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Evaluation and/or Verification:  

Successful completion of this technical module will be based on the student's successful completion of the following components.  
1. The student will complete a written evaluation of knowledge items.  
2. The student will demonstrate safe operation of the lathe.  
3. The student shall fabricate a component to specified tolerance when given a drawing, tools, and equipment. (Refer to figure 1)  

---  

Summary:  

Review the main lesson points using the objective as a guide. Hold class discussion and answer student questions.  

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Next Lesson Assignment:  

MASTER Technical Module (IMM-F6) dealing with the use and care of a drill press.
Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves; and,
Not wearing rings, watches, jewelry, or loose clothing while operating equipment.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.
MASTER Video Tape (IMM-F5-VT1)

"Feeds and Speeds"
Objective(s):

Upon completion of this unit the student will be able to:

a. Identify major component parts of an engine lathe;
b. Properly set up and use lathe accessories required for basic lathe operation;
c. Determine correct speed and feed for a given metal;
d. Identify safety concerns relative to lathe operation;
e. Demonstrate set up and use of lathe operation;
f. Identify and use different types of lathe cutting tools;
g. Face cut and turn stock between centers to a specified tolerance; and,
h. Demonstrate method of drilling, boring and reaming a hole to obtain specified tolerance.

Reading Assignments:

The following chapters are assigned to read from Technology of Machine Tools, Krar, McGraw-Hill Publishers, Latest Edition:

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<td>Machining Between Centers</td>
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<td>54</td>
<td>Turning Tapers Using Compound Rest</td>
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</tbody>
</table>

Module Outline:

I. Discuss the Importance of the Lathe to the Maintenance Mechanic
   A. Give each student a copy of the following attachments:
      1. Laboratory aid and required video tapes
      2. Objectives, reading assignments, and module outline
      3. Laboratory worksheet 1 and 2
      4. Project 2 drawing and duties/tasks profile

II. Identify and Discuss Component Parts of an Engine Lathe
A. Control panel
B. Bed & ways
C. Head stock
D. Gear box
E. Carriage
F. Tailstock

III. Identify, Setup and Demonstrate Use of Lathe Accessories
A. Centers
B. Chucks
C. Faceplates
D. Mandrels
E. Steady and follower rest
F. Lathe dogs
G. Driver plates
H. Tool holders
I. Boring bars

IV. Discuss and Demonstrate How to Select the Correct Speed and Feed for Various Metals
A. Steel
B. Aluminum
C. Brass

V. Discuss Lathe Safety
A. Clamping of work
B. Watches & rings
C. Housekeeping
D. Chuck wrenches
E. Removing chips
F. Measurements

VI. Discuss and Demonstrate Use of Lathe Centers
A. Mounting
B. Removing
C. Aligning

VII. Discuss and Demonstrate Use of Cutting Tools
A. Grinding a toolbit
B. Conditioning point of bits
C. Types of cutting tools

VIII. Discuss and Demonstrate Turning Between Centers
A. Why face cut
B. Center drill
C. Using a tailstock center
E. Using steady rest
F. Using chucks

IX. Discuss and Demonstrate Method of Drilling, Boring and Reaming Using a Lathe
Operate Lathes
Attachment 3: MASTER Laboratory Worksheet

WORK SHEET 1:

1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   Tool grinder
   Hand tools as required to operate lathe
   Set of inside and outside micrometers up to 3"
   Telescoping gages
   Dial calipers
   Toolstock
   Face shield
   Side shields
   3-6" sections of bar stock for practice
   Drill and sleeve appropriate to hole required
   Reamer appropriate for hole required
   Lathe with accessories suitable for project

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercises tool grinding:
   A. Grind lathe cutting tool appropriate to metal being turned.
      (Instructor must see lathe tool prior to proceeding.)

5. Practice exercise lathe familiarization.
   A. Student shall practice using lathe controls until familiar.
      (1) Selecting speeds & feeds (use of S & L chart).
      (2) Start and stopping of machine and emergency stop.
      (3) Engage and disengage feed controls.
      (4) Positioning tool in tool holder.
   B. Student shall practice using accessories.
      (1) Centering stock in available chucks.
      (2) Setting up stock between centers.
      (3) Running machine with stock mounted in the chuck.
   C. Lathe operation.
      (1) Practice taking cuts using manual feed
      (2) Practice taking cuts using the engine driven feed and speed controls.
      (3) Practice center drilling.
(4) Practice drilling with the drill bit mounted in the tail stock.
(5) Practice reaming.
(6) Practice cutting a taper using the compound rest (manual feed).
D. Fabricate a part to tolerances specified on the drawing provided.
WORKSHEET 2:

1. This exercise will combine the skills and knowledge practices in previous lab exercises to fabricate the component described by attachment V.

2. Pre-established safety concerns by the drawing.

3. Maintain tolerances by the drawing.

The project will require the student to demonstrate skills and knowledge in the following:
- Practice safety
- Basic math
- Blueprint reading
- Measuring instruments
- Pedestal grinder operation
- Lathe operation
Attachment 5 consists of a drawing of project 2.

NOTE
ALL DIA. + OR - .003"
ALL LENGTH + OR - .016"
ALL DIM. IN INCHES

DATE 2-28-96
DRAWN BY: REW
APPROVED BY: SRG
MATERIAL ALUM. 6061-T3

AUGUSTA TECH
3116 DEANS BRIDGE RD
AUGUSTA GA. 30906 USA
SCALE 1-1
DRAW# 463

AUGUSTA TECH
AUGUSTA GA. 30906 USA
DRAW# 470
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-F6

Subject: Industrial Maintenance
Time: 40 Hrs.

Duty: Operate Machine Tools
Task: Use and Care of Drill Press

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate use and care of drill press;
b. Identify major components;
c. Describe the function and operation of all controls;
d. Describe typical accessories found on most radial arm drills;
e. Describe the safety concerns associated with operation of a radial arm drill; and,
f. Setup and safely operate a drill press to a specified standard.

Instructional Materials:

MASTER Handout (IMM-F6-HO)
MASTER Laboratory Aid (IMM-F6-LA)
MASTER Laboratory Worksheet (IMM-F6-LW)
MASTER Self-Assessment
Drill Press
Assorted Drills from 9/16" to 1-1/2"
2" stock for practice
Compound Rest
Clamping Dogs
Tools as required for setup
Safety Glasses with side shields
Counter Sink
Reamer

References:

Machine Shop Operations and Setup, Lascoe, Nelson and Porter,
American Technical Society, Latest Edition
Student Preparation:

Students should have previously completed the following Technical Modules:

**IMM-F5**  "Operate Lathes"

Introduction:

One of the most important machines that the machinist may be called on to operate is a drilling machine. The principle of a rotating tool producing a hole in a work piece is very basic to all machine operations. Not only are drill presses used to produce holes, but they are also capable of threading, countersinking, reaming, boring, counterboring, and many other operations necessary for the production of goods in American industry today. Many entry level machine operators and machinists will find their first job to be that of a drill press operator.

Presentation Outline:

I. Identify Major Components
   A. Bed/table
   B. Motor
   C. Speed/Feed/directional controls
   D. Start/stop/emergency stop
   E. Coolant system
   F. Drill head
   G. Column
   H. Spindle
   I. Radial arm

II. Describe the Function and Demonstrate Operations of All Controls
   A. Speed, feed and directional control
   B. Raise, lower and position drill head

III. Describe and Demonstrate the Use of Accessories Found on Most Radial Arm Drills
   A. Compound rest
   B. Clamping dogs
   C. Tapered shank drill sleeves
   D. Drill chuck
   E. Fly cutter

IV. Describe the Safety Concerns Associated with Operation of a Radial Arm Drill
   A. Hot chips
   B. Sharp edges
Practical Application:

The student shall:
1. Practice operating all controls
   A. Speed, feed and directional control
   B. Raise, lower and position drill head
2. Practice using all accessories available for the radial arm drill press in use
   A. Compound rest
   B. Clamping dogs
   C. Tapered shank drill sleeves
3. Describe the safety concerns associated with operation of a radial arm drill
   A. Hot chips
   B. Sharp edges
   C. Flying derbies
   D. High torque rotating equipment
4. Practice the setup and safe operation a radial arm drill to a specified standard

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-G1) dealing with the Shielded Metal Arc Welding (SMAW) process.
Standards of performance:

Student shall identify the two major factors in working safely by:
1. Listing four steps you can take prior to performing work that will insure a safe outcome;
2. Identifying the employee's responsibility if a potential accident or unsafe condition exist;
3. Selecting specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to:

a. Demonstrate use and care of drill press;
b. Identify major components;
c. Describe the function and operation of all controls;
d. Describe typical accessories found on most radial arm drills;
e. Describe the safety concerns associated with operation of a radial arm drill; and,
f. Setup and safely operate a drill press to a specified standard.

Reading Assignments:

The following chapters are assigned to read from Technology of Machine Tools by Krar, McGraw-Hill Publishers, Latest Edition:

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<th>Chapter</th>
<th>Title</th>
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Module Outline:

I. Identify Major Components
   A. Bed/table
   B. Motor
   C. Speed/feed/directional controls
D. Start/stop/emergency stop
E. Coolant system
F. Drill head
G. Column
H. Spindle
I. Radial arm

II. Describe the Function and Demonstrate Operations of All Controls
A. Speed, feed and directional control
B. Raise, lower and position drill head

III. Describe and Demonstrate the Use of Accessories Found on Most Radial Arm Drills
A. Compound rest
B. Clamping dogs
C. Tapered shank drill sleeves
D. Drill chuck
E. Fly cutter

IV. Describe the Safety Concerns Associated with Operation of a Radial Arm Drill
A. Hot chips
B. Sharp edges
C. Flying derbies

V. Demonstrate the Setup and Safely Operate a Radial Arm Drill Press to a Specified Standard
Standards of performance:

Student shall identify the two major factors in working safely by:
1. Listing four steps you can take prior to performing work that will insure a safe outcome;
2. Identifying the employee's responsibility if a potential accident or unsafe condition exist;
3. Selecting specific task that have the potential to cause an injury.
Worksheet:

1. The Instructor will:
   A. Identify major components.
      (1) Bed/table
      (2) Motor
      (3) Speed/feed/directional controls
      (4) Start/stop/Emergency Stop
      (5) Coolant system
      (6) Drill head
      (7) Column
      (8) Spindle
      (9) Radial arm
   B. Describe the function and demonstrate operations of all controls.
      (1) Speed, feed and directional control
      (2) Raise, lower and position drill head
   C. Describe and demonstrate the use of accessories found on most radial arm drills.
      (1) Compound rest
      (2) Clamping dogs
      (3) Tapered shank drill sleeves
      (4) Drill chuck
      (5) Fly cutter
   D. Describe the safety concerns associated with operation of a radial arm drill.
      (1) Hot chips
      (2) Sharp edges
      (3) Flying derbies
   E. Demonstrate the setup and safely operate a radial arm drill press to a specified standard.

2. Student will:
   A. Identify major components.
      (1) Bed/table
      (2) Motor
      (3) Speed/feed/directional controls
      (4) Start/stop/Emergency Stop
      (5) Coolant system
      (6) Drill head
      (7) Column
(8) Spindle
(9) Radial arm

B. Describe the function and demonstrate operations of all controls.
(1) Speed, feed and directional control
(2) Raise, lower and position drill head

C. Describe and demonstrate the use of accessories found on most radial arm drills.
(1) Compound rest
(2) Clamping dogs
(3) Tapered shank drill sleeves
(4) Drill chuck
(5) Fly cutter

D. Describe the safety concerns associated with operation of a radial arm drill.
(1) Hot chips
(2) Sharp edges
(3) Flying derbies

E. Demonstrate the setup and safely operate a radial arm drill press to a specified standard.

3. Instructor will grade student on:
A. Identify major components.
(1) Bed/table
(2) Motor
(3) Speed/feed/directional controls
(4) Start/stop/Emergency Stop
(5) Coolant system
(6) Drill head
(7) Column
(8) Spindle
(9) Radial arm

B. Describe the function and demonstrate operations of all controls.
(1) Speed, feed and directional control
(2) Raise, lower and position drill head

C. Describe and demonstrate the use of accessories found on most radial arm drills.
(1) Compound rest
(2) Clamping dogs
(3) Tapered shank drill sleeves
(4) Drill chuck
(5) Fly cutter

D. Describe the safety concerns associated with operation of a radial arm drill.
(1) Hot chips
(2) Sharp edges
(3) Flying derbies

E. Demonstrate the setup and safely operate a radial arm drill press to a specified standard.
IMM-F6
Use and Care of Drill Press
Self-Assessment

Circle the letter preceding the correct answer.

1. Which of the following types of drill presses would be best suited for high volume production parts?
   A. CNC drilling machine
   B. Sensitive drill press
   C. Radial drill press
   D. Gang drilling machine

2. Taper shank twist drills are mounted in the drill press using a
   _______
   A. Drill spindle
   B. Drill sleeve
   C. Drill socket
   D. All of the above

3. How is a tapered shank drill removed from a drill press spindle?
   A. With a reversible drill socket
   B. With a drill drift
   C. With a ball peen hammer
   D. With a spindle remover

4. A conventional drill point usually has an included angle of ________.
   A. 60°
   B. 90°
   C. 18°
   D. 135°

5. Which of the following types of drill bits has a removable cutting bit?
   A. A core drill
   B. A gun drill
   C. A spade drill
   D. A variable size drill
6. When a drill bit shows excessive wear at the outer corners of the point, the problem will usually be _____________.
   A. Improper web thinning
   B. Cutting lips with unequal angles
   C. Excessive feed
   D. Excessive speed

7. When a drill bit produces a hole which is excessively oversize, the problem will usually be _____________.
   A. Improper web thinning
   B. Cutting lips with unequal angles
   C. Cutting lips with unequal lengths
   D. Excessive feed

8. To make it easier for a drill bit to do its work, which of the following will help greatly?
   A. Thin the web of the drill
   B. Use coolant
   C. Inspect the drill bit
   D. All of the above

9. Which of the following factors affect the rate of feed chosen for a job?
   A. The diameter of the drill
   B. The material of the work piece
   C. The condition of the drilling machine
   D. All of the above

10. As a general rule; for holes up to \( \frac{1}{2} \)" diameter, allow ________ for reaming and for holes over \( \frac{3}{4} \)" diameter, allow ________ for reaming.
    A. 1/64", 1/32"
    B. 1/32", 1/64"
    C. .100", .200"
    D. None of the above

11. Which of the following types of taps cannot be used with the drill press?
    A. A gun tap
    B. A spiral-fluted tap
    C. A hand tap
    D. A tap drill
12. Which of the following is not a valid system of drill sizing?
   A. Fractional drills
   B. Taper drills
   C. Metric drills
   D. Letter drills
IMM-F6
Use and Care of Drill Press
Self-Assessment Answer Key

1. A
2. D
3. B
4. C
5. C
6. D
7. C
8. D
9. D
10. A
11. D
12. B
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B</strong> Apply Mathematical Concepts</td>
<td>B-1 Perform basic arithmetic functions</td>
</tr>
<tr>
<td><strong>C</strong> Interpret Engineering Drawings and Control Documents</td>
<td>C-1 Identify basic types of drawings</td>
</tr>
<tr>
<td><strong>D</strong> Use Measuring Tools</td>
<td>D-1 Use non-precision measuring tools</td>
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<td><strong>E</strong> Use Hand Tools</td>
<td>E-1 Identify and use maintenance technician's hand tools</td>
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<td><strong>F</strong> Operate Machine Tools</td>
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</tr>
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<td><strong>G</strong> Perform Welding Operations</td>
<td>G-1 Weld with shielded metal arc welding (SMAW) process</td>
</tr>
<tr>
<td><strong>H</strong> Maintain/ Troubleshoot Equipment and Systems</td>
<td>H-1 Maintain air conditioning systems</td>
</tr>
<tr>
<td><strong>I</strong> Repair Power Transmission Systems</td>
<td>I-1 Maintain and troubleshoot belt drive systems</td>
</tr>
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<td><strong>J</strong> Fabricate/ Install Sheet Metal Parts</td>
<td>J-1 Layout sheet metal parts</td>
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</table>
INDUSTRIAL MAINTENANCE MECHANIC uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
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<tr>
<td>Piping Operations</td>
<td>K-1 Perform basic pipefitting calculations</td>
</tr>
<tr>
<td>Basic Rigging</td>
<td>L-1 Rigging fundamentals</td>
</tr>
<tr>
<td>Bearing Maintenance</td>
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</tr>
<tr>
<td>Use Computers</td>
<td>N-1 Perform basic word processing</td>
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<tr>
<td>Align Shafts</td>
<td>O-1 Principles of alignment</td>
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<td>Install/Align Machines</td>
<td>P-1 Install electrical connections</td>
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<tr>
<td>Maintain Electrical Devices</td>
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</tr>
<tr>
<td>Basic Mechanical Concepts</td>
<td>R-1 Force</td>
</tr>
<tr>
<td>Fasteners and Preloading</td>
<td>S-1 Fasteners and nomenclature</td>
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<thead>
<tr>
<th></th>
<th>K-2 Cut, thread, and reuse pipe</th>
<th>K-3 Pipe assembly</th>
<th>K-4 Install and adjust pipe support</th>
<th>K-5 Tubing</th>
<th>K-6 Fittings</th>
<th>K-7 Plastic pipe</th>
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<tr>
<td>L-2 Demonstrate basic rigging skills</td>
<td>M-2 Rolling element bearings</td>
<td>N-2 Perform basic spreadsheet operations</td>
<td>O-2 Methods of alignment</td>
<td>P-2 Setting and leveling</td>
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<tr>
<td>Q-2 Apply basic terms to electrical circuits</td>
<td>Q-3 Analyze series, parallel, and complex AC/DC circuits</td>
<td>Q-4 Check AC and DC motors</td>
<td>Q-5 Troubleshoot electrical devices</td>
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<tr>
<td>R-2 Work</td>
<td>R-3 Mechanical motion and rate</td>
<td>R-4 Simple machines</td>
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<tr>
<td>S-2 Application for various fasteners</td>
<td>S-3 Techniques for removing damaged fasteners</td>
<td>S-4 Cleaning and restoring threaded fasteners</td>
<td>S-5 Torque preload theory</td>
<td>S-6 Effects of lubricating threads prior to torquing</td>
<td>S-7 Demonstrate appropriate torquing technique</td>
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</table>
Subject: Industrial Maintenance

Duty: Perform Welding Operations
Task: Weld with Shielded Metal Arc Welding (SMAW) Process

Objective(s):

Upon completion of this module the student will be able to:

a. Weld with shielded metal arc (SMAW) process.

Instructional Materials:

MASTER Handout (IMM-G1-HO)
MASTER Laboratory Worksheet (IMM-G1-LW)
MASTER Laboratory Aid (IMM-G1-LA)
MASTER Self-Assessment
Basic hand tools
Welding gloves
Chipping hammer
Welding helmet
Wire brush
Constant current welding machine
Ground cable and clamp
Safety glasses
Welding lens (#7-14)
Clear welding lens
Manufacturers' equipment manuals
Material Safety Data Sheet (MSDS)
E6010 electrode
E7018 electrode

References:


Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-F6    “Use and Care of Drill Press”

Introduction:

At various times the technician must cut and weld parts of the equipment encountered. Although various similarities exist among the processes, specific differences separate the following cutting/welding processes:

A. Oxyacetylene cutting;
B. Carbon arc gouging/cutting;
C. Shielded metal arc welding; and,
D. Gas metal arc welding.

**Shielded Metal Arc Welding (SMAW)** is a welding process which joins metals by heating them with an arc between a covered metal electrode and the metals being joined. Shielding is obtained from the decomposition (breakdown) of the electrode covering. Pressure is not used and filler metal is obtained from the electrode.

The electric arc flowing across an air gap produces very intense heat and light. An electric arc has been measured at 10,000°F. Considering that steel melts at around 2800°F, the electric arc is indeed a very fast and efficient heat source for melting steel when welding.

Presentation Outline:

I. Machines and Accessories
   A. Selecting the electrode
II. Striking an Arc
III. Running Continuous
IV. The Flat Position
   A. The horizontal position
   B. The vertical position
   C. The overhead position
   D. Cast iron
   E. Carbon steels
   F. Alloy steels
   G. Non-ferrous metals
Practical Application:

The student must score 90% on the competency self-assessment and perform a shielded metal arc welding task.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-G2) dealing with welding with oxyacetylene.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
1. Using OSHA required safety equipment for the shop;
   - Safety glasses;
   - Hearing protection;
   - Face shields;
   - Gloves;
2. Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
3. Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
   a. Weld with shielded metal arc (SMAW) process.

Reading Assignments:

The following chapters are assigned to read from *Welding Skills and Practices*, by Week, Published by ATS, Latest Edition:

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<th>Topic</th>
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<td>Selecting the Electrode</td>
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<td>7</td>
<td>Striking an Arc</td>
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<td>Running Continuous Beads</td>
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<td>The Flat Position</td>
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<td>10</td>
<td>The Horizontal Position</td>
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<td>The Vertical Position</td>
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<td>12</td>
<td>The Overhead Position</td>
</tr>
<tr>
<td>13</td>
<td>Cast Iron</td>
</tr>
<tr>
<td>14</td>
<td>Carbon Steels</td>
</tr>
<tr>
<td>15</td>
<td>Alloy Steels</td>
</tr>
<tr>
<td>16</td>
<td>Non-Ferrous Metals</td>
</tr>
</tbody>
</table>

Module Outline:

I. Machines and Accessories
   A. Selecting the electrode
II. Striking an Arc
III. Running Continuous
IV. The Flat Position
   A. The horizontal position
   B. The vertical position
   C. The overhead position
   D. Cast iron
   E. Carbon steels
   F. Alloy steels
   G. Non-ferrous metals
The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

CAUTION: Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.

B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.

C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.

D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

CAUTION: Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.

B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.

C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.

D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.

E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.

F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.

G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.

B. Cover all skin surfaces. Keep shirt sleeves rolled down.

C. Wear cuffless pants to eliminate spatter traps.

D. Wear leather boots. Pant legs should cover boot tops.

E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.

F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.

G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.

H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.

I. Wear a 100% cotton cap to protect the head from sparks or spatter.

J. Wear long gauntlet leather gloves.

K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.

L. Protect nearby workers from exposure to the welding arc by putting up shields.

M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).
FILTER RECOMMENDATIONS  
(adapted from ANSI Safety Standard Z49.1-88)  
SMAW

<table>
<thead>
<tr>
<th>Application</th>
<th>Minimum Shade No.</th>
<th>Suggested Shade*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 60 amps</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>60 to 160 amps</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>160 to 250 amps</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>250 to 500 amps</td>
<td>11</td>
<td>14</td>
</tr>
</tbody>
</table>

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

**FIGURE 2 FILTER RECOMMENDATIONS**

**CAUTION:** Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.
C. Cover combustibles that cannot be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.
D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.
E. If combustibles cannot be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.
F. Do not weld on materials having either a coating or internal structure that is combustible.
G. Place hot scrap and slag in non-combustible containers.
H. Ensure that fire extinguishers are available nearby.
I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails. DON'T CARRY A BOMB IN YOUR POCKET.
Worksheet:

1. **Choose Proper Power Source**
   
   **Step 1.** With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.

   **Step 2.** An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. **Choose a Proper Electrode**
   
   **Step 1.** Choose the proper electrode for the job.

   **NOTE:** The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the fast-freeze family of electrodes and the E7018 belongs to the low-hydrogen family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

   The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

   **Step 2.** Store the electrodes properly.

   a. **Low-hydrogen electrodes:**
      
      (1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.

      (2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.
(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Step 3. Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

<table>
<thead>
<tr>
<th>ROD DESIGNATION</th>
<th>DC+</th>
<th>DC-</th>
<th>AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>E6010</td>
<td>YES</td>
<td>NEVER</td>
<td>NEVER</td>
</tr>
<tr>
<td>E7015</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>E7016</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>E7018</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>E7048</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
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</table>

**Definitions:**
AC Alternating Current
DC+(DCRP) Direct Current Reverse Polarity
DC-(DCSP) Direct Current Straight Polarity

*Figure 5* Welding Rod Polarities
### Electrode Diameter (in.)

<table>
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<tr>
<th>Electrode Diameter (in.)</th>
<th>E6010, E6011 DC+</th>
<th>E6012</th>
<th>E6013</th>
<th>E6020</th>
<th>E6027</th>
<th>E7014</th>
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<td>330-415</td>
<td>315-400</td>
<td>335-430</td>
<td>400-525*</td>
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**FIGURE 6 TYPICAL CURRENT RANGES FOR ELECTRODES**

3. **Prepare Weldment for Welding**

   **Step 1.** Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.
   a. Weld joint configuration will depend upon:
      (1) Product design
      (2) Material thickness
      (3) Design strength requirements
      (4) Welding process employed
   b. SMAW weld joint configuration may be a:
      (1) Lap joint
      (2) Tee joint
      (3) Corner joint
      (4) Edge joint
      (5) Butt joint with backing
      (6) Butt joint without backing

   **Step 2.** Clean the areas to be welded prior to fit-up
   a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing
   b. Remove oils and greases with a safe, suitable solvent
Step 3. Turn on the power source and set the current range (amps) on the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. **Complete Welding Operation**

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
   a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
   b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
   c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.
   a. As the material thickness increases, the travel speed must slow down.
   b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.
   c. Higher welding speeds are attainable by using the forehand (pushing) technique.
5. Troubleshoot Welding Problems

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW process:
   a. Type of electrode
   b. Diameter of electrode
   c. Type of current (AC or DC)
   d. Current polarity (DC+ or DC-)
   e. Current setting
   f. Arc length
   g. Travel speed
   h. Electrode angle
   i. Electromagnetic arc blow
   j. Electrode manipulation technique (drag, whip, or
   k. Thoroughness of slag removal prior to restarts and new bead placement

Step 2. Be aware of general welding variables and how they can affect the weld:
   a. Type of base metal
   b. Thickness of base metal
   c. Surface condition of base metal (clean, rusty, or painted)
   d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it (see Figure 7).
IMM-G1
Weld with Shielded Metal Arc Welding (SMAW) Process
Self-Assessment

1. The size of the bead is _______ proportional to the speed of travel.
   A. Directly
   B. Inversely
   C. Not
   D. None of the above

2. The eye shield of the welding helmet should be:
   A. Just light enough to clearly see the arc.
   B. Too dark to clearly see the arc.
   C. A minimum of #5.
   D. None of the above.

3. Welding in confined spaces may require:
   A. Air supplied hoods or hose masks.
   B. Frequent breaks.
   C. Large, high-displacement fans.
   D. All of the above.
   E. None of the above.

4. Long sleeves protect the arms against:
   A. Ultraviolet radiation.
   B. Infrared radiation.
   C. Welding splatter.
   D. All of the above.
   E. None of the above.

5. Which of the following is NOT a variable in the SMAW process?
   A. Current polarity
   B. Arc length
   C. Length of the electrode
   D. All of the above are variables in the process.
   E. None of the above are variables in the process.

6. Acceptable welding footwear includes:
   A. Roman sandals.
   B. Tennis shoes.
   C. Canvas boots.
   D. All of the above.
   E. None of the above.
7. A welder whose travel speed is too fast may have problems with:
   A. Excess convexity.
   B. Overlap.
   C. Porosity.
   D. All of the above.
   E. None of the above.

8. Technician A says that low-hydrogen electrodes can only be in the open air for two to four hours. Technician B says that the humidity and the base metal determine the amount of time that low-hydrogen electrodes can be exposed. Who is correct?
   A. Technician A only.
   B. Technician B only.
   C. Both Technicians A and B.
   D. Neither Technician A nor B.

9. E6010 electrodes should only be used with:
   A. DC-.
   B. DC+.
   C. AC.
   D. There is no such electrode.

10. Technician A says that they should weld only in well ventilated areas. Technician B says that welding produces gases that are odorless, colorless, and heavier than air. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

11. Technician A says that they should never carry butane lighters into the welding area because they may explode. Technician B says that gasoline should never be taken into the welding area, either. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

12. When repairing welding equipment, its electrical power should be:
    A. On.
    B. Off.
    C. On or off, depending on the repair.
    D. The SMAW machine is not electrical.
13. To prevent electrical shocks, all electrical equipment and the work piece should be:
   A. On rubber work mats.
   B. Elevated off the floor.
   C. Grounded.
   D. All of the above.
   E. None of the above.

14. Which of the following electrodes in NOT in the low-hydrogen family?
   A. E7015
   B. E7016
   C. E7018
   D. All of the above are low-hydrogen electrodes.
   E. All of the above are fast-freeze electrodes.

15. Technician A says that undercutting is caused by too much current.
    Technician B says that wet electrodes can also cause undercutting. Who is correct?
    A. Technician A only.
    B. Technician B only.
    C. Both Technicians A and B.
    D. Neither Technician A nor B.

16. Fire inspections should be continued for at least __________ after completion of the welding.
    A. Fifteen minutes
    B. Thirty minutes
    C. One hour
    D. Two hours

17. The welding area should be:
    A. Isolated from other workers by shields.
    B. At least 35 feet from combustible materials.
    C. Dry.
    D. All of the above.
    E. None of the above.

18. Seam welds generally require __________ oscillation.
    A. No
    B. Very little
    C. Moderate
    D. Great
19. Technician A says that all electrical connections must be tight, clean, and dry. Technician B says that poor electrical connections can heat up and even melt. Who is correct?
A. Technician A only.
B. Technician B only.
C. Both Technicians A and B.
D. Neither Technician A nor B.

20. If it is impractical to properly remove combustible materials from the vicinity of the welding, then:
A. Do not weld.
B. Take frequent breaks to inspect the area for fires.
C. Station a fire watcher near the combustible materials.
D. Any of the above is acceptable.
E. None of the above is practical.

21. E7018 electrodes should never be used with:
A. DC-.
B. DC+.
C. AC.
D. There is no such electrode.

22. Areas to be welded should be thoroughly cleaned:
A. Prior to fit-up.
B. By brushing, sanding, or grinding.
C. With safe solvents.
D. All of the above, as necessary.
E. None of the above.

23. Technician A says that porosity can be caused by a current setting that is too low. Technician B says that porosity can be caused by too long an arc. Who is correct?
A. Technician A only.
B. Technician B only.
C. Both Technicians A and B.
D. Neither Technician A nor B.

24. Low-hydrogen electrodes may be stored:
A. In sealed cans or heated rod ovens.
B. Under water.
C. In petroleum jelly.
D. Any of the above.
E. None of the above.
25. As the material being welded increases in thickness, the travel speed of the weld must:
   A. Increase.
   B. Decrease.
   C. Either a or b, depending on the desired effect.
   D. Stay the same.
   E. None of the above.
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INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-G2

Subject: Industrial Maintenance
Duty: Perform Welding Operations
Task: Weld/Cut with Oxyacetylene

Time: 30 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Select proper cylinder;
b. Select proper regulator;
c. Select proper valve;
d. Fabricate cutting equipment;
e. Weld with oxyacetylene equipment;
f. Prepare to cut;
g. Light the torch;
h. Cut the metal with the torch; and,
i. Extinguish the torch.

Instructional Materials:

- Master Handout (IMM-G2-HO)
- Master Laboratory Aid (IMM-G2-LA)
- Master Laboratory Worksheet (IMM-G2-LW)
- Master Self-Assessment
- Oxygen tank
- Acetylene tank
- Welding torch
- MSDS
- Safety glasses
- Practice metal

References:

Introduction:

At various times the technician must cut and weld parts of the equipment encountered. Although various similarities exist among the processes, specific differences separate the following cutting/welding processes:

- Oxyacetylene cutting;
- Carbon arc cutting/gouging;
- Shielded metal arc welding; and,
- Gas metal arc welding.

This module examines the basics of oxyacetylene cutting/welding. Oxyacetylene cutting requires the use of specific procedures and specific techniques in order to work safely and to produce acceptable cuts. Proper flame adjustments, torch angles, and flame-to-work distances must be maintained in order to produce good cuts. Oxyacetylene cutting can be done from both fixed cutting stations and from portable cutting stations.

Presentation Outline:

I. Gas Cutting Safety
II. Gas Cutting Fundamentals
III. Gasses
IV. Cylinders
V. Regulators
VI. Valves
VII. Oxygen
VIII. Oxygen Hoses
IX. Acetylene
X. Acetylene Hoses
XI. Cutting Torch and Tips
XII. Flame
XIII. Setting Up Equipment
XIV. Light Torch
XV. Cutting Procedure
XVI. Welding Procedure
Practical Application:

You must score 90% on the competency post-test and you must perform oxyacetylene cutting and welding to established standards.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-G3) dealing with performing gas soldering.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Select proper cylinder;
b. Select proper regulator;
c. Select proper valve;
d. Fabricate cutting equipment;
e. Weld with oxyacetylene equipment;
f. Prepare to cut;
g. Light the torch;
h. Cut the metal with the torch; and,
i. Extinguish the torch.

READING ASSIGNMENTS:

The following chapters are assigned to read from Basic Oxyacetylene Welding, Griffin, Delmar Publishers, Latest Edition.

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**Module Outline:**

I. Gas Cutting Safety  
II. Gas Cutting Fundamentals  
III. Gasses  
IV. Cylinders  
V. Regulators  
VI. Valves  
VII. Oxygen  
VIII. Oxygen Hoses  
IX. Acetylene  
X. Acetylene Hoses  
XI. Cutting Torch and Tips  
XII. Flame  
XIII. Setting Up Equipment
XIV.  Light Torch
XV.  Cutting Procedure
XVI.  Welding Procedure
Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.

b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.

c. When lighting the torch, direct the torch away from yourself and other personnel.

d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.

e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.

f. Never cut on containers that have contained flammable or toxic substances.

g. Either move work away from or protect wooden or other flammable materials which may be close to the work.

h. When cutting, cover concrete floors with sheet metal where sarks and molten metal are being directed.

i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.

j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.

k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.

b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.

c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.

d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
f. Do not use pipe-fitting compounds or thread lubricants for making connections.
g. Never use a cylinder that is leaking.
h. Store and transport cylinders in the upright position.
i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.

j. Never tamper with fusible plugs or other safety devices on cylinders.
k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.
l. Never use any cylinder, full or empty, as a roller or support.
m. Never use oxygen as though it were compressed air.
n. Do not handle oxygen cylinders on the same platform with oil.
o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
p. Store oxygen cylinders separately from fuel gas cylinders.
q. Always keep empty cylinders separate from full cylinders.
r. Mark all empty cylinders as such after use.
s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
t. Never bring any arc or flame close to or directly into contact with a cylinder.
u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.
Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?

2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?

3. What are the precautions for minimizing the risk of R.B.O.?

4. What are the steps in preparing to cut with oxyacetylene?

5. What are the steps in lighting the torch?

6. What are the steps in cutting metal with the torch?

7. What are the steps in extinguishing the torch?

8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
   a. Use goggles or shield with a number five shade.
   b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
   c. When lighting the torch, direct the torch away from yourself and other personnel.
   d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
   e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
   f. Never cut on containers that have contained flammable or toxic substances.
   g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.

j. Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.

k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
   a. Keep acetylene operating pressures at or below 15 psi.
   b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
   c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
   d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
   e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
   f. Do not use pipe-fitting compounds or thread lubricants for making connections.
   g. Never use a cylinder that is leaking.
   h. Store and transport cylinders in the upright position.
   i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
   j. Never tamper with fusible plugs or other safety devices on cylinders.
   k. To open and close acetylene cylinder valves not provided with hand-wheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
   l. Never use any cylinder, full or empty, as a roller or support.
   m. Never use oxygen as though it were compressed air.
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   r. Mark all empty cylinders as such after use.
   s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
   t. Never bring any arc or flame close to or directly into contact with a cylinder.
u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of R.B.O.
   a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
   b. Use only oxygen regulators to control oxygen supply. A pressure-reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
   c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
   d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
   a. Obtain the proper size cutting tip.
      (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
      (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
   b. Screw the cutting torch head in place, hand-tight only.
c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
d. Attach the regulators, hoses, torch, and correct-sized torch tip.
e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counter-clockwise until there is a little free play.)
f. Make sure all cutting torch valves are initially closed.
g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
h. Open the acetylene torch valve. Turn the acetylene torch valve off.
i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
j. Turn the acetylene torch valve off.
k. Turn both oxygen torch valves on.
l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
a. Put on gloves.
b. Put on welding goggles.
c. Open the torch acetylene valve one-half turn.
d. **Immediately** light the torch with a friction lighter only.
e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
f. Open the torch's oxygen valve slowly until the desired type flame is obtained.
   (1) The preheat flame needs to be of the *neutral* type, which means that equal parts of oxygen and acetylene are being burnt.
   (2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in “Step e” again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut—assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
   (1) Cutting tip size.
   (2) Oxygen operating pressure.
   (3) Acetylene operating pressure.
   (4) Preheat flame type.
   (5) Size of preheat flame.
b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.

c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to ½" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.

d. Select the correct torch angle.
   (1) For square cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
   (2) For beveled cuts, the torch should be held at the angle of the bevel throughout the cutting procedure.
   (3) For holes, the torch must be held perpendicular to the base metal throughout the cut.

e. Cut at the proper travel speed. At the correct travel speed, the lines of the cut which project through the thickness of the base metal will be in a straight line. At too fast a travel speed, the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed lag or drag lines. (The amount of drag is often expressed as a percent.)

f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
   a. Close the torch acetylene valve, thus extinguishing the flame.
   b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
   a. Close the oxygen cylinder valve.
   b. Close the acetylene cylinder valve.
   c. Open the torch acetylene valve and bleed the acetylene from the line.
   d. Close the torch acetylene valve.
   e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
   f. Open the torch oxygen valve and bleed the oxygen from the line.
   g. Close the torch oxygen valve.
   h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
IMM-G2
Weld/Cut with Oxyacetylene
Self-Assessment

Circle the letter preceding the correct answer.

1. Which of the following can be used to ignite an oxyacetylene torch?
   a. Matches
   b. A cigarette lighter
   c. A spark or friction lighter
   d. Any of the above
   e. None of the above

2. Technician A says that they can cut into an old gasoline can with the torch. Technician B says that containers of flammable or toxic substances should never be cut with a torch. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

3. If adequate ventilation is unavailable, the technician should:
   a. Cut the metal anyway; ventilation is not important.
   b. Cut the metal while wearing a respirator.
   c. Cut the metal while wearing a heavy-duty dust mask.
   d. Refuse to make the cut.

4. Acetylene operating pressures must be kept at or below:
   a. 5 psi.
   b. 15 psi.
   c. 25 psi.
   d. Acetylene operating pressures are immaterial.

5. Acetylene hoses are _____; acetylene fittings are _____________.
   a. Red . . . left-handed
   b. Blue . . . left-handed
   c. Red . . . right-handed
   d. Blue . . . left-handed
   e. None of the above is correct.
6. All cylinders should be secured except when:
   a. Transporting them.
   b. Storing them.
   c. Using them.
   d. Always secure cylinders with chains or in permanent racks.
   e. Securing cylinders is unnecessary.

7. Technician A says that oxygen cylinders should be stored well away from fuel gas cylinders. Technician B says that separate storage is unnecessary. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

8. The maximum safe withdrawal rate for acetylene cylinders is:
   a. One fourth of current content per hour.
   b. One fifth of current content per hour.
   c. One seventh of current content per hour.
   d. One tenth of current content per hour.
   e. None of the above

9. Technician A says that only oxygen-specific regulators can be used on oxygen cylinders. Technician B says that it is acceptable to use oxygen regulators on other gas cylinders. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

10. Which of the following can be cut with an oxyacetylene torch?
    a. Aluminum
    b. Copper
    c. Chromium
    d. All of the above
    e. None of the above

11. Technician A says that the acetylene cylinder's valve should be opened all the way. Technician B says that the oxygen cylinder's valve should be opened no more than one full turn. Who is correct?
    a. Technician A only
    b. Technician B only
    c. Both Technicians A and B
    d. Neither Technician A nor B
12. Before attaching the regulators to the cylinder valves:
   a. Clean the nipples with acetone.
   b. Crack the valves to blow out any dirt.
   c. Lubricate the threads with oil.
   d. All of the above
   e. None of the above

13. Technician A says that they must reduce the acetylene flow until the flame just starts to produce black smoke around its edges. Technician B says that the acetylene flow must then be increased until the smoke disappears. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

14. Dirty orifices on the cutting tip can produce:
   a. Wide kerfs.
   b. Adherent slag.
   c. Rough cut appearance.
   d. All of the above.
   e. None of the above

15. Technician A says that, for cutting holes, the torch must be held parallel to the base metal throughout the cut. Technician B says that square cuts require the torch to be held at 45° to the base metal. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

16. Lag lines are the result of:
   a. Correct travel speed.
   b. Too great a travel speed.
   c. Too slow a travel speed.
   d. Incorrect torch angle.
   e. None of the above

17. When extinguishing the torch, Technician A says that the acetylene torch valve should be closed first. Technician B says that the oxygen torch valve should be closed first. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B
18. Good oxy-fuel cuts require an oxygen purity of at least:
   a. 99.5%.
   b. 95.9%.
   c. 59.9%.
   d. None of the above is correct.

19. Both acetylene and oxygen lines should be ____________ when closing down the work station.
   a. Removed
   b. Cleaned with acetone
   c. Bled free of gas or fuel
   d. All of the above
   e. None of the above

20. Technician A says that since B is left-handed, B should cut from left to right. Technician B says that the pre-heat flame should still be from 1/6" to 1/2" from the base metal, regardless of the direction of travel. Who is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B
1. c  
2. b  
3. b  
4. b  
5. a  
6. d  
7. a  
8. c  
9. a  
10. e 

11. d  
12. b  
13. c  
14. d  
15. d  
16. b  
17. a  
18. a  
19. c  
20. c
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-G3

Subject: Industrial Maintenance          Time: 20 Hrs.
Duty: Perform Welding Operations
Task: Perform Gas Soldering

Objective(s):

Upon completion of this module the student will be able to:
a. Identify soldering, brazing and braze welding;
b. Describe the advantages of soldering and brazing;
c. Demonstrate methods of cleaning and assembling metals;
d. Perform required soldering, brazing and braze welding joints; and,
e. Determine the proper fluxes for the soldering, brazing and braze weld joints.

Instructional Materials:

Master Handout (IMM-G3-HO)
Master Laboratory Aid (IMM-G3-LA)
Master Laboratory Worksheet (IMM-G3-LW)
Master Self-Assessment
Oxygen tank
Acetylene tank
Torch
Work materials
Hoses
Goggles (PPE)
Flux for soldering (silver solder)
Flux for brazing (bronze filler rods)
Wire brush
Flame resistant clothing
Welding gloves
Well ventilated work area

References:

Introduction:

Brazing is used to make strong joints of good appearance using a bronze filler metal. Brazing is a process in which metals are joined at a temperature greater than 800 degrees F. A brazed joint is bonded rather than welded.

Presentation Outline:

I. Oxyacetylene Soldering Safety
II. Soldering with Oxyacetylene
III. Equipment Set Up
IV. Light Torch
V. Torch and Rod Control
VI. Soldering with Filter Material
VII. Soldering a But Joint
VIII. Soldering in a Vertical Position

Practical Application:

You must score 90% on the competency post-test and you must perform soldering or bronzing to established standards.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (IMM-H1) dealing with maintaining air conditioning systems.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify soldering, brazing and braze welding;
b. Describe the advantages of soldering and brazing;
c. Demonstrate methods of cleaning and assembling metals;
d. Preform required soldering, brazing and braze welding joints; and,
e. Determine the proper fluxes for the soldering, brazing and braze weld joints.

Reading Assignments:

The following chapters are assigned to read from Basic Oxyacetylene Welding, by Griffin, Delmar Publishers, Latest Edition

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Module Outline:

I. Oxyacetylene Soldering Safety
II. Soldering with Oxyacetylene
III. Equipment Set Up
IV. Light Torch
V. Torch and Rod Control
VI. Soldering with Filter Material
VII. Soldering a But Joint
VIII. Soldering in a Vertical Position
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
1. Instructor will demonstrate how to:
   - Braze with bronze rod;
   - Run a bead with a bronze rod;
   - Square butt braze on light steel plate;
   - Braze lap joints;
   - Braze tee joints;
   - Braze beveled butt joints on heavy steel plate;
   - Braze beveled joints on cast iron;
   - Silver soldering of nonferrous metals; and,
   - Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   - Brazing with bronze rod;
   - Running beads with bronze rod;
   - Square butt brazing on light steel plate;
   - Brazed lap joints;
   - Brazing tee joints;
   - Brazing beveled butt joints on heavy steel plate;
   - Brazing beveled joints on cast iron;
   - Silver soldering nonferrous metals; and,
   - Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on:
   - Brazing with bronze rod;
   - Running beads with bronze rod;
   - Square butt brazing on light steel plate;
   - Brazed lap joints;
   - Brazing tee joints;
   - Brazing beveled butt joints on heavy steel plate;
   - Building-up on cast iron;
   - Brazing beveled joints on cast iron;
   - Silver soldering nonferrous metals; and,
   - Silver soldering ferrous and nonferrous metals.
IMM-G3
Perform Gas Soldering
Self-Assessment

1. What two conditions determines whether the joint is brazed or welded?

2. How does flux act as a guide to the temperature of the joint?

3. What happens to the color of the plate when it is at the proper temperature for brazing?

4. Is brazing stronger than fusion welding?

5. For silver soldering, what is a 3x flame?

6. What alloys are contained in typical silver soldering?

7. How can material be prepared for silver soldering?

8. Is it possible to make fillets when using silver soldering alloys?
Perform Gas Soldering
Self-Assessment Answer Key


2. When flux melts and flow freely.

3. Plate changes color when ready for brazing.

4. No

5. Carburizing flame.

6. Copper, silver, phosphorus.

7. Wire brushing, rub with emery cloth or steel wool, or dip in acid bath.

8. No
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-H1

Subject: Industrial Maintenance
Time: 60 Hrs.

Duty: Maintain/Troubleshoot Equipment and Systems
Task: Maintain Air Conditioning Systems

Objective(s):

Upon completion of this module the student will be able to:

a. Draw and explain operation of basic refrigeration cycle;
b. Discuss air properties and how psychrometries are used;
c. List HVAC basic components and their explain sequence of operation;
d. List typical HVAC instrumentation and test equipment;
e. Draw mechanical and electrical diagrams of compressors;
f. List sequence of operation for control and protective devices for compressors;
g. List procedures for maintenance and repair of compressors; and,
h. List procedures for maintenance and repair of HVAC systems.

Instructional Materials:

MASTER Handout (IMM-H1-HO)
MASTER Laboratory Aid (IMM-H1-LA)
MASTER Laboratory Worksheet (IMM-H1-LW)
MASTER Self-Assessment
HVAC system
HVAC instrumentation
HVAC test equipment

References:

Student Preparation:

Students should have previously completed the following Technical Modules:

- IMM-G3  “Perform Gas Soldering”

Introduction:

HVAC provides climate control of a designated environment. This is very common in many industrial plants today for better control of product and personnel working in this environment. It is so common that it has become accepted as a part of life for many plants. The maintenance mechanic is required to know and maintain this complex system.

Presentation Outline:

I. Basic Refrigeration Cycle
II. Air Properties and Psychometrics
III. HVAC Basic Components and Their Operation
IV. HVAC Instrumentation and Test Equipment
V. Compressors
VI. Control and Protective Devices for Compressors
VII. Maintenance and Repair of Compressors
VIII. Maintenance and Repair of HVAC Systems

Practical Application:

1. Instructor will demonstrate selection and proper use of HVAC equipment.
2. Students will be allowed to practice the use of HVAC equipment.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (IMM-H2) dealing with maintaining and troubleshooting pneumatic control circuits
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wear rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Draw and explain operation of basic refrigeration cycle;
b. Discuss air properties and how phycrometrics are used;
c. List HVAC basic components and their explain sequence of operation;
d. List typical HVAC instrumentation and test equipment;
e. Draw mechanical and electrical diagrams of compressors;
f. List sequence of operation for control and protective devices for compressors;
g. List procedures for maintenance and repair of compressors; and,
h. List procedures for maintenance and repair of HVAC systems.

Reading Assignments:

The following chapters are assigned to read from *Air Conditioning and Refrigeration Compressors*, TPC Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Compressors</td>
</tr>
<tr>
<td>4</td>
<td>Control and Protective Devices</td>
</tr>
<tr>
<td>5</td>
<td>Maintenance and Repair</td>
</tr>
</tbody>
</table>

Module Outline:

I. Basic Refrigeration Cycle
II. Air Properties and Psychometrics
III. HVAC Basic Components and Their Operation
IV. HVAC Instrumentation and Test Equipment
V. Compressors
VI. Control and Protective Devices for Compressors
VII. Maintenance and Repair of Compressors
VIII. Maintenance and Repair of HVAC Systems
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
1. Instructor will demonstrate how to:
   a. Draw and explain operation of basic refrigeration cycle;
   b. Discuss air properties and how psychrometrics are used;
   c. List HVAC basic components and their explain sequence of operation;
   d. List typical HVAC instrumentation and test equipment;
   e. Draw mechanical and electrical diagrams of compressors;
   f. List sequence of operation for control and protective devices for compressors;
   g. List procedures for maintenance and repair of compressors; and,
   h. List procedures for maintenance and repair of HVAC systems.

2. Student will demonstrate how to:
   a. Draw and explain operation of basic refrigeration cycle;
   b. Discuss air properties and how psychrometrics are used;
   c. List HVAC basic components and their explain sequence of operation;
   d. List typical HVAC instrumentation and test equipment;
   e. Draw mechanical and electrical diagrams of compressors;
   f. List sequence of operation for control and protective devices for compressors;
   g. List procedures for maintenance and repair of compressors; and,
   h. List procedures for maintenance and repair of HVAC systems.

3. Instructor will grade students ability to:
   a. Draw and explain operation of basic refrigeration cycle;
   b. Discuss air properties and how psychrometrics are used;
   c. List HVAC basic components and their explain sequence of operation;
   d. List typical HVAC instrumentation and test equipment;
   e. Draw mechanical and electrical diagrams of compressors;
   f. List sequence of operation for control and protective devices for compressors;
   g. List procedures for maintenance and repair of compressors; and,
   h. List procedures for maintenance and repair of HVAC systems.
IMM-H1
Maintain Air Conditioning Systems
Self-Assessment

Circle the letter preceding the correct answer.

1. Which of the following could cause the oil in a compressor to be low?
   a. Compressor is burning oil
   b. Oil has vaporized
   c. Oil is trapped in the system
   d. All of the above

2. To repair a leaking gasket on a compressor, the first step is to:
   a. Remove the part that the gasket seals
   b. Check the bolt torque
   c. Clean off the compressor
   d. Pump down the compressor

3. What can you use to clean dirt and oxidation from starter and control contacts?
   a. Special contact cleaning solvents
   b. Vacuum cleaner
   c. R-11
   d. Soap and water

4. On three-phase motors, the imbalance between phases should be no greater than:
   a. 2%
   b. 5%
   c. 10%
   d. 20%

5. Which of the following parts can you probably replace without removing the compressor from the system?
   a. Head gasket
   b. Suction valve
   c. Terminal plate gasket
   d. All of the above
6. If the compressor starts to make a pounding noise during pumpdown, it is probably:
   a. Pumped down enough
   b. Slugging oil
   c. Ready for new valves
   d. Leaking oil

7. Copper plating on internal compressor parts indicates that:
   a. The compressor is slugging oil
   b. The compressor is low on oil
   c. The system contains moisture or acids
   d. The compressor is slugging refrigerant

8. After cleaning the compressor parts, check the tolerance, roundness, taper of crankpin, and bearing journals using a:
   a. Micrometer
   b. Straightedge
   c. Feeler gage
   d. Plug gage

9. Which of the following could cause a compressor motor cookout?
   a. Oversized overload protector
   b. Welded overload contractor
   c. Frequent resetting of overload protector
   d. All of the above

10. Which of the following parts would you install in a system to clean out contaminants from a mild burnout using the operating method?
    a. Suction line filter-drier
    b. Liquid line filter-drier
    c. System cleaner
    d. All of the above
IMM-H1
Maintain Air Conditioning Systems
Self-Assessment Answer Key

1. C
2. B
3. A
4. A
5. D
6. B
7. C
8. A
9. D
10. B
Subject: Industrial Maintenance
Time: 4 Hrs.

Duty: Maintain/Troubleshoot Equipment and Systems
Task: Maintain Pneumatic Control Circuits

Objective(s):

Upon completion of this module the student will be able to:

a. Maintain control valves; and,
b. Maintain pneumatic control circuit.

Instructional Materials:

MASTER Handout (IMM-H2-HO)
MASTER Laboratory Aid (IMM-H2-LA)
MASTER Laboratory Worksheet (IMM-H2-LW)
MASTER Self-Assessment
Shutoff valve
Check valve
One-way valve
Two-way valve
Three-way valve
Four-way valve
Quick-release valve
Maintenance
A. General
B. Disassemble and rework
Basic circuit

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-H1 “Maintain Air Conditioning Systems”
Introduction:

Pneumatic circuits are quick and usually more powerful than electrical control devices. Air also is less likely to cause sparks or explosions. Air is used in environments that are somewhat explosive.

Presentation Outline:

I. Shut-Off Valve
II. Check Valve
III. One-Way Valve
IV. Two-Way Valve
V. Three-Way Valve
VI. Four-Way Valve
VII. Quick-Release Valve
VIII. Maintenance
   A. General
   B. Disassemble and rework
IX. Basic Circuit

Practical Application:

Student will work with pneumatic control circuits and pneumatic components.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Self-Assessment.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-H3) dealing with troubleshooting centrifugal pumps.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Maintain control valves; and,
b. Maintain pneumatic control circuit.

Reading Assignments:

The following chapters are assigned to read from *Fluid Power*, by Parker Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Energy Transmission Using A Pneumatic System</td>
</tr>
<tr>
<td>11</td>
<td>Simple Pressure Control Valves</td>
</tr>
</tbody>
</table>

Module Outline:

I. Shut-Off Valve
II. Check Valve
III. One-Way Valve
IV. Two-Way Valve
V. Three-Way Valve
VI. Four-Way Valve
VII. Quick-Release Valve
VIII. Maintenance
   A. General
   B. Disassemble and rework
IX. Basic Circuit
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Practice Disassembling:
1. Shut-Off Valve
2. Check Valve
3. One-Way Valve
4. Two-Way Valve
5. Three-Way Valve
6. Four-Way Valve
7. Quick-Release Valve
8. Maintenance
   A. General
   B. Disassemble and rework
9. Basic Circuit
1. The action produced by compressed air is ______________.
   a. smooth.
   b. easily converted into a rate.
   c. erratic.
   d. never reciprocal.

2. When you decrease the volume of confined air, pressure ____________.
   a. increases.
   b. decreases.
   c. remains the same.

3. When you decrease the volume of confined air, heat ______________
   a. increases.
   b. decreases.
   c. remains the same.

4. A compressor piston is powered by a ________________.
   a. surge of energy.
   b. prime shaker.
   c. prime mover.
   d. nuclear turbine.

5. Air outside the compressor is known as ________________.
   a. vacuum.
   b. ambient.
   c. standard.
   d. potentially noxious.

6. The connecting point of a compressor piston ________________ force.
   a. concentrates
   b. diminishes
   c. magnifies
   d. None of the above.
7. The displacement of air in a working pneumatic system indicates a constant ______________ of energy.
   a. build-up
   b. waste
   c. misunderstanding
   d. expenditure

8. Air ceases to flow when its pressure ______________.
   a. divides.
   b. multiplies.
   c. equalizes.
   d. peaks.

9. Compressors are used to ________________.
   a. compress metals for recycling.
   b. convert atmospheric air into a useful power source.
   c. regulate air pressure in a plant air system.
   d. reduce the amount of air in the system.

10. The purpose of the oil injector is to
    a. inject oil into the compressor motor.
    b. speed up the flow of air in the pipes.
    c. provide a source of lubrication to pneumatic power tools.
    d. remove oil from the system.
IMM-H2
Maintain Pneumatic Control Circuits
Self-Assessment Answer Key

1. c
2. a
3. a
4. c
5. b
6. a
7. d
8. c
9. b
10. c
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-H3

Subject: Industrial Maintenance

Time: 20 Hrs.

Duty: Maintain/Troubleshoot Equipment and Systems

Task: Troubleshoot Centrifugal Pumps

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the principles of hydraulics;
b. Describe hydrodynamics and water flow;
c. Describe the operation of a centrifugal pump;
d. List the classifications of a centrifugal pump;
e. Identify and describe the parts of a centrifugal pumps;
f. Demonstrate the installation of a centrifugal pump;
g. Set-up and operate a centrifugal pump safely;
h. Identify problems by troubleshooting centrifugal pumps;
i. Describe maintenance and repair of centrifugal pumps;
j. Demonstrate corrosion resisting centrifugal pumps; and,
k. Describe impeller design consideration.

Instructional Materials:

MASTER Handout (IMM-H3-HO)
MASTER Laboratory Aid (IMM-H3-LA)
MASTER Laboratory Worksheet (IMM-H3-LW)
MASTER Self-Assessment
Centrifugal pump
Hand tools

References:

Mechanics' and Millwrights' (Audel), Carl A. Nelson, Macmillan

Centrifugal Pumps Design and Applications, Lobanoff and Ross, Gulf
Publishing Company, Latest Edition


Video: Maintaining Centrifugal Pumps, Tel-a-Train, 309 North Market
Street, P. O. Box 4752, Chattanooga, TN 37405, Latest Edition
Introduction:

Due to the importance of moving fluids in manufacturing, construction and even providing water for everyday usage, pumps are extremely important. This lesson pertains to the centrifugal pump, its safe operations, installation, set-up, troubleshooting, and repair.

Presentation Outline:

I. Describe the Principles of Hydraulics
   A. Introduction
   B. Basic principles
   C. Static head
   D. Static lift
   E. Displacement
   F. Buoyancy
   G. Hydrostatic paradox
   H. Hydrostatic balance

II. Describe Hydrodynamics and Water Flow
    A. Dynamic head
    B. Dynamic lift
    C. Total column
    D. Friction of water in pipes
    E. Measurement of water flow
    F. Siphon
    G. Flow through orifices
    H. Specific gravity
    I. Summary

III. Describe the Operation of a Centrifugal Pump
     A. Basic principles
     B. Straight vane pumps
     C. Curved vane pumps
     D. Volute (curve)
     E. Effects of the curvature

IV. Discuss the Classifications of Centrifugal Pump
A. Single-stage
B. Multistage
C. Impellers
D. Balancing

V. Identify and Describe the Parts of a Centrifugal Pump
A. House or casting
B. Impeller
C. Stuffing box assembly
D. Bearings and housing
E. Shaft assembly
F. Drive

VI. Demonstrate the Installation of a Centrifugal Pump
A. Location
B. Foundation
C. Leveling-aligning
D. Grouting
E. Inlet pipe
F. Discharge pipe
G. High temperature material pumping

VII. Set-Up and Operate a Centrifugal Pump
A. First check
   1. Rotation
   2. Lubrication
   3. Bearing cooling water
   4. Inspect all parts
B. Priming
C. Starting the pump
D. Stopping the pump
E. Abnormal conditions

VIII. Identify Problems by Troubleshooting Centrifugal Pumps
A. Reduced capacity or pressure and failure to deliver material
B. Loses water after starting
C. Pump overloads driver
D. Pump vibrates
E. Pointers on pump operation

IX. Describe Maintenance and Repair of Centrifugal Pumps
A. Lateral end clearances
B. Parts renewals
C. Points on assembly

X. Demonstrate Corrosion Resisting Centrifugal Pumps
A. Typical application
B. Corrosion resisting pump installation
C. Maintenance
D. Troubleshooting

XI. Describe Impeller Design Considerations
A. Introduction
B. Velocity of impeller
C. Total hydraulic load and lift
D. Velocity head

Practical Application:

1. Set-up and operate a centrifugal pump.
2.Troubleshoot a centrifugal pump.
3. Stop the centrifugal pump.
4. Disassemble, replace needed parts, and reassemble the centrifugal pump.
5. Reinstall the centrifugal pump.
6. Operate and troubleshoot the centrifugal pump.
7. Repeat steps 1 through 6 on other types of centrifugal pumps.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-H4) dealing with troubleshooting positive displacement pumps.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Describe the principles of hydraulics;
b. Describe hydrodynamics and water flow;
c. Describe the operation of a centrifugal pump;
d. List the classifications of a centrifugal pump;
e. Identify and describe the parts of a centrifugal;
f. Demonstrate the installation of a centrifugal pump;
g. Set-up and operate a centrifugal pump safely;
h. Identify problems by troubleshooting centrifugal pumps;
i. Describe maintenance and repair of centrifugal pumps;
j. Demonstrate corrosion resisting centrifugal pumps; and,
k. Describe impeller design consideration.

Reading Assignments:

The following chapters are assigned to read from *Pumps*, Stewart/Miller and
Macmillian, Audel Publishing Company, Latest Edition:

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<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Principles of Hydraulics</td>
</tr>
<tr>
<td>3</td>
<td>Centrifugal Pumps</td>
</tr>
</tbody>
</table>

Module Outline:

I. Describe the Principles of Hydraulics
   A. Introduction
B. Basic principles
C. Static head
D. Static lift
E. Displacement
F. Buoyancy
G. Hydrostatic paradox
H. Hydrostatic balance

II. Describe Hydrodynamics and Water Flow
A. Dynamic head
B. Dynamic lift
C. Total column
D. Friction of water in pipes
E. Measurement of water flow
F. Siphon
G. Flow through orifices
H. Specific gravity
I. Summary

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B. Impeller
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D. Bearings and housing
E. Shaft assembly
F. Drive

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A. Location
B. Foundation
C. Leveling-aligning
D. Grouting
E. Inlet pipe
F. Discharge pipe
G. High temperature material pumping

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A. First check
1. Rotation
2. Lubrication
3. Bearing cooling water
4. Inspect all parts
B. Priming
C. Starting the pump
D. Stopping the pump
E. Abnormal conditions

VIII. Identify Problems by Troubleshooting Centrifugal Pumps
A. Reduced capacity or pressure and failure to deliver material
B. Loses water after starting
C. Pump overloads driver
D. Pump vibrates
E. Pointers on pump operation

IX. Describe Maintenance and Repair of Centrifugal Pumps
A. Lateral end clearances
B. Parts renewals
C. Points on assembly

X. Demonstrate Corrosion Resisting Centrifugal Pumps
A. Typical application
B. Corrosion resisting pump installation
C. Maintenance
D. Troubleshooting

XI. Describe Impeller Design Considerations
A. Introduction
B. Velocity of impeller
C. Total hydraulic load and lift
D. Velocity head
IMM-H3-LA
Troubleshoot Centrifugal Pumps
Attachment 2: MASTER Laboratory Aid

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical object;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Set-up and operate a centrifugal pump;
   c. Troubleshoot a centrifugal pump;
   d. Stop the centrifugal pump;
   e. Disassemble, replace needed parts, reassemble the centrifugal pump;
   f. Reinstall the centrifugal pump;
   g. Operate and troubleshoot the centrifugal pump; and,
   h. Repeat steps a. through g. on other types of centrifugal pumps.
IMM-H3-LW
Troubleshoot Centrifugal Pumps
Attachment 3: MASTER Laboratory Worksheet

1. Instructor will observe the safe and proper procedures for the following:
   a. Set-up and operate a centrifugal pump;
   b. Troubleshoot a centrifugal pump;
   c. Stop the centrifugal pump;
   d. Disassemble, replace needed parts, and reassemble the centrifugal pump;
   e. Reinstall the centrifugal pump; and,
   f. Operate and troubleshoot the centrifugal pump.

2. Student will:
   a. Set-up and operate a centrifugal pump;
   b. Troubleshoot a centrifugal pump;
   c. Stop the centrifugal pump;
   d. Disassemble, replace needed parts, and reassemble the centrifugal pump;
   e. Reinstall the centrifugal pump;
   f. Operate and troubleshoot the centrifugal pump; and,
   g. Repeat steps a. through f. on other types of centrifugal pumps.

3. Instructor will grade student's performance on the following:
   a. Set-up and operate a centrifugal pump;
   b. Troubleshoot a centrifugal pump;
   c. Stop the centrifugal pump;
   d. Disassemble, replace needed parts, and reassemble the centrifugal pump;
   e. Reinstall the centrifugal pump; and,
   f. Operate and troubleshoot the centrifugal pump.
IMM-H3
Troubleshoot Centrifugal Pumps
Self-Assessment

Circle the letter preceding the most correct answer.

1. The roughness of a wall of a long pipe, fittings and elbows is called ___________ head.
   a. Velocity
   b. Empty
   c. Friction
   d. Static

2. The flow of water inside a centrifugal pump is from ________________.
   a. Left to right
   b. Right to left
   c. Out to center
   d. Center out

3. To insure economical and satisfactory pumping operations the proper type of __________ selection is important.
   a. Impeller
   b. Casting
   c. Stuffing box
   d. Shaft assembly

4. If a long inlet pipe must be used the pipe should be ________________.
   a. Made of galvanized pipe
   b. Made of black iron
   c. Larger than the inlet
   d. Smaller than the inlet

5. Most centrifugal pumps should not be run dry, therefore it must be __________ before running.
   a. Sealed
   b. Primed
   c. Oiled
   d. Leveled
6. When starting a pump with oil lubricated bearings, it should be
   a. Drained of water
   b. Warmed with heaters
   c. Run dry for five minutes
   d. Rotated by turning the rotor, by hand, several times

7. If the pump fails to discharge, check to see if ________________
   a. There are leaks in the suction line
   b. The motor is misaligned
   c. The suction or discharge valves are closed
   d. There are leaks in the stuffing box

8. If the pump fails to discharge, check to see if ________________
   a. The direction of rotation is wrong
   b. Air or vapor is in the liquid
   c. The speed is too slow
   d. The shaft is bent

9. If the pump discharges and then stops; check to see if ________________
   a. Direction of rotation is wrong
   b. Supply level is too high
   c. The lift is too high
   d. There are leaks in the suction line

10. If the pump is noisy or vibrates check to see if ________________
    a. The lift is too high
    b. There is a misalignment
    c. The supply level is too low
    d. The pump is primed

11. When tightening the flange nuts allowance for lateral movement must be
    __________ inches for small pumps.
    a. 1/4
    b. 1/8
    c. 1/64
    d. .003

12. The corrosion resisting pumps are usually made of two materials which are
    noryl or ________________
    a. Brass
    b. Polypropylene
    c. Cast iron
    d. Mild steel
13. If a corrosion resisting pump motor will not hum or rotate check:
   a. The main power box for blown fuse, etc.
   b. For foreign materials inside the pump
   c. For leaking seal
   d. For low fluid supply

14. If a corrosion resisting pump loses prime check:
   a. For improper line voltage
   b. Thermal overload on the motor
   c. For clogged inlet port and/or impeller
   d. For leaking seal

15. If disassembly of a corrosion resisting pump is necessary the first step should be:
   a. Remove the ceramic piece from the impeller
   b. Removing the carbon graphite seals from the front of the body
   c. Detaching the body from the motor
   d. Shut off power to the motor
IMM-H3
Troubleshoot Centrifugal Pumps
Self-Assessment Answer Key

1. C
2. D
3. A
4. C
5. B
6. D
7. C
8. A
9. D
10. B
11. C
12. B
13. A
14. D
15. D
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-H4

Subject: Industrial Maintenance

Time: 20 Hrs.

Duty: Maintain/Troubleshoot Equipment and Systems

Task: Troubleshoot Positive Displacement Pumps

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the principles of operation of rotary pumps;
b. Describe the construction of rotary pumps;
c. Demonstrate the installation and operation of rotary pumps;
d. Identify problems in troubleshooting rotary pumps;
e. Describe rotary pump calculations;
f. Describe the principles of operation of a reciprocating pump;
g. Describe the construction of a reciprocating pump;
h. Perform reciprocating pump calculations; and,
i. Identify and describe special service pumps.

Instructional Materials:

MASTER Handout (IMM-H4-HO)
MASTER Laboratory Aid (IMM-H4-LA)
MASTER Laboratory Worksheet (IMM-H4-LW)
MASTER Self-Assessment
Vane pump
Piston pump
Lift pump
Self priming pump
Hand tools

References:

Mechanics’ and Millwrights’ Guide (Audel), Carl A. Nelson, Macmillan
Centrifugal Pumps Design and Applications, Lobanoff and Ross, Gulf
Publishing Company, Latest Edition
Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-H3 "Troubleshoot Centrifugal Pumps"

Introduction:

Due to importance of moving fluids in manufacturing, construction and even providing water for everyday usage, pumps are extremely important. This lesson pertains to the positive displacement pump, its safe operations, installation, setup, troubleshooting, and repair.

Presentation Outline:

I. Describe the Principles of Operation of Rotary Pumps
   A. Gear-type pumps
   B. Vane-type pumps
   C. Piston-type pumps
II. Describe the Construction of Rotary Pumps
    A. Gear-type pumps
    B. Vane-type pumps
    C. Piston-type pumps
III. Demonstrate the Installation and Operation of Rotary Pumps
    A. Introduction of installation
    B. Alignment
    C. Drives for rotary gear pumps
    D. Power for driving pumps
    E. Piping
    F. Direction of rotating
    G. Starting and operating the pump
    H. Practical installation
    I. Types of gear pumps
    J. Pressure relief valve
IV. Identify Problems in Troubleshooting Rotary Pumps
    A. No liquid delivered
    B. Insufficient liquid delivered
    C. Pump delivers for a short period, then quits
D. Rapid wear
E. Pump requires too much power
F. Noisy operation

V. Describe Rotary Pump Calculations
A. Correct pipe size
B. Friction of water in pipe
C. Friction loss in rubber hose
D. Dynamic column or total load
E. Dynamic lift
F. Dynamic head
G. Horsepower required

VI. Describe the Principles of Operation of a Reciprocating Pump
A. Lift pump
B. Force pump
C. Self-priming or siphon pump

VII. Describe the Construction of a Reciprocating Pump
A. Uses
B. Operations

VIII. Perform Reciprocating Pump Calculations
A. Lift
B. Size of pipe
C. Head
D. Displacement
E. Piston speed
F. Slip
G. Capacity
H. Efficiency

IX. Identify and Describe Special Service Pumps
A. Introduction to special service pumps
B. Chemical and process pumps
C. Pumps for handling of sewage
D. Magma pumps
E. Sump pumps
F. Irrigation pumps
G. Diaphragm type pumps
H. Shallow and deep well pumps
I. Turbine pumps
J. Rubber impeller pumps
K. Tubing pumps

Practical Application:

1. Set-up and operate a positive displacement pump.
2. Troubleshoot a positive displacement pump.
3. Stop the positive displacement pump.
4. Disassemble, replace needed parts, reassemble the positive displacement pump.
5. Reinstall the positive displacement pump.
6. Operate and troubleshoot the positive displacement pump.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-H5) dealing with maintaining gate, globe, ball, plug and butterfly valves.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Set-up and operate a positive displacement pump;
b. Troubleshoot a positive displacement pump;
c. Stop the positive displacement pump;
d. Disassemble, replace needed parts, reassemble the positive displacement pump;
e. Reinstall the positive displacement pump; and,
f. Operate and troubleshoot the positive displacement pump.

Reading Assignments:

The following chapters are assigned to read from *Pumps (Audel),* Stewart/Miller, Macmillian Publishing Company, Latest Edition

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Module Outline:

I. Describe the Principles of Operation of Rotary Pumps
   A. Gear-type pumps
   B. Vane-type pumps
   C. Piston-type pumps
II. Describe the Construction of Rotary Pumps
A. Gear-type pumps
B. Vane-type pumps
C. Piston-type pumps

III. Demonstrate the Installation and Operation of Rotary Pumps
A. Introduction of installation
B. Alignment
C. Drives for rotary gear pumps
D. Power for driving pumps
E. Piping
F. Direction of rotating
G. Starting and operating the pump
H. Practical installation
I. Types of gear pumps
J. Pressure relief valve

IV. Identify Problems in Troubleshooting Rotary Pumps
A. No liquid delivered
B. Insufficient liquid delivered
C. Pump delivers for a short period, then quits
D. Rapid wear
E. Pump requires too much power
F. Noisy operation

V. Describe Rotary Pump Calculations
A. Correct pipe size
B. Friction of water in pipe
C. Friction loss in rubber hose
D. Dynamic column or total load
E. Dynamic lift
F. Dynamic head
G. Horsepower required

VI. Describe the Principles of Operation of a Reciprocating Pump
A. Lift pump
B. Force pump
C. Self-priming or siphon pump

VII. Describe the Construction of a Reciprocating Pump
A. Uses
B. Operations

VIII. Perform Reciprocating Pump Calculations
A. Lift
B. Size of pipe
C. Head
D. Displacement
E. Piston speed
F. Slip
G. Capacity
H. Efficiency
IX. Identify and Describe Special Service Pumps

A. Introduction to special service pumps
B. Chemical and process pumps
C. Pumps for handling of sewage
D. Magma pumps
E. Sump pumps
F. Irrigation pumps
G. Diaphragm type pumps
H. Shallow and deep well pumps
I. Turbine pumps
J. Rubber impeller pumps
K. Tubing pumps
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop.
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. Instructor will demonstrate how to:
   a. Set-up and operate a positive displacement pump;
   b. Troubleshoot a positive displacement pump;
   c. Stop the positive displacement pump;
   d. Disassemble, replace needed parts, reassemble the positive displacement pump;
   e. Reinstall the positive displacement pump; and,
   f. Operate and troubleshoot the positive displacement pump.

2. Student will:
   a. Set-up and operate a positive displacement pump;
   b. Troubleshoot a positive displacement pump;
   c. Stop the positive displacement pump;
   d. Disassemble, replace needed parts, reassemble the positive displacement pump;
   e. Reinstall the positive displacement pump; and,
   f. Operate and troubleshoot the positive displacement pump.

3. Instructor will grade the student’s performance on:
   a. Set-up and operation of a positive displacement pump;
   b. Troubleshooting a positive displacement pump;
   c. Stopping the positive displacement pump;
   d. Disassembling, replacing needed parts, reassembling the positive displacement pump;
   e. Reinstalling the positive displacement pump; and,
   f. Operating and troubleshooting the positive displacement pump.
IMM-H4
Troubleshoot Positive Displacement Pumps
Self-Assessment

Circle the letter preceding the most correct answer.

1. The rotary pump differs from the centrifugal pump because the rotary pump
   a. Has a rotating action
   b. Uses a single valve impeller
   c. Uses a positive displacement
   d. Has a two stroke action

2. The three types of rotary pumps are ____________, ____________, and ____________ types.
   a. Gear, piston, tubing
   b. Gear, vane, piston
   c. Diaphragm, tubing, piston
   d. Diaphragm, gear, jet

3. There are ____________ types of spur gear rotary pumps.
   a. 8
   b. 6
   c. 4
   d. 2

4. The rotary pump that can withstand rugged operating conditions, simple in construction, economical and have fewer working parts is the ____________ type pump.
   a. Gear
   b. Piston
   c. Vane
   d. Force

5. After correctly aligning the rotary pump the ____________ may then prevent the transmission of end thrust and compensate for slight changes in alignment during normal operation.
   a. Pump bearings
   b. Pump gasket
   c. Pump base
   d. Flexible coupling
6. If no liquid is being delivered by the rotary pump the first step is to
   a. Increase the RPM
   b. Check for air leak in inlet line
   c. Check for oil in the stuffing box
   d. Flexible coupling

7. If there is insufficient liquid delivery check for
   a. Air leak in inlet line or stuffing box
   b. Speed too fast
   c. Lift too low
   d. Coupling bearing out of balance

8. A 4000 gallon tank must be filled in two hours; the size pump required would be
   a. 15
   b. 20
   c. 25
   d. 70

9. A reciprocating pump is classified as a
   a. Rotary, centrifugal
   b. Lift, force
   c. Vane, gear
   d. Spur, impeller

10. Reciprocating pumps are designed with
   a. 5, 7, 8, 10
   b. 5, 6, 7, 8
   c. 3, 5, 7, 9
   d. 2, 4, 6, 8

11. A double action, high pressure, horizontal duplex reciprocating piston pump
    is considered a
    a. Centrifugal
    b. Sewage
    c. Chemical
    d. Service
12. The pump that uses a flexible substance such as rubber is called a ______ type pump.
   a. Centrifugal
   b. Diaphragm
   c. Piston
   d. Vane

13. The water in a shallow well should be less than _______ feet.
   a. 22
   b. 47
   c. 88
   d. 125
IMM-H4
Troubleshoot Positive Displacement Pumps
Self-Assessment Answer Key

1. C
2. B
3. B
4. A
5. D
6. D
7. A
8. C
9. B
10. C
11. D
12. B
13. A
INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-H5

Subject: Industrial Maintenance

Time: 8 Hrs.

Duty: Maintain/Troubleshoot Equipment and Systems

Task: Maintain Gate, Globe, Ball, Plug, and Butterfly Valves

Objective(s):

Upon completion of this module the student will be able to:

a. Maintain gate valves;
b. Maintain globe valves;
c. Maintain ball valves;
d. Maintain plug valves; and,
e. Maintain butterfly valves.

Instructional Materials:

MASTER Handout (IMM-H5-H0)
MASTER Laboratory Aid (IMM-H5-LA)
MASTER Laboratory Worksheet (IMM-H5-LW)
MASTER Self-Assessment

Gate valve
Globe valve
Ball valve
Plug valve
Butterfly valve
Hand tools

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-H4 "Troubleshoot Positive Displacement Pumps"
Introduction:

Valves control fluid and air flow. They control both the amount and the direction of flow. This phenomenon is important in maintaining power consistency and application.

Presentation Outline:

I. Valve Function
II. Gate Valve
III. Globe Valve
IV. Ball Valve
V. Plug Valve
VI. Butterfly Valve
VII. Maintenance Procedures
VIII. Valve Replacement

Practical Application:

Students will operate valves and learn to perform common maintenance in order to prolong the life of the valves.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluations.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-H6) dealing with maintaining check valves and relief valves.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain gate valve;
b. Maintain globe valve;
c. Maintain ball valve;
d. Maintain plug valve; and,
e. Maintain butterfly valve.

Reading Assignments:

The following chapters are assigned to read from *Piping Systems*, Schoolcraft Publishers, Latest Edition:

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<thead>
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Module Outline:

I. Valve Function
II. Gate Valve
III. Globe Valve
IV. Ball Valve
V. Plug Valve
VI. Butterfly Valve
VII. Maintenance Procedures
VIII. Valve Replacement
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment;
Not participating in horse play or practical joking.
1. Instructor will demonstrate how to maintain:
   a. Gate valve
   b. Globe valve
   c. Ball valve
   d. Plug valve
   e. Butterfly valve

2. Student will demonstrate how to maintain:
   a. Gate valve
   b. Globe valve
   c. Ball valve
   d. Plug valve
   e. Butterfly valve

3. Instructor will grade student's ability to maintain:
   a. Gate valve
   b. Globe valve
   c. Ball valve
   d. Plug valve
   e. Butterfly valve
IMM-H5
Maintain Gate, Globe, Ball, Plug, and Butterfly Valves
Self-Assessment

1. Describe how gate valve works.

2. Describe how globe valve works.

3. Describe how ball valve works.

4. Describe how plug valve works.

5. Describe how butterfly valve works.
1. Valve has a disk or plate that endures a translational motion in a plane transverse to the flow passage or valve body.

2. Valve has a disk or plug which is forced into a seat. Angle of tapered mating surface depends on valve size. Valve has globular external shape.

3. Has a solid ball with a diametric hole through it which can be rotated within a spherical seat. Ball is rotated so side lines up with inlet port to allow flow.

4. Shut off valve containing a tapered rod with a lateral hole through it. By rotating rod, flow can be controlled.

5. Consists of a disk that is rotated to control flow.
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-H6

Subject: Industrial Maintenance

Time: 6 Hrs.

Duty: Maintain/Troubleshoot Equipment and Systems

Task: Maintain Check Valves and Relief Valves

Objective(s):

Upon completion of this module the student will be able to:

a. Maintain check valve; and,

b. Maintain relief valve.

Instructional Materials:

MASTER Handout (IMM-H6-HO)
MASTER Laboratory Aid (IMM-H6-LA)
MASTER Laboratory Worksheet (IMM-H6-LW)
MASTER Self-Assessment
Check valve
Relief valve
Hand tools

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-H5 "Maintain Gate, Globe, Ball, Plug, and Butterfly Valves"

Introduction:

Valves control fluid and/or air flow.
Presentation Outline:

I. Valve Function
II. Check Valve Function
III. Relief Valve Function
IV. Maintenance Procedures
V. Valve Replacement

Practical Application:

Student will practice common maintenance procedures on check valves and relief valves.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide to discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-H7) dealing with troubleshooting and repairing blowers.
IMM-H6-HO
Maintain Check Valves and Relief Valves
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participate in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain check valve; and,
b. Maintain relief valve.

Reading Assignments:

The following chapters are assigned to read from Piping Systems, Schoolcraft Publishers, Latest Edition

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Module Outline:

I. Valve Function
II. Check Valve Function
III. Relief Valve Function
IV. Maintenance Procedures
V. Valve Replacement
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. Instructor will demonstrate how to:
   - Properly use check valve;
   - Properly use relief valve;
   - Maintain check valve;
   - Maintain relief valve;
   - Replace check valve; and,
   - Replace relief valve.

2. Student will demonstrate how to:
   - Properly use check valve;
   - Properly use relief valve;
   - Maintain check valve;
   - Maintain relief valve;
   - Replace check valve; and,
   - Replace relief valve.

3. Instructor will grade student's ability to:
   - Properly use check valve;
   - Properly use relief valve;
   - Maintain check valve;
   - Maintain relief valve;
   - Replace check valve; and,
   - Replace relief valve.
IMM-H6
Maintain Check Valves and Relief Valves
Self-Assessment

1. Describe purpose of check valve.
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

2. Describe purpose of relief valve.
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

3. The valve body is usually made of ________________________________.

4. The valve cover is usually a _________________________________.

5. The relief valve may be the __________________ type, or the __________ type, or the __________ type.
1. Allows fluids to flow in only one direction.
2. If pressure increases above present value, valve will open.
3. Iron, aluminum or bronze.
4. Casting or a screw, machine part.
5. Direct acting, direct operated pilot, or remote operated pilot.
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-H7

Subject: Industrial Maintenance

Duty: Maintain/Troubleshoot Equipment and Systems
Task: Troubleshoot and Repair Blowers

Objective(s):

Upon completion of this module the student will be able to:

a. Troubleshoot blowers; and,

b. Repair blowers.

Instructional Materials:

MASTER Handout (IMM-H7-HO)
MASTER Laboratory Aid (IMM-H7-LA)
MASTER Laboratory Worksheet (IMM-H7-LW)
MASTER Self-Assessment

Blowers
Hand tools
Multimeter

References:

Mechanics’ and Millwrights’ Guide (Audel), Carl A. Nelson, Macmillan

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-H6 “Maintain Check Valves and Relief Valves”

Introduction:

Blowers move air at a rapid pace. This air movement aids in combustion content, cooling, induced draft or forced air applications.
Presentation Outline:

I. Blower Functions
II. Combustion Control
III. Cooling Control
IV. Induced Draft
V. Forced Draft
VI. Maintain Blowers
VII. Troubleshoot Blowers

Practical Application:

Students will use blowers for different applications. Students will maintain and troubleshoot blowers.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-H8) dealing with troubleshooting, maintaining, and repairing hydraulic systems.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Troubleshoot blowers; and,
b. Repair blowers.

Reading Assignments:

The following chapters are assigned to read from Industrial Motor Control, Alerich, Delmar Publishers, Latest Edition:

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Module Outline:

I. Blower Functions
II. Combustion Control
III. Cooling Control
IV. Induced Draft
V. Forced Draft
VI. Maintain Blowers
VII. Troubleshoot Blowers
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.
Worksheet:

1. Instructor will demonstrate how to:
   Troubleshoot blowers; and,
   Repair blowers.

2. Student will demonstrate how to:
   Troubleshoot blowers; and,
   Repair blowers.

3. Instructor will grade student's ability to:
   Troubleshoot blowers; and,
   Repair blowers.
IMM-H7
Troubleshoot and Repair Blowers
Self-Assessment

1. List troubleshooting steps.

   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________

2. List replacement steps.

   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________

3. Define CFM.

   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________

4. How does blade angle affect CFM?

   __________________________________________
   __________________________________________
   __________________________________________
   __________________________________________

   602
5. How are blowers used in industry?
IMM-H7
Troubleshoot and Repair Blowers
Self-Assessment Answer Key

1. Isolation
   Sectionalize

2. Device must be dismantled so part can be removed. Reverse procedures to install new part.

3. Cubic fast per minute

4. Blade angle can increase or decrease CPM. If there is more contact with air this will increase the CFM.

5. Blowers are used to cool fluid or materials.
Subject: Industrial Maintenance  
Time: 40 Hrs.

Duty: Maintain/Troubleshoot Equipment and Systems  
Task: Troubleshoot, Maintain, and Repair Hydraulic Systems

Objective(s):

Upon completion of this module the student will be able to:

a. Troubleshoot hydraulic system;

b. Maintain hydraulic system; and,

c. Repair hydraulic system.

Instructional Materials:

MASTER Handout (IMM-H8-HO)  
MASTER Laboratory Worksheet (IMM-H8-LW)  
MASTER Laboratory Aid (IMM-H8-LA)  
MASTER Self-Assessment  
Hydraulic trainer

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-H7  "Troubleshoot and Repair Blowers"

Introduction:

With hydraulic power, one is able to move large objects. Hydraulic power is large but moves slow. Hydraulic power moves large loads in industry.

Presentation Outline:

I. Hydraulic Theory
II. Storage Devices
III. Pumps-Prime Movers
IV. Actuators
V. Control Devices
VI. Accumulators

Practical Application:

1. Instructors will demonstrate how to troubleshoot, maintain and repair hydraulic systems.
2. Student will demonstrate how to troubleshoot, maintain and repair hydraulic systems.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-H9) dealing with troubleshooting, maintaining, and repairing pneumatic systems.
IMM-H8-HO
Troubleshoot, Maintain, and Repair Hydraulic Systems
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Troubleshoot hydraulic system;
b. Maintain hydraulic system; and
c. Repair hydraulic system.

Reading Assignments:

The following chapters are assigned to read from *Fluid Power 1*, by Parker Publishers, Latest Edition:

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<td>Directional Control Valves</td>
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<td>12</td>
<td>Pilot Operated Pressure Control Valves</td>
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</table>

Module Outline:

I. Hydraulic Theory
II. Storage Devices
III. Pumps-Prime Movers
IV. Actuators
V. Control Devices
VI. Accumulators
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. Student will practice:
   a. Troubleshooting hydraulic system;
   b. Maintaining hydraulic system; and,
   c. Repairing hydraulic system.

2. Instructor will grade student's performance.
IMM-H8
Troubleshoot, Maintain, and Repair Hydraulic Systems
Self-Assessment

1. In the above diagram, what is the force generated (disregard friction)?
   A. 14560 lbs
   B. 13560 lbs
   C. 12560 lbs
   D. 11560 lbs

2. At what speed is the cylinder moving?
   A. 184 inches per minute
   B. 17 feet per minute
   C. Either A or B
   D. Neither A or B

3. This diagram shows a:
   A. Unworkable circuit.
   B. Meter-in circuit.
   C. Meter-in, meter-out circuit.
   D. Meter-out circuit.
A system malfunction has been traced to a bad pump. In addition to replacing the pump, one should also:
A. Replace the relief valve.
B. Adjust the main control valve.
C. Adjust the cylinder packing.
D. Find out what caused the pump to fail.

5. Cavitation occurs in a pump when:
A. The fluid does not completely fill the space provided for it in the pump.
B. The pressure from the output causes the pump to cease pumping action.
C. The flow from the pump cannot be increased by increasing the RPM.
D. The inlet is too large, allowing too much oil to the pump.
IMM-H8
Troubleshoot, Maintain, and Repair Hydraulic Systems
Self-Assessment Answer Key

1. C
2. D
3. A
4. D
5. A
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-H9

Subject: Industrial Maintenance  Time: 40 Hrs.

Duty: Maintain/Troubleshoot Equipment and Systems
Task: Troubleshoot, Maintain, and Repair Pneumatic Systems

Objective(s):

Upon completion of this module the student will be able to:

a. Maintain pneumatic system;
b. Troubleshoot pneumatic system; and,
c. Repair pneumatic system.

Instructional Materials:

MASTER Handout (IMM-H9-HO)
MASTER Laboratory Worksheet (IMM-H-9-LW)
MASTER Laboratory Aid (IMM-H-9-LA)
MASTER Self-Assessment
Directional control valves
Relief valve
Tubing
Compressor

References:


Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-H8  "Troubleshoot, Maintain, and Repair Hydraulic Systems"

Introduction:

Pneumatic systems are used to control HVAC systems, cleaning, cutting, turning, mixing, moving and many other industrial and business application.
Presentation Outline:

I. Pneumatic Theory  
II. Compressor  
III. Regulators  
IV. Valves  
V. Actuators  
VI. Safety  
VII. Prevention Maintenance  
VIII. Troubleshooting Pneumatic Devices  
IX. Repair Pneumatic Devices  

Practical Application:  

Student will practice with a working pneumatic system.  

Evaluation and/or Verification:  

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.  

Summary:  

Review the main lesson points using the objectives as a guide for discussion and answer student questions.  

Next Lesson Assignment:  

MASTER Technical Module (IMM-I1) dealing with maintaining and troubleshooting belt drive systems.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain pneumatic system;
b. Troubleshoot pneumatic system; and,
c. Repair pneumatic system.

Reading Assignments:

The following chapters are assigned to read from *Fluid Power 1*, by Parker Publisher, Latest Edition:

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Module Outline:

I. Pneumatic Theory
II. Compressor
III. Regulators
IV. Valves
V. Actuators
VI. Safety
VII. Prevention Maintenance
VIII. Troubleshooting Pneumatic Devices
IX. Repair Pneumatic Devices
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. Draw a circuit utilizing a single acting cylinder, gravity return, as the load. Use a directional control valve. Make the cylinder extend. Have the instructor approve the diagram. Construct the circuit. Have the instructor approve the circuit. Run the circuit.

2. Same as Problem #1, except use double acting cylinder.

3. Practice PM on an existing pneumatic system. Instructor will go over typical PM procedures.

4. Same as Problem #1, except use meter-out circuit.

5. Same as Problem #1, except use a quick exhaust circuit.
IMM-H9
Troubleshoot, Maintain, and Repair Pneumatic Systems
Self-Assessment

Circle the letter preceding the correct answer.

1. If a force exerted by a piston of 9 in.\(^2\) area is 2430 pounds, the pressure on the piston is ______ pounds per square inch.
   a. 2430
   b. 1215
   c. 270
   d. 30

2. Which of the following elements is basic to a complete pneumatic system?
   a. Filters
   b. Tank Storage and Conditioning Equipment
   c. Pressure Gauges
   d. Thermal Sensors

3. The first step in troubleshooting a problem in a pneumatic system is to ______:
   a. Check the fluid level in the reservoir.
   b. List the symptoms.
   c. Study the system's recent history.
   d. Shut down the malfunctioning equipment.

4. The first item to check when you are troubleshooting a pneumatic system is the ________.
   b. Time of the last overhaul.
   c. Operator's opinion.
   d. Supply air pressure.

5. Which of the following should be checked if a control valve is inoperative? (pneumatics)
   a. Exhaust Muffler
   b. Pilot Pressure
   c. Valve Actuator
   d. All of the above.
6. If a water-cooled compressor has a closed system, it means ______________.
   a. The water is recirculated.
   b. The compressor is sealed as a unit.
   c. The compressor requires no external cooling.
   d. The compressor must be operated indoors.

7. How is the cylinder of a single-acting, air-oil system returned to its starting position?
   a. Gravity
   b. External Load
   c. Return Air-Oil Pressure
   d. Gravity or External Load
1. c
2. b
3. d
4. c
5. c
6. a
7. d
EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY

Industrial Maintenance Series
INSTRUCTOR'S HANDBOOK
DUTIES I THROUGH S
INDUSTRIAL MAINTENANCE MECHANIC... uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<td>J-3 Fasten sheet metal parts together</td>
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INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-I1

Subject: Industrial Maintenance
Time: 7 Hrs.

Duty: Repair Power Transmission Systems
Task: Maintain and Troubleshoot Belt Drive Systems

Objective(s):

Upon completion of this module the student will be able to:

a. Maintain belt drive systems; and,
b. Troubleshoot belt drive systems.

Instructional Materials:

MASTER Handout (IMM-I1-HO)
MASTER Laboratory Worksheet (IMM-I1-LW)
MASTER Laboratory Aid (IMM-I1-LA)
MASTER Self-Assessment
Belt drives (assortment)

References:


Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-H9 "Troubleshoot, Maintain, and Repair Pneumatic Systems"

Introduction:

Belt drives provide a means of transferring mechanics energy from a motor to a driven component.
Presentation Outline:

I.  Belt Drives
II. Pulleys
III. Sheaves
IV. Types of Belts
V.  Belt Tension
VI. Belt Friction
VII. Variable Belts
VIII. Belt Maintenance
IX.  Belt Replacement

Practical Application:

1.  Student will learn how to maintain a belt drive system.
2.  Student will learn how to troubleshoot a belt drive system.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-I2) dealing with maintaining and troubleshooting gear power transmission drives.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Maintain belt drive systems; and,
b. Troubleshoot belt drive systems.

Reading Assignments:

The following chapters are assigned to read from Industrial Motor Control, Alerich, Delmar Publishers, Latest Edition

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Module Outline:

I. Belt Drives
II. Pulleys
III. Sheaves
IV. Types of Belts
V. Belt Tension
VI. Belt Friction
VII. Variable Belts
VIII. Belt Maintenance
IX. Belt Replacement
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.
Worksheet:

1. Instructor will demonstrate how to:
   Maintain belt drive systems; and,
   Troubleshoot belt drive systems.

2. Student will demonstrate how to:
   Maintain belt drive systems; and,
   Troubleshoot belt drive systems.

3. Instructor will grade student's ability to:
   Maintain belt drive systems; and,
   Troubleshoot belt drive systems.
IMM-I1
Maintain and Troubleshoot Belt Drive Systems
Self-Assessment

1. The correct tension for a belt is _____________________________________.
   a. as tight as possible.
   b. found in the equipment manual.
   c. dependent on the number of belts on the drive.
   d. impossible to maintain without an idler pulley.

2. The preferred method for adjusting belt tension is to
   _____________________________________.
   a. move the pulleys closer or farther apart.
   b. use an idler pulley.
   c. Both a. and b.
   d. None of the above.

3. The section of a V-belt that contains the cords is the _________________.
   a. tension section.
   b. strength section.
   c. compression section.
   d. All of the above.

4. The section of a V-belt that is in the shape of a wedge is the
   _____________________________________.
   a. tension section.
   b. strength section.
   c. compression section.
   d. All of the above.

5. The section of a V-belt that stretches as the belt wraps around a pulley is
   _____________________________________.
   a. tension section.
   b. strength section.
   c. compression section.
   d. All of the above.

6. When one belt breaks in a three-belt set, how many belts are needed to repair the drive?
   a. one
   b. two
   c. three
   d. four
Use the following information to answer questions 7 through 10.

The drive pulley is eight inches in diameter. It turns at 1800 rpm (revolutions per minute). The driven pulley is 36 inches in diameter. The pulleys are 25 inches apart (center to center).

7. What is the speed of the driven pulley?
   a. 400 rpm
   b. 900 rpm
   c. 1,800 rpm
   d. 8,100 rpm

8. What is the length of the belt on this drive?
   a. 94 inches
   b. 119 inches
   c. 188 inches
   d. None of the above.

9. What is the pulley ratio?
   a. 4 to 9
   b. 8 to 18
   c. 1 to 18
   d. 1 to 288

10. What is the driven shaft speed if the drive shaft is slowed to 900 rpm?
    a. 200 rpm
    b. 450 rpm
    c. 1,800 rpm
    d. 900 rpm

11. What is the purpose of a multi-belt arrangement?
    a. to increase the speed of the drive
    b. to increase the ratio the drive can handle
    c. to increase the amount of power the drive can transmit
    d. All of the above.

12. When a flat belt on a conveyor is riding to one side, you should
    a. increase the speed of the belt.
    b. level the conveyor.
    c. adjust the end rollers.
    d. None of the above.
13. ____________ is a way to connect the ends of a flat belt.
   a. Gluing
   b. Weaving
   c. Vulcanizing
   d. All of the above.

14. Most belts are made from a combination of
   a. rubber, glass, and cloth.
   b. rubber, rubber-like fabric, and cords.
   c. glass, cloth, and cords.
   d. None of the above.

15. One pulley in a automatically adjusting variable-speed pulley arrangement must be a
   a. manually adjusting variable-speed pulley.
   b. normal one-speed pulley.
   c. pneumatically adjusting variable-speed pulley.
   d. spring-loaded adjusting pulley.
IMM-I1
Maintain and Troubleshoot Belt Drive Systems
Self-Assessment Answer Key

1. b
2. a
3. b
4. c
5. a
6. c
7. a
8. b
9. a
10. a
11. c
12. c
13. d
14. b
15. d
INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-I2

Subject: Industrial Maintenance
Time: 8 Hrs.

Duty: Repair Power Transmission Systems
Task: Maintain and Troubleshoot Gear Power Transmission Drives

Objective(s):

Upon completion of this module the student will be able to:
a. Maintain gear power transmission drives; and,
b. Troubleshoot gear power transmission drives.

Instructional Materials:

MASTER Handout (IMM-I2-HO)
MASTER Laboratory Worksheet (IMM-I2-LW)
MASTER Laboratory Aid (IMM-I2-LA)
MASTER Self-Assessment
Gear drive assortment

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-I1 “Maintain and Troubleshoot Belt Drive Systems”

Introduction:

Gear drives offer the highest transfer of energy. Gears are used on many types of industrial machines.
Presentation Outline:

I. Define Gear
II. Bevel
III. Ring and Pinion
IV. Spur
V. Gear Maintenance
VI. Gear Troubleshooting

Practical Application:

1. Student will be able to compare spur gear to bevel gear.
2. Student will be able to perform maintenance in a spur gear.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-I3) dealing with maintaining and troubleshooting chain power transmission drives.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain gear power transmission drives; and,
b. Troubleshoot gear power transmission drives.

Reading Assignments:

The following chapters are assigned to read from Mechanics’ and Millwrights’ Guide, Nelson, Audel Publishers, Latest Edition:

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Module Outline:

I. Define Gear
II. Bevel
III. Ring and Pinion
IV. Spur
V. Gear Maintenance
VI. Gear Troubleshooting
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. Instructor will demonstrate how to:
   Maintain gear power transmission drives; and,
   Troubleshoot gear power transmission drives.

2. Student will demonstrate how to:
   Maintain gear power transmission drives; and,
   Troubleshoot gear power transmission drives.

3. Instructor will grade student's ability to:
   Maintain gear power transmission drives; and,
   Troubleshoot gear power transmission drives.
1. What is a spur gear?
__________________________________________________
__________________________________________________
__________________________________________________

2. What is a bevel gear?
__________________________________________________
__________________________________________________
__________________________________________________

3. What is a herringbone gear?
__________________________________________________
__________________________________________________
__________________________________________________

4. What is a ring and pinion gear?
__________________________________________________
__________________________________________________
__________________________________________________
5. List three (3) common maintenance techniques for gear.

____________________________________________________

____________________________________________________

____________________________________________________

6. Compare spur gear to bevel gear.

____________________________________________________

____________________________________________________

____________________________________________________
IMM-I2
Maintain and Troubleshoot Gear Power Transmission Drives
Self-Assessment Answer Key

1. A spear gear has straight teeth, cut parallel with the axis of rotation.

2. a. Bevel gear is cut at 45 degrees.
   b. Over gears are conical gears.
   c. (One supplies) Usually used to connect shafts that have connecting axis.

3. Double helical=herringbone

4. This gear has teeth on a horizontal plan.

5. 1. Proper lubrication
    2. Cleanliness
    3. Replace when show signs of wear

6. Helical gears have teeth cut along a helical surface.
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-I3

Subject: Industrial Maintenance

Duty: Repair Power Transmission Systems

Task: Maintain and Troubleshoot Chain Power Transmission Drives

Objective(s):

Upon completion of this module the student will be able to:

a. Maintain chain power transmission drives; and,

b. Troubleshoot chain driven power transmission drives.

Instructional Materials:

MASTER Handout (IMM-I3-HO)
MASTER Laboratory Worksheet (IMM-I3-LW)
MASTER Laboratory Aid (IMM-I3-LA)
MASTER Self-Assessment
Chain assortment

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-I2 “Maintain and Troubleshoot Gear Power Transmission Drives”

Introduction:

Chain drives are more powerful than belt drives, but not as powerful as gear drives.
Presentation Outline:

I. Chains
II. Single Link
III. Double Link
IV. Roller Chain
V. Silent Chain
VI. Chain Maintenance
VII. Troubleshoot Chains

Practical Application:

1. Student will be able to identify single link chains.
2. Student will be able to identify double link chains.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-I4) dealing with maintaining and troubleshooting clutches.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain chain power transmission drives; and,
b. Troubleshoot chain driven power transmission drives.

Reading Assignments:

The following chapters are assigned to read from Mechanics’ and Millwrights’

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Module Outline:

I. Chains
II. Single Link
III. Double Link
IV. Roller Chain
V. Silent Chain
VI. Chain Maintenance
VII. Troubleshoot Chains
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. Instructor will demonstrate how to:
   Maintain chain power transmission drives; and,
   Troubleshoot chain driven power transmission drives.

2. Student will demonstrate how to:
   Maintain chain power transmission drives; and,
   Troubleshoot chain driven power transmission drives.

3. Instructor will grade student’s ability to:
   Maintain chain power transmission drives; and,
   Troubleshoot chain driven power transmission drives.
1. When a sprocket becomes worn and its teeth are hooked or leaning,
   a. the drive is misaligned.
   b. the sprocket is not the same size as the chain.
   c. the chain is worn.
   d. All of the above.

2. The advantage chain drives have over belt drives is
   a. they are not damaged by oil and grease.
   b. they can withstand higher temperatures.
   c. they do not slip on their sprockets.
   d. All of the above.

3. A roller link is made up of
   a. one side bar, two rollers, and two bushings.
   b. two side bars, two rollers, and two pins.
   c. two side bars, two rollers, and two bushings.
   d. two side bars, two rollers, and one bushing.

4. A chain with a pitch of one inch is a number
   a. 40 chain.
   b. 80 chain.
   c. 100 chain.
   d. 200 chain.

5. The chain best suited for applications where noise reduction is most important is
   a. silent chain.
   b. conveyor chain.
   c. saw chain.
   d. O-ring chain.

6. The chain that has tabs on its side bars is a
   a. silent chain.
   b. conveyor chain.
   c. saw chain.
   d. O-ring chain.
7. The chain that has lubricant sealed in at the factory is a/an
   a. silent chain.
   b. conveyor chain.
   c. saw chain.
   d. O-ring chain.

8. Chain tension should be
   a. as tight as possible.
   b. just enough slack to allow the slack side to touch the tight side.
   c. just enough to allow flexing by hand.
   d. loose enough to allow the operator to remove the chain without adjusting tension.

9. On roller chain, the areas needing lubrication are between the
   a. rollers and bushings.
   b. pins and bushings.
   c. side bars.
   d. All of the above.

10. Roller chain should be replaced
    a. when it is rusty.
    b. every time the drive is worked on.
    c. every six months.
    d. All of the above.
IMM-13
Maintain and Troubleshoot Chain Power Transmission Drives
Self-Assessment

1. c
2. d
3. c
4. b
5. a
6. b
7. d
8. c
9. d
10. a
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-I4

Subject: Industrial Maintenance  Time: 8 Hrs.
Duty: Repair Power Transmission Systems
Task: Maintain and Troubleshoot Clutches

Objective(s):

Upon completion of this module the student will be able to:

a. Maintain clutches; and,
b. Troubleshoot clutches.

Instructional Materials:

MASTER Handout (IMM-I4-HO)
MASTER Laboratory Worksheet (IMM-I4-LW)
MASTER Laboratory Aid (IMM-I4-LA)
MASTER Self-Assessment
Clutch assortment

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-I3  “Maintain and Troubleshoot Chain Power Transmission Drives”

Introduction:

Clutches allow variable control of speed from zero to full speed.
Presentation Outline:

I. Clutch
II. Mechanical Clutch
III. Electrical Clutch
IV. Hydraulic Clutch
V. Pneumatic Clutch
VI. Clutch-Brake Assembly

Practical Application:

1. Student will be able to maintain hydraulic clutches.
2. Student will be able to maintain pneumatic clutches.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-J1) dealing with layout of sheet metal parts.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Maintain clutches; and,
b. Troubleshoot clutches.

Reading Assignments:

The following chapters are assigned to read from Mechanics’ and Millwrights’

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<td>3</td>
<td>Mechanical Power Transmission</td>
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</table>

Module Outline:

I. Clutch
II. Mechanical Clutch
III. Electrical Clutch
IV. Hydraulic Clutch
V. Pneumatic Clutch
VI. Clutch-Brake Assembly
IMM-I4-LA
Maintain and Troubleshoot Clutches
Attachment 2: MASTER Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. Instructor will demonstrate how to:
   A. Maintain:
      (1) Clutch
      (2) Mechanical clutch
      (3) Electrical clutch
      (4) Hydraulic clutch
      (5) Pneumatic clutch
      (6) Clutch-brake assembly
   B. Troubleshoot:
      (1) Clutch
      (2) Mechanical clutch
      (3) Electrical clutch
      (4) Hydraulic clutch
      (5) Pneumatic clutch
      (6) Clutch-brake assembly

2. Student will demonstrate how to:
   A. Maintain:
      (1) Clutch
      (2) Mechanical clutch
      (3) Electrical clutch
      (4) Hydraulic clutch
      (5) Pneumatic clutch
      (6) Clutch-brake assembly
   B. Troubleshoot:
      (1) Clutch
      (2) Mechanical clutch
      (3) Electrical clutch
      (4) Hydraulic clutch
      (5) Pneumatic clutch
      (6) Clutch-brake assembly

3. Instructor will grade student’s ability to:
   A. Maintain:
      (1) Clutch
      (2) Mechanical clutch
      (3) Electrical clutch
      (4) Hydraulic clutch
B. Troubleshoot:

(1) Clutch
(2) Mechanical clutch
(3) Electrical clutch
(4) Hydraulic clutch
(5) Pneumatic clutch
(6) Clutch-brake assembly
IMM-I4
Maintain and Troubleshoot Clutches
Self-Assessment

1. _______ is used to engage and disengage a jaw clutch.
   a. A friction plate
   b. A shift arm
   c. A release fork
   d. A ball bearing

2. A spring-action clutch is disengaged by a/an
   a. engage/disengage collar.
   b. drive keyway.
   c. shift lever.
   d. special release bearing.

3. The basic function of a clutch is to ____________________________.

4. The basic parts of a clutch are the __________ member and the __________ member.

5. The four general categories of clutches are __________, __________, __________, and __________.

6. Three types of friction clutches are __________, __________, and __________.

7. The majority of mechanical clutches are __________ clutches.

8. Jaw clutches are also called __________ __________ clutches.

9. Mechanical clutches are often actuated __________.

10. A __________ controls the tension between the drive and driven members in a jaw clutch with a slip feature.
IMM-I4
Maintain and Troubleshoot Clutches
Self-Assessment Answer Key

1. b
2. d
3. transmit torque
4. drive, driven
5. mechanical, electrical, hydraulic, pneumatic
6. Any three of the following:
   spring-action; wedge-action; centrifugal force; overrunning
7. friction
8. positive contact
9. manually
10. spring
INDUSTRIAL MAINTENANCE MECHANIC uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
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<tr>
<td>Practice Safety</td>
<td>A-1 Use protective equipment</td>
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<tr>
<td>Apply Mathematical Concepts</td>
<td>B-1 Perform basic arithmetic functions</td>
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<tr>
<td>Interpret Engineering Drawings and Control Documents</td>
<td>C-1 Identify basic types of drawings</td>
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<tr>
<td>Use Measuring Tools</td>
<td>D-1 Use non-precision measuring tools</td>
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<tr>
<td>Use Hand Tools</td>
<td>E-1 Identify and use maintenance technician's hand tools</td>
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<tr>
<td>Operate Machine Tools</td>
<td>F-1 Use and care of milling machines</td>
</tr>
<tr>
<td>Perform Welding Operations</td>
<td>G-1 Weld with shielded metal arc welding (SMAW) process</td>
</tr>
<tr>
<td>Maintain/ Troubleshoot Equipment and Systems</td>
<td>H-1 Maintain air conditioning systems</td>
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<tr>
<td>Repair Power Transmission Systems</td>
<td>I-1 Maintain and troubleshoot belt drive systems</td>
</tr>
<tr>
<td>Fabricate/ Install Sheet Metal Parts</td>
<td>J-1 Layout sheet metal parts</td>
</tr>
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INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
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<td><strong>Piping Operations</strong></td>
<td><strong>K-1</strong> Perform basic pipefitting calculations</td>
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<td><strong>K-2</strong> Cut, thread, and ream pipe</td>
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<td><strong>K-3</strong> Pipe assembly</td>
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<td><strong>Basic Rigging</strong></td>
<td><strong>K-4</strong> Install and adjust pipe support</td>
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<td><strong>Basic Rigging</strong></td>
<td><strong>K-5</strong> Tubing</td>
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<tr>
<td><strong>Basic Rigging</strong></td>
<td><strong>L-1</strong> Rigging fundamentals</td>
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<td><strong>L-2</strong> Demonstrate basic rigging skills</td>
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<td><strong>Bearing Maintenance</strong></td>
<td><strong>M-1</strong> Plain bearings</td>
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<td><strong>Bearing Maintenance</strong></td>
<td><strong>M-2</strong> Rolling element bearings</td>
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<td><strong>Align Shafts</strong></td>
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<td><strong>Install/Align Machines</strong></td>
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<td><strong>P-4</strong> Special mountings</td>
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<td><strong>Maintain Electrical Devices</strong></td>
<td><strong>Q-1</strong> Use electrical test equipment</td>
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<td><strong>Maintain Electrical Devices</strong></td>
<td><strong>Q-2</strong> Apply basic terms to electrical circuits</td>
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<td><strong>Maintain Electrical Devices</strong></td>
<td><strong>Q-3</strong> Analyze series, parallel, and complex AC/DC circuits</td>
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<td><strong>Maintain Electrical Devices</strong></td>
<td><strong>Q-4</strong> Check AC and DC motors</td>
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<td><strong>Q-5</strong> Troubleshoot electrical devices</td>
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<td><strong>Basic Mechanical Concepts</strong></td>
<td><strong>R-1</strong> Force</td>
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<td><strong>R-2</strong> Work</td>
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<td><strong>Basic Mechanical Concepts</strong></td>
<td><strong>R-4</strong> Simple machines</td>
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<td><strong>R-6</strong> Power</td>
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<td><strong>S-1</strong> Fasteners and nomenclature</td>
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<tr>
<td><strong>Fasteners and Preloading</strong></td>
<td><strong>S-2</strong> Application for various fasteners</td>
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<td><strong>Fasteners and Preloading</strong></td>
<td><strong>S-3</strong> Techniques for removing damaged fasteners</td>
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<td><strong>Fasteners and Preloading</strong></td>
<td><strong>S-4</strong> Cleaning and restoring threaded fasteners</td>
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<td><strong>Fasteners and Preloading</strong></td>
<td><strong>S-5</strong> Torque preload theory</td>
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<tr>
<td><strong>Fasteners and Preloading</strong></td>
<td><strong>S-6</strong> Effects of lubricating threads prior to torquing</td>
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<tr>
<td><strong>Fasteners and Preloading</strong></td>
<td><strong>S-7</strong> Demonstrate appropriate torquing technique</td>
</tr>
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</table>
Subject: Industrial Maintenance  
Duty: Fabricate/Install Sheet Metal Parts  
Task: Layout Sheet Metal Parts  

Objective(s):  
Upon completion of this module the student will be able to:  
a. Identify sheet metal sizes and products;  
b. Describe sheet metal patterns and patternmaking; and,  
c. Describe sheet metal and wire size.

Instructional Materials:  
MASTER Handout (IMM-J1-HO)  
MASTER Laboratory Worksheet (IMM-J1-LW)  
MASTER Laboratory Aid (IMM-J1-LA)  
MASTER Self-Assessment  
Tools and materials necessary to complete the projects

References:  

Student Preparation:  
Students should have previously completed the following Technical Modules:  
IMM-A1 through IMM-A6  “Practice Safety” series  
IMM-B1 through IMM-B6  “Apply Mathematical Concepts” series  
IMM-C1 through IMM-C3  “Interpret Engineering Drawings and Control Documents” series  
IMM-D1 through IMM-D2  “Use Measuring Tools” series  
IMM-E1 through IMM-E2  “Use Hand Tools” series
Introduction:

Sheet metal work is a very important part of our every day lives. We find use in our homes in a variety of appliance, heating and air conditioners. We travel to work in cars, busses and air planes with parts made of sheet metal. At work we find some buildings, desks, chairs and file cabinets, to name a few, that are made of sheet metal. In other words our lives would not be nearly as comfortable without sheet metal. This lesson discusses the basic layout of sheet metal parts.

Presentation Outline:

I. Identify Sheet Metal Sizes and Products
   A. Sizes
   B. Products

II. Describe Sheet Metal Patterns and Patternmaking
   A. Introduction
   B. Types of pattern development
   C. Hem and seam allowances on patterns
   D. Bending sequence
   E. Bend allowance

III. Describe Sheet Metal and Wire Sizes
   A. Sheet metal and wire gages
   B. Manufacturers' standard gages and sheet steel
   C. Brown and Sharp or American Standard gage

Practical Application:

1. Practice making parallel line pattern of a rectangular pan
   a. Use necessary drawing tools
   b. Use necessary tools and materials for safe assembly

2. Practice making parallel line development for a cylinder
   a. Use necessary drawing tools
   b. Use necessary tools and materials for safe assembly

3. Practice making parallel line development of a truncated cylinder
   a. Use necessary drawing tools
   b. Use necessary tools and materials for a safe assembly
Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-J2) dealing with forming and/or bending sheet metal parts.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
  a. Identify sheet metal sizes and products;
  b. Describe sheet metal patterns and patternmaking; and,
  c. Describe sheet metal and wire size.

Reading Assignments:

The following chapters are assigned to read from Metal Technology and Practice, Pepp/McCarthy, Glencoe/McMillan/McGraw-Hill Publishers, Latest Edition

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<td>Sheet Metal Processing</td>
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</table>

Module Outline:

I. Identify Sheet Metal Sizes and Products
   A. Sizes
   B. Products

II. Describe Sheet Metal Patterns and Patternmaking
   A. Introduction
   B. Types of pattern development
   C. Hem and seam allowances on patterns
   D. Bending sequence
   E. Bend allowance

III. Describe Sheet Metal and Wire Sizes
A. Sheet metal and wire gages
B. Manufacturers' standard gages and sheet steel
C. Brown and Sharp or American Standard gage
1. Instructor will:
   a. Demonstrate the proper layout procedures for sheet metal layout;
   b. Insure proper tools are available for layout;
   c. Insure proper tools are construction of project are available;
   d. Insure proper techniques are used for layout; and,
   e. Insure proper techniques are used in safely constructing the projects.

2. Student will:
   a. Layout and construct sheet metal patterns on paper;
   b. Practice making parallel line pattern of a rectangular pan;
      (1) Use necessary drawing tools;
      (2) Use necessary tools and materials for safe assembly;
   c. Practice making parallel line development for a cylinder;
      (1) Use necessary drawing tools;
      (2) Use necessary tools and materials for safe assembly;
   d. Practice making parallel line development of a truncated cylinder;
      (1) Use necessary drawing tools; and,
      (2) Use necessary tools and materials for a safe assembly.
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<th>UNITED STATES STANDARD</th>
<th>MANUFACTURERS' STANDARD FOR SHEET METAL</th>
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DRAW AND CONSTRUCT
ALLOW 3/8" FOR OPEN TOP SINGLE HEM
ALLOW 3/8" FOR OUTSIDE CORNER LAP SEAM
45 DEGREES ON ALL HEMS AND SEAMS
DRAW AND CONSTRUCT

NO TOP OR BOTTOM
ALLOW 3/8" FOR LAP SEAM

DATE
9-26-97

DRAWN
BY:
REW

APPROVED
BY:
REW

MASTER

SCALE
1-1

REV.

TITLE
TRUNCATED CYLINDER

MATERIAL:
PAPER

REV.

3.000

3.000

2.000
1. The thickness of sheet metal is _________ inch or less.
   a. 5/8
   b. 1/2
   c. 3/8
   d. 1/8

2. One of the most common materials classified as sheet metal is _________.
   a. Pure lead
   b. Galvanized steel
   c. Pure tin
   d. White cast iron

3. To develop a pattern for a rectangular object is considered _________ development.
   a. Triangulation
   b. Radial Line
   c. Parallel Line
   d. Truncated

4. To develop a pattern for a cone is considered _________ development.
   a. Triangulation
   b. Radial line
   c. Parallel line
   d. Truncated

5. When trying to eliminate sharp edges and provide strength on sheet metal parts a _________ is used.
   a. Hem
   b. Seam
   c. Lap
   d. Flap
6. There are three common sheet metal hems, the single, double and the
   ___________________
   a. Countersunk
   b. Inside
   c. Capsnap
   d. Wire edge

7. When determining the size of the sheet metal for a part the ________
   must be considered.
   a. Heat on the part
   b. Bend allowance
   c. Exterior coating
   d. Height of the part

8. Sheet metal and wire diameters are specified by ____________.
   a. Gage numbers
   b. Roman numeral
   c. Letters
   d. Common fraction

9. On one side of the wire gage is stamped the __________ and the other side
   is stamped with the ____________.
   a. Fraction, gage number
   b. Letter, fraction
   c. Roman numeral, letter
   d. Gage number, decimal equivalent
IMM-J1
Layout Sheet Metal Parts
Self-Assessment Answer Key

1. d
2. b
3. c
4. b
5. a
6. d
7. b
8. a
9. d
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-J2

Subject: Industrial Maintenance         Time: 4 Hrs.

Duty: Fabricate/Install Sheet Metal Parts
Task: Form and/or Bend Sheet Metal Parts

Objective(s):

Upon completion of this module the student will be able to:

a. Identify sheet metal hand tools;
b. Describe sheet metal cutting tools;
c. Set up and operate sheet metal tools bending machines;
d. Set up and operate sheet metal tools for performing of cylindrical parts; and,
e. Demonstrate sheet metal hand bending stakes.

Instructional Materials:

MASTER Handout (IMM-J2-HO)
MASTER Laboratory Worksheet (IMM-J2-LW)
MASTER Laboratory Aid (IMM-J2-LA)
MASTER Self-Assessment
Tools and materials necessary to complete the projects

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-J1 "Layout Sheet Metal Parts"
Introduction:

Sheet metal work is a very important part of our everyday lives. We find use in our homes in a variety of appliances, heating and air conditioners. We travel to work in cars, busses and airplanes with parts made of sheet metal. At work we find some buildings, desks, chairs and file cabinets, to name a few, that are made of sheet metal. In other words our lives would not be nearly as comfortable without sheet metal. This lesson discusses the hand tools and basic machines used to produce sheet metal parts.

Presentation Outline:

I. Identify Sheet Metal Hand Tools
   A. Layout blue and removers
   B. Layout tools
   C. Hammers
   D. Pliers
   E. Hand seamers
   F. Hand groovers

II. Describe Sheet Metal Cutting Tools
    A. Hand hole punches
    B. Turret punch
    C. Tin snips
    D. Aviation snips
    E. Double-cutting shear
    F. Squaring shear
    G. Notcher
    H. Ring and circle shear
    I. Lever shear
    J. Electric and pneumatic nibblers and sheers

III. Set-up and Operate Sheet Metal Bending Machines
     A. Bar folder
     B. Cornice brake
     C. Press brake
     D. Box and pan brake

IV. Set-up and Operate Sheet Metal Tools Forming of Cylindrical Parts
    A. Slip roll forming machine
    B. Turning machines and wiring machine
    C. Burring, setting down and double seaming machines
    D. Crimping and beading machines
    E. Grooving machines
    F. Pittsburgh lock forming machines

V. Demonstrate Sheet Metal Hand Bending Stakes
   A. Bench plate
   B. Double seaming stake
C. Beakhorn stake
D. Bevel-edge square stake
E. Hatchet stake
F. Needle-case stake
G. Blowhorn stake
H. Hollow mandrel stake

Practical Application:

1. Layout pan project on 20 gauge sheet metal using the proper layout and handtools following proper safe procedures.
2. Cut the pan layout to proper size and shape using the proper cutting tools.
3. Bend the pan project using the proper machines and procedures safely.
4. Safely punch or drill the holes using the proper procedures.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-J3) dealing with fastening sheet metal parts together.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify sheet metal hand tools;
b. Describe sheet metal cutting tools;
c. Set up and operate sheet metal tools bending machines;
d. Set up and operate sheet metal tools for performing of cylindrical parts; and,
e. Demonstrate sheet metal hand bending stakes.

Reading Assignments:

The following chapters are assigned to read from *Metal Work Technology and Practice*, Repp/McCarthy, Glencoe/McMillian/McGraw-Hill Publishers, Latest Edition:

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<td>Sheet Metal Processing</td>
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Module Outline:

I. Identify Sheet Metal Hand Tools
   A. Layout blue and removers
   B. Layout tools
   C. Hammers
   D. Pliers
   E. Hand seamers
   F. Hand groovers
II. Describe Sheet Metal Cutting Tools
   A. Hand hole punches
   B. Turret punch
   C. Tin snips
   D. Aviation snips
   E. Double-cutting shear
   F. Squaring shear
   G. Notcher
   H. Ring and circle shear
   I. Lever shear
   J. Electric and pneumatic nibblers and shears

III. Set-up and Operate Sheet Metal Bending Machines
   A. Bar folder
   B. Cornice brake
   C. Press brake
   D. Box and pan brake

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   A. Bench plate
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   D. Bevel-edge square stake
   E. Hatchet stake
   F. Needle-case stake
   G. Blowhorn stake
   H. Hollow mandrel stake
IMM-J2-LA
Form and/or Bend Sheet Metal Parts
Attachment 2: MASTER Laboratory Aid

1. Instructor will:
   a. Insure proper procedures are used to construct the pan project;
   b. Insure proper tools and materials are available for the pan project;
   c. Proper techniques are used in layout; and,
   d. Proper techniques and safety procedures are followed in construction of the pan project.

2. Student will:
   a. Layout and construct sheet metal pan project;
   b. Layout pan project on 20 gauge sheet metal using the proper layout and handtools following proper safe procedures;
   c. Cut the pan layout to proper size and shape using the proper cutting tools;
   d. Bend the pan project using the proper machines and procedures safely; and,
   e. Safely punch or drill the holes using the proper procedures.
Form and/or Bend Sheet Metal Parts
Attachment 3: MASTER Laboratory Worksheet

IMM-J2-LW

DRAW AND CONSTRUCT
ALLOW 3/8" FOR OPEN TOP SINGLE HEM
ALLOW 3/8" FOR OUTSIDE CORNER LAP SEAM
45 DEGREES ON ALL HEMS AND SEAMS

DRAWN BY: REW
PROVED BY: REW

DATE 9-26-97

SCALE 1:1

MATERIAL: 20 GAGE GALVANIZED SHEET METAL

MEDIUM: 20 GAGE GALVANIZED SHEET METAL
IMM-J2
Form and/or Bend Sheet Metal Parts
Self-Assessment

Circle the letter preceding the most correct answer.

1. A tool used in sheet metal layout to produce arcs and circles is called a
   a. Compass
   b. Wing divider
   c. Scratch awl
   d. Inside caliper

2. The hammer used to produce curved parts in sheet metal which can not be
   produced by a forming machine is a __________ hammer.
   a. Setting
   b. Riveting
   c. Raising
   d. Ball peen

3. After sheet metal is folded and hooked together, __________ should be
   used to close the seam.
   a. A hand groover
   b. A raising hammer
   c. Flat nose pliers
   d. A center punch

4. The tool used to cut around stove or furnace pipe is __________.
   a. Aviation snips
   b. Tin snips
   c. A double cutting sheer
   d. A hawk's bill scroll snips

5. A hand cutting tool made in right, left and straight blades are
   __________.
   a. Aviation snips
   b. Tin snips
   c. Double cutting
   d. Hawk's bills
6. If several pieces of sheet metal need to be cut to the same length using the squaring shear the ____________ gage may be lock to length.
   a. Wire
   b. Floor
   c. Side
   d. Back

7. If it is necessary to cut small rods the ____________ sheer should be used.
   a. Squaring
   b. Notcher
   c. Lever
   d. Ring and circle

8. The bending machine designed to bend seams and hems is the ____________.
   a. Press brake
   b. Bar folder
   c. Cornice brake
   d. Box and pan

9. The upper jaw of a ____________ brake, is made of several blocks which can be used together or some removed if necessary.
   a. Press brake
   b. Bar folder
   c. Cornice brake
   d. Box and pan brake

10. The forming machine which produces the end on stove and furnace pipes is the ____________ machine.
    a. Burring
    b. Slip roll forming
    c. Crimping and beading
    d. Grooving
IMM-J2
Form and/or Bend Sheet Metal Parts
Self-Assessment Answer Sheet:

1. B
2. C
3. A
4. C
5. A
6. D
7. C
8. B
9. D
10. C
INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-J3

Subject: Industrial Maintenance

Duty: Fabricate/Install Sheet Metal Parts
Task: Fasten Sheet Metal Parts Together

Objective(s):

Upon completion of this module the student will be able to:
a. Identify sheet metal self threading screws;
b. Describe rivets and riveting;
c. Demonstrate soldering sheet metal; and,
d. Set up demonstrate brazing and braze welding of sheet metal.

Instructional Materials:

MASTER Handout (IMM-J3-HO)
MASTER Laboratory Worksheet (IMM-J3-LW)
MASTER Laboratory Aid (IMM-J3-LA)
MASTER Self-Assessment

Tools and material necessary to complete the projects

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-J2 "Form and/or Bend Sheet Metal Parts"
Introduction:

Sheet metal work is a very important part of our every day lives. We find use in our homes in a variety of appliance, heating and air conditioners. We travel to work in cars, busses and air planes with parts made of sheet metal. At work we find some buildings, desks, chairs and file cabinets, to name a few, that are made of sheet metal. In other words our lives would not be nearly as comfortable without sheet metal. This lesson discusses the ways of fastening sheet metal parts together.

Presentation Outline:

I. Identify Sheet Metal Self Threading Screws  
   A. Thread forming screws  
   B. Thread cutting screws  
   C. Head styles used on threaded fasteners  
   D. Driver recesses used on screw heads  
   E. Drive screw

II. Describe Rivets and Riveting  
   A. Introduction  
   B. Riveting  
   C. Rivet size  
   D. Tinners rivets  
   E. Choosing a rivet  
   F. Rivet spacing  
   G. The rivet set  
   H. How to rivet  
   I. Hot and cold rivets  
   J. Removing rivets  
   K. Tubular and special rivets  
   L. Blind rivets

III. Demonstrate Soldering Sheet Metal  
   A. Introduction to soldering  
   B. Soft soldering  
   C. Heat for soft soldering  
   D. Soldering copper  
   E. Tin a soldering copper  
   F. Preparing the workpiece  
   G. Joints for soft soldering  
   H. Soft soldering techniques  
   I. Hard soldering techniques

IV. Set up and Demonstrate Brazing and Braze Welding of Sheet Metal  
   A. Introduction  
   B. Difference between brazing and braze welding  
   C. Brazing and braze welding fluxes
D. Rods for brazing and braze welding
E. How to braze with a torch

Practical Application:

1. Secure sheet metal using self threading screws
2. Secure sheet metal using rivets and riveting
3. Secure sheet metal using soldering
4. Secure sheet metal using brazing
5. Secure pan project using pop rivets

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-K1) dealing with performing basic pipefitting calculations.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify sheet metal self threading screws;
b. Describe rivets and riveting;
c. Demonstrate soldering sheet metal; and,
d. Set up demonstrate brazing and braze welding of sheet metal.

Reading Assignments:

The following chapters are assigned to read from Metal Technology and Practice, Repp/McCarthy, Glencoe/McMillan/McGraw-Hill Publishers, Latest Edition

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Module Outline:

I. Identify Sheet Metal Self Threading Screws
   A. Thread forming screws
   B. Thread cutting screws
   C. Head styles used on threaded fasteners
   D. Driver recesses used on screw heads
   E. Drive screw

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    A. Introduction
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C. Rivet size
D. Tinners rivets
E. Choosing a rivet
F. Rivet spacing
G. The rivet set
H. How to rivet
I. Hot and cold rivets
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A. Introduction to soldering
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F. Preparing the workpiece
G. Joints for soft soldering
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I. Hard soldering techniques

IV. Set up and Demonstrate Brazing and Braze Welding of Sheet Metal
A. Introduction
B. Difference between brazing and braze welding
C. Brazing and braze welding fluxes
D. Rods for brazing and braze welding
E. How to braze with a torch
1. Instructor will:
   a. Insure proper procedures are used to assemble sheet metal parts;
   b. Insure proper tools and materials are available for projects; and,
   c. Proper techniques and safety procedures are followed in constructing projects.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the projects;
   b. Secure sheet metal using self threading screws;
   c. Secure sheet metal using rivets and riveting;
   d. Secure sheet metal using soldering;
   e. Secure sheet metal using brazing; and,
   f. Secure pan project using pop rivets.
IMM-J3-LW
Fasten Sheet Metal Parts Together
Attachment 3: MASTER Laboratory Worksheet

DRAW AND CONSTRUCT
ALLOW 3/8" FOR OPEN TOP SINGLE HEM
ALLOW 3/8" FOR OUTSIDE CORNER LAP SEAM
45 DEGREES ON ALL HEMS AND SEAMS

DATE
9-26-97
DRAWN BY:
REW
APPROVED BY:
REW
MASTER
TITLE J2&3PAN
PAN
MATERIAL: 20 GAGE
GALVANIZED SHEET METAL
SCALE
1 - 1
DRAW #
REV. #
ASSEMBLE 2 EA. WITH SELF THREADING SCREWS
ASSEMBLE 2 EA. WITH RIVETS
ASSEMBLE 2 EA. BY SOLDERING
ASSEMBLE 2 EA. BY BRAZING

MATERIAL: 20 GA. GALVANIZED SHEET METAL

DATE: 9-26-97
DRAWN BY: REW
APPROVED BY: REW
TITLE: J37THRIV THREAD AND RIVET PLT.

SCALE 1:1
DRAW #
REV. #

698
IMM-J3
Fasten Sheet Metal Parts Together
Self-Assessment

Circle the letter preceding the most correct answer:

1. The drill size to use for self threading screw is _____________.
   a. 1/8" diameter
   b. 1/16 smaller than the minor diameter of the screw
   c. Slightly larger than the minor diameter of the screw
   d. The same size as the major diameter of the screw

2. Another name for blind rivets is _____________.
   a. Solid
   b. Pop
   c. Tubular
   d. Tinners

3. Tinners rivets for sheet metal are supplied in sizes determined by their _____________.
   a. Material
   b. Diameter
   c. Length
   d. Weight per 1000

4. The rivet should be ____________ in diameter than the holes in the pieces to be riveted.
   a. .003" to .016" larger
   b. .003" to .016" smaller
   c. .016" to .032" larger
   d. .016 to .032" smaller

5. A plier like hand tool is used for clinching ____________ rivets.
   a. Tubular
   b. Blind
   c. Solid
   d. Tinners
6. When soldering sheet metal if the solder melts below 800°F the process is called ___________.
   a. Hard soldering
   b. Brazing
   c. Soft soldering
   d. Fusion

7. For general work when soft soldering a solder of one half lead and one half ___________ is used.
   a. Silver
   b. Steel
   c. Bronze
   d. Tin

8. The flux used in soldering is used to remove the ___________ from the material being soldered.
   a. Oxide
   b. Carbon
   c. Rust
   d. Grease

9. When brazing the filler metal melts and flows into the joint by ___________.
   a. Fusion
   b. Forming a bead
   c. Capillary action
   d. Like arc welding

10. The main two metals used in brazing rods are copper and ___________.
    a. Tin
    b. Lead
    c. Iron
    d. Zinc
IMM-J3
Fasten Sheet Metal Parts Together
Self-Assessment Answer Key

1. C
2. B
3. B
4. B
5. B
6. C
7. D
8. A
9. C
10. D
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<td>B. Apply Mathematical Concepts</td>
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<td>E. Use Hand Tools</td>
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<td>G. Perform Welding Operations</td>
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<td>B. 3 Convert basic metric/english measurements</td>
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<td>J. Fabricate/ Install Sheet Metal Parts</td>
<td>B. 4 Perform basic algebraic operations</td>
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<td>B. 5 Perform basic trigonometric functions</td>
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<td>G. 1 Weld with shielded metal arc welding (SMAW) processes</td>
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<td>J. 3 Fasten sheet metal parts together</td>
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INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-K1

Subject: Industrial Maintenance
Time: 4 Hrs.

Duty: Piping Operations
Task: Perform Basic Pipefitting Calculations

Objective(s):

Upon completion of this module the student will be able to:

a. Identify terms frequently used in pipe fitting formulas;
b. Identify various calculations and measurements required of a pipe fitter;
c. Identify conditions that will require these calculations to be performed; and,
d. Layout on paper piping system consisting of typical runs and offsets to a tolerance of 1/8".

Instructional Materials:

MASTER Handout (IMM-K1-H0)
MASTER Self-Assessment
Assorted of threaded and socket weld fittings
6' carpenters folding ruler
Pipe fitters hand books
Framing square

References:

Mathematics for Plumbers and Pipefitters, Arcangelo, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-J3 “Fasten Sheet Metal Parts Together”
Introduction:

Pipes need to be of exact lengths and exactly placed. Accurately performing piping calculations is necessary to fabricate the pipe to fit correctly.

Presentation Outline:

I. Identify Terms Frequently Used in Pipe Fitting Formulas
   A. Run
   B. Set
   C. Travel
   D. Offset

II. Identify Conditions That Will Require the Use of Pipe Fitting Formulas
   A. Obstructions to be worked around
      1. Other pipe
      2. Wall
      3. Equipment

III. Identify and Demonstrate Various Calculations and Measurements Required of a Pipe Fitter
   A. Center line measurements. (point to point)
   B. Simple offset
      1. Using table of multipliers for calculating simple offsets
      2. Discuss the concept that an offset is nothing more than the missing side of a right triangle
   C. Equal spread offset
      1. Two-pipe spread using 22-1/2 degree threaded fittings
      2. Review formula and tables from pipe fitting hand book
   D. Rolling offset
      1. Use of trigonometric tables in calculation of rolling offset
      2. Demonstrate simplified method of finding a rolling offset using a framing square

IV. Demonstrate How to Lay out on Paper a Piping System Consisting of Horizontal Runs, Vertical Runs and a Simple Rolling Offset to a Tolerance of 1/8"

Practical Application:

The student will:
1. Identify terms frequently used in pipe fitting formulas.
   A. Run
   B. Set
   C. Travel
   D. Offset
2. Identify conditions that will require the use of pipe fitting formulas.
A. Obstructions to be worked around.
   1. Other pipe
   2. Wall
   3. Equipment

3. Identify and demonstrate various calculations and measurements required of a pipe fitter.
   A. Center line measurements. (point to point)
   B. Simple offset
      1. Using table of multipliers for calculating simple offsets.
      2. Discuss the concept that an offset is nothing more than the missing side of a right triangle.
   C. Equal spread offset.
      1. Two pipe spread using 22-1/2 degree screwed fittings.
      2. Review formula and tables from pipe fitting hand book.
   D. Rolling offset.
      1. Use of trigonometric tables in calculation of rolling offset.
      2. Demonstrate simplified method of finding a rolling offset using a framing square.

4. Demonstrate how to lay out on paper a piping system consisting of horizontal runs, vertical runs and a simple rolling offset to a tolerance of 1/8".

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Self-Assessment.

Summary:

Review the main lesson points using the objectives as a guide to discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-K2) dealing with cutting, threading, and reaming pipe.
Standards of performance:

Student will demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Identify terms frequently used in pipe fitting formulas;
b. Identify various calculations and measurements required of a pipe fitter;
c. Identify conditions that will require these calculations to be performed; and,
d. Layout on paper piping system consisting of typical runs and offsets to a tolerance of 1/8".

Reading Assignments:

The following chapters are assigned to read from Millwright's Handbook, Audel Publishers, Latest Edition:

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<tr>
<th>Chapters</th>
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<tbody>
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<td>Fittings</td>
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</table>

Module Outline:

I. Identify Terms Frequently Used in Pipe Fitting Formulas
   A. Run
   B. Set
   C. Travel
   D. Offset

II. Identify Conditions That Will Require the Use of Pipe Fitting Formulas
   A. Obstructions to be worked around
III. Identify and Demonstrate Various Calculations and Measurements Required of a Pipe Fitter
   A. Center line measurements. (point to point)
   B. Simple offset
      1. Using table of multipliers for calculating simple offsets
      2. Discuss the concept that an offset is nothing more than the missing side of a right triangle
   C. Equal spread offset
      1. Two-pipe spread using 22-1/2 degree threaded fittings
      2. Review formula and tables from pipe fitting hand book
   D. Rolling offset
      1. Use of trigonometric tables in calculation of rolling offset
      2. Demonstrate simplified method of finding a rolling offset using a framing square

IV. Demonstrate How to Lay out on Paper a Piping System Consisting of Horizontal Runs, Vertical Runs and a Simple Rolling Offset to a Tolerance of 1/8"
IMM-K1
Perform Basic Pipefitting Calculations
Self-Assessment

1. Define run.

2. Define offset.

3. Define travel.

4. Define right triangle.

5. Define rolling offset.

6. List steps to perform equal spread offsets.
1. Length of conduit

2. Raising or lowering the line of the conduit or alignment. This is accomplished by bending the line at a 45° angle and at the depth of offset placing another 45° angle in the opposite direction to the first angle.

3. Distance moves on a horizontal plane

4. A 3 sided figure. One of the three angles is 90°

5. Pipe that is offset has parallel lines separated by two 45° angles

# INDUSTRIAL MAINTENANCE MECHANIC SERIES

## MASTER Technical Module No. IMM-K2

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<td>Piping Operations</td>
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<td>Task:</td>
<td>Cut, Thread, and Ream Pipe</td>
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## Objective(s):

Upon completion of this module the student will be able to:

- a. Identify two methods of cutting reaming and threading pipe;
- b. Identify equipment required to cut thread and ream pipe;
- c. Describe the use and care of equipment required when cutting, threading and reaming pipe;
- d. Identify safety concerns that apply to use of cutting, threading and reaming equipment; and,
- e. Fabricate from pipe stock, using a NPT threaded nipple that is cut square and properly reamed.

## Instructional Materials:

- MASTER Handout (IMM-K2-H0)
- MASTER Laboratory Worksheet (IMM-K2-LW)
- MASTER Laboratory Aid (IMM-K2-LA)
- MASTER Self-Assessment
- Hand pipe reamer
- Set of hand operated pipe dies
- Pipe vice
- Electric pipe threading, cutting and reaming equipment
- 6' Folding ruler
- Cutting fluid
- Assorted sections of metal pipe

## References:

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-K1 “Perform Basic Pipefitting Calculations”

Introduction:

Pipe need to be placed in exact locations. Therefore, pipe must be cut, threaded and reamed. Reaming removes burrs so materials can go through the pipe unobstructed. Threading allows pipes to be joined.

Presentation Outline:

I. Identify Two Methods of Cutting, Reaming and Threading Pipe
   A. Hand operated
   B. Electric

II. Identify Equipment Required to Cut Thread and Ream Pipe
   A. Hand pipe reamer
   B. Hand or electric
   C. Set of hand operated pipe dies
   D. Pipe vice
   E. Electric pipe threading, cutting and reaming equipment
   F. Folding ruler
   G. Cutting fluid
   H. Describe the use and care of equipment required when cutting, threading and reaming pipe.

III. Identify Safety Concerns That Apply to Use of Cutting, Threading and Reaming Equipment
   A. High torque rotating equipment
   B. Sharp edges and metal shavings
   C. Sharp tools
   D. Flying particles

IV. Demonstrate How to Fabricate from Pipe Stock, Using a NPT Threaded Nipple That Is Cut Square and Properly Reamed

Practical Application:

I. Identify safety concerns that apply to use of cutting, threading and reaming equipment;
   A. High torque rotating equipment;
   B. Sharp edges and metal shavings;
   C. Sharp tools;
   D. Flying particles;
II. Practice hand cutting, reaming and threading pipe;
III. Practice using the electric pipe cutting, threading and reaming equipment; and,
IV. Practice fabricating from pipe stock, using a NPT threaded nipple that is cut, square and properly reamed.

**Evaluation and/or Verification:**

Successful completion of this technical module will be based on the student’s successful completion of the written evaluation.

**Summary:**

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

**Next Lesson Assignment:**

MASTER Technical Module (IMM-K3) dealing with pipe assembly.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Identify two methods of cutting, reaming and threading pipe;
b. Identify equipment required to cut, thread and ream pipe;
c. Describe the use and care of equipment required when cutting, threading and reaming pipe;
d. Identify safety concerns that apply to use of cutting, threading and reaming equipment; and,
e. Fabricate from pipe stock, a NPT threaded nipple that is cut, square and properly reamed.

Module Outline:

I. Identify Safety Concerns That Apply to Use of Cutting, Threading and Reaming Equipment
   A. High torque rotating equipment
   B. Sharp edges and metal shavings
   C. Sharp tools
   D. Flying particles

II. Practice Hand Cutting, Reaming and Threading Pipe

III. Practice Using the Electric Pipe Cutting, Threading and Reaming Equipment

IV. Practice Fabricating from Pipe Stock, Using a NPT Threaded Nipple That Is Cut Square and Properly Reamed
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.
Practice:

1. Identifying methods of cutting, reaming and threading pipe.

2. Identify equipment required to cut thread and ream pipe.

3. Identify safety concerns that apply to use of cutting, threading and reaming equipment.

4. Demonstrate how to fabricate from pipe stock.

5. Demonstrate how a NPT threaded nipple is cut.
6. Demonstrate how to square and properly ream a NPT threaded nipple.

Instructor will use the following to generate a practical exam:

1. Identify two methods of cutting, reaming and threading pipe.

2. Identify equipment required to cut thread and ream pipe.

3. Identify safety concerns that apply to use of cutting, threading and reaming equipment.

4. Demonstrate how to fabricate from pipe stock, a NPT threaded nipple that is cut square and properly reamed.
IMM-K2
Cut, Thread, and Ream Pipe
Self-Assessment

1. Identify two methods of cutting, reaming and threading pipe.

2. Identify equipment required to cut, thread and ream pipe.

3. Describe the use and care of equipment required when cutting, threading and reaming pipe.

4. Identify safety concerns that apply to use of cutting, threading and reaming equipment.

5. Discuss how to fabricate from pipe stock, using a NPT threaded nipple that is cut square and properly reamed.
IMM-K2
Cut, Thread, and Ream Pipe
Self-Assessment Answer Key

1. Manual with hand tools or using power operated equipment.
2. Pipe cutter, pipe threader, and pipe reamer
3. Cutting, threading and reaming creates sharp edges and hot surfaces. Make sure equipment is clean and well lubricated to reduce heat and friction.
4. Cutting, threading and reaming creates sharp edges and hot surfaces. Be careful not to cut or burn oneself due to this activity.
5. A threaded nipple can be screwed into a pipe coupling or male fitting.
Subject: Industrial Maintenance
Duty: Piping Operations
Task: Pipe Assembly

Time: 4 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify two types of threaded companion flanges;
b. Identify typical materials from which threaded flanges are made;
c. Identify how threaded flanges are assembled;
d. Identify safety concerns that apply to assembling a threaded flange; and,
e. Assemble a threaded flange connection from threaded pipe flanges.

Instructional Materials:

MASTER Handout (IMM-K3-H0)
MASTER Laboratory Worksheet (IMM-K3-LW)
MASTER Laboratory Aid (IMM-K3-LA)
MASTER Self-Assessment
Pipe Vice
Ruler
Cutting Fluid
Sections of Threaded Metal Pipe
Pipe Wrenches
Pipe Compound
Nut, bolts, and washers appropriate for the flange in use
Gasket suitable for the flange in use

References:

*Plumbing Installation and Design*, James A. Sullivan, Latest Edition
Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-K2 "Cut, Thread, and Ream Pipe"

Introduction:

In order to maintain rigidity and withstand a harsh environment, pipes and flanges must be threaded.

Presentation Outline:

I. Identify Two Types of Threaded Companion Flanges
   A. Standard
   B. Heavy

II. Identify Typical Materials from Which Threaded Flanges Are Made
    A. Iron
    B. Cast Iron
    C. Stainless Steel
    D. Various types of plastic

III. Identify How Threaded Flanges Are Assembled (Assume Pipe Is Already Threaded)
     A. Apply pipe compound appropriate for the system to the pipe threads
     B. Install first flange half snug but not tight
     C. Install last flange half snug
     D. Tighten both flanges until bolt holes are in line

IV. Identify Safety Concerns That Apply to Assembling a Threaded Flange
    A. Sharp threads
    B. Heavy components in awkward positions
    C. Heavy gloves
    D. Safety glasses with side shields

V. Demonstrate the Assembly of a Threaded Flange Connection
   A. Explain why a pipe should not be over threaded
   B. Correct amount of compound
   C. Correct assembly technique
   D. Gasket type and position

Practical Application:

1. Point out safety concerns that apply to assembling a threaded flange.
   A. Sharp threads
   B. Heavy components in awkward positions
   C. Heavy gloves
D. Safety glasses with side shields

2. Practice assembling a threaded flange connection.
   A. Explain why a pipe should not be over threaded
   B. Correct amount of compound
   C. Correct assembly technique
   D. Gasket positioning

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-K4) dealing with installing and adjusting pipe support.
IMM-K3-HO
Pipe Assembly
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

 Upon completion of this module the student will be able to:
a. Identify two types of threaded companion flanges;
b. Identify typical materials from which threaded flanges are made;
c. Identify how threaded flanges are assembled;
d. Identify safety concerns that apply to assembling a threaded flange; and,
e. Assemble a threaded flange connection from threaded pipe flanges.

Reading Assignments:

The following chapters are assigned to read from Millwrights’ Handbook, Audel Publishers, Latest Edition:

<table>
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<th>Chapters</th>
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</tbody>
</table>

Module Outline:

I. Identify Two Types of Threaded Companion Flanges
   A. Standard
   B. Heavy
II. Identify Typical Materials from Which Threaded Flanges Are Made
   A. Iron
   B. Cast Iron
   C. Stainless Steel
   D. Various types of plastic
III. Identify How Threaded Flanges Are Assembled (Assume Pipe Is Already Threaded)
   A. Apply pipe compound appropriate for the system to the pipe threads
   B. Install first flange half snug but not tight
   C. Install last flange half snug
   D. Tighten both flanges until bolt holes are in line

IV. Identify Safety Concerns That Apply to Assembling a Threaded Flange
   A. Sharp threads
   B. Heavy components in awkward positions
   C. Heavy gloves
   D. Safety glasses with side shields

V. Demonstrate the Assembly of a Threaded Flange Connection
   A. Explain why a pipe should not be over threaded
   B. Correct amount of compound
   C. Correct assembly technique
   D. Gasket type and position
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. Practice identifying types of threaded companies flanges.
2. List materials that threaded flanges are made up of.
3. List steps to assemble threaded flanges.
4. Assemble a threaded flange.
5. List safety concerns when assembling a threaded flange.
IMM-K3
Pipe Assembly
Self-Assessment

1. List two common materials used in threaded flanges.

2. List steps to assemble threaded flanges.

3. List two safety concerns when assembling a threaded flange.

4. List two ways to join threaded flanges.

5. Explain purpose of cutting fluid.
1. Forged or cast pipe.

2. Clean parts, proper alignment, proper support, proper gasket insertion, proper tightening of bolts.

3. Eye and hand protection.

4. Flanges are joined by welding or being bolted together.

5. Cutting fluid serves to lubricate and reduce friction, therefore, reducing heat.
INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-K4

Subject: Industrial Maintenance  Time: 3 Hrs.
Duty: Piping Operations
Task: Install and Adjust Pipe Support

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the purpose of pipe supports;
b. Identify the types of pipe supports;
c. Describe the distance between hangers; and,
d. Identify the pipe support fastener.

Instructional Materials:

MASTER Handout (IMM-K4-HO)
MASTER Laboratory Aid (IMM-K4-LA)
MASTER Laboratory Worksheet (IMM-K4-LW)
MASTER Self-Assessment

References:

Video: *Plumbing and Pipe Fitting*, 730 Bergwall, Bergwall, P.O. Box 238, Garden City, New York 11530, 1-800-645-3565, Latest Edition
*Tube Fittings*, Industrial Training Inc., 2023 Eastern Ave. S.E., P.O. Box 7186, Grand Rapids, MI 49510, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-K3  “Pipe Assembly”

Introduction:

Piping systems are a very essential part of our lives. Industrial plants have miles of pipe lines to carry their products, gases or fluids necessary for producing the product.
Construction and many other pieces of equipment rely on hydraulic flow to complete their operations. Even our homes need water lines and piping for appliances, heating and cooling systems for our comfort and health. This section pertains to the way pipe lines must be supported for proper material flow.

Presentation Outline:

I. Describe the Purpose of Pipe Supports
   A. Position
   B. Materials the support may be attached to
   C. Reasons for pipe supports
II. Identify the Types of Pipe Supports
   A. Reznor hook
   B. Pipe strap
   C. Perforated iron strap
   D. Clevis hanger
   E. F&M hanger
   F. Coil hanger
   G. Spring cushion
   H. Special hangers
   I. Split ring hanger
III. Describe the Distance Between Hangers
    A. Type of pipe
    B. Type of joints
IV. Identify the Pipe Support Fastener
    A. Fastening to different materials
    B. The type and procedure for each fastener

Practical Application:

1. Support the side of the piping project to a vertical wood 2x4 using proper hardware.
2. Support the top of the piping project 12" from a horizontal wood 2x4 using proper hardware.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.
Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-K5) dealing with tubing.
IMM-K4-HO
Install and Adjust Pipe Support
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Describe the purpose of pipe supports;
b. Identify the types of pipe supports;
c. Describe the distance between hangers; and,
d. Identify the pipe support fastener.

Reading Assignments:

The following chapters are assigned to read from Basic Plumbing, Harry Slater &
Lee Smith, Delmar Publishers, Latest Edition:

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<th>Unit</th>
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<td>28-Pipe Hangers</td>
</tr>
<tr>
<td>5-Plumbing Hardware</td>
<td>29-Fastenings</td>
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</table>

Module Outline:

I. Describe the Purpose of Pipe Supports
   A. Position
   B. Materials the support may be attached to
   C. Reasons for pipe supports

II. Identify the Types of Pipe Supports
   A. Reznor hook
   B. Pipe strap
   C. Perforated iron strap
   D. Clevis hanger
E. F&M hanger
F. Coil hanger
G. Spring cushion
H. Special hangers
I. Split ring hanger

III. Describe the Distance Between Hangers
A. Type of pipe
B. Type of joints

IV. Identify the Pipe Support Fastener
A. Fastening to different materials
B. The type and procedure for each fastener
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Instructor will grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Support the side of the piping project to a vertical wood 2x4 using proper hardware; and,
   c. Support the top of the piping project 12" from a horizontal wood 2x4 using proper hardware.
1. Instructor will:
   a. Demonstrate how to install pipe supports; and,
   b. Demonstrate how to adjust pipe supports.

2. Student will:
   a. Demonstrate how to install pipe supports; and,
   b. Demonstrate how to adjust pipe supports.

3. Instructor will grade student’s ability to:
   a. Install pipe supports; and,
   b. Adjust pipe supports.
IMM-K4
Install and Adjust Pipe Support
Self-Assessment

Circle the letter preceding the most correct answer.

1. The first consideration of selecting a pipe hanger would be the weight of the pipe and its ________________.
   a. Direction of flow
   b. Content weight
   c. Number of joints
   d. Number of tees

2. The ________________ of the material in the pipe could affect the hanger selection due to expansion and contraction.
   a. Thickness
   b. Weight
   c. Temperature
   d. Color

3. The hanger that is made of wire which is bent, pointed and is driven in wood is the ________________.
   a. Reznor hook
   b. Clevis hanger
   c. F&M hanger
   d. Pipe strap

4. The hanger used on walls or ceilings to support small pipe is the ________________.
   a. Reznor hook
   b. Clevis hanger
   c. F&M hanger
   d. Pipe strap

5. The pipe strap should be fastened to a wood structure by using ________________.
   a. #16 nails
   b. #8 nails
   c. Round head screws
   d. Hex head screws
6. The hanger used for large pipe where the top half may be installed first because the bottom half is removable is the ________________.
   a. Coil hanger
   b. Reznor hook
   c. F&M hanger
   d. Clevis hanger

7. Rigid steel, brass, or copper should have a support about every __________ feet apart.
   a. 5-10
   b. 15-20
   c. 20-25
   d. 25-30

8. When securing a clevis hanger to a wood joist a/an ________________ is used.
   a. U-bolt
   b. Hanger bolt
   c. Hex head machine screw
   d. Allen head cap screw

9. A general rule for horizontal pipe supports allow the pipe to hang __________ inches.
   a. 6-12
   b. 12-24
   c. 24-30
   d. 24-36

10. To secure hangers to concrete, stone, or brick, a hole may be drilled using a ________________ tipped masonry bit.
    a. Mild steel
    b. Carbon steel
    c. High speed steel
    d. Carbide
IMM-K-4
Install and Adjust Pipe Support
Self-Assessment Answer Key

1. B
2. C
3. A
4. D
5. C
6. D
7. A
8. B
9. B
10. D
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-K5

Subject: Industrial Maintenance       Time: 4 Hrs.
Duty: Piping Operations
Task: Tubing

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the differences of tubing to pipe;
b. Demonstrate how to join tubing;
c. Identify types of tubing; and,
d. Describe tubing maintenance.

Instructional Materials:

MASTER Handout (IMM-K5-HO)
MASTER Laboratory Aid (IMM-K5-LA)
MASTER Laboratory Worksheet (IMM-K5-LW)
MASTER Self-Assessment
3/4 Black Steel Pipe
1/2 Hard Copper
1/4 Soft Copper Tubing
1/2 CPVC Plastic Pipe
Ample Elbows
Tees
Reducers
Flare & Ferrel Tubing
Fittings
Couplings
Unions
Also enough flux, solder, plastic pipe solvent to complete the pipe project

References:

Basic Plumbing, Harry Slater and Lee Smith, Delmar Publishers, Latest Edition
Video: Plumbing and Pipefitting 730, Bergwall, P.O. Box 238, Garden City, New York 11530, 1-800-645-3565, Latest Edition
Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-K4 “Install and Adjust Pipe Support”

Introduction:

Tubing is used in many applications from hydraulics to refrigeration, from industrial to residential, and everywhere in between. It is essential that tubing, of all types, be understood.

Presentation Outline:

I. Describe the Difference of Tubing to Pipe
   A. Introduction
   B. Advantages of tubing

II. Demonstrate How to Join Tubing
    A. Cutting
    B. Deburring
    C. Soldering
    E. Flared and ferrule fittings
    E. Bending

III. Identify Types of Tubing
    A. Copper
    B. Steel
    C. Aluminum
    D. Plastic
    E. Other applications

IV. Describe Tubing Maintenance
    A. Check system
    B. Repair system

Practical Application:

1. Cut type M rigid copper tubing.
2. Deburr solder proper fittings to type M rigid 1/2 inch copper tubing.
3. Bend, cut, and debur 1/4 inch soft copper tubing.
4. Flare one end and use a ferrule on the tee end of 1/4 inch soft copper tubing.
Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-K6) dealing with fittings.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Describe the differences of tubing to pipe;
b. Demonstrate how to join tubing;
c. Identify types of tubing; and,
d. Describe tubing maintenance.

Reading Assignments:

The following chapters are assigned to read from *Piping Systems, Mechanical Equipment Series 736*, Schoolcraft Publishing, 750 Lake Cook Road, Suite 250, Buffalo Grove, IL 60089, 1-800-837-1255, Latest Edition:

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Module Outline:

I. Describe the Difference of Tubing to Pipe
   A. Introduction
   B. Advantages of tubing

II. Demonstrate How to Join Tubing
   A. Cutting
   B. Deburring
   C. Soldering
   E. Flared and ferrule fittings
   E. Bending
III. Identify Types of Tubing
   A. Copper
   B. Steel
   C. Aluminum
   D. Plastic
   E. Other applications

IV. Describe Tubing Maintenance
   A. Check system
   B. Repair system
1. Instructor will:
a. Insure proper procedures are used to safely construct physical project;
b. Insure proper tools and materials are available for project completion;
c. Proper techniques and safety procedures are followed in completing the project; and,
d. Instructor will grade procedures and finished project.

2. Student will:
a. Follow proper instructions and safety procedures to complete the project;
b. Cut type M rigid copper tubing;
c. Debur solder proper fittings to type M rigid 1/2 inch copper tubing;
d. Bend, cut, and debur 1/4 inch soft copper tubing; and,
e. Flair one end and use a ferrule on the tee end of 1/4 inch soft copper tubing.
Circle the letter preceding the most correct answer.

1. **Tubing wall thickness is measured in _________________.**
   a. Fraction of an inch
   b. Decimal of an inch
   c. Fraction of a foot
   d. Decimal of a foot

2. **Metallic tubing is made from _________________.**
   a. Steel, lead, and aluminum
   b. Copper, stainless steel, tin, and steel
   c. Steel, copper, stainless steel, and aluminum
   d. Iron, copper, steel, and aluminum

3. **When pressure may reach 6000 pounds the tubing is made of ________________.**
   a. Copper
   b. Stainless steel
   c. Aluminum
   d. Plastic

4. **One reason the wall thickness of tubing is thinner than pipe is because of the ________________.**
   a. Length of the pipe
   b. Length of the tubing
   c. Coating applied to tubing
   d. Way it is joined

5. **If a fluid system must be installed in a confined area with several directional changes, _______________ would be recommended for the system.**
   a. Tubing
   b. Wrought iron
   c. Cast iron
   d. Steel pipe
6. If a water system requires an on-off flow, tubing would be used because it
   a. Wall thickness is stronger
   b. Uses threaded fittings
   c. Is more giving
   d. Comes in longer lengths

7. Tubing cutters will cut tubing square because of the __________ rollers
   on the opposite side of the cutting wheel.
   a. 5
   b. 4
   c. 3
   d. 2

8. When soldering tubing it must be cleaned with emery cloth or wire brush and
   chemically cleaned with ____________.
   a. Soap and water
   b. Solvent
   c. Flux
   d. Oil

9. When tubing is bent in a conical shape on the end to be joined to a fitting,
   __________ must be used.
   a. A flaring tool
   b. A plumbob
   c. A hacksaw
   d. Slip joint pliers

10. A flareless fitting used in connecting tubing uses ____________ to
    prevent the tubing fitting from leaking.
    a. Pipe dope
    b. Teflon
    c. Duct tape
    d. A ferrule

11. To make tubing soft so it may be flared or bent without cracking, it is put
    through a process called ____________.
    a. Annealing
    b. Heat treatment
    c. Soldering
    d. Salting
12. Copper tubing used in general plumbing and heating applications with a medium wall thickness is type _____________.
   a. K
   b. L
   c. M
   d. N

13. Small diameter tubing may be bent with hand benders while large diameter tubing must be bent with _________________.
   a. Ball peen hammer
   b. Hydraulic benders
   c. Pipe wrenches
   d. A round pipe
IMM-K5
Tubing
Self-Assessment Answer Key

1. B
2. C
3. B
4. D
5. A
6. C
7. D
8. C
9. A
10. D
11. A
12. C
13. B
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-K6

Subject: Industrial Maintenance
Duty: Piping Operations
Task: Fittings

Time: 8 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the purpose of fittings;
b. Identify the function of fittings;
c. Demonstrate how fittings are connected; and,
d. Identify drawing symbols.

Instructional Materials:

- MASTER Handout (IMM-K6-HO)
- MASTER Laboratory Aid (IMM-K6-LA)
- MASTER Laboratory Worksheet (IMM-K6-LW)
- MASTER Self-Assessment
- 3/4 Black Steel Pipe
- 1/2 Hard Copper
- 1/4 Soft Copper Tubing
- 1/2 CPVC Plastic Pipe
- Ample Elbows
- Tees
- Reducers
- Flare & Ferrel Tubing
- Fittings
- Couplings
- Unions
- Also enough flux, solder, plastic pipe solvent to complete the pipe project.

References:

Basic Plumbing, Harry Slater and Lee Smith, Delmar Publishers, Latest Edition
Video: Plumbing and Pipefitting 730, Bergwall, P.O. Box 238, Garden City, New York 11530, 1-800-645-3565, Latest Edition
Introduction:

There are miles and miles of pipe and tubing lines throughout this world providing us with goods and services. In industry, for the products to be manufactured, it requires piping systems to insure quality and safety. Our homes have many systems, such as water, both hot and cold, sewerage and drain lines; even the refrigerators and air conditioners have many tubing and piping systems. This section deals with the fitting that put these and other systems together.

Presentation Outline:

I. Describe the Purpose of Fittings
   A. Connect sections
   B. Change the flow
   C. Pipe and tubing

II. Identify the Function of Fittings
   A. Change the direction of flow
   B. Providing branch connections
   C. Change line size
   D. Caps, plugs and couplings

III. Demonstrate How Fittings Are Connected
   A. Screwed
   B. Flanged
   C. Welded
   D. Tubing

IV. Identify Drawing Symbols
   A. Flanged
   B. Screwed
   C. Welded
   D. Bell and spigot
   E. Soldered

Practical Application:

1. Join pipe in piping project.
2. Join copper tubing by soldering in piping project.
3. Join copper tubing with fittings, ferrule and flare in piping project.
4. Join plastic tubing in piping project.

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**Evaluation and/or Verification:**

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

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**Summary:**

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

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**Next Lesson Assignment:**

MASTER Technical Module (IMM-K7) dealing with plastic pipe.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Describe the purpose of fittings;
b. Identify the function of fittings;
c. Demonstrate how fittings are connected; and,
d. Identify drawing symbols.

Reading Assignments:

The following chapters are assigned to read from Piping Systems, Mechanical Equipment Series 736, Schoolcraft Publishing, 750 Lake Cook Road, Suite 250, Buffalo Grove, IL. 60089, 1-800-837-1255, Latest Edition:

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Module Outline:

I. Describe the Purpose of Fittings
   A. Connect sections
   B. Change the flow
   C. Pipe and tubing

II. Identify the Function of Fittings
   A. Change the direction of flow
   B. Providing branch connections
   C. Change line size
   D. Caps, plugs and couplings
III. Demonstrate How Fittings Are Connected
   A. Screwed
   B. Flanged
   C. Welded
   D. tubing

IV. Identify Drawing Symbols
   A. Flanged
   B. Screwed
   C. Welded
   D. Bell and spigot
   E. Soldered
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Instructor will grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Join pipe in piping project;
   c. Join copper tubing by soldering in piping project;
   d. Join copper tubing with fittings, ferrule and flare in piping project; and,
   e. Join plastic tubing in piping project.
IMM-K6
Fittings
Self-Assessment

Circle the letter preceding the most correct answer.

1. Most tubing fittings are threadless because tubing does not have the __________ needed.
   a. Length
   b. Shape
   c. Coating
   d. Wall thickness

2. The most commonly used fitting is the ell with the most common angles which are the __________ degree.
   a. 90 and 37-1/2
   b. 90 and 82
   c. 45 and 90
   d. 45 and 60

3. A straight tee means __________ threads.
   a. One outlet is 45°
   b. All outlets are the same size
   c. One outlet is reduced
   d. All outlets are different sizes

4. A nipple has __________ threads.
   a. A male and a female
   b. Two female
   c. One male and two female
   d. Two male

5. When reducing a pipe line in a straight run at a coupling a __________ would be used.
   a. Hexagon bushing
   b. Reducing tee
   c. Reducing ell
   d. Lateral
6. When a pipe line must end and not leak a __________ may be used.
   a. Tee or a coupling
   b. Plug or a cap
   c. Lateral or an elbow
   d. 45 degree elbow or a nipple

7. For ease in disconnecting and reconnecting a pipe line without disturbing the pipe's position a __________ may be used.
   a. Side outlet elbow
   b. Union
   c. Coupling
   d. Reducer

8. To tighten the bolts evenly on a pipe flange you should tighten __________.
   a. The opposite bolts in crossing
   b. In a clockwise direction
   c. In a counter clockwise direction
   d. Every other bolt

9. Welding fittings are supplied with __________.
   a. Tapered pipe threads
   b. Straight pipe threads
   c. Beveled ends
   d. Bell shaped ends

10. Each item for a welded fitting symbol may be identified by the __________.
    a. Parallel lines
    b. One line
    c. Circle
    d. Cross or x
 Subject: Industrial Maintenance
Duty: Piping Operations
Task: Plastic Pipe

Objective(s):

Upon completion of this module the student will be able to:

a. Describe plastic pipe;
b. Demonstrate joining plastic pipe; and,
c. Identify plastic pipe maintenance procedures.

Instructional Materials:

MASTER Handout (IMM-K7-HO)
MASTER Laboratory Aid (IMM-K7-LA)
MASTER Laboratory Worksheet (IMM-K7-LW)
MASTER Self-Assessment
Plastic Pipe
Pipe Compound

References:

*Basic Plumbing*, Harry Slater and Lee Smith, Delmar Publishers, Latest Edition
Video: *Plumbing and Pipefitting 730*, Bergwall, P.O. Box 238, Garden City, New York 11530, 1-800-645-3565, Latest Edition
*Tube Fittings*, Industrial Training Inc., 2023 Eastern Ave. S.E., P.O. Box 7186, Grand Rapids, MI 49510, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-K6 “Fittings”
Introduction:

Plastic pipe has become a very important part of plumbing in industrial, commercial and residential use. It is corrosion resistant, has self-insulating properties, is free from rust or rot, light weight, easy to join, and low in cost. These factors have made it better in some applications than other pipe. Here we will learn of their use, applications and assembly in this section.

Presentation Outline:

I. Describe Plastic Pipe
   A. Advantages
   B. Thermoplastic piping
   C. Thermo-setting plastics
   D. Limitations
II. Demonstrate Joining Plastic Pipe
   A. Welding
   B. Threaded joints
III. Identify Plastic Pipe Maintenance Procedures
   A. Identify
   B. Repair

Practical Application:

1. Join a coupling to plastic pipe by solvent welding.
2. Install a cap to CPVC by solvent welding.
3. Install plastic pipe to pipe project.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-L1) dealing with rigging fundamentals.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Describe plastic pipe;
b. Demonstrate joining plastic pipe; and,
c. Identify plastic pipe maintenance procedures.

Reading Assignments:

The following chapters are assigned to read from Piping Systems, Mechanical Equipment Series 736, Schoolcraft Publishing, Latest Edition

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Module Outline:

I. Describe Plastic Pipe
   A. Advantages
   B. Thermoplastic piping
   C. Thermosetting plastics
   D. Limitations
II. Demonstrate Joining Plastic Pipe
    A. Welding
    B. Threaded joints
III. Identify Plastic Pipe Maintenance Procedures
    A. Identify
    B. Repair
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Instructor will grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Join a coupling to plastic pipe by solvent welding;
   c. Install a cap to CPVC by solvent welding; and,
   d. Install plastic pipe to pipe project.
1. Instructor will demonstrate how to:
   a. Join a coupling to plastic pipe by solvent welding;
   b. Install a cap to CPVC by solvent welding; and,
   c. Install plastic pipe to pipe project.

2. Student will demonstrate how to:
   a. Join a coupling to plastic pipe by solvent welding;
   b. Install a cap to CPVC by solvent welding; and,
   c. Install plastic pipe to pipe project.

3. Instructor will grade student's ability to:
   a. Join a coupling to plastic pipe by solvent welding;
   b. Install a cap to CPVC by solvent welding; and,
   c. Install plastic pipe to pipe project.
IMM-K7
Plastic Pipe
Self-Assessment

Circle the letter preceding the most correct answer.

1. One advantage plastic piping has over black iron pipe is _____________.
   a. Heavier in weight
   b. Lower corrosion resistance
   c. Self-insulating
   d. Ease in threading

2. Generally speaking PVC is made from ____________ major plastic group.
   a. Thermosetting
   b. Thermoplastic
   c. Plexiglass
   d. Vinyl

3. Salt solutions do not cause as many problems due to corrosion if it is carried in ____________ pipe lines.
   a. Cast iron
   b. Copper
   c. Black iron
   d. PVC

4. One limitation of using plastic pipe is on ____________ lines.
   a. Water supply
   b. Drain
   c. High pressures
   d. Sewage

5. When joining thermoplastic, PVC, ABS, and CAB plastic lines the ____________ welding process is usually used.
   a. Solvent
   b. Fusion
   c. Fillet
   d. Arc
6. PE and similar plastics are joined by fusion welding using ___________.
   a. Special heater  
   b. Oxyacetylene torch  
   c. Arc rod  
   d. Chemical action

7. Plastic pipe may be threaded in limited cases and when the pipe is at least schedule ___________.
   a. 20  
   b. 40  
   c. 60  
   d. 80

8. When inspecting plastic pipe you should check for _____________.
   a. Leaks, sagging and rust  
   b. Leaks, sagging and out-of-round  
   c. Needing repainting, sagging and rusting  
   d. Sagging, leaks and needing repainting

9. Leaks are repaired by using ____________ for the particular pipe material.
   a. Duct tape  
   b. A special wood glue  
   c. Correct solvent  
   d. Special repair solvent

10. After repairs are made a drying time of ____________ hours is needed.
    a. 2  
    b. 4  
    c. 8  
    d. 10
IMM-K7
Plastic Pipe
Self-Assessment Answer Key:

1. C
2. B
3. D
4. C
5. A
6. A
7. D
8. B
9. C
10. D
INDUSTRIAL MAINTENANCE MECHANIC uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<td>H-2 Maintain pneumatic control circuits</td>
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<td>H-3 Troubleshoot centrifugal pumps</td>
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<td>H-4 Troubleshoot positive displacement pumps</td>
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<td>H-5 Maintain gate, globe, ball, plug, and butterfly valves</td>
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<td>H-6 Maintain check valves and relief valves</td>
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<td>H-7 Troubleshoot and repair blowers</td>
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<td></td>
<td>H-8 Troubleshoot, maintain, and repair hydraulic systems</td>
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<td></td>
<td>H-9 Troubleshoot, maintain, and repair pneumatic systems</td>
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<tr>
<td></td>
<td>I-1 Maintain and troubleshoot belt drive systems</td>
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<td></td>
<td>I-2 Maintain and troubleshoot gear power transmission drives</td>
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<tr>
<td></td>
<td>I-3 Maintain and troubleshoot chain power transmission drives</td>
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<tr>
<td></td>
<td>I-4 Maintain and troubleshoot clutches</td>
</tr>
<tr>
<td></td>
<td>J-1 Layout sheet metal parts</td>
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<td></td>
<td>J-2 Form and/or bend sheet metal parts</td>
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<tr>
<td></td>
<td>J-3 Fasten sheet metal parts together</td>
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</tbody>
</table>
INDUSTRIAL MAINTENANCE MECHANIC…uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<thead>
<tr>
<th>Duties</th>
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<td>O</td>
<td>Align Shafts</td>
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<tr>
<td>P</td>
<td>Install/Align Machines</td>
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<tr>
<td>Q</td>
<td>Maintain Electrical Devices</td>
</tr>
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<td>R</td>
<td>Basic Mechanical Concepts</td>
</tr>
<tr>
<td>S</td>
<td>Fasteners and Preloading</td>
</tr>
</tbody>
</table>

K-1 Perform basic pipefitting calculations
K-2 Cut, thread, and reuse pipe
K-3 Pipe assembly
K-4 Install and adjust pipe support
K-5 Tubing
K-6 Fittings
K-7 Plastic pipe

L-1 Rigging fundamentals
L-2 Demonstrate basic rigging skills

M-1 Plain bearings
M-2 Rolling element bearings

N-1 Perform basic word processing
N-2 Perform basic spreadsheet operations

O-1 Principles of alignment
O-2 Methods of alignment

P-1 Install electrical connections
P-2 Setting and leveling
P-3 Grouting
P-4 Special mountings

Q-1 Use electrical test equipment
Q-2 Apply basic terms to electrical circuits
Q-3 Analyze sensors, parallel, and complex AC/DC circuits
Q-4 Check AC and DC motors
Q-5 Troubleshoot electrical devices

R-1 Force
R-2 Work
R-3 Mechanical motion and rate
R-4 Simple machines
R-5 Power

S-1 Fasteners and nomenclature
S-2 Application for various fasteners
S-3 Techniques for removing damaged fasteners
S-4 Cleaning and restoring threaded fasteners
S-5 Torque preload theory
S-6 Effects of breaking threaded fasteners
S-7 Demonstrate appropriate torquing technique
INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-L1

Subject: Industrial Maintenance
Duty: Basic Rigging
Task: Rigging Fundamentals
Time: 12 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. State formula for dealing with center of gravity;
b. Compare wire rope to fiber rope usage;
c. Compare chain to block and tackle usage; and,
d. List two ways to construct a sling.

Instructional Materials:

MASTER Handout (IMM-L1-HO)
MASTER Self-Assessment

References:

Blueprint Reading, TPC Publishers, Latest Edition
Basic Blueprint Reading and Sketching, Olivo and Olivo, Delmar Publishers, Latest Edition
Reading Blueprints, Industrial Media, Inc., Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-K7 "Plastic Pipe"

Introduction:

Rigging allows one to gain mechanical advantage.

Presentation Outline:

I. Center of Gravity
II. Fiber Ropes and Lines
III. Wire Ropes and Lines
IV. Chains
V. Slings
VI. Block and Tackle

Practical Application:
1. Basic laws of physics will be analyzed.
2. Physical characteristics of materials will be analyzed.

Evaluation and/or Verification:
Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:
Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:
MASTER Technical Module (IMM-L2) dealing with demonstrating basic rigging skills.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. State formula for dealing with center of gravity;
b. Compare wire rope to fiber rope usage;
c. Compare chain to block and tackle usage; and,
d. List two ways to construct a sling.

Reading Assignments:

The following chapters are assigned to read from Mechanics' and Millwrights' Guide, Anderson, Audel Publishers, Latest Edition:

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<tr>
<th>Chapters</th>
<th>Title</th>
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<tr>
<td>21</td>
<td>Rigging</td>
</tr>
</tbody>
</table>

Module Outline:

I. Center of Gravity
II. Fiber Ropes and Lines
III. Wire Ropes and Lines
IV. Chains
V. Slings
VI. Block and Tackle
1. The weight of a load is perfectly balanced around the
   a. Fulcrum.
   b. Center of gravity.
   c. Adjacent corners.
   d. Lift point.

2. If the load tilts down to the left when you perform a trial lift, move the hoisting point
   a. To the left.
   b. To the right.
   c. Forward.
   d. Backward.
   e. Up or down.

3. ___________ is the strongest of the synthetic fiber ropes.
   a. Nylon
   b. Fiberglass
   c. Orlon
   d. Polypropylene

4. Chain is _______________ than wire rope.
   a. More resistant to corrosion
   b. More resistant to abrasion
   c. Better when resistance to cutting caused by sharp bending is needed
   d. All of the above

5. To make sure chain is in good working condition _______________ regularly.
   a. Inspect it
   b. Soak it in a mild acid solution
   c. Wash it with soap and water
   d. Stress test it, with a 105% capacity test load

6. A wire rope which has been kinked, can _______________ when the strain is taken off.
   a. Break
   b. Fail
   c. Snarl
   d. Grip more securely
7. ___________ slings are seldom used because of their weight.
   a. Manila
   b. Chain
   c. Nylon
   d. Wire rope

8. If the legs of a sling are spread further apart, the safe working load of the sling ___________.
   a. Decreases
   b. Increases
   c. Is not affected
   d. Is spread out

9. Proper running of the ropes through a block and tackle system is called
   a. Lacing.
   b. Splicing.
   c. Reeving.
   d. Sheaving.

10. What is the name for the rope on the block and tackle, which is pulled on to exert force and lift the load?
    a. Lead line
    b. Tag line
    c. Byline
    d. Hook line

11. If a rope is too small for a sheave, it can
    a. Be pinched.
    b. Flatten out.
    c. Cut a groove in the sheave.
    d. Both b and c.

12. The ___________ is the moving section of a derrick or crane, which supports the load.
    a. Base
    b. Boom
    c. Lead line
    d. Tag line

13. The ___________ on an A-frame derrick should never be used for anything other than very light loads.
    a. Topping lift
    b. Working tackle
    c. Boom
    d. Lead line
14. Over extending the _____________ on any type of crane or derrick can cause it to fail or collapse.
a. Lead line  
b. Base  
c. Jib  
d. Boom  

15. When moving a load up a ramp, a/an _____________ is attached to the load to allow it to be safely moved up the ramp.
a. Lever  
b. Inclined plane  
c. Wheel  
d. Snatch block  

16. A heavy load lowered onto blacktop in hot weather can mire up without something to
a. Spread out the pressure under it.  
b. Cool it off.  
c. Concentrate the pressure under the legs.  
d. Spread out its center of gravity.  

17. _____________ is not/are not a required safety item for rigging.
a. A hardhat  
b. Rubber gloves  
c. Safety goggles  
d. Safety shoes  

18. You should only exceed the rated capacity of hoisting equipment when
a. Ordered to do so by your supervisor.  
b. Time is running out to complete the job.  
c. The load you are lifting is the last load of the day.  
d. Never.
1. b
2. a
3. a
4. d
5. a
6. c
7. b
8. a
9. c
10. a
11. d
12. b
13. a
14. d
15. d
16. a
17. b
18. d
# INDUSTRIAL MAINTENANCE MECHANIC SERIES

**MASTER Technical Module No. IMM-L2**

<table>
<thead>
<tr>
<th>Subject:</th>
<th>Industrial Maintenance</th>
<th>Time: 10 Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duty:</td>
<td>Basic Rigging</td>
<td></td>
</tr>
<tr>
<td>Task:</td>
<td>Demonstrate Basic Rigging Skills</td>
<td></td>
</tr>
</tbody>
</table>

**Objective(s):**

Upon completion of this module the student will be able to:

- a. State formula for dealing with center of gravity;
- b. Compare wire rope to fiber rope usage;
- c. Compare chain to block and tackle usage;
- d. List two ways to construct a sling; and,
- e. Demonstrate basic rigging skills.

**Instructional Materials:**

- MASTER Handout (IMM-L2-HO)
- MASTER Laboratory Worksheet (IMM-L2-LW)
- MASTER Laboratory Aid (IMM-L2-LA)

**References:**

- *Basic Blueprint Reading and Sketching*, Olivo and Olivo, Delmar Publishers, Latest Edition

**Student Preparation:**

Students should have previously completed the following Technical Modules:

IMM-L1 "Rigging Fundamentals"

**Introduction:**

Rigging allows one to gain mechanical advantage. Successful demonstration proves a good understanding of rigging fundamentals.
Presentation Outline:

I. Center of Gravity  
II. Fiber Ropes and Lines  
III. Wire Ropes and Lines  
IV. Chains  
V. Slings  
VI. Block and Tackle

Practical Application:

1. Basic laws of physics will be analyzed.  
2. Physical characteristics of materials will be analyzed.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-M1) dealing with plain bearings.
IMM-L2-HO
Demonstrate Basic Rigging Skills
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
 a. State formula for dealing with center of gravity;
 b. Compare wire rope to fiber rope usage;
 c. Compare chain to block and tackle usage;
 d. List two ways to construct a sling; and,
 e. Demonstrate basic rigging skills.

Reading Assignments:

The following chapters are assigned to read from Mechanics' and Millwrights' Guide, Anderson, Audel Publishers, Latest Edition::

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<td>Rigging</td>
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</table>

Module Outline:

I. Center of Gravity
II. Fiber Ropes and Lines
III. Wire Ropes and Lines
IV. Chains
V. Slings
VI. Block and Tackle
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Demonstrate Basic Rigging Skills
Attachment 3: MASTER Laboratory Worksheet

1. Instructor will demonstrate how to:
a. Calculate center of gravity;
b. Treat fiber ropes and lines;
c. Treat wire ropes and lines;
d. Use chains for rigging;
e. Use slings safety to lift loads; and,
f. Use block and tackle safely to lift loads.

2. Student will demonstrate how to:
a. Calculate center of gravity;
b. Treat fiber ropes and lines;
c. Treat wire ropes and lines;
d. Use chains for rigging;
e. Use slings safety to lift loads; and,
f. Use block and tackle safely to lift loads.

3. Instructor will grade student’s ability to:
a. Calculate center of gravity;
b. Treat fiber ropes and lines;
c. Treat wire ropes and lines;
d. Use chains for rigging;
e. Use slings safety to lift loads; and,
f. Use block and tackle safely to lift loads.
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<tr>
<td>B</td>
<td>Apply Mathematical Concepts</td>
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<tr>
<td>C</td>
<td>Interpret Engineering Drawings and Control Documents</td>
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<tr>
<td>D</td>
<td>Use Measuring Tools</td>
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<td>E</td>
<td>Use Hand Tools</td>
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<td>F</td>
<td>Operate Machine Tools</td>
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<td>G</td>
<td>Perform Welding Operations</td>
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<td>H</td>
<td>Maintain/Redress Equipment and Systems</td>
</tr>
<tr>
<td>I</td>
<td>Repair Power Transmission Systems</td>
</tr>
<tr>
<td>J</td>
<td>Fabricate/Install Sheet Metal Parts</td>
</tr>
</tbody>
</table>

**Tasks:***

- A-1 Use protective equipment
- A-2 Accident prevention
- A-3 Working aloft
- A-4 Fire safety
- A-5 Lifting safety
- A-6 Lockout/tagout
- B-1 Perform basic arithmetic functions
- B-2 Convert fractions/decimals
- B-3 Convert Metric/English measurements
- B-4 Perform basic algebraic operations
- B-5 Perform basic trigonometric functions
- B-6 Perform basic geometric calculations
- C-1 Identify basic types of drawings
- C-2 Identify basic layout of drawings
- C-3 Review blueprint notes and dimensions
- D-1 Use non-precision measuring tools
- D-2 Use precision measuring tools
- E-1 Identify and use maintenance technician's handtools
- E-2 Identify and use hand held power tools
- F-1 Use and care of milling machines
- F-2 Use and care of horizontal and vertical band saws
- F-3 Use and care of surface grinder
- F-4 Use and care of pedestal grinder
- F-5 Operate lathes
- F-6 Use and care of drill press
- G-1 Weld with shielded metal arc welding (SMAW) process
- G-2 Weld with oxyacetylene
- G-3 Perform gas soldering
- H-1 Maintain air conditioning systems
- H-2 Maintain pneumatic control circuits
- H-3 Troubleshoot centrifugal pumps
- H-4 Troubleshoot positive displacement pumps
- H-5 Maintain gate, globe, ball, plug, and butterfly valves
- H-6 Maintain check valves and relief valves
- H-7 Troubleshoot and repair blowers
- H-8 Troubleshoot, maintain, and repair hydraulic systems
- H-9 Troubleshoot, maintain, and repair pneumatic systems
- I-1 Maintain and troubleshoot belt drive systems
- I-2 Maintain and troubleshoot gear power transmission drives
- I-3 Maintain and troubleshoot chain power transmission drives
- I-4 Maintain and troubleshoot clutches
- J-1 Layout and construct metal parts
- J-2 Form and/or bend sheet metal parts
- J-3 Fasten sheet metal parts together
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<td>K-1 Perform basic pipelining calculations</td>
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<td><strong>L</strong> Basic Rigging</td>
<td>L-1 Rigging fundamentals</td>
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<td><strong>M</strong> Bearing Maintenance</td>
<td>M-1 Plain bearings</td>
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<td><strong>N</strong> Use Computers</td>
<td>N-1 Perform basic processing</td>
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<td><strong>O</strong> Align Shafts</td>
<td>O-1 Principles of alignment</td>
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<tr>
<td><strong>P</strong> Install/Align Machines</td>
<td>P-1 Install electrical connections</td>
</tr>
<tr>
<td><strong>Q</strong> Maintain Electrical Devices</td>
<td>Q-1 Use electrical test equipment</td>
</tr>
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<td><strong>R</strong> Basic Mechanical Concepts</td>
<td>R-1 Force</td>
</tr>
<tr>
<td><strong>S</strong> Fasteners and Preloading</td>
<td>S-1 Fasteners and nomenclature</td>
</tr>
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</table>
INDUSTRIAL MAINTENANCE MECHANIC SERIES

MASTER Technical Module No. IMM-M1

Subject: Industrial Maintenance

Duty: Bearing Maintenance
Task: Plain Bearings

Time: 8 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the principles of operation of plain bearings;
b. Identify the types and materials of plain bearings;
c. Demonstrate maintenance practices for plain bearings; and,
d. Identify failure patterns of plain bearings.

Instructional Materials:

MASTER Handout (IMM-M1-HO)
MASTER Laboratory Aid (IMM-M1-LA)
MASTER Laboratory Worksheet (IMM-M1-LW)
MASTER Self-Assessment
Clean work area with parts washer
Arbor press
Hydraulic press
Bearing pullers
Good assortment of plain and roller bearings
Oil and grease with applicators
Hubs for pressure bearings into and removing then
Shafts for aligning bearings
Puller set
Bearing heater
Bearing separators
Table for mounting pillow block bearings
Necessary hand and measuring tools
Mounting dollies and sleeves
References:

Videos:
- Bearing Maintenance, Industrial Training Inc. (ITI), 2023
  Eastern Ave., S.E., P.O. Box 7186, Grand Rapids, MI
  49510, Latest Edition
- Bearing Failure Analysis, Industrial Training Inc. (ITI), 2023
  Eastern Ave., S.E., P.O. Box 7186, Grand Rapids, MI
  49510, Latest Edition
- Bearings, MAJEC Training Consultants, Inc., Shawnee
  Mission, Kansas, Latest Edition
- Maintaining Bearings, Tel-A-Trains, Mechanical
  Maintenance Series, 309 North Market Street, P.O. Box
  4752, Chattanooga, Tennessee 37405, 615-266-0113,
  Latest Edition
- Bearing Failures and their Causes, SKF, Latest Edition

Also check with your bearing distributor.

Student Preparation:

Students should have previously completed the following Technical Modules:

- IMM-A1 through IMM-A6 "Practice Safety" series
- IMM-B1 through IMM-B6 "Apply Mathematical Concepts" series
- IMM-C1 through IMM-C3 "Interpret Engineering Drawings and Control
  Documents" series
- IMM-D1 through IMM-D2 "Use Measuring Tools" series
- IMM-E1 through IMM-E2 "Use Hand Tools" series

Introduction:

Think of all the mechanical products we buy for work, play and the necessities of life. Almost all mechanical devices are composed of many different shapes, sizes and materials. Bearings, in these mechanical devices, support and insure that the parts move smoothly and easily to give long trouble-free life. In this section we will learn about plain bearings.

Presentation Outline:

I. Describe the Principles of Plain Bearings
   A. Introduction of bearings
   B. Lubrication
   C. Reason for soft bearing materials
II. Identify the Types and Materials of Plain Bearings
   A. Journal bearings
III. Demonstrate Maintenance Practices for Plain Bearings
A. General
B. Assembly
C. Cleaning
D. Relining journal bearings
E. Start-up

IV. Identify Failure Patterns of Plain Bearings
A. Operating symptoms
B. Symptoms found on inspection
C. Causes of failure

Practical Application:

1. Install shaft in two plain pillows block bearings;
2. Align, secure bearings to table and secure shaft to bearings;
3. Remove old bearing and press plain bearing in housing using proper tools and procedures;
4. Check inside diameter and shaft for proper fit;
5. Hone to size if necessary;
6. Lubricate bearings; and,
7. Run and troubleshoot bearing and shaft assemblies.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-M2) dealing with rolling element bearings.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the principles of operation of plain bearings;
b. Identify the types and materials of plain bearings;
c. Demonstrate maintenance practices for plain bearings; and,
d. Identify failure patterns of plain bearings.

Reading Assignments:

The following chapters are assigned to read from *Principles of Machine Operation and Maintenance*, Dick Jeffrey, ISBN 0170087050, Delmar/I.T.P., Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
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<tbody>
<tr>
<td>6.1</td>
<td>Plain Bearings</td>
</tr>
</tbody>
</table>

Module Outline:

I. Describe the Principles of Plain Bearings
   A. Introduction of bearings
   B. Lubrication
   C. Reason for soft bearing materials

II. Identify the Types and Materials of Plain Bearings
   A. Journal bearings
   B. Thrust bearings
   C. Linear bearings
   D. Material characteristics
E. Material types and uses

III. Demonstrate Maintenance Practices for Plain Bearings
   A. General
   B. Assembly
   C. Cleaning
   D. Relining journal bearings
   E. Start-up

IV. Identify Failure Patterns of Plain Bearings
   A. Operating symptoms
   B. Symptoms found on inspection
   C. Causes of failure
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Install shaft in two plain pillows block bearings;
   c. Align, secure bearings to table and secure shaft to bearings;
   d. Remove old bearing and press plain bearing in housing using proper tools and procedures;
   e. Check inside diameter and shaft for proper fit;
   f. Hone to size if necessary;
   g. Lubricate bearings; and,
   h. Run and troubleshoot bearing and shaft assemblies.
Review the general section under maintenance practices pages of text (reading assignment) prior to performing practical applications.
IMM-M1
Plain Bearings
Self-Assessment

Circle the letter preceding the most correct answer.

1. Plain bearing are described as having __________.
   a. Balls in two raceways
   b. Two surfaces sliding together
   c. Rollers in two raceways
   d. Pins in two raceways

2. In plain bearings the two surfaces must be __________ and __________
   to provide minimum resistance.
   a. Rough sanded and dry
   b. Knurled and lubricated
   c. Smooth and lubricated
   d. Smooth and dry

3. In a plain bearing the material of the bearing is __________ than the
   shaft.
   a. Softer
   b. Longer
   c. Harder
   d. Rougher

4. The linear plain bearing with a GIB adjustment is a ____________.
   a. Single-slide
   b. Double-slide
   c. V-angled way
   d. Dovetail

5. If a plain bearing does not have a material with conform ability it is very
   necessary to insure ____________ during installation.
   a. Extra lubrication is used
   b. Minimum clearance is provided
   c. Proper alignment
   d. Clean mounting
6. Before pressing a plain bearing into a housing check the ____________ of the shaft and housing.
   a. Dimensions
   b. Hardness
   c. Softness
   d. Flatness

7. If at all possible a plain bearing should be installed by using ____________.
   a. Sledge hammer
   b. An arbor press
   c. Wood block and hammer
   d. An oxyacetylene torch

8. The clearance and roundness of the bearing a shaft may be checked with ____________.
   a. Outside and inside calipers
   b. A 12' steel tape
   c. A folding rule
   d. A micrometer and gage

9. The first thing to check before running the shaft in the plain bearing is alignment using ____________ to indicate wear spots.
   a. Teflon tape
   b. Bluing
   c. Pipe dope
   d. Shin stock

10. Of the operating symptoms of plain bearing failure ____________ could cause extensive equipment damage.
    a. Noise
    b. Vibration
    c. Seizure
    d. Overheating
<p>| | |</p>
<table>
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<tbody>
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<td>1.</td>
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<td>2.</td>
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<td>9.</td>
<td>B</td>
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<td>10.</td>
<td>C</td>
</tr>
</tbody>
</table>
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-M2

Subject: Industrial Maintenance  Time: 8 Hrs.
Duty: Bearing Maintenance
Task: Rolling Element Bearings

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the principles of operation of rolling element bearings;
b. Identify the types of rolling element bearings;
c. Describe rolling element bearing assembly design;
d. Demonstrate maintenance practices of rolling element bearings; and,
e. Identify failure patterns of rolling element bearings.

Instructional Materials:

MASTER Handout (IMM-M2-HO)
MASTER Laboratory Aid (IMM-M2-LA)
MASTER Laboratory Worksheet (IMM-M2-LW)
MASTER Self-Assessment
Clean work area with parts washer
Arbor press
Hydraulic press
Bearing pullers
Good assortment of plain and roller bearings
Oil and grease with applicators
Hubs for pressure bearings into and removing them
Shafts for aligning bearings
Puller set
Bearing heater
Bearing separators
Table for mounting pillow block bearings
Necessary hand and measuring tools
Mounting dollies and sleeves
Introduction:

Think of all the mechanical products we buy for work, play and the necessities of life. Almost all mechanical devices are composed of many different shapes, sizes and materials. Bearings, in these mechanical devices, support and insure that the parts move smoothly and easily to give long trouble-free life. In this section we will learn about rolling element bearings.

Presentation Outline:

I. Describe the Principle of Operation of Rolling Element Bearings
   A. Introduction
   B. Ball bearings
   C. Roller bearings
   D. Linear bearings

II. Identify the Types of Rolling Elements Bearings
A. Journal bearings  
B. Thrust bearings  

III. Describe Roller Element Bearing Assembly Design  
A. Shaft and housing fits  
B. Thermal expansion  
C. Types of mountings  

IV. Demonstrate Maintenance Practices of Roller Element Bearings  
A. General  
B. Tools and equipment  
C. Mounting procedures  
D. Pre-lubrication  
E. Selection of mounting method  
F. Special considerations  
G. Dismounting procedures  

V. Identify Failure Patterns of Rolling Element Bearings  
A. Operating symptoms  
B. Symptoms found on inspection  
C. Cause of failure  

---  

**Practical Application:**  

1. Install a shaft in two self-aligning pillow block bearing with rolling element bearings;  
2. Change the rolling element bearing in a self-aligning pillow block to a different size;  
3. Remove a rolling element bearing from a shaft and install another bearing;  
4. Remove a rolling element bearing from a housing and install another bearing; and,  
5. Clean and pre-lubricate a rolling element bearing.  

---  

**Evaluation and/or Verification:**  

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.  

---  

**Summary:**  

Review the main lesson points using the objectives as a guide for discussion and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (IMM-N1) dealing with basic word processing operations.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Describe the principles of operation of rolling element bearings;
b. Identify the types of rolling element bearings;
c. Describe rolling element bearing assembly design;
d. Demonstrate maintenance practices of rolling element bearings; and,
e. Identify failure patterns of rolling element bearings.

Reading Assignments:

The following chapters are assigned to read from *Principles of Machine Operation and Maintenance*, Dick Jeffrey, Delmar/ITP Publishing, Latest Edition

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2</td>
<td>Rolling Element Bearings</td>
</tr>
</tbody>
</table>

Module Outline:

I. Describe the Principle of Operation of Rolling Element Bearings
   A. Introduction
   B. Ball bearings
   C. Roller bearings
   D. Linear bearings

II. Identify the Types of Rolling Elements Bearings
   A. Journal bearings
   B. Thrust bearings
III. Describe Roller Element Bearing Assembly Design
   A. Shaft and housing fits
   B. Thermal expansion
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   A. General
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   C. Mounting procedures
   D. Pre-lubrication
   E. Selection of mounting method
   F. Special considerations
   G. Dismounting procedures

V. Identify Failure Patterns of Rolling Element Bearings
   A. Operating symptoms
   B. Symptoms found on inspection
   C. Cause of failure
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Install a shaft in two self aligning pillow block bearing with rolling element bearings;
   c. Change the rolling element bearing in a self aligning pillow block to a different size;
   d. Remove a rolling element bearing from a shaft and install another bearing;
   e. Remove a rolling element bearing form a housing and install another bearing; and,
   f. Clean and pre-lubricate a rolling element bearing.
Review the general section, under maintenance practices pages of text (reading assignment) prior to performing practical applications.
6. New bearings should be kept ______________ until you are ready to mount it.
   a. In solvent
   b. Covered in used motor oil
   c. Wrapped in its paper
   d. Covered in water

7. Rolling element bearings usually may be cold mounted if they are less than __________ inches in diameter.
   a. 10
   b. 8
   c. 6
   d. 4

8. When using a sleeve to press a rolling element bearing onto a shaft the sleeve should rest on the __________ interference fit.
   a. Ball assembly next to the
   b. Cage next to the
   c. Bearing ring closes to the
   d. Bearing ring away from the

9. When hot mounting a rolling element bearing the bearing should never be heated above __________ degrees F.
   a. 150
   b. 250
   c. 350
   d. 450

10. The single most common cause of rolling element bearing failure is ______________.
    a. Lack of lubrication
    b. Moisture
    c. Dirt
    d. Electric currents
6. New bearings should be kept ____________ until you are ready to mount it.
   a. In solvent
   b. Covered in used motor oil
   c. Wrapped in its paper
   d. Covered in water

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9. When hot mounting a rolling element bearing the bearing should never be heated above ____________ degrees F.
   a. 150
   b. 250
   c. 350
   d. 450

10. The single most common cause of rolling element bearing failure is ____________.
    a. Lack of lubrication
    b. Moisture
    c. Dirt
    d. Electric currents
IMM-M2
Rolling Element Bearings
Self-Assessment Answer Key

1. C
2. B
3. D
4. B
5. A
6. C
7. D
8. C
9. B
10. A
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> Practice Safety</td>
<td>A-1 Use protective equipment</td>
</tr>
<tr>
<td><strong>B</strong> Apply Mathematical Concepts</td>
<td>B-1 Perform basic mathematical functions</td>
</tr>
<tr>
<td><strong>C</strong> Interpret Engineering Drawings and Control Documents</td>
<td>C-1 Identify basic types of drawings</td>
</tr>
<tr>
<td><strong>D</strong> Use Measuring Tools</td>
<td>D-1 Use non-precision measuring tools</td>
</tr>
<tr>
<td><strong>E</strong> Use Hand Tools</td>
<td>E-1 Identify and use maintenance technician's hand tools</td>
</tr>
<tr>
<td><strong>F</strong> Operate Machine Tools</td>
<td>F-1 Use and care of milling machines</td>
</tr>
<tr>
<td><strong>G</strong> Perform Welding Operations</td>
<td>G-1 Weld with shielded metal arc welding (SAW) process</td>
</tr>
<tr>
<td><strong>H</strong> Maintain/ Troubleshoot Air conditioning systems</td>
<td>H-1 Maintain air conditioning systems</td>
</tr>
<tr>
<td><strong>I</strong> Repair Power Transmission Systems</td>
<td>I-1 Maintain and troubleshoot belt drive systems</td>
</tr>
<tr>
<td><strong>J</strong> Fabricate/ Install Sheet Metal Parts</td>
<td>J-1 Layout sheet metal parts</td>
</tr>
</tbody>
</table>

**Tasks**

- A-2 Accident prevention
- A-3 Working at heights
- A-4 Fire safety
- A-5 Lifting safety
- A-6 Lockout/tagout
- B-2 Convert fractions/decimals
- B-3 Convert Metric/English measurements
- B-4 Perform basic algebraic operations
- B-5 Perform basic trigonometric functions
- B-6 Perform basic geometric calculations
- C-2 Identify basic layout of drawings
- C-3 Review blueprint notes and dimensions
- D-2 Use precision measuring tools
- E-2 Identify and use hand held power tools
- F-3 Use and care of surface grinder
- F-6 Operate lathes
- F-8 Use and care of drill press
- G-3 Perform gas soldering
- H-2 Maintain pneumatic control circuits
- H-3 Troubleshoot centrifugal pumps
- H-4 Troubleshoot positive displacement pumps
- H-5 Maintain gate, globe, ball, plug, and butterfly valves
- H-6 Maintain check valves and relief valves
- H-7 Troubleshoot, maintain, and repair hydraulic systems
- H-8 Troubleshoot, maintain, and repair pneumatic systems
- I-2 Maintain and troubleshoot gear power transmission drives
- I-3 Maintain and troubleshoot chain power transmission drive
- I-4 Maintain and troubleshoot clutches
- J-2 Form or bend sheet metal parts together
- J-3 Fasten sheet metal parts
INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
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<tbody>
<tr>
<td>Piping Operations</td>
<td>K-1 Perform basic pipelfitting calculations</td>
</tr>
<tr>
<td>Basic Rigging</td>
<td>L-1 Rigging fundamentals</td>
</tr>
<tr>
<td>Bearing</td>
<td>M-1 Plain bearings</td>
</tr>
<tr>
<td>Maintenance</td>
<td>M-2 Rolling element bearings</td>
</tr>
<tr>
<td>Use Computers</td>
<td>N-1 Perform basic word processing</td>
</tr>
<tr>
<td>Align Shafts</td>
<td>O-1 Principles of alignment</td>
</tr>
<tr>
<td>Install/Align Machines</td>
<td>P-1 Install electrical connections</td>
</tr>
<tr>
<td>Maintain Electrical Devices</td>
<td>Q-1 Use electrical test equipment</td>
</tr>
<tr>
<td>Basic Mechanical Concepts</td>
<td>R-1 Force</td>
</tr>
<tr>
<td>Fasteners and Preloading</td>
<td>S-1 Fasteners and nomenclature</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-2 Cut, thread, and ream pipe</td>
</tr>
<tr>
<td>K-3 Pipe assembly</td>
</tr>
<tr>
<td>K-4 Install and adjust pipe support</td>
</tr>
<tr>
<td>K-5 Tubing</td>
</tr>
<tr>
<td>K-6 Fittings</td>
</tr>
<tr>
<td>K-7 Plastic pipe</td>
</tr>
<tr>
<td>L-2 Demonstrate basic rigging skills</td>
</tr>
<tr>
<td>M-2 Rolling element bearings</td>
</tr>
<tr>
<td>N-2 Perform basic spreadsheet operations</td>
</tr>
<tr>
<td>O-2 Methods of alignment</td>
</tr>
<tr>
<td>P-2 Setting and leveling</td>
</tr>
<tr>
<td>P-3 Grouting</td>
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<tr>
<td>P-4 Special mountings</td>
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<tr>
<td>Q-2 Apply basic terms to electrical circuits</td>
</tr>
<tr>
<td>Q-3 Analyze series, parallel, and complex AC/DC circuits</td>
</tr>
<tr>
<td>Q-4 Check AC and DC motors</td>
</tr>
<tr>
<td>Q-5 Troubleshoot electrical devices</td>
</tr>
<tr>
<td>R-2 Work</td>
</tr>
<tr>
<td>R-3 Mechanical motion and rate</td>
</tr>
<tr>
<td>R-4 Simple machines</td>
</tr>
<tr>
<td>R-5 Power</td>
</tr>
<tr>
<td>S-2 Application for various fasteners</td>
</tr>
<tr>
<td>S-3 Techniques for removing damaged fasteners</td>
</tr>
<tr>
<td>S-4 Cleaning and restoring threaded fasteners</td>
</tr>
<tr>
<td>S-5 Torque preload theory/Effects of lubricating threads prior to torquing</td>
</tr>
<tr>
<td>S-7 Demonstrate appropriate torquing technique</td>
</tr>
</tbody>
</table>
# INDUSTRIAL MAINTENANCE MECHANIC SERIES
## MASTER Technical Module No. IMM-N1

<table>
<thead>
<tr>
<th>Subject:</th>
<th>Industrial Maintenance</th>
<th>Time: 30 Hrs.</th>
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<tbody>
<tr>
<td>Duty:</td>
<td>Use Computers</td>
<td></td>
</tr>
<tr>
<td>Task:</td>
<td>Perform Basic Word Processing</td>
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</table>

**Objective(s):**

Upon completion of this module the student will be able to:

- a. Create a document;
- b. Edit a document;
- c. Select fonts;
- d. Cut, copy, and paste;
- e. Select tab and indent;
- f. Get help;
- g. Use speller and thesaurus;
- h. Find and replace;
- i. Create header and footer;
- j. Create tables;
- k. Use columns; and,
- l. Import and export graphics.

**Instructional Materials:**

- MASTER Handout (IMM-N1-HO)
- MASTER Laboratory Worksheet (IMM-N1-LW)
- MASTER Laboratory Aid (IMM-N1-LA)
- MASTER Self-Assessment
- Computer with word processing software loaded (Windows preferred)

**References:**

- *MS Word*, Microsoft Press, Latest Edition
Student Preparation:

Introduction:

Word processing on a computer, in conjunction with a printer, replaces a typewriter. Also, a word processor allows for ease in changing text, graphics, tables, and columns. Many technicians are required to produce reports, memos, etc. A basic understanding of a word processor allows the technician to generate and alter documents.

Presentation Outline:

I. Create a Document
II. Edit a Document
III. Select Fonts
IV. Cut, Copy, and Paste
V. Tab and Indent
VI. Help
VII. Speller
VIII. Thesaurus
IX. Replace
X. Header
XI. Footer
XII. Table
XIII. Columns
XIV. Graphics

Practical Application:

1. Instructor will demonstrate steps to produce documents using a word processor.

2. Student will demonstrate steps to produce documents using a word processor.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.
Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-N2) dealing with basic spreadsheet operations.
Standards of performance:

Student shall demonstrate safe work habits in the computer laboratory by not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Create a document;
b. Edit a document;
c. Select fonts;
d. Cut, copy, and paste;
e. Select tab and indent;
f. Get help;
g. Use speller and thesaurus;
h. Find and replace;
i. Create header and footer;
j. Create tables;
k. Use columns; and,
l. Import and export graphics.

Reading Assignments:

The following chapters are assigned to read from *Learning WordPerfect* by Corel Corp., Latest Edition:

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Creating a Document</td>
</tr>
<tr>
<td>1</td>
<td>Editing a Document</td>
</tr>
<tr>
<td>1</td>
<td>Selecting Fonts</td>
</tr>
<tr>
<td>1</td>
<td>Using Cut, Copy, and Paste</td>
</tr>
<tr>
<td>2</td>
<td>Using Tab and Indent</td>
</tr>
<tr>
<td>2</td>
<td>Using Help</td>
</tr>
<tr>
<td>3</td>
<td>Using Speller and Thesaurus</td>
</tr>
<tr>
<td>3</td>
<td>Find and Replace</td>
</tr>
<tr>
<td>3</td>
<td>Headers and Footers</td>
</tr>
<tr>
<td>3</td>
<td>Tables</td>
</tr>
<tr>
<td>4</td>
<td>Columns</td>
</tr>
<tr>
<td>4</td>
<td>Graphics</td>
</tr>
</tbody>
</table>
Module Outline:

I. Create a Document
II. Edit a Document
III. Select Fonts
IV. Cut, Copy, and Paste
V. Tab and Indent
VI. Help
VII. Speller
VIII. Thesaurus
IX. Replace
X. Header
XI. Footer
XII. Table
XIII. Columns
XIV. Graphics
The students will:

a. Follow housekeeping rules set up by instructor and school;

b. Follow closely instructions given by instructor;

c. Do not go faster than instructor, this could create problems;

d. If unable to follow instructor, let instructor know; and,

e. Ask questions if steps are not clear.
The students will:

a. Practice using software commands;

b. After practicing setting up spreadsheet, proceed to creating charts; and,

c. After practicing creating charts, let instructor know that you are ready to take performance measure.
Perform Basic Word Processing
Self-Assessment

Instructions: Circle the correct response.

**Word**

1. To set the top, bottom, left, and right margins in a word processing document, use the _________.
   A. Page Setup command from the File Menu
   B. Headers and Footers command from the View Menu
   C. Paragraph command from Format Menu
   D. Options command from the Tools Menu

2. The Headers and Footers command is found on the ________ menu.
   A. File
   B. Edit
   C. View
   D. Format

3. The entry in the Headers and Footers dialog box to specify printing the page number in the header is ________.
   A. &page
   B. &number
   C. &p
   D. #

4. In normal view, a header created the Headers and Footers command will ________.
   A. Display at the top of each screen unless certain boxes have been selected
   B. Display on the screen only when there is a page break mark on the screen
   C. Print at the top of each page unless certain boxes have been selected
   D. Display on the screen and print at the top of each page unless certain boxes have been selected
5. Dragging the first-line indent marker on the ruler one-half inch to the right will cause ________________.
   A. All lines typed to be indented one-half inch
   B. All new sentences to be indented one-half inch
   C. The first line of each paragraph to be indented one-half inch
   D. The first line each paragraph to be indented one-half inch if you press the TAB key

6. When you choose the Footnote command from the Insert menu, ________________.
   A. A footnote panel appears at the top of the screen allowing you to type the footnote
   B. A footnote panel appears at the end of the document allowing you to select a number or a character as a footnote reference mark
   C. A footnote dialog box displays in the footnote panel
   D. A footnote dialog box displays in the center of the screen allowing you to select a numbered footnote or a character

7. To cause a manual page break to occur on a document ________________.
   A. Choose the Break command in the Insert Menu
   B. Press CTRL+ALT
   C. Press CTRL+SHIFT
   D. Press SHIFT+ENTER

8. The command used to replace one or more words at time in a document with another word or words is the ________________ command.
   A. Find
   B. Go To
   C. Thesaurus
   D. Replace

9. The Works drag-and-drop method may be used to ________________.
   A. Move text from one location to another in a document
   B. Copy text from one location to the another location in a document with the copied text remaining in its original position
   C. Position footnotes at the end of a document
   D. Both A and B

10. To create a table in a word processing document, you can use the ________________.
    A. Insert Table button on the Toolbar
    B. Spreadsheet/Table command from the Insert menu
    C. Object command from the Insert menu
    D. A, B, and C
IMM-N1
Perform Basic Word Processing
Self-Assessment Answer Key

1. A
2. C
3. D
4. C
5. A
6. D
7. A
8. D
9. D
10. A
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-N2

Subject: Industrial Maintenance

Duty: Use Computers

Task: Perform Basic Spreadsheet Operations

Time: 8 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate how to use file menu commands;
b. Demonstrate how to use edit menu commands;
c. Demonstrate how to use format menu commands;
d. Demonstrate how to use print spreadsheet; and,
e. Demonstrate how to develop chart from spreadsheet.

Instructional Materials:

MASTER Handout (IMM-N2-HO)
MASTER Laboratory Aid (IMM-N2-LA)
MASTER Laboratory Worksheet (IMM-N2-LW)
MASTER Self-Assessment
Computer with spreadsheet software (E.g.: Excel, Lotus 123, Window Works)

References:

MS Excel, Microsoft Press, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-N1 “Perform Basic Word Processing”
Introduction:

Spreadsheets allows a person to organize subject areas and separate by fields.

Presentation Outline:

I. File Menu Commands
II. Edit Menu Commands
III. Format Menu Commands
IV. Print Spreadsheet
V. Develop Chart from Spreadsheet

Practical Application:

1. Instructor will demonstrate how to use the software commands to create spreadsheets and charts.

2. Student will demonstrate how to use the software command to create spreadsheets and charts.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-O1) dealing with principles of alignment.
Standards of performance:

Student shall demonstrate safe work habits in the computer lab.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate how to use file menu commands;
b. Demonstrate how to use edit menu commands;
c. Demonstrate how to use format menu commands;
d. Demonstrate how to use print spreadsheet; and,
e. Demonstrate how to develop chart from spreadsheet.

Reading Assignments:

The following chapters are assigned to read from PFS: Window Works by Spinnaker Publishing Co., Latest Edition:

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>File Menu Commands</td>
</tr>
<tr>
<td>11</td>
<td>Edit Menu Commands</td>
</tr>
<tr>
<td>11</td>
<td>Format Menu Commands</td>
</tr>
<tr>
<td>11</td>
<td>Create Chart</td>
</tr>
</tbody>
</table>

Module Outline:

I. File Menu Commands
II. Edit Menu Commands
III. Format Menu Commands
IV. Print Spreadsheet
V. Develop Chart from Spreadsheet
IMM-N2-LA
Perform Basic Spreadsheet Operations
Attachment 2: MASTER Laboratory Aid

1. Follow housekeeping rules set up by instructor and school;
2. Follow closely instructions given by instructor;
3. Do not go faster than instructor; this could create problems;
4. If unable to follow instructor, let instructor know; and,
5. Ask questions if steps are not clear.
1. Practice using software commands;
2. After practicing setting up spreadsheet, proceed to creating charts; and,
3. After practicing creating charts, let instructor know that you are ready to take Self-Assessment.
IMM-N2
Perform Basic Spreadsheet Operations
Self-Assessment

Instructions: Circle the correct response.

Excel

1. You can highlight a cell by ____________.
   A. Clicking the cell while the mouse pointer is in the cell
   B. Pressing an arrow key until the desired cell is outlined with a heavy border
   C. Both A and B
   D. Neither A nor B

2. The column titles, September, October, November, and December, can be conveniently placed in a spreadsheet by using the ____________ command.
   A. Fill series
   B. Fill right
   C. Replace
   D. Select all

3. ________________ is a block of adjacent cells in a spreadsheet.
   A. Range
   B. Group
   C. Highlight
   D. Format

4. Clicking the Autosum button two times is the same as ________________.
   A. Clicking the Autosum button one time and pressing the RIGHT ARROW key
   B. Clicking the Autosum button one time and clicking the Enter box
   C. Clicking the Autosum button one time
   D. Clicking the Autosum button and clicking the Currency button on the Toolbar

5. To change the width of more than one column at a time, you must first ________________.
   A. Highlight cell A1
   B. Highlight any cell in the beginning column
   C. Highlight at least one cell in every column you want to change
   D. Highlight the entire spreadsheet
6. To remove the highlighting from a group of cells, _____________.
   A. Click any cell on the spreadsheet
   B. Choose the Clear command from the Edit menu
   C. Click the Cut button on the Toolbar
   D. Press the DELETE key on the keyboard

7. To save your spreadsheet the first time, choose the ________________.
   A. Save As button on the Toolbar
   B. Startup button on the Toolbar
   C. Close button on the Toolbar
   D. Save button on the Toolbar

8. To create a chart, highlight the portion of the spreadsheet to be charted and then ________________.
   A. Choose the New Chart command from the View menu
   B. Click the New Chart button on the Toolbar
   C. Choose the Options command from the Tools menu
   D. Select the Window menu

9. To delete a character in the formula bar, ________________.
   A. Place the insertion point to the right of the character to delete and press the DELETE key
   B. Place the insertion point to the right of the character to delete and press the BACKSPACE key
   C. Place the insertion point to the left of the character to delete and press the SPACEBAR
   D. Place the insertion point of the left of the character to delete and press the BACKSPACE key

10. To remove the contents and formatting of a highlighted cell, ________________.
    A. Press the DELETE key
    B. From the EDIT menu, choose the Clear command
    C. Click the Cut button on the Toolbar
    D. From the Edit menu, choose the Delete command
IMM-N2
Perform Basic Spreadsheet Operations
Self-Assessment Answer Key

1. C
2. B
3. B
4. B
5. C
6. A
7. A
8. B
9. B
10. A
**INDUSTRIAL MAINTENANCE MECHANIC** uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

### Duties

| **A** | Practice Safety |
| **B** | Apply Mathematical Concepts |
| **C** | Interpret Engineering Drawings and Control Documents |
| **D** | Use Measuring Tools |
| **E** | Use Hand Tools |
| **F** | Operate Machine Tools |
| **G** | Perform Welding Operations |
| **H** | Maintain/Troubleshoot Equipment and Systems |
| **I** | Repair Power Transmission Systems |
| **J** | Fabricate/Install Sheet Metal Parts |

### Tasks

| A-1 | Use protective equipment |
| A-2 | Accident prevention |
| A-3 | Working aloft |
| A-4 | Fire safety |
| A-5 | Lifting safety |
| A-6 | Lockout/tagout |
| B-1 | Perform basic arithmetic functions |
| B-2 | Convert fractions/decimals |
| B-3 | Convert metric/english measurements |
| B-4 | Perform basic algebraic operations |
| B-6 | Perform basic trigonometric functions |
| B-7 | Perform basic geometric calculations |
| C-1 | Identify basic types of drawings |
| C-2 | Identify basic layout of drawings |
| C-3 | Review blueprint notes and dimensions |
| D-1 | Use non-precision measuring tools |
| D-2 | Use precision measuring tools |
| E-1 | Identify and use maintenance technician's hand tools |
| E-2 | Identify and use hand held power tools |
| F-1 | Use and care of milling machines |
| F-2 | Use and care of horizontal and vertical band saws |
| F-3 | Use and care of surface grinder |
| F-4 | Use and care of drill press |
| F-5 | Operate lathes |
| F-6 | Operate lathes |
| G-1 | Weld with shielded metal arc welding (SMAW) process |
| G-2 | Weld with oxyacetylene |
| G-3 | Perform gas soldering |
| H-1 | Maintain air conditioning systems |
| H-2 | Maintain pneumatic control circuits |
| H-3 | Troubleshoot centrifugal pumps |
| H-4 | Troubleshoot positive displacement pumps |
| H-5 | Maintain check valves and relief valves |
| H-6 | Maintain, maintain, and repair hydraulic systems |
| H-7 | Maintain, maintain, and repair hydraulic systems |
| H-8 | Maintain, maintain, and repair hydraulic systems |
| H-9 | Maintain, maintain, and repair hydraulic systems |
| I-1 | Maintain and troubleshoot belt drive systems |
| I-2 | Maintain and troubleshoot gear power transmission drives |
| I-3 | Maintain and troubleshoot chain power transmission drives |
| I-4 | Maintain and troubleshoot clutches |
| J-1 | Layout sheet metal parts |
| J-2 | Form and/or bend sheet metal parts |
| J-3 | Fasten sheet metal parts together |

**BEST COPY AVAILABLE**
INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<td>S-6 Effects of lubricating threads prior to torquing</td>
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<td>S-7 Demonstrate appropriate torquing techniques</td>
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</tbody>
</table>
Subject: Industrial Maintenance

Time: 4 Hrs.

Duty: Align Shafts

Task: Principles of Alignment

Objective(s):

Upon completion of this module the student will be able to:

a. Describe misalignment;
b. Identify tolerances for alignment;
c. Describe adjustments procedures;
d. Demonstrate how to align using a dial indicators;
e. Describe thermal growth; and,
f. Demonstrate doweling after alignment.

Instructional Materials:

MASTER Handout (IMM-01-HO)
MASTER Laboratory Aid (IMM-01-LA)
MASTER Laboratory Worksheet (IMM-01-LW)
MASTER Self-Assessment

Steel plate 2" x 6"
Drills and ream
1/4 x 1/2 dowel pins
Tools necessary to complete the project

References:


Videos: Couplings, Tel-A-Train, Mechanical Maintenance Series, 309 North Market Street, P. O. Box 4752, Chattanooga, Tennessee 37405, 615-266-0113, Latest Edition

Coupling Alignment, Tel-A-Train, Mechanical Maintenance Series, 309 North Market Street, P. O. Box 4752, Chattanooga, Tennessee 37405, 615-266-0113, Latest Edition
Introduction:

It is very important to insure shaft alignment is as close as possible. Poor alignment may cause critical damage to drives and equipment due to excessive vibration. This vibration could damage to bearings, seals, couplings and other machine elements. After completion of this section you will better understand the principles of shaft alignment and doweling.

Presentation Outline:

I. Describe Misalignment
   A. Parallel misalignment
   B. Angular misalignment
   C. Combination misalignment

II. Identify Tolerances for Alignment
    A. Coupling manufacturers
    B. Machinery manufacturers
    C. Special conditions

III. Describe Adjustment Procedures
     A. Unit to adjust
     B. Distance and soft foot
     C. Equipment rocking (soft-foot)
     D. Vertical alignment first

IV. Determine How to Align Using a Dial Indicator
    A. Introduction to a dial indicator
    B. Total indicator run-out

V. Describe Thermal Growth
   A. Effects of temperature
   B. Aligning steam turbines
VI. Demonstrate Doweling after Alignment
   A. Purpose
   B. Location

Practical Application:

1. Mount a pump and a motor to a bed plate or two shafts in pillow block bearings; and,
2. Secure 2 each, 2" x 1/4" x 6" long steel plates, using dowel pins.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-O2) dealing with methods of alignment.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Describe misalignment;
b. Identify tolerances for alignment;
c. Describe adjustments procedures;
d. Demonstrate how to align using a dial indicators;
e. Describe thermal growth; and,
f. Demonstrate doweling after alignment.

Reading Assignments:

The following chapters are assigned to read from *Principles of Machine Operations and Maintenance*, Dick Jeffrey, Delmar Publishing/ATP, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
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Module Outline:

I. Describe Misalignment
   A. Parallel misalignment
   B. Angular misalignment
   C. Combination misalignment

II. Identify Tolerances for Alignment
   A. Coupling manufacturers
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   A. Effects of temperature
   B. Aligning steam turbines

VI. Demonstrate Doweling after Alignment
   A. Purpose
   B. Location
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Mount a pump and a motor to a bed plate or two shafts in pillow block bearings; and,
   c. Secure 2 each, 2" x 1/4" x 6" long steel plates, using dowel pins.
2.000

.250 REAM 2 HOLES

2 ea. Plates, drill, ream and dowel
Use 2 ea. 1/4" X 1/2" dowel pins
1. If the driven unit shaft is level but the driver unit front is higher than the rear is called ____________ misalignment.
   a. Foot  
   b. Soft foot  
   c. Angular  
   d. Parallel

2. Coupling alignment becomes more critical with ______________.
   a. High speeds and with high power transmission  
   b. Slow speed and with high power transmission  
   c. Low speed and with low torque  
   d. Small sump pumps

3. When performing coupling alignment it is normal to adjust the __________.
   a. Front pulley  
   b. Gear shaft  
   c. Driven machine  
   d. Driving machine

4. The shaft of the driven machine should be approximately __________ inches higher than the driving machine for coupling alignment.
   a. .002  
   b. .050  
   c. .125  
   d. .250

5. The dial indicator should be zeroed when the plunger is ________________.
   a. At midway of the travel  
   b. Reading .010"  
   c. Fully depressed  
   d. Reading .050"
6. If a dial indicator is zeroed at the top position and the shaft is rotated 180 degrees and then reads .025 inches the total run out is _________ inches.
   a. .0375
   b. .0125
   c. .025
   d. .050

7. If a dial indicator is zeroed at the top position and the shaft is rotated 180 degrees and then reads .025 inches the center line of the two shafts are _______ inches out of line.
   a. .0375
   b. .0125
   c. .025
   d. .050

8. If a dial indicator plunger is depressed the reading is ____________.
   a. Doubled
   b. 1/2 the reading
   c. Negative
   d. Positive

9. If the thermal expansion is evident in alignment the driving shaft should be _________ than the driven shaft.
   a. Larger
   b. Smaller
   c. Set lower
   d. Set higher

10. After the couplings have been properly aligned dowel pins should be positioned ____________.
    a. With two pins on each foot
    b. 2 inches a part
    c. 4 inches a part
    d. As far a part as possible
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>1</td>
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INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-O2

Subject: Industrial Maintenance
Duty: Align Shafts
Task: Methods of Alignment

Time: 10 Hrs.

Objective(s):

Upon completion of this module the student will be able to:
a. Demonstrate the straight edge and feeler gage method;
b. Describe the face and rim method of aligning couplings;
c. Set-up and align couplings using the reverse indicators method; and,
d. Describe the general hints on alignment.

Instructional Materials:

MASTER Handout (IMM-O2-HO)
MASTER Laboratory Aid (IMM-O2-LA)
MASTER Laboratory Worksheet (IMM-O2-LW)
MASTER Self-Assessment
Two dial indicators with clamps
Couplings and shafts
Four pillow block bearings
Shim stock
6" steel rule
Feeler gage set
Tools necessary to complete the project

References:

Videos: Couplings, Tel-A-Train, Mechanical Maintenance Series, 309 North Market Street, P. O. Box 4752, Chattanooga, Tennessee 37405, 615-266-0113, Latest Edition
Coupling Alignment, Tel-A-Train, Mechanical Maintenance Series, 309 North Market Street, P. O. Box 4752, Chattanooga, Tennessee 37405, 615-266-0113, Latest Edition
Student Preparation:

Students should have previously completed the following Technical Modules:

**IMM-O1**  "Principles of Alignment."

Introduction:

It is very important to insure shaft alignment is as close as possible. Poor alignment may cause critical damage to drives and equipment due to excessive vibration. This vibration could damage the bearings, seals, couplings and other machine elements. After completing this section you will be able to align couplings several ways.

Presentation Outline:

I. Demonstrate the Straight Edge and Feeler Gage Method
   A. Angular misalignment
   B. Parallel misalignment
   C. Tolerances
II. Describe the Face and Rim Method of Aligning Couplings
   A. Introduction
   B. Short comings
III. Set-Up and Align Couplings Using the Reverse Indicator Method
   A. Advantages of
   B. Procedures for aligning
IV. Describe the General Hints on Alignment
   A. Measuring tools and shims
   B. Equipment

Practical Application:

1. Align a coupling using the straight edge and feeler gage method; and,
2. Align a coupling using dial indicators.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.
Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-P1) dealing with installing electrical connections.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Demonstrate the straight edge and feeler gage method;
b. Describe the face and rim method of aligning couplings;
c. Set-up and align couplings using the reverse indicators method; and,
d. Describe the general hints on alignment.

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I. Demonstrate the Straight Edge and Feeler Gage Method
   A. Angular misalignment
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    B. Shortcomings

III. Set-Up and Align Couplings Using the Reverse Indicator Method
     A. Advantages of
B. Procedures for aligning

IV. Describe the General Hints on Alignment
A. Measuring tools and shims
B. Equipment
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Align a coupling using the straight edge and feeler gage method; and,
   c. Align a coupling using dial indicators.
Review:

a. General hints on alignment; and,
b. Pages in textbook on alignment.
IMM-O2
Methods of Alignment
Self-Assessment

Circle the letter preceding the most correct answer.

1. The simplest, easiest and least accurate method of aligning shafts is the ___________ method.
   a. 25 foot tape rule
   b. Straight edge and feeler gage
   c. Dial indicator
   d. Laser

2. The straight edge and feeler gage method is only recommended with flexible coupling with tolerances of ___________.
   a. High horse power and fast speeds
   b. Low horse power and fast speeds
   c. 15 degrees and .010" parallel
   d. 1 degree and .001" parallel run-out

3. When using the face and ream method of aligning couplings the indicator is rotated 360 degrees with readings taken at every ________ degree intervals.
   a. 30
   b. 45
   c. 60
   d. 90

4. One of the advantages of the reverse indicator method over the face and rim method is the __________ does not need to be removed.
   a. Driven shaft
   b. Thrust bearings
   c. Coupling spacer
   d. Driver shaft

5. If the dial indicator method is used it is necessary to check __________ in the face and rim as well as the reverse indicator method.
   a. For dial indicator support bracket deflection
   b. The thrust bearings in the driving unit
   c. The temperature of the shaft
   d. Feeler gage roughness
6. The dial indicator plunges should bear on the ____________ when using the reverse indicator method.
   a. Coupling spacer
   b. O.D. of coupling hubs or shaft
   c. I.D. of the coupling
   d. Face of the couplings

7. The driven and the driving machine shafts may be roughly centered by checking the reading ____________ degrees from top dead center.
   a. 90 and 270
   b. 45 and 225
   c. 30 and 210
   d. 60 and 240

8. When mounting both indicators on driving and driven couplings insure both may be rotated ______ degrees without interference.
   a. 90
   b. 180
   c. 270
   d. 360

9. Suppose both indicators are zeroed at top dead center and rotated 180 degrees and reread. This operation is checking the ________________.
   a. Bearing wear or adjustment
   b. Coupling bore
   c. Vertical and/or angular misalignment
   d. Scaring of driver shaft

10. Before using a dial indicator check to see if ____________.
    a. The plunger sticks
    b. It is a .0001 reading indicator
    c. It has a 2 inch travel
    d. The needle is bent
IMM-O2
Methods of Alignment
Self-Assessment Answer Key

1. B
2. C
3. D
4. C
5. A
6. B
7. A
8. D
9. C
10. A
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INDUSTRIAL MAINTENANCE MECHANIC uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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</table>

- **K-2 Cut, thread, and ream pipe**
- **K-3 Pipe assembly**
- **K-4 Install and adjust pipe support**
- **K-5 Tubing**
- **K-6 Fittings**
- **K-7 Plastic pipe**
- **L-2 Demonstrate basic rigging skills**
- **M-2 Rolling element bearings**
- **N-2 Perform spreadsheet operations**
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- **P-2 Setting and leveling**
- **P-3 Gearing**
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- **Q-2 Apply basic terms to electrical circuits**
- **Q-3 Analyze series, parallel, and complex AC/DC circuits**
- **Q-4 Check AC and DC motors**
- **Q-5 Troubleshoot electrical devices**
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- **S-4 Cleaning and restoring threaded fasteners**
- **S-5 Torque preload theory**
- **S-6 Effects of lubricating threads prior to torquing**
- **S-7 Demonstrate appropriate torqueing technique**

---
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-P1

Subject: Industrial Maintenance
Time: 6 Hrs.

Duty: Install/Align Machines
Task: Install Electrical Connections

Objective(s):

Upon completion of this module the student will be able to:

a. Install electrical connections;
b. Install crimp connections;
c. Install butt connections;
d. Install proper layers of insulation;
e. Install twist connectors;
f. Install torque connections; and,
g. Install underground connections.

Instructional Materials:

MASTER Handout (IMM-P1-HO)
MASTER Laboratory Worksheet (IMM-P1-LW)
MASTER Laboratory Aid (IMM-P1-LA)
MASTER Self-Assessment
Electrical Connection Assortment

References:

Electricity I, Delmar Publishers, Latest Edition
Industrial Motor Control, Alerich, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-O1 "Principles of Alignment"
IMM-O2 "Methods of Alignment"
Introduction:

Improper electrical connections may cause excessive heat, equipment damage or personal injury.

Presentation Outline:

I. Reasons for Proper Electrical Connections
II. Types of Electrical Connections
III. Insulation Techniques

Practical Application:

Student will demonstrate proper installation of electrical connections.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-P2) dealing with setting and leveling.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Install electrical connections;
b. Install crimp connections;
c. Install butt connections;
d. Install proper layers of insulation;
e. Install twist connectors;
f. Install torque connections; and,
g. Install underground connections.

Reading Assignments:

The following chapters are assigned to read from Westinghouse Electrical Maintenance Hints, Westinghouse Electrical Corporation, publishers, Latest Edition:

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<tr>
<th>Chapters</th>
<th>Title</th>
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<tr>
<td>4</td>
<td>Cable Contraction and Application</td>
</tr>
<tr>
<td>41</td>
<td>Insulation Materials</td>
</tr>
</tbody>
</table>

Module Outline:

I. Reasons for Proper Electrical Connections
II. Types of Electrical Connections
III. Insulation Techniques
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
1. Instructor will demonstrate how to:
   a. Install electrical connections;
   b. Install crimp connections;
   c. Install butt connections;
   d. Install proper layers of insulation;
   e. Install twist connectors;
   f. Install torque connections; and,
   g. Install underground connections.

2. Student will demonstrate how to:
   a. Install electrical connections;
   b. Install crimp connections;
   c. Install butt connections;
   d. Install proper layers of insulation;
   e. Install twist connectors;
   f. Install torque connections; and,
   g. Install underground connections.

3. Instructor will grade students ability to:
   a. Install electrical connections;
   b. Install crimp connections;
   c. Install butt connections;
   d. Install proper layers of insulation;
   e. Install twist connectors;
   f. Install torque connections; and,
   g. Install underground connections.
IMM-P1
Install Electrical Connections
Self-Assessment

1. Describe procedure to attachment terminal leads to line leads.

2. What is a butt connector?

3. Describe how a wing nut or a twist connector works.

4. Describe operation of torque wench.

5. Describe procedure for making underground connections.
IMM-P1
Install Electrical Connections
Self-Assessment Answer Key

1. Twisting of bare ends of line leads and terminal leads is done first. Next wire nuts are twisted onto bare twisted leads. Electrical tape is then covered over the wire nuts and make sure that no bare parts are exposed.

2. This connector is used at the end of two wires. The two wires are placed in alignment with bare ends inside one side of the butt connector.

3. Two protruded metal pieces extend out each side of a wire nut. Sometimes the sides of the twist connector are indented to provide a friction surface.

4. A torque wrench is similar to a socket wrench with the added feature of an indicator of pressure applied. This added feature may be an analog or digital dial indicator or it may be a bar mechanism for indicating pressure.

5. Same as Number 1 answer with additional taping to insure a moisture resistant. Kits are available with all supplies necessary to make safe underground connections.
INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-P2

Subject: Industrial Maintenance
Time: 6 Hrs.

Duty: Install/Align Machines
Task: Setting and Leveling

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the importance of setting and leveling machinery;

b. Identify shim shapes and locations; and,

c. Demonstrate the procedures for setting and leveling machines.

Instructional Materials:

MASTER Handout (IMM-P2-HO)
MASTER Laboratory Aid (IMM-P2-LA)
MASTER Laboratory Worksheet (IMM-P2-LW)
MASTER Self-Assessment
4 each 1" pillow block bearings
2 each 1" shaves 18" long
1 each coupling
1 each bedplate suitable to mount above on anchor bolts.
Shim pack with necessary shims
Tools and materials to mount project

References:


Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-P1 “Install Electrical Connections”
Introduction:

It is absolutely necessary for a machine to be mounted and secured properly to avoid vibration, walking, shifting, and even damage to the machine itself. In this unit you will understand why and how to mount a machine to its foundation.

Presentation Outline:

I. Describe the Importance of Setting and Leveling Machinery
   A. Bedplate
   B. Foundation

II. Identify Shim Shapes and Locations
   A. Flat shims
   B. Wedge-shaped shims
   C. Check for bedplate distortion

III. Demonstrate the Procedures for Setting and Leveling Machines
   A. Setting
   B. Leveling
   C. Shim thickness

Practical Application:

1. Mount pillow block bearings, shaft and coupling to a suitable bedplate; and,
2. Mount the bedplate to the floor or pre-poured foundation with anchor bolts installed and level.

Suggestion: Use 2x4's to make a form. Pour concrete on plastic and around anchor bolts or drill concrete after hardening. Foundation will break up with sledge hammer after use of it is necessary to remove it.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-P3) dealing with grouting.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the importance of setting and leveling machinery;
b. Identify shim shapes and locations; and,
c. Demonstrate the procedures for setting and leveling machines.

Reading Assignments:

The following chapters are assigned to read from Principles of Machine Operation and Maintenance, Dick Jeffrey, Delmar/ATP Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
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<tbody>
<tr>
<td>3</td>
<td>Machinery Mounting</td>
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</tbody>
</table>

Module Outline:

I. Describe the Importance of Setting and Leveling Machinery
   A. Bedplate
   B. Foundation

II. Identify Shim Shapes and Locations
    A. Flat shims
    B. Wedge-shaped shims
    C. Check for bedplate distortion

III. Demonstrate the Procedures for Setting and Leveling Machines
    A. Setting
    B. Leveling
C. Shim thickness
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Mount pillow block bearings, shaft and coupling to a suitable bedplate; and,
   c. Mount the bedplate to the floor or pre-poured foundation with anchor bolts installed and level.

Suggestion: Use 2x4's to make a form. Pour concrete on plastic and around anchor bolts or drill concrete after hardening. Foundation will break up with sledge hammer after use of it is necessary to remove it.
Circle the letter preceding the most correct answer.

1. The portion of the machine where the driver-driven units are mounted is called the _________.
   a. Foundation
   b. Bedplate
   c. Floor
   d. Setting block

2. One function of the ________ is to absorb machine vibration.
   a. Foundation
   b. Bedplate
   c. Driver motor
   d. Leveling shims

3. To determine the shim thickness to use on leveling a bedplate on small equipment use a/an ________ level.
   a. Angular or grade
   b. Line or string
   c. Surveyors
   d. Engineers or machinist

4. On large equipment or where special accuracy is required use a/an ________ level.
   a. Angular or grade
   b. Line or string
   c. Surveyors
   d. Engineers or machinist

5. Shims should be placed ________.
   a. On 3 inch centers
   b. On top of the bedplate
   c. Midway between the anchor bolts
   d. At the anchor bolt location
6. Wedge shaped shims should be ________________.
   a. On 3 inch centers
   b. Midway between the anchor bolts
   c. Stacked causing the top and bottom to be parallel
   d. Driven under the Bedplate edges

7. When the bedplate is pulled down to the foundation to insure no warping has occurred, use a ________________ on a driver-driven units.
   a. Dial indicator
   b. Micrometer
   c. Line level
   d. Steel rule

8. If the bedplate is warping, the placement of additional shims is known by loosening the ________________ bolts one at a time.
   a. Coupling
   b. Anchor
   c. Drive unit
   d. Drive unit

9. The thickness of the shim pack will depend on the size and weight of the machine, with the minimum being ________ inch.
   a. 1/8
   b. 1/4
   c. 3/4
   d. 1 1/2

10. After the shim thickness is known to make the level read level, the ratio of the length of the level to the length of the ____________ must be known to obtain the thickness of the shim at the anchor bolt.
    a. Bedplate
    b. Driver
    c. Driven
    d. Shim
IMM-P2
Setting and Leveling
Self-Assessment Answer Key

1. B
2. A
3. D
4. C
5. D
6. C
7. A
8. B
9. C
10. A
# INDUSTRIAL MAINTENANCE MECHANIC SERIES

**MASTER Technical Module No. IMM-P3**

<table>
<thead>
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<th>Subject:</th>
<th>Industrial Maintenance</th>
<th>Time: 4 Hrs.</th>
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<td>Duty:</td>
<td>Install/Align Machines</td>
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<tr>
<td>Task:</td>
<td>Grouting</td>
<td></td>
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</tbody>
</table>

**Objective(s):**

Upon completion of this module the student will be able to:

a. Describe the purpose of grouting.
b. Demonstrate grouting procedures.

**Instructional Materials:**

- MASTER Handout (IMM-P3-HO)
- MASTER Laboratory Aid (IMM-P3-LA)
- MASTER Laboratory Worksheet (IMM-P3-LW)
- MASTER Self-Assessment
- Grout
- Form Boards
- Necessary tools and materials to complete the project

**References:**


**Student Preparation:**

Students should have previously completed the following Technical Modules:

- IMM-P2  “Setting and Leveling”

**Introduction:**

It is absolutely necessary for a machine to be mounted and secured properly to avoid vibration, walking, shifting, and even damage to the machine itself. In this unit you will understand how and why grouting is a necessary part of machinery installation.
Presentation Outline:

I. Describe the Purpose of Grouting
   A. Effect on the shims
   B. Effect on bed plate

II. Demonstrate Grouting Procedures
    A. Grout dam

Practical Application:

1. Build a dam around the mounted unit in IMM-P2, “Setting and Leveling” practical application section; and, 
2. Grout the mounted unit in IMM-P2, “Setting and Leveling” practical outline application section.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-P4) dealing with special mountings.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Describe the purpose of grouting.
b. Demonstrate grouting procedures.

Reading Assignments:

The following chapters are assigned to read from Principles of Machine Operation and Maintenance, Dick Jeffrey, Delmar/ITP Publishers, Latest Edition:

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<td>3</td>
<td>Machinery Mounting</td>
</tr>
</tbody>
</table>

Module Outline:

I. Describe the Purpose of Grouting
   A. Effect on the shims
   B. Effect on bed plate
II. Demonstrate Grouting Procedures
    A. Grout dam
IMM-P3-LA
Grouting
Attachment 2: MASTER Laboratory Aid

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Build a dam around the mounted unit in IMM-P2, “Setting and Leveling” practical application section; and,
   c. Grout mounted unit in IMM-P2, “Setting and Leveling” practical outline application section.
Circle the letter preceding the most correct answer.

1. Grout is a mortar-like concrete which __________ when it sets.
   a. Is rubbery
   b. Soft
   c. Expands
   d. Shrinks

2. The grout secures the __________ and ensures they cannot be dislodged.
   a. Anchor bolts
   b. Shims
   c. Drive unit
   d. Coupling

3. The grout protects the shims from __________.
   a. Corrosion
   b. Paint
   c. Oil
   d. Dust

4. If grout completely fills the __________ it will protect it from corrosion and hazardous liquids.
   a. Foundation
   b. Driver unit
   c. Bedplate
   d. Coupling

5. Grout should be poured at least __________ inches above the shims.
   a. 1/16
   b. 1/8
   c. 3/8
   d. 1
IMM-P3
Grouting
Self-Assessment Answer Key

1. C
2. B
3. A
4. C
5. C
INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-P4

Subject: Industrial Maintenance
Duty: Install/Align Machines
Task: Special Mountings

Time: 4 Hrs.

Objective(s):
Upon completion of this module the student will be able to:

a. Describe adjustable mountains; and,
b. Identify vibration isolators.

Instructional Materials:
MASTER Handout (IMM-P4-HO)
MASTER Laboratory Aid (IMM-P4-LA)
MASTER Laboratory Worksheet (IMM-P4-LW)
MASTER Self-Assessment
Suitable bedplate
A variety of special mountings
Tools and materials to complete the project

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-P3 “Grouting”

Introduction:

It is absolutely necessary for a machine to be mounted and secured properly to avoid vibration, walking, shifting, and even damage to the machine itself. This unit will describe the reasons and applications for special mounting devices.
Presentation Outline:

I. Describe Adjustable Mountings
   A. Applications
   B. Pre-installation
   C. Maintenance
II. Identify Vibration Isolators
    A. Absorbent materials
    B. Spring mountings

Practical Application:

1. Mount bedplate on adjustable mountings; and,
2. Mount bedplate on vibration isolators.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-Q1) dealing with using electrical test equipment.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Describe adjustable mountings; and,
b. Identify vibration isolators.

Reading Assignments:

The following chapters are assigned to read from Principles of Machine Operation and Maintenance, Dick Jeffrey, Delmar/ITP Publishers, Latest Edition:

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<th>Title</th>
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<tbody>
<tr>
<td>3</td>
<td>Machinery Mounting</td>
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</tbody>
</table>

Module Outline:

I. Describe Adjustable Mountings
   A. Applications
   B. Pre-installation
   C. Maintenance

II. Identify Vibration Isolators
    A. Absorbent materials
    B. Spring mountings
IMM-P4-LA
Special Mountings
Attachment 2: MASTER Laboratory Aid

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Mount bedplate on adjustable mountings; and,
   c. Mount bedplate on vibration isolators.
Review the special mountings pages in the textbook.
IMM-P4
Special Mountings
Self-Assessment

Circle the letter preceding the most correct answer.

1. In case of free-standing machines where their positions are frequently changes, anchor bolts may be replaced with ___________.
   a. Felt pads  
   b. Adjustable mounts  
   c. Spring mounts  
   d. Wood screws

2. The adjustable mount should be cleaned and greased to insure the __________ will not jam during re-adjustment.
   a. Air line  
   b. Bearings  
   c. Threads  
   d. Coupling

3. A machine using adjustable mountings should have _____________.
   a. Flexible service lines  
   b. Rigid service lines  
   c. Wood bed plates  
   d. Secure anchor

4. Machines producing slight vibration, noise and shock should be equipped with special _____________.
   a. Wood bed plates  
   b. Adjusting mounts  
   c. Spring mounts  
   d. Absorbent pads

5. Absorbent pads of rubber or felt are sandwiched between two ____________ to reduce vibration.
   a. Clay pads  
   b. Wood disk  
   c. Steel plates  
   d. Anchor bolts
6. If vibration is severe and must be absorbed by the mountings a _________ should be used.
   a. Spring mount
   b. Rubber pad
   c. Felt pad
   d. Adjustable mount
IMM-P4
Special Mountings
Self-Assessment Answer Key

1. B
2. C
3. A
4. D
5. C
6. A
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> Practice Safety</td>
<td>A-1 Use protective equipment</td>
</tr>
<tr>
<td><strong>B</strong> Apply Mathematical Concepts</td>
<td>A-2 Accident prevention</td>
</tr>
<tr>
<td><strong>C</strong> Interpret Engineering Drawings and Control Documents</td>
<td>A-3 Working aloft</td>
</tr>
<tr>
<td><strong>D</strong> Use Measuring Tools</td>
<td>A-4 Fire safety</td>
</tr>
<tr>
<td><strong>E</strong> Use Hand Tools</td>
<td>A-6 Lifting safety</td>
</tr>
<tr>
<td><strong>F</strong> Operate Machine Tools</td>
<td>A-8 Lockout/layout</td>
</tr>
<tr>
<td><strong>G</strong> Perform Welding Operations</td>
<td>B-1 Perform basic arithmetic functions</td>
</tr>
<tr>
<td><strong>H</strong> Maintain/Troubleshoot Equipment and Systems</td>
<td>B-2 Convert fractions/decimals</td>
</tr>
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<td><strong>I</strong> Repair Power Transmission Systems</td>
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INDUSTRIAL MAINTENANCE MECHANIC... uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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**Tasks:**
- K-2 Cut, thread, and ream pipe
- K-3 Pipe assembly
- K-4 Install and adjust pipe support
- K-5 Tubing
- K-6 Fittings
- K-7 Plastic pipe
- L-2 Demonstrate basic rigging skills
- M-2 Rolling element bearings
- N-2 Perform basic spreadsheet operations
- O-2 Methods of alignment
- P-2 Setting and leveling
- P-3 Grouting
- P-4 Special mountings
- Q-2 Apply basic terms to electrical circuits
- Q-3 Analyze series, parallel, and complex AC/DC circuits
- Q-4 Check AC and DC motors
- Q-5 Troubleshoot electrical devices
- R-2 Work
- R-3 Mechanical motion and rate
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- S-3 Techniques for removing damaged fasteners
- S-4 Cleaning and restoring threaded fasteners
- S-5 Torque preload theory
- S-6 Effects of lubricating threads prior to torquing
- S-7 Demonstrate appropriate torquing technique
Subject: Industrial Maintenance

Duty: Maintain Electrical Devices

Task: Use Electrical Test Equipment

Objective(s):

Upon completion of this module the student will be able to:

a. Properly use electrical test equipment;
b. Measure ohms;
c. Measure DC volts;
d. Measure AC volts; and,
e. Measure DC amps.

Instructional Materials:

- MASTER Handout (IMM-Q1-HO)
- MASTER Laboratory Worksheet (IMM-Q1-LW)
- MASTER Laboratory Aid (IMM-Q1-LA)
- MASTER Self-Assessment
- VOM-Analog
- VOM-Digital

References:


Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition

Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

- IMM-A1 through IMM-A6  "Practice Safety" series
- IMM-P4  "Special Mountings"
Introduction:

Working safely should be the concern of every individual. Safety includes protecting yourself and others from injury. While others - your employer, your family, governmental agencies, and insurance companies - are concerned for your well-being, you have the final responsibility for your safety in the workplace. Being aware of your surrounding and selecting and using correct safety equipment is your responsibility.

Presentation Outline:

I. DC Voltage Measurement
II. AC Voltage Measurement
III. DC Current Measurement
IV. Resistance Measurement

Practical Application:

1. Instructor will demonstrate selection and proper use of electrical test equipment.
2. Students will be allowed to practice the use of electrical test equipment.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-Q2) dealing with application of basic terms to electrical circuits.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Properly use electrical test equipment;
b. Measure ohms;
c. Measure DC volts;
d. Measure AC volts; and,
e. Measure DC amps.

Reading Assignments:

The following chapters are assigned to read from Electricity I, Kubala, Delmar Publishing, Latest Edition:

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Module Outline:

I. DC Voltage Measurement
II. AC Voltage Measurement
III. DC Current Measurement
IV. Resistance Measurement
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
1. Student will practice performing.
   a. DC voltage measurement;
   b. AC voltage measurement;
   c. DC current measurement; and,
   d. Resistance measurement.

2. Instructor will grade student's performance on.
   a. DC voltage measurement;
   b. AC voltage measurement;
   c. DC current measurement; and,
   d. Resistance measurement.
1. Describe how to use an analog multimeter to measure DC voltage.

2. Describe how to use an analog multimeter to measure AC voltage.

3. Describe how to use an analog multimeter to measure DC current.

4. Describe how to use an analog multimeter to measure resistant.

5. Describe how to use a digital multimeter to measure DC voltage.
6. Describe how to use a digital multimeter to measure AC voltage.

7. Describe how to use a digital multimeter to measure DC current.

8. Describe how to use a digital multimeter to measure resistant.
1. Move range switch to highest DC voltage scale. Plug red lead into positive terminal. Plug black lead into negative terminal. Measure voltage. If reading is low enough so the scale can be reduced to the next lowest scale, then disconnect leads from DC voltage and change scale to next lower scale. This process can be repeated until the needle moves to highest reading without going off scale.

2. Same procedure as question 1 except use AC voltage scale instead of DC voltage scale. Move range switch to highest AC voltage scale. Plug red lead into positive lead on the multimeter. Plug black lead into the negative terminal on the multimeter. Measure voltage. If reading is low enough so the scale can be reduced to the next lowest scale, then disconnect leads from AC voltage and change scale to next lower scale. This process can be repeated until the needle moves to highest reading without going off scale.

3. Use same procedure as question 1 with two exceptions; use DC current scales instead of DC voltage scales and make sure the lead connections are made so that the multimeter is placed in series with the load instead of parallel with the load.

4. Move range switch to highest DC ohmic scale. Plug red lead into positive lead on the multimeter. Plug black lead into the negative terminal on the multimeter. Measure resistance. If reading is low enough so the scale can be reduced to the next lowest scale, then disconnect leads from source and change scale to next lower scale. This process can be repeated until needle moves to highest reading without going off scale.

5. Same procedure as question 1 for the analog multimeter except reading is a digital number instead of a needle movement. Some digital multi meters may have autorange capability. Move range switch to highest DC voltage scale. Plug red lead into positive terminal. Plug black lead into negative terminal. Measure voltage. If reading is low enough so the scale can be reduced to the next lowest scale, then disconnect leads from DC voltage and change the scale to the next lower scale. This process can be repeated until the digital number moves to highest reading without going off scale.

6. Same procedure as question 2 for the analog multimeter except reading is a digital number instead of a needle movement. Move range switch to highest AC voltage scale. Plug red lead into positive terminal. Plug black lead into negative terminal. Measure voltage. If reading is low enough so the scale can be reduced to the next lowest scale, then disconnect leads from AC voltage scale.
and change scale to next lower scale. This process can be repeated until the digital number moves to the highest reading without going off scale.

7. Same procedure as question 3 for the analog multimeter except reading is a digital number instead of a needle movement. Move range switch to highest DC current scale. Plug red lead into positive terminal. Plug black lead into negative terminal. Measure current. If reading is low enough so the scale can be reduced to the next lowest scale, then disconnect leads from DC current source and change scale to next lower scale. This process can be repeated until the digital number indicates the highest reading without going off scale.

8. Same procedure as question 4 for the analog multimeter except reading is a digital number instead of a needle movement. Move range switch to highest ohmic scale. Plug red lead into positive terminal. Plug black lead into negative terminal. Measure ohms. If reading is low enough so the scale can be reduced to the next lowest scale, then disconnect leads from DC voltage and change scale to next lower scale. This process can be repeated until the digital number moves to the highest reading without going off scale.
INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-Q2

Subject: Industrial Maintenance

Duty: Maintain Electrical Devices
Task: Apply Basic Terms to Electrical Circuits

Time: 10 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Polarity;
b. Electron;
c. Proton;
d. Neutrons;
e. Coulomb;
f. Atom;
g. Voltage (potential difference);
h. Resistance;
i. Amperage (current);
j. Open circuit;
k. Sources of electricity;
l. Ohm’s Law; and,
m. Power.

Instructional Materials:

MASTER Handout (IMM-Q2-HO)
MASTER Self-Assessment
Classroom
Chalkboard
Overhead

References:

Instrumentation, Kirk, ATP Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Student Preparation:

Students should have previously completed the following Technical Modules:
   IMM-Q1 "Use Electrical Test Equipment"

Introduction:

In order to understand electricity, a basic understanding of electrical terms is essential.

Presentation Outline:

I.  Polarity  
II. Electron  
III. Proton  
IV. Neutrons  
V.  Coulomb  
VI. Atom  
VII. Voltage (Potential Difference)  
VIII. Resistance  
IX. Amperage (Current)  
X.  Closed Circuit  
XI. Open Circuit  
XII. Sources of Electricity  
XIII. Ohm's Law  
XIV. Power

Practical Application:

Student will use knowledge to build information practical circuit application in next technical module.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (IMM-Q3) dealing with analyzing series, parallel and complex AC/DC circuits.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Polarity;
b. Electron;
c. Proton;
d. Neutrons;
e. Coulomb;
f. Atom;
g. Voltage (potential difference);
h. Resistance;
i. Amperage (current);
j. Closed circuit;
k. Open circuit;
l. Sources of electricity;
m. Ohm’s Law; and,
m. Power.

Reading Assignments:

The following chapters are assigned to read from Basic Electronics, Bernard Grab, McGraw-Hill Publishers, Latest Edition

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<tbody>
<tr>
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<td>Survey of Electronics</td>
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<td>Electricity</td>
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<td>3</td>
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Module Outline:

I. Polarity
II. Electron
III. Proton
IV. Neutrons
V. Coulomb
VI. Atom
VII. Voltage (Potential Difference)
VIII. Resistance
IX. Amperage (Current)
X. Closed Circuit
XI. Open Circuit
XII. Sources of Electricity
XIII. Ohm’s Law
XIV. Power
1. The ________ is the basic circuit of negative charge.

2. A ________ hrs. The same amount of charges as the neutron.

3. ________ polarity is used with the electron.

4. All matter has electricity in the form of ________ in the ________.

5. Potential difference can be exposed as ________.

6. Define open circuit.

7. Define closed circuit.

8. ________ is a measure of the quantity of stored charge.

9. An ________ is the measure of resistance.

10. A ________ has no charge.

11. Define Ohm's Law.

12. Define power (formula).
IMM-Q2
Apply Basic Terms to Electrical Circuits
Self-Assessment Answer Key

1. Electron
2. mp
3. Negative
4. Charges, atom
5. Voltage
6. The circuit is not complete or closed, therefore, no current can flow in this circuit.
7. A complete closed circuit is one that current flows when a voltage source is present.
8. Coulomb
9. Ohm
10. Neutron
11. $E = I \times R$
12. $P = E \times I$
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-Q3

Subject: Industrial Maintenance

Time: 24 Hrs.

Duty: Maintain Electrical Devices

Task: Analyze Series, Parallel, and Complex AC/DC Circuits

Objective(s):

Upon completion of this module the student will be able to:

a. Calculate series circuit;
b. Construct series circuit safely;
c. Calculate parallel circuit;
d. Construct parallel circuit safely;
e. Calculate series-parallel circuit;
f. Construct series-parallel circuit safely;
g. Calculate AC single phase circuit; and,
h. Construct AC single phase circuit.

Instructional Materials:

MASTER Handout (IMM-Q3-HO)
MASTER Laboratory Aid (IMM-Q3-LA)
MASTER Laboratory Worksheet (IMM-Q3-LW)
MASTER Self-Assessment

Resistors
Series Circuit
Parallel Circuit
Series-Parallel Circuit
Inductors
DC Source
AC Single Phase Source

References:

Instrumentation, Kirk, ATP Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Student Preparation:

Students should have previously completed the following Technical Modules:
- IMM-Q2 "Apply Basic Terms to Electrical Circuits"

Introduction:

Electrical circuits are fundamental to all electrical devices and controls.

Presentation Outline:

I. Series Circuits
II. Parallel Circuits
III. Series-Parallel Circuits
IV. Voltage Dividers
V. DC Meters
VI. AC Circuits
VII. AC Meters

Practical Application:

Student will calculate and construct:
- Series circuits
- Parallel circuits
- Series-parallel circuits
- Voltage dividers
- DC meters
- AC circuits
- AC meters

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (IMM-Q4) dealing with checking AC/DC motors.
IMM-Q3-HO
Analyze Series, Parallel, and Complex AC/DC Circuits
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Calculate series circuit;
b. Construct series circuit safely;
c. Calculate parallel circuit;
d. Construct parallel circuit safely;
e. Calculate series-parallel circuit;
f. Construct series-parallel circuit safely;
g. Calculate AC single phase circuit; and,
h. Construct AC single phase circuit.

Reading Assignments:

The following chapters are assigned to read from Electrical Circuits, Bernard Grob, McGraw-Hill Publishers, Latest Edition

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<td>Parallel Circuits</td>
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<td>Series-Parallel Circuits</td>
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<td>7</td>
<td>Voltage Dividers</td>
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<td>8</td>
<td>DC Meters</td>
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Module Outline:

I. Series Circuits
II. Parallel Circuits
III. Series-Parallel Circuits
IV. Voltage Dividers
V. DC Meters
VI. AC Circuits
VII. AC Meters
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
1. The student will practice:
   a. Calculating series circuit;
   b. Constructing series circuit safely;
   c. Calculating parallel circuit;
   d. Constructing parallel circuit safely;
   e. Calculating series-parallel circuit;
   f. Constructing series-parallel circuit safely;
   g. Calculating AC single phase circuit; and,
   h. Constructing AC single phase circuit.

2. Instructor will grade student’s performance.
Circle the letter preceding the most correct answer.

1. A circuit with two or more current paths is a/an _________ circuit.
   A. series
   B. parallel
   C. open
   D. compound

2. A loose or dirty electrical connection will produce ____________:
   A. excess heat at the connection.
   B. a lot of noise on start up.
   C. chatter until circuit warms up.
   D. excess voltage and damage to the unit.

3. A closed electrical circuit is one where ________________:
   A. fewer electrons can flow because of the closure.
   B. the path for current flow is complete.
   C. there is more than one load in the circuit.
   D. the switch is in the open position.

4. A circuit that has only one path for current flow is a/an _________ circuit.
   A. series
   B. parallel
   C. series-parallel
   D. none of the above

5. In a series circuit the current in the circuit ________________:
   A. is the same anywhere in the circuit.
   B. is divided between the total resistors in the circuit.
   C. is not dependent upon the total voltage applied to the circuit.
   D. is not related to the electron (charge) flow rate

6. In a parallel circuit the total resistance is ________________:
   A. smaller than the smallest branch resistance.
   B. the sum of all the resistors in all branches.
   C. dependent upon the number of branches in the circuit.
   D. all the above.
7. In a series-parallel circuit the voltage drop across the series resistor ________:
   A. will always be larger than the branch voltage drops.
   B. will not effect the total current in the circuit.
   C. will determine the total resistance in the branches.
   D. will determine the voltage drop across the other branches.

8. The algebraic sum of the source voltage and the voltage drops in any closed circuit ________:
   A. is equal to the sum of the voltage drops across each resistor.
   B. is dependent upon the source voltage.
   C. is equal to zero.
   D. none of the above

9. An electrical circuit in which voltage is equally applied to every load is known as a ________ circuit.
   A. series
   B. parallel
   C. series-parallel
   D. reactive

10. Current is directly proportional to voltage and inversely proportional to resistance. Therefore when ________:
    A. resistance is increased, current will be decreased.
    B. resistance is increased, current will be increased.
    C. resistance is decreased, current will be decreased.
    D. resistance is decreased, current will not change.

11. Current is directly proportional to voltage and inversely proportional to resistance. Therefore when ________:
    A. voltage is increased, current will be decreased.
    B. voltage is increased, current will be increased.
    C. voltage is decreased, current will be increased.
    D. voltage is decreased, current will not change.

12. The considered standard frequency of AC power in the United States is ________ Hertz.
    A. 400
    B. 120
    C. 60
    D. 50
13. The effective value of AC voltage and current is also known as what value?
   A. RMS
   B. Peak-to-Peak
   C. Equivalent
   D. Average

14. The current in an inductive circuit is caused to ________________:
   A. lag the voltage.
   B. lead the voltage.
   C. oppose the voltage.
   D. be in phase with the voltage.

15. If AC is applied to resistance in a normally DC circuit ________________:
   A. Ohm's Law calculations do not apply.
   B. rules for series and parallel circuits do not apply.
   C. Ohm's Law and rules for series and parallel circuits do apply.
   D. Ohm's Law and rules for series circuits only do apply.

16. Amplitude of an AC voltage or current sine wave is the ______ of the wave.
   A. effective value
   B. peak value
   C. wavelength value
   D. frequency value
IMM-Q3
Analyze Series, Parallel, and Complex AC/DC Circuits
Self-Assessment Answer Key

1. B
2. A
3. B
4. A
5. A
6. A
7. D
8. C
9. B
10. A
11. B
12. C
13. A
14. A
15. C
16. B
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-Q4

Subject: Industrial Maintenance                      Time: 40 Hrs.
Duty: Maintain Electrical Devices
Task: Check AC and DC Motors

Objective(s):

Upon completion of this module the student will be able to install, maintain
and troubleshoot:

a. Capacitor motors;  
b. Repulsion motors;  
c. Three phase motors;  
d. Direct current motors;  
e. Universal motors;  
f. Shaded pole motors;  
g. Generator; and,
h. Alternator.

Instructional Materials:

MASTER Handout (IMM-Q4-HO)  
MASTER Laboratory Worksheet (IMM-Q4-LW)  
MASTER Laboratory Aid (IMM-Q4-LA)  
MASTER Self-Assessment
Capacitor motors  
Repulsion motors  
Three phase motors  
Direct current motors  
Universal motors  
Shaded pole motors  
Generator  
Alternator

References:

Instrumentation, Kirk, ATP Publishers, Latest Edition
Introduction:

Motors perform many useful functions and activities for an industrial maintenance mechanic. Motors turn pumps, fans, compressors, and create rotational mechanical motion.

Presentation Outline:

I. Capacitor Motors
II. Repulsion Motors
III. Three Phase Motors
IV. Direct Current Motors
V. Universal Motors
VI. Shaded Pole Motors
VII. Generator
VIII. Alternator

Practical Application:

Student will check the following motors in a lab setting:

a. Capacitor motors;
b. Repulsion motors;
c. Three phase motors;
d. Direct current motors;
e. Universal motors;
f. Shaded pole motors;
g. Generator; and,
h. Alternator.
Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-Q5) dealing with troubleshooting electrical devices.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to install, maintain and troubleshoot:

a. Capacitor motors;  
b. Repulsion motors;  
c. Three phase motors;  
d. Direct current motors;  
e. Universal motors;  
f. Shaded pole motors;  
g. Generator; and,  
h. Alternator.

Reading Assignments:

The following chapters are assigned to read from *Electrical Motors*, by Audel Publishing, Latest Edition: Use entire book as a reading assignment.

Module Outline:

I. Capacitor Motors  
II. Repulsion Motors  
III. Three Phase Motors  
IV. Direct Current Motors  
V. Universal Motors  
VI. Shaded Pole Motors  
VII. Generator  
VIII. Alternator
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
1. Student will practice installing, maintaining and troubleshooting the following motors:
   a. Capacitor motors;
   b. Repulsion motors;
   c. Three phase motors;
   d. Direct current motors;
   e. Universal motors;
   f. Shaded pole motors;
   g. Generator; and,
   h. Alternator.

2. Instructor will grade performance of student.
IMM-Q4
Check AC and DC Motors
Self-Assessment

Draw the symbols for:

1. Capacitor Motors
2. Repulsion Motors
3. Three Phase Motors
4. Direct Current Motors
5. Universal Motors
6. Shaded Pole Motors
7. Generator
8. Alternator

Briefly explain operation of:

1. Capacitor Motors
2. Repulsion Motors
3. Three Phase Motors
<table>
<thead>
<tr>
<th></th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Direct Current Motors</td>
</tr>
<tr>
<td>5</td>
<td>Universal Motors</td>
</tr>
<tr>
<td>6</td>
<td>Shaded Pole Motors</td>
</tr>
<tr>
<td>7</td>
<td>Generator</td>
</tr>
<tr>
<td>8</td>
<td>Alternator</td>
</tr>
</tbody>
</table>
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-Q5

Subject: Industrial Maintenance
Time: 10 Hrs.

Duty: Maintain Electrical Devices
Task: Troubleshoot Electrical Devices

Objective(s):

Upon completion of this module the student will be able to troubleshoot the following devices:

a. Resistors;
b. Capacitors;
c. Inductors;
d. Motors; and,
e. Relays.

Instructional Materials:

MASTER Handout (IMM-Q5-HO)
MASTER Laboratory Aid (IMM-Q5-LA)
MASTER Laboratory Worksheet (IMM-Q5-LW)
MASTER Self-Assessment
Resistor
Capacitors
Inductors
Motors
Relays

References:

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-Q4  “Check AC and DC Motors”

Introduction:

Troubleshooting is the skill of solving an electrical problem and fixing the problem. This skill is in high demand today.

Presentation Outline:

I. Resistors
II. Capacitors
III. Inductors
IV. Motors
V. Relays

Practical Application:

Student will practice troubleshooting electrical devices.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

NEXT LESSON ASSIGNMENT:

MASTER Technical Module (IMM-R1) dealing with force.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to troubleshoot the following devices:
a. Resistors;
b. Capacitors;
c. Inductors;
d. Motors; and,
e. Relays.

Reading Assignments:

The following chapters are assigned to read from Basic Electronics, Grob, McGraw-Hill Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Capacitance</td>
</tr>
<tr>
<td>20</td>
<td>Inductance</td>
</tr>
</tbody>
</table>

Module Outline:

I. Resistors
II. Capacitors
III. Inductors
IV. Motors
V. Relays
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
1. Student will practice troubleshooting:
   a. Resistors;
   b. Capacitors;
   c. Inductors;
   d. Motors; and,
   e. Relays.

2. Instructor will grade students performance.
IMM-Q5
Troubleshoot Electrical Devices
Self-Assessment

1. Define troubleshooting.

2. List logical steps to troubleshooting an electrical service.

3. What does a resistor do in an electrical circuit?

4. Define capacitance.

5. Define inductance.

6. What is the normal function for a relay?

7. List major types of DC, single phase AC and three phase motors.
1. To search for the cause of a malfunction.

2. Isolate or sectionalize problem

3. Reduce current flow.

4. Increase power factor, ability of a dielectric to store electric charge, opposite to inductance characteristic.

5. Ability of a conductor to produce induced voltage when current varies.

6. At least one coil and one contact. Allows a small voltage source to control a larger voltage load.

7. DC: series, parallel and compound.
   AC: single phase: capacitor, repulsion, split phase, shaded pole, and universal.
   AC: three phase: squirrel cage induction, synchronous and wound rotor.
INDUSTRIAL MAINTENANCE MECHANIC... uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Practice Safety</td>
<td>A-1 Use protective equipment</td>
</tr>
<tr>
<td>B. Apply Mathematical Concepts</td>
<td>B-1 Perform basic arithmetic functions</td>
</tr>
<tr>
<td>C. Interpret Engineering Drawings</td>
<td>C-1 Identify basic types of drawings</td>
</tr>
<tr>
<td>D. Use Measuring Tools</td>
<td>D-1 Use non-precision measuring tools</td>
</tr>
<tr>
<td>E. Use Hand Tools</td>
<td>E-1 Identify and use maintenance technician's hand tools</td>
</tr>
<tr>
<td>F. Operate Machine Tools</td>
<td>F-1 Use and care of milling machines</td>
</tr>
<tr>
<td>G. Perform Welding Operations</td>
<td>G-1 Weld with shielded metal arc welding (SMAW) process</td>
</tr>
<tr>
<td>H. Maintain/ Troubleshoot</td>
<td>H-1 Maintain air conditioning systems</td>
</tr>
<tr>
<td>I. Repair Power Transmission Systems</td>
<td>I-1 Maintain and troubleshoot belt drive systems</td>
</tr>
<tr>
<td>J. Fabricate/ Install Sheet Metal</td>
<td>J-1 Layout sheet metal parts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2 Accident prevention</td>
</tr>
<tr>
<td>A-3 Working aloft</td>
</tr>
<tr>
<td>A-4 Fire safety</td>
</tr>
<tr>
<td>A-5 Lifting safety</td>
</tr>
<tr>
<td>A-6 Lockout/ tagout</td>
</tr>
<tr>
<td>B-2 Convert fractions/ decimals</td>
</tr>
<tr>
<td>B-3 Convert Metric/ English measurements</td>
</tr>
<tr>
<td>B-4 Perform basic algebraic operations</td>
</tr>
<tr>
<td>B-5 Perform basic trigonometric functions</td>
</tr>
<tr>
<td>B-6 Perform basic geometric calculations</td>
</tr>
<tr>
<td>C-2 Identify basic layout of drawings</td>
</tr>
<tr>
<td>C-3 Review blueprint notes and dimensions</td>
</tr>
<tr>
<td>D-2 Use precision measuring tools</td>
</tr>
<tr>
<td>E-2 Identify and use hand held power tools</td>
</tr>
<tr>
<td>F-2 Use and care of horizontal and vertical band saws</td>
</tr>
<tr>
<td>F-3 Use and care of surface grinder</td>
</tr>
<tr>
<td>F-4 Use and care of pedestal grinder</td>
</tr>
<tr>
<td>F-6 Operate lathes</td>
</tr>
<tr>
<td>F-6 Use and care of drill press</td>
</tr>
<tr>
<td>G-2 Weld with oxyacetylene</td>
</tr>
<tr>
<td>G-3 Perform gas welding</td>
</tr>
<tr>
<td>H-2 Maintain pneumatic control circuits</td>
</tr>
<tr>
<td>H-3 Troubleshoot centrifugal pumps</td>
</tr>
<tr>
<td>H-4 Troubleshoot positive displacement pumps</td>
</tr>
<tr>
<td>H-5 Maintain gate, globe, ball, plug, and butterfly valves</td>
</tr>
<tr>
<td>H-6 Maintain check valves and relief valves</td>
</tr>
<tr>
<td>H-7 Troubleshoot, maintain, and repair hydraulic systems</td>
</tr>
<tr>
<td>H-8 Troubleshoot, maintain, and repair pneumatic systems</td>
</tr>
<tr>
<td>H-9 Maintain and troubleshoot clutch clutches</td>
</tr>
<tr>
<td>J-2 Form and/or bend sheet metal parts</td>
</tr>
<tr>
<td>J-3 Fasten sheet metal parts together</td>
</tr>
</tbody>
</table>
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>L-1 Rigging fundamentals. L-2 Demonstrate basic rigging skills.</td>
</tr>
<tr>
<td>M</td>
<td>M-1 Plain bearings. M-2 Rolling element bearings.</td>
</tr>
<tr>
<td>N</td>
<td>N-1 Perform basic word processing. N-2 Perform basic spreadsheet operations.</td>
</tr>
<tr>
<td>O</td>
<td>O-1 Principles of alignment. O-2 Methods of alignment.</td>
</tr>
<tr>
<td>P</td>
<td>P-1 Install electrical connections. P-2 Setting and leveling. P-3 Grouting. P-4 Special mountings.</td>
</tr>
<tr>
<td>Q</td>
<td>Q-1 Use electrical test equipment. Q-2 Apply basic terms to electrical circuits. Q-3 Analyze series, parallel, and complex AC/DC circuits. Q-4 Check AC and DC motors. Q-5 Troubleshoot electrical devices.</td>
</tr>
</tbody>
</table>
| S      | S-1 Fasteners and nomenclature. S-2 Application for various fasteners. S-3 Techniques for removing damaged fasteners. S-4 Cleaning and restoring threaded fasteners. S-5 Torque pre-load theory. S-6 Effects of lubricating threads prior to torquing. S-7 Demonstrate appropriate torquing technique.
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-R1

<table>
<thead>
<tr>
<th>Subject:</th>
<th>Industrial Maintenance</th>
<th>Duty:</th>
<th>Basic Mechanical Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task:</td>
<td>Force</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Objective(s):

Upon completion of this module the student will be able to:

a. Define force;
b. Describe linear force;
c. Describe rotational force;
d. Calculate linear force; and,
e. Calculate rotational force.

Instructional Materials:

- MASTER Handout (IMM-R1-HO)
- MASTER Self-Assessment
- Classroom
- Overhead Projector
- Chalkboard

References:


Student Preparation:

Students should have previously completed the following Technical Modules:

- IMM-Q5 “Troubleshoot Electrical Devices”

Introduction:

Force may cause motion. Force may change equilibrium. Forces alter many areas of an industrial maintenance mechanic's job.
Presentation Outline:

I. Introduction
II. Define Force
III. Measuring Force
IV. Basic Types and Effects of Force

Practical Application:

Student will relate how force can affect motion.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-R2) dealing with work.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
  a. Define force;
  b. Describe linear force;
  c. Describe rotational force;
  d. Calculate linear force; and,
  e. Calculate rotational force.

Reading Assignments:

The following chapters are assigned to read from *Introduction to Physical Science*, James T. Shipman, D.C. Heath Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Force and Motion</td>
</tr>
</tbody>
</table>

Module Outline:

I. Introduction
II. Define Force
III. Measuring Force
IV. Basic Types and Effects of Force
IMM-R1
Force
Self-Assessment

1. Define Force.

________________________________________________________________________
________________________________________________________________________

2. List basic types of forces.

________________________________________________________________________
________________________________________________________________________
1. A mechanical force is a push or a pull.

2. Concurrent, parallel in the same direction, parallel in the opposite direction and collinear, balanced and unbalanced.
INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-R2

Subject: Industrial Maintenance

Time: 4 Hrs.

Duty: Basic Mechanical Concepts
Task: Work

Objective(s):

Upon completion of this module the student will be able to:

a. Define work;
b. Compare force to work;
c. Define kinetic energy;
d. Define potential energy; and,
e. List forms of energy.

Instructional Materials:

MASTER Handout (IMM-R2-HO)
MASTER Self-Assessment
Chalkboard

References:

Energy For Man, Thirring, Hans, Greenwood Press, Latest Edition
Power-Prime Mover of Technology, Duffy, Joseph, McKnight and McKnight Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-R1 “Force”

Introduction:

Work is useable energy. This is a useful term.
Presentation Outline:

I. Define Work
II. Work in Mechanical System
III Calculating Work
IV. Effects of Mechanical Work
V. Work and Efficiency

Practical Application:

Student will reflect how work is related to motion.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-R3) dealing with mechanical motion and rate.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define work;
b. Compare force to work;
c. Define kinetic energy;
d. Define potential energy; and,
e. List forms of energy.

Reading Assignments:

The following chapters are assigned to read from Introduction to Physical Science, James Shipman, DC Heath Publishes, Latest Edition:

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Work and Energy</td>
</tr>
</tbody>
</table>

Module Outline:

I. Define Work
II. Work in Mechanical System
III Calculating Work
IV. Effects of Mechanical Work
V. Work and Efficiency
IMM-R2
Work
Self-Assessment

1. Define work.

2. Define kinetic energy.

3. Define potential energy.

4. List four forms of energy.

IMM-R2
Work
Self-Assessment Answer Key

1. Work happens when a force causes an object to move.

2. Energy relating to dynamic motion. Bodies in motion.

3. Energy relating to the position or height above a place to which an object may fall. Bodies at rest.

4. Electrical, mechanical, chemical, thermal, radiant or vibrational. (Pick 4)

5. Sometimes energy may change forms, but it is conserved.
INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-R3

Subject: Industrial Maintenance
Duty: Basic Mechanical Concepts
Task: Mechanical Motion and Rate

Time: 3 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Define motion;
b. Define rate; and,
c. Compare motion to rate.

Instructional Materials:

MASTER Handout (IMM-R3-HO)
MASTER Laboratory Aid (IMM-R3-LA)
MASTER Laboratory Worksheet (IMM-R3-LW)
MASTER Self-Assessment
Chalkboard
Chalk

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-R2 “Work”
Introduction:

Mechanical motion causes devices, people, materials, and parts to change. Location a fundamental understanding of how this happens is important. This technical module deals with a study of mechanical motion and rate.

Presentation Outline:

I. Introduction
II. Define Rate
III. Define Mechanical Motion
IV. Mechanical Motion and Rate

Practical Application:

1. Demonstrate mechanical motion; and,
2. Demonstrate how a different rate effects speeds.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-R4) dealing with simple machines.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define motion;
b. Define rate; and,
c. Compare motion to rate.

Reading Assignments:

The following chapters are assigned to read from Mechanism Analysis, Barton, Dekker Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Types of Motion</td>
</tr>
</tbody>
</table>

Module Outline:

I. Introduction
II. Define Rate
III. Define Mechanical Motion
IV. Mechanical Motion and Rate
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Demonstrate mechanical motion; and,
   c. Demonstrate how a different rate effects speeds.
1. Instructor will design a series of experiments to demonstrate:
   a. Linear motion;
   b. Rotational motion;
   c. Transnational motion;
   d. Rectangular motion;
   e. Curvilinear motion;
   f. Three dimensional motion;
   g. Linear displacement;
   h. Angular displacement;
   i. Velocity;
   j. Acceleration;
   k. Speed; and,
   l. Cyclic motion.

2. Student will be graded on his/her ability to demonstrate:
   a. Linear motion;
   b. Rotational motion;
   c. Transnational motion;
   d. Rectangular motion;
   e. Curvilinear motion;
   f. Three dimensional motion;
   g. Linear displacement;
   h. Angular displacement;
   i. Velocity;
   j. Acceleration;
   k. Speed; and,
   l. Cyclic motion.
IMM-R3
Mechanical Motion and Rate
Self-Assessment

1. Define motion.

2. Define rate.

3. Compare motion to rate.
1. Movement, process of changing place.

2. Speed of motion.

3. Motion is movement, rate is the speed of movement.
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-R4

Subject: Industrial Maintenance
Duty: Basic Mechanical Concepts
Task: Simple Machines

Time: 9 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Calculate force;
b. Properly install and adjust levers;
c. Properly use wedges;
d. Properly adjust cams; and,
e. Properly install and adjust pulleys.

Instructional Materials:

- MASTER Handout (IMM-R4-HO)
- MASTER Laboratory Worksheet (IMM-R4-LW)
- MASTER Laboratory Aid (IMM-R4-LA)
- MASTER Self-Assessment
- Chalkboard
- Overhead
- Classroom

References:


Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-R3 “Mechanical Motion and Rate”

Introduction:

Machines play an integral part of the daily operation of an industrial plant. Machines to be stretched, merged, tossed, cut, heated, and etc.
Presentation Outline:

I. Force Transforming
II. Levers
III. Incline Planes
IV. Wedge
V. Cam
VI. Pulleys
VII. Combining Simple Machines

Practical Application:

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-R5) dealing with power.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Calculate force;
b. Properly install and adjust levers;
c. Properly use wedges;
d. Properly adjust cams; and,
e. Properly install and adjust pulleys.

Reading Assignments:

The following chapters are assigned to read from Industrial Trades Handbook, Basarnba, IPT Publishers, Latest Edition

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Pulleys</td>
</tr>
</tbody>
</table>

Module Outline:

I. Force Transforming
II. Levers
III. Incline Planes
IV. Wedge
V. Cam
VI. Pulleys
VII. Combining Simple Machines
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
1. Instructor will demonstrate how to:
   a. Calculate force;
   b. Properly install and adjust levers;
   c. Properly use wedges;
   d. Properly adjust cams; and,
   e. Properly install and adjust pulleys.

2. Student will be graded on:
   a. Calculating force;
   b. Properly installing and adjusting levers;
   c. Properly using wedges;
   d. Properly adjusting cams; and,
   e. Properly installing and adjusting pulleys.
1. The force acting on lever (6" long) with an acceleration of 6 ft/min is ________________.

2. Define pulley.
   ____________________________
   ____________________________
   ____________________________

3. Define lever.
   ____________________________
   ____________________________
   ____________________________

4. Define cam.
   ____________________________
   ____________________________
   ____________________________
1. Force = 1/2 ft. times 6 ft./min. = 3 ft. sq./min.

2. A sheave or wheel with a grooved rim in which a rope or belt is placed in to cause mechanical motion.

3. A rigid piece that transmits motion when force is applied to a point on the lever.

4. A rotating or sliding piece in a mechanical linkage used to transmit rotating motion into linear motion or vice versa.
INDUSTRIAL MAINTENANCE MECHANIC SERIES
MASTER Technical Module No. IMM-R5

Subject: Industrial Maintenance  Time: 4 Hrs.
Duty: Basic Mechanical Concepts
Task: Power

Objective(s):

Upon completion of this module the student will be able to:
   a. Define power;
   b. Compare power to work;
   c. Define mechanical power; and,
   d. Compare mechanical power to electrical power.

Instructional Materials:

   MASTER Handout (IMM-R5-HO)
   MASTER Self-Assessment
   Chalkboard
   Overhead
   Classroom

References:

   Energy For Man, Thirring, Hans, Greenwood Press, Latest Edition
   Power-Prime Mover of Technology, Duffy, Joseph, McKnight and McKnight Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
   IMM-R4 "Simple Machines"

Introduction:

Power is a very important term to a maintenance mechanic. Power creates motion. Mechanical motion is the prime mover. Power also creates heat.
Presentation Outline:

I. Define Power
II. Power in Linear Mechanical System
III. Circuits of Mechanical Power
IV. Power Efficiency
V. Calculating Mechanical Power

Practical Application:

Student will relate how power effects mechanical motion.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-S1) dealing with fasteners and nomenclature.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Define power;
b. Compare power to work;
c. Define mechanical power; and,
d. Compare mechanical power to electrical power.

Reading Assignments:

The following chapters are assigned to read from *Introduction to Physical Science*, James Shipman, D. C. Heath Co. Publishers, Latest Edition

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Module Outline:

I. Define Power
II. Power in Linear Mechanical System
III. Circuits of Mechanical Power
IV. Power Efficiency
V. Calculating Mechanical Power
IMM-R5
Power
Self-Assessment

1. Define power.

2. Compare work to power.

3. Define mechanical power.

4. Compare electrical power to mechanical power.
1. Power is the rate of doing work.

2. Work does not depend on speed or time. However, power does depend on time. Power is a measure of how fast or slow work is done.

3. The power formula for mechanical is \( P = F \times V \). Power is found by two methods. In the first method, work is determined. Then the value of work is divided by time, giving power \( P = \frac{W}{T} \). In the second method, power is found directly from the product of force and speed \( P = F \times V \). The conversion from ft-lb/sec to horsepower (HP) is then calculated.

4. The power formula for electrical is \( P = \frac{W}{T} \). The power formula for mechanical is \( P = F \times V \).
INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<td>J-1 Layout sheet metal parts</td>
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- **Tasks**
  - **A-1 Use protective equipment**
  - **A-2 Accident prevention**
  - **A-3 Working aloft**
  - **A-4 Fire safety**
  - **A-5 Lifting safety**
  - **A-6 Lockout/tagout**
  - **B-1 Perform basic arithmetic functions**
  - **B-2 Convert basic types of drawings**
  - **B-3 Identify basic layout of drawings**
  - **B-4 Perform basic algebraic operations**
  - **B-5 Perform basic trigonometric functions**
  - **B-6 Perform basic geometric calculations**
  - **C-1 Identify basic types of drawings**
  - **C-2 Identify basic layout of drawings**
  - **C-3 Review blueprints and dimensions**
  - **D-1 Use non-precision measuring tools**
  - **D-2 Use precision measuring tools**
  - **E-1 Identify and use maintenance technician's hand tools**
  - **E-2 Identify and use hand held power tools**
  - **F-1 Use and care of milling machines**
  - **F-2 Use and care of horizontal and vertical band saws**
  - **F-3 Use and care of horizontal and vertical band saws**
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  - **F-5 Operate lathes**
  - **F-6 Operate lathes**
  - **F-7 Use and care of drill press**
  - **G-1 Weld with shielded metal arc welding (GMAW) process**
  - **G-2 Weld/cut with oxyacetylene**
  - **G-3 Perform gas soldering**
  - **H-1 Maintain air conditioning systems**
  - **H-2 Maintain pneumatic control circuits**
  - **H-3 Troubleshoot pneumatic control circuits**
  - **H-4 Troubleshoot positive displacement pumps**
  - **H-5 Maintain gate, globe, ball, plug, and butterfly valves**
  - **H-6 Maintain check valves and relief valves**
  - **H-7 Troubleshoot and repair blowers**
  - **H-8 Troubleshoot, maintain, and repair hydraulic systems**
  - **H-9 Troubleshoot, maintain, and repair pneumatic systems**
  - **I-1 Maintain and troubleshoot belt drive systems**
  - **I-2 Maintain and troubleshoot gear power transmission drives**
  - **I-3 Maintain and troubleshoot chain power transmission drives**
  - **I-4 Maintain and troubleshoot clutches**
  - **J-1 Layout sheet metal parts**
  - **J-2 Fasten sheet metal parts together**
  - **J-3 Fasten sheet metal parts together**
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<td>S-7 Demonstrate appropriate torquing technique</td>
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INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-S1

Subject: Industrial Maintenance

Duty: Fasteners and Preloading

Task: Fasteners and Nomenclature

Time: 11 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify and describe common bolts and screws;
b. Give examples of common bolts and screws;
c. Describe how bolts and screws are sized;
d. List shapes of heads for common bolts and screws;
e. Identify and describe common nuts, washers, pins and rivets; and,
f. Identify and describe common keys, retaining rings, and self threading screws.

Instructional Materials:

MASTER Handout (IMM-S1-HO)
MASTER Laboratory Aid (IMM-S1-LA)
MASTER Laboratory Worksheet (IMM-S1-LW)
MASTER Self-Assessment

Assortment of fasteners including bolts, screws, pins and rivets
Internal retain ring pliers
External retain ring pliers
Screwdrivers: straight and phillips
Wrench-torque: open and box end
Rivet gun
Ball peen hammer

References:

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-R5  "Power"

Introduction:

Parts are held together with fasteners.

Presentation Outline:

I. Introduction
II. Bolts
   A. Head
   B. Body
III. Screws
   A. Cap
   B. Machine
IV. Nuts
   A. Machine screw
   B. Jam
V. Washers
   A. Plain
   B. Lock
   C. Pre-assembled screw and washer
VI. Pins
   A. Cotter
   B. Tapered
VII. Keys
   A. Square
   B. Gib
   C. Woodruff
VIII. Retaining Ring
   A. Internal
   B. External
IX. Rivets
   A. Head
   B. Size
   C. Length
   D. Tinner
   E. Material
F. Tubular
G. Blind
X. How to Specify Fasteners
A. Name
B. Quantity
C. Kind
D. Size
E. Shape
F. Catalog

Practical Application:

1. Identify all fasteners displayed in lab; and,
2. Identify all tools displayed in lab.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-S2) dealing with applications for various fasteners.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Identify and describe common bolts and screws;
b. Give examples of common bolts and screws;
c. Describe how bolts and screws are sized;
d. List shapes of heads for common bolts and screws;
e. Identify and describe common nuts, washers, pins and rivets; and,
f. Identify and describe common keys, retaining rings, and self threading screws.

Reading Assignments:

The following chapters are assigned to read from Metal Work, Cupples, Glencoe Publishers, Latest Edition

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Module Outline:

I. Introduction
II. Bolts
   A. Head
   B. Body
III. Screws
   A. Cap
   B. Machine
IV. Nuts
   A. Machine screw
   B. Jam

V. Washers
   A. Plain
   B. Lock
   C. Pre-assembled screw and washer

VI. Pins
   A. Cotter
   B. Tapered

VII. Keys
    A. Square
    B. Gib
    C. Woodruff

VIII. Retaining Ring
    A. Internal
    B. External

IX. Rivets
    A. Head
    B. Size
    C. Length
    D. Tinner
    E. Material
    F. Tubular
    G. Blind

X. How to Specify Fasteners
   A. Name
   B. Quantity
   C. Kind
   D. Size
   E. Shape
   F. Catalog
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Identify all fasteners displayed in lab; and,
   c. Identify all tools displayed in lab.
1. Instructor will demonstrate how to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

2. Student will demonstrate how to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

3. Instructor will grade student’s ability to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.
Circle the letter preceding the most correct answer.

1. When measuring length of a screw, this screw includes measuring the head also:
   a. Machine
   b. Wood
   c. Lag
   d. Flat head

2. This fastener is used to fasten wooden parts to metal:
   a. Stove
   b. Carriage
   c. Stud
   d. All of these

3. The screw is threaded like a wood screw, used to fastened machines to wooden floors.
   a. Machine
   b. Wood
   c. Lag
   d. Flat head

4. This fastener locks in another, prevents loosening by vibration.
   a. Jam
   b. Machine screw
   c. Castle
   d. Wing

5. This pin is used to slip through a hole in bolt and opening in castle nut to prevent turning:
   a. Tapered
   b. Roll
   c. Cotter
   d. All of these
6. This type of retaining pin is driven into place:
   a. Self-locking
   b. Internal
   c. External
   d. All of these
IMM-S1
Fasteners and Nomenclature
Self-Assessment Answer Key

1. D
2. B
3. C
4. A
5. C
6. A
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-S2

Subject: Industrial Maintenance
Duty: Fasteners and Preloading
Task: Application for Various Fasteners

Time: 12 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify and describe common bolts and screws;
b. Give examples of common bolts and screws;
c. Describe how bolts and screws are sized;
d. List shapes of heads for common bolts and screws;
e. Identify and describe common nuts, washers, pins and rivets; and,
f. Identify and describe common keys, retaining rings, and self threading screws.

Instructional Materials:

MASTER Handout (IMM-S2-HO)
MASTER Laboratory Aid (IMM-S2-LA)
MASTER Laboratory Worksheet (IMM-S2-LW)
MASTER Self-Assessment
Assortment of fasteners including bolts, screws, pins and rivets
Internal retain ring pliers
External retain ring pliers
Screwdrivers: straight and phillips
Wrench-torque: open and box end
Rivet gun
Ball peen hammer

References:

Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-S1  "Fasteners and Nomenclature"

Introduction:

Parts are held together with fasteners.

Presentation Outline:

I. Introduction
II. Bolts
   A. Head
   B. Body
III. Screws
    A. Cap
    B. Machine
IV. Nuts
    A. Machine screw
    B. Jam
V. Washers
    A. Plain
    B. Lock
    C. Pre-assemble screw and washer
VI. Pins
    A. Cotter
    B. Tapered
VII. Keys
     A. Square
     B. Gib
     C. Woodruff
VIII. Retaining Ring
    A. Internal
    B. External
IX. Rivets
    A. Head
    B. Size
    C. Length
    D. Tinner
    E. Material
X. How to Specify Fasteners

A. Name
B. Quantity
C. Kind
D. Size
E. Shape
F. Catalog

Practical Application:

Student will demonstrate how to specify fasteners.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student’s successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-S3) dealing with techniques for removing damaged fasteners.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Identify and describe common bolts and screws;
b. Give examples of common bolts and screws;
c. Describe how bolts and screws are sized;
d. List shapes of heads for common bolts and screws;
e. Identify and describe common nuts, washers, pins and rivets; and,
f. Identify and describe common keys, retaining rings, and self threading screws.

Reading Assignments:

The following chapters are assigned to read from Metal Work, Cupples, Glencoe Publishers, Latest Edition:

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Module Outline:

I. Introduction
II. Bolts
   A. Head
   B. Body
III. Screws
   A. Cap
   B. Machine
IV. Nuts
   A. Machine screw
   B. Jam

V. Washers
   A. Plain
   B. Lock
   C. Pre-assemble screw and washer

VI. Pins
   A. Cotter
   B. Tapered

VII. Keys
    A. Square
    B. Gib
    C. Woodruff

VIII. Retaining Ring
      A. Internal
      B. External

IX. Rivets
    A. Head
    B. Size
    C. Length
    D. Tinner
    E. Material
    F. Tubular
    G. Blind

X. How to Specify Fasteners
   A. Name
   B. Quantity
   C. Kind
   D. Size
   E. Shape
   F. Catalog
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Student will demonstrate how to specify fasteners.
1. Instructor will demonstrate how to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

2. Student will demonstrate how to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

3. Instructor will grade student's ability to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.
1. What are carriage bolts used for?

2. Name two types of setscrews and give an example of how each is used.

3. Describe a lag screw. What is it used for?

4. Describe a thumbscrew. What is it used for?

5. What is a jam nut used for?

6. What is a castles nut used for?
7. How is a cotter pin used?

8. How are taper pins used?

9. What are retaining rings, and how are they used?

10. List two types of self-threading screws. How are they used?
1. Carriage bolts: fasten wooden parts to metal
   Stove bolts: general purpose- no precision fit
   Stud bolts: inserted into metal parts needed to project bolts to fasten to other parts.

2. Square head used to fasten pulleys and collars on shafts; headless used as a safety device on moving parts.

3. Threaded like wood screws with square or hex head; fasten machines to wooden floors.

4. One or more wings; used for hand tightening.

5. Locks into another nut; reduce vibrations.

6. Locked to bolt with cotter key; wheel bearings.

7. Slip through hole in bolt and castle nut to prevent turning.

8. Fit into taper hole in joining parts; fasten parts together.

9. Seated in internal or external grooves to lock in position.

10. Cut threads or form threads; divine into holes slightly larger than diameter of screws.
Subject: Industrial Maintenance  
Duty: Fasteners and Preloading  
Task: Techniques for Removing Damaged Fasteners

Time: 3 Hrs.

Objective(s):

Upon completion of this module the student will be able to use screw extractors to remove a broken bolt.

Instructional Materials:

MASTER Handout (IMM-S3-HO)  
MASTER Laboratory Aid (IMM-S3-LA)  
MASTER Laboratory Worksheet (IMM-S3-LW)  
Sealed extractor  
Diamond point chisel  
Tap wrench  
Broken Bolt  
Power Drill  
Drill bit for use with broken bolt

References:


Student Preparation:

Students should have previously completed the following Technical Modules:  
IMM-S2 “Application for Various Fasteners”
Introduction:

A broken bolt or screw can be removed from a hole. If the bolt or screw is not made of hardened steel, this procedure is possible. This module deals with the procedure to remove a broken bolt.

Presentation Outline:

I. Screw Extractor Components
   A. Screw extractor
   B. Tap wrench

II. Procedure for Removing a Broken Bolt
   A. Use hand drill
   B. Deduct drill bit
   C. Secure drill bit in hand drill
   D. Drill hole in broken bolt
   E. Place tap wrench onto screw extractor
   F. Turn screw extractor counter clock wise
   G. When force to firm, stop turning and pull extract out, plus broken bolt

Practical Application:

1. Student will use screw extractor to remove broken bolt; and,
2. Student will use diamond point chisel to remove broken bolt.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-S4) dealing with cleaning and restoring threaded fasteners.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to use screw
extractors to remove a broken bolt.

Reading Assignments:

The following chapters are assigned to read from Metal Work, Cupples, Glencoe
Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>25</td>
<td>Fasteners</td>
</tr>
</tbody>
</table>

Module Outline:

I. Screw Extractor Components
   A. Screw extractor
   B. Tap wrench

II. Procedure for Removing a Broken Bolt
   A. Use hand drill
   B. Deduct drill bit
   C. Secure drill bit in hand drill
   D. Drill hole in broken bolt
   E. Place tap wrench onto screw extractor
   F. Turn screw extractor counter clock wise
   G. When force to firm, stop turning and pull extract out, plus broken bolt
IMM-S3-LA
Techniques for Removing Damaged Fasteners
Attachment 2: MASTER Laboratory Aid

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Student will use screw extractor to remove broken bolt; and,
   c. Student will use diamond point chisel to remove broken bolt.
1. Instructor will demonstrate how to use screw extractors to remove a broken bolt.

2. Student will demonstrate how to use screw extractors to remove a broken bolt.

3. Instructor will grade student's ability to use screw extractors to remove a broken bolt.
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER TECHNICAL MODULE NO. IMM-S4

Subject: Industrial Maintenance
Time: 3 Hrs.

Duty: Fasteners and Preloading
Task: Cleaning and Restoring Threaded Fasteners

Objective(s):

Upon completion of this module the student will be able to:
a. Clean threaded fasteners; and,
b. Restore threaded fasteners.

Instructional Materials:

MASTER Handout (IMM-S4-HO)
MASTER Laboratory Aid (IMM-S4-LA)
MASTER Laboratory Worksheet (IMM-S4-LW)

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-S3 “Techniques for Removing Damaged Fasteners”

Introduction:

Housekeeping is important. Housekeeping of fasteners is also important to make parts mate properly. Sometimes threads may become cross threaded and may require rethreading in order to mate properly.
Presentation Outline:

I. Cleaning Technique
   A. Air
   B. Liquid
   C. Cloth
II. Restoring Threads

Practical Application:

1. Student will demonstrate how to clean threaded fasteners; and,
2. Student will demonstrate how to restore threaded fasteners.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-S5) dealing with torque/preload theory.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Clean threaded fasteners; and,
b. Restore threaded fasteners.

Reading Assignments:

The following chapters are assigned to read from *Metal Work*, Cupples, Glencoe
Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>15</td>
<td>Fasteners</td>
</tr>
</tbody>
</table>

Module Outline:

I. Cleaning Technique
   A. Air
   B. Liquid
   C. Cloth

II. Restoring Threads
1. **Instructor will:**
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing
      the project; and,
   d. Grade procedures and finished project.

2. **Student will:**
   a. Follow proper instructions and safety procedures to complete the
      project;
   b. Student will demonstrate how to clean threaded fasteners; and,
   c. Student will demonstrate how to restore threaded fasteners.
1. Instructor will demonstrate how to:
   a. Clean threaded fasteners; and,
   b. Restore threaded fasteners.

2. Student will demonstrate how to:
   a. Clean threaded fasteners; and,
   b. Restore threaded fasteners.

3. Instructor will grade student’s ability to:
   a. Clean threaded fasteners; and,
   b. Restore threaded fasteners.
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-S5

Subject: Industrial Maintenance

Time: 4 Hrs.

Duty: Fasteners and Preloading
Task: Torque/Preload Theory

Objective(s):

Upon completion of this module the student will be able to:

a. Define torque;
b. Define preload;
c. List common torque pattern;
d. Define retorquing; and,
e. List common torque technique.

Instructional Materials:

MASTER Handout (IMM-S5-HO)
MASTER Self-Assessment
Classroom
Chalkboard

References:

Modern General Shop, Brown, W. C., et al., Goodheart-Willcox Publishing,
Latest Edition
Latest Edition
Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

IMM-S4  "Cleaning and Restoring Threaded Fasteners"
Introduction:

Proper torque is essential to mate two mechanical parts together.

Presentation Outline:

I. Torque
II. Preload
III. Torque Patterns
IV. Retorquing
V. Layout
VI. Standard Torquing Technique
VII. Non-Standard Torquing Techniques

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-S6) dealing with the effects of lubricating threads prior to torquing.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define torque;
b. Define preload;
c. List common torque pattern;
d. Define retorquing; and,
e. List common torque technique.

Reading Assignments:

The following chapters are assigned to read from Mechanics' and Millwrights' Guide, Nelson, Audel Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
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<tbody>
<tr>
<td>11</td>
<td>Torque Wrench</td>
</tr>
</tbody>
</table>

Module Outline:

I. Torque
II. Preload
III. Torque Patterns
IV. Retorquing
V. Layout
VI. Standard Torquing Technique
VII. Non-Standard Torquing Techniques
1. Define torque.

2. Define preload.

3. List common torque pattern.

4. Define retorquing.

5. List common torque technique.
1. A twisting force which tends to relate an object.
2. Start activity with a torqued valued at the beginning.
3. If several bolts are in a plate, tighten opposite sides and rotate around.
4. Apply additional 2nd torquing to an object.
5. Gradually apply pressure until predetermined value is reached.
INDUSTRIAL MAINTENANCE MECHANIC
SERIES
MASTER Technical Module No. IMM-S6

Subject: Industrial Maintenance
Duty: Fasteners and Preloading
Task: Effects of Lubricating Threads Prior to Torquing

Time: 4 Hrs.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate what effects are seen by lubricating threads prior to torquing; and,

b. Demonstrate what effects are seen by not lubricating threads prior to torquing.

Instructional Materials:

MASTER Handout (IMM-S6-HO)
MASTER Laboratory Aid (IMM-S6-LA)
MASTER Laboratory Worksheet (IMM-S6-LW)
MASTER Self-Assessment
Lubricant
Torque wrench

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-S5 “Torque/Preload Theory”
Introduction:

Lubrication is needed in many mechanical situations. This module deals with lubrication and torquing.

Presentation Outline:

I. Lubrication  
II. Torquing  
III. Torquing Without Lubricating  
IV. Lubrication Plus Torquing

Practical Application:

1. Demonstrate what effects are seen by lubricating threads prior to torquing; and,  
2. Demonstrate what effects are seen by not lubricating threads prior to torquing.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (IMM-S7) dealing with demonstrating appropriate torquing technique.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Demonstrate what effects are seen by lubricating threads prior to torquing; and,
b. Demonstrate what effects are seen by not lubricating threads prior to torquing.

Reading Assignments:

The following chapters are assigned to read from Mechanics' and Millwrights' Guide, Nelson, Audel Publishers, Latest Edition:

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<tr>
<th>Chapter</th>
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<tbody>
<tr>
<td>13</td>
<td>Mechanical Fasteners</td>
</tr>
</tbody>
</table>

Module Outline:

I. Lubrication
II. Torquing
III. Torquing Without Lubricating
IV. Lubrication Plus Torquing
IMM-S6-LA
Effects of Lubricating Threads Prior to Torquing
Attachment 2: MASTER Laboratory Aid

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Demonstrate what effects are seen by lubricating threads prior to torquing; and,
   c. Demonstrate what effects are seen by not lubricating threads prior to torquing.
1. Instructor will demonstrate how lubrication affects torquing.

2. Student will demonstrate how lubrication affects torquing.

3. Instructor will grade student's ability to demonstrate how lubrication affects torquing.
1. What effects are seen by lubricating threads prior to torquing.

2. What effects are seen by not lubricating threads prior to torquing.
1. Lubrication causes threads to exhibit a smoother surface, therefore, making torquing activities easier.

2. Lack of lubrication causes threads to exhibit a rougher surface, therefore, making torquing activities more difficult because there is more friction.
Subject: Industrial Maintenance

Duty: Fasteners and Preloading
Task: Demonstrate Appropriate Torquing Technique

Objective(s):

Upon completion of this module the student will be able to demonstrate appropriate torquing technique.

Instructional Materials:

MASTER Handout (IMM-S7-HO)
MASTER Laboratory Aid (IMM-S7-LA)
MASTER Laboratory Worksheet (IMM-S7-LW)
MASTER Self-Assessment
Torque Wrenches

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
IMM-S6 "Effects of Lubricating Threads Prior to Torquing"

Introduction:

Proper torquing is essential to achieving a tight, uniform, well sealed mechanical parts.
Presentation Outline:

I. Types of Torque Wrenches
II. Torque Wrench Selection
III. Use of Torque Wrench
IV. Care of Torque Wrench
V. Fastener Torquing

Practical Application:

Student will demonstrate appropriate torquing technique.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

This completes the series of Industrial Maintenance Mechanic technical modules.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to demonstrate appropriate torquing technique.

Reading Assignments:

The following chapters are assigned to read from Mechanics' and Millwrights' Guide, Nelson, Audel Publishers, Latest Edition:

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<tr>
<td>11</td>
<td>Torque Wrench</td>
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</tbody>
</table>

Module Outline:

I. Types of Torque Wrenches
II. Torque Wrench Selection
III. Use of Torque Wrench
IV. Care of Torque Wrench
V. Fastener Torquing

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IMM-S7-LA
Demonstrate Appropriate Torquing Technique
Attachment 2: MASTER Laboratory Aid

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Student will demonstrate appropriate torquing technique.
1. Instructor will demonstrate:
   a. Types of torque wrenches;
   b. Torque wrench selection;
   c. Use of torque wrench;
   d. Care of torque wrench; and,
   e. Fastener torquing.

2. Student will demonstrate:
   a. Types of torque wrenches;
   b. Torque wrench selection;
   c. Use of torque wrench;
   d. Care of torque wrench; and,
   e. Fastener torquing.

3. Instructor will grade student's ability to:
   a. List types of torque wrenches;
   b. Select appropriate torque wrench selection;
   c. Properly use torque wrench;
   d. Properly care of torque wrench; and,
   e. Torque fasteners.
IMM-S7
Demonstrate Appropriate Torquing Technique
Self-Assessment

1. List types of torque wrenches.

2. List proper torque wrench selection.

3. Explain use of torque wrench.

4. Explain care of torque wrench.

5. Explain how a torque wrench is used for fastener torquing.
1. Dial, lever

2. Adequate capacity to provide accuracy (25 to 75 is range). Avoid oversize torque wrench. Should torque wrench be pushed or pulled?

3. It is a combination wrench and measuring tool.

4. Use same care as used with other measuring devices.

5. Find out maximum torque for a specific fastener. Torque required to rotate a fastener before make up occurs is rundown resistance. When tight threads produce a run down resistance, torque required to overcome this resistance should be considered. In the last stages of rotation seizing of fastener may occur. If this happens back off and again apply tightening torque. The torque required to loosen a fasten is less than tightened torque.
MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

a consortium of educators and industry

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY

Industrial Maintenance Series
STUDENT LABORATORY MANUAL

Supported by the National Science Foundation's Advanced Technological Education Program
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ACKNOWLEDGEMENTS

This project was made possible by the cooperation and direct support of the following organizations:

National Science Foundation - Division of Undergraduate Education
MASTER Consortia of Employers and Educators

MASTER has built upon the foundation which was laid by the Machine Tool Advanced Skills Technology (MAST) Program. The MAST Program was supported by the U.S. Department of Education - Office of Vocational and Adult Education. Without this prior support MASTER could not have reached the level of quality and quantity that is contained in these project deliverables.

MASTER DEVELOPMENT CENTERS
Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES

COLLEGE AFFILIATES

FEDERAL LABS
Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS
Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin D - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -
Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS
American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS
Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS
The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.
Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Dic
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION
Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.
Manufacturing in the Augusta Region
Augusta is the second largest city in Georgia and manufacturing represents the largest sector of the Augusta economy. The region is home to 810 manufacturers employing 89,717 people, an industrial base consisting of about 75% process control and 25% discrete parts production facilities. Major areas of emphasis for industry include technology transfer, factory floor training, and job certification programs. Growth of manufacturing in the region has been driven by Augusta’s high tech development in electronics, process control, telecommunications, computers, medical services and instrumentation.

Augusta Technical Institute and Center for Advanced Technology (CADTEC)
Augusta Technical Institute (ATI) is part of Georgia’s Department of Technical and Adult Education system, serving a large percentage of the two-state Central Savannah River area through its main campus and satellite facilities. The student body includes vocational-technical and college prep students, as well as current workers seeking retraining or skills upgrade; ATI has long emphasized outreach and special attention to the needs of low income, rural and disadvantaged residents, as well as displaced workers, single parents, women in non-traditional fields, and the disabled. In 1983, the Institute used the opportunity to host one of Georgia’s new regional advanced technology centers (ATC’s) to streamline its technical programs and thereby help to ensure the future employability of its students. ATI’s Center for Advanced Technology (CADTEC) is designed to provide technology research and demonstration, industry assessments, technical consulting, and industry-specific contract training for the many established and emerging high tech companies in the Augusta region.

Development Team
- **Project Director**: Mr. Ray Center, Director of CADTEC, served as program director for the MASTER project.
- **Subject Matter Expert**: Ronnie Lambert, MS, MASTER Site Coordinator, had program responsibility for developing skill standards based on the industry skills verification process, as well as developing course curricula and program materials for the MASTER pilot program in Industrial Maintenance Mechanic and Instrumentation Technician. Mr. Lambert has taught Industrial Maintenance Mechanic and Instrumentation for 32 years in colleges and industry across the Southeast.
Introduction:
STUDENT LABORATORY MANUAL

Prior to the development of this Student Laboratory Manual, MASTER project staff visited over 150 companies, conducted interviews with over 500 expert workers, and analyzed data from a national survey involving over 2800 participating companies. These investigations led to the development of a series of Instructor Handbooks, with each being fully industry-driven and specific to one of the technologies shown below:

- Advanced CNC and CAM
- Automated Equipment Repair
- Computer Aided Design & Drafting
- Conventional Machining
- Industrial Maintenance
- Instrumentation
- LASER Machining
- Manufacturing Technology
- Mold Making
- Tool And Die
- Welding

Each Instructor's Handbook contains a collection of Technical Training Modules which are built around a Competency Profile for the specific occupation. The Competency Profile which is the basis for this Student Laboratory Manual may be found on the following page (and on each of the tab pages in this book).

This Student Laboratory Manual has been developed as an learning aid for both the instructor and for the student, and is intended to be used in conjunction with the Instructor's Handbook.

This Student Laboratory Manual is arranged by Duty groupings (Duty A, Duty B, etc.) with learning modules available for each Task Box on the Competency Profile.

This Student Laboratory Manual is supplied with an accompanying Instructor's Handbook for use by the instructor.

Each module in the Instructor's Handbook has a corresponding learning module in the Student Laboratory Manual.
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<td>H-2 Maintain pneumatic control circuits</td>
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<td><strong>A-1</strong> Use protective equipment</td>
</tr>
<tr>
<td><strong>B</strong> Apply Mathematical Concepts</td>
<td><strong>A-2</strong> Accident prevention</td>
</tr>
<tr>
<td><strong>C</strong> Interpret Engineering Drawings and Control Documents</td>
<td><strong>A-3</strong> Working aloft</td>
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<tr>
<td><strong>D</strong> Use Measuring Tools</td>
<td><strong>A-4</strong> Fire safety</td>
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<tr>
<td><strong>E</strong> Use Hand Tools</td>
<td><strong>A-5</strong> Lifting safety</td>
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<tr>
<td><strong>F</strong> Operate Machine Tools</td>
<td><strong>A-6</strong> Lockout/tagout</td>
</tr>
<tr>
<td><strong>G</strong> Perform Welding Operations</td>
<td><strong>B-1</strong> Perform basic arithmetic functions</td>
</tr>
<tr>
<td><strong>H</strong> Maintain/Troubleshoot Equipment and Systems</td>
<td><strong>B-2</strong> Convert fractions/decimals</td>
</tr>
<tr>
<td><strong>I</strong> Repair Power Transmission Systems</td>
<td><strong>B-3</strong> Convert English measurements</td>
</tr>
<tr>
<td><strong>J</strong> Fabricate/Install Sheet Metal Parts</td>
<td><strong>B-4</strong> Perform basic algebraic operations</td>
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<td><strong>B-5</strong> Perform basic trigonometric functions</td>
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<td></td>
<td><strong>B-6</strong> Perform basic geometric calculations</td>
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<tr>
<td></td>
<td><strong>C-1</strong> Identify basic types of drawings</td>
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<td></td>
<td><strong>C-2</strong> Identify basic layout of drawings</td>
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<td></td>
<td><strong>C-3</strong> Review blueprint notes and dimensions</td>
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<td></td>
<td><strong>D-1</strong> Use non-precision measuring tools</td>
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<tr>
<td></td>
<td><strong>D-2</strong> Use precision measuring tools</td>
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<td></td>
<td><strong>E-1</strong> Identify and use maintenance technician's hand tools</td>
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<td><strong>E-2</strong> Identify and use hand held power tools</td>
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<tr>
<td></td>
<td><strong>F-1</strong> Use and care of milling machines</td>
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<tr>
<td></td>
<td><strong>F-2</strong> Use and care of horizontal and vertical band saws</td>
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<td><strong>F-3</strong> Use and care of horizontal band saws</td>
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<td></td>
<td><strong>F-4</strong> Use and care of surface grinder</td>
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<td><strong>F-5</strong> Operate lathes</td>
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<td><strong>F-6</strong> Use and care of drill press</td>
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<td></td>
<td><strong>G-1</strong> Weld with shielded metal arc welding (SMAW) process</td>
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<td><strong>G-2</strong> Weld with oxyacetylene</td>
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<td><strong>G-3</strong> Perform gas soldering</td>
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<tr>
<td></td>
<td><strong>H-1</strong> Maintain air conditioning systems</td>
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<td><strong>H-2</strong> Maintain pneumatic control circuits</td>
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<td><strong>H-5</strong> Maintain gate, globe, ball, plug, and butterfly valves</td>
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Standards of performance safety:

Student shall demonstrate safe work habits in the workshop by:
- Using OSHA required safety equipment for the shop;
- Safety glasses;
- Hearing protection;
- Face shields;
- Gloves;
- Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
- Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify safety equipment appropriate to protect the eyes from flying particle matter or chemicals;
b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
c. Identify equipment appropriate to protect against high level of noise;
d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials; and,
e. Identify safety equipment appropriate to protect the lungs from chemicals or particles.

Reading Assignments:

The following chapters are assigned to read from Supervisor's Safety Manual textbook, Latest Edition:

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<thead>
<tr>
<th>Chapter</th>
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<tr>
<td>7</td>
<td>Controlling Hazards; Protecting the Eyes: Equipment Types, Face Protection, Overcoming Employee Complaints; Protecting the Head: Fabrication, Auxiliary Features, Overcoming Objections; Ear Protection: Amount of Protection, Insert-Type Protectors, Muff Types; Protecting Fingers, Palms, and Hands; Protecting the Torso; Respiratory Protective Equipment: Selecting the Respirator, Overcoming Employee Complaints; Safety Belts and Harnesses: Fabrication, Lifelines, Inspection</td>
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Module Outline:

I. Describe Types of Conditions That Would Require the Use of Protective Equipment Due to Air Borne Partials
   A. Grinding operations
   B. Any time while in an active production environment
   C. Near welding operations
   D. Near high pressure water, air, or other mediums, i.e., oil
   E. Possibility of splashing chemicals

II. Identify Condition That Would Require the Use of a Hard Hat
    A. Generally anytime while in a construction or manufacturing environment
    B. In areas with low overhead clearances

III. Review Conditions That Would Require Use of Hearing Protection
     A. Ear plugs
     B. Ear muffs
     C. OSHA requirements

IV. Describe Typical Conditions That Would Warrant Use of Gloves to Protect the Hands
    A. Grinding
    B. Working with rough metals
    C. Working with multi strand steel cables
    D. Electrical (special insulated gloves may be required for certain voltages)

V. Identify How Lungs Are Protected from Harmful Chemicals/particles
   A. Plant engineering/ventilation
   B. Use of respirators or bubble suits
   C. Review OSHA requirements for fiber glass, asbestos and chemical protection
Standards of Performance Safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Conduct:

1. There will be no horse play or practical joking; and,
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.
1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   Ear plugs
   Ear muffs

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercise inserting and removing ear plugs.

5. Practice using ear plugs.

6. Practice exercise using ear muffs.
Objective(s):

Upon completion of this module the student will be able to:

a. Identify the two major factors in working safely;

b. List four steps you can take prior to performing work that will insure a safe outcome;

c. Identify the employees responsibility if a potential accident or unsafe condition exist; and,

d. Select specific task that have the potential to cause an injury.

Reading Assignments:

The following chapters are assigned to read from Supervisor's Safety Manual textbook, Latest Edition:

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<td>Giving Instructions: Importance of Job Instruction, Starting the New Man; On-the-Job Training: Over-the-Shoulder Coaching; Job Safety Analysis: Select the Job, Break the Job Down, Identify Hazards and Potential Accidents, Develop Solutions, Benefits of JSA; Job Instruction Training: Step 1-Preparations, Step 2-Presentation, Step 3-Application, Step 4-Testing Follow-up; Other Methods of Instruction: The Lesson Plan, Programmed Instruction, Independent Study, Closed-Circuit TV, Summary.</td>
</tr>
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FIRE PREVENTION CHECK LIST

ELECTRICAL EQUIPMENT

☐ No make shift wiring
☐ Extension cords serviceable
☐ Motors and tools free of dirt and grease
☐ Lights clear of combustible materials
☐ Safest cleaning solvents used
☐ Fuse and control boxes clean and closed
☐ Circuits properly fused
☐ Equipment approved for use in hazardous areas (if required)
☐ Ground connection clean and tight

FRITION

☐ Machinery properly lubricated
☐ Machinery properly adjusted and aligned

SPECIAL FIRE-HAZARD MATERIALS

☐ Special isolation of flammable materials
☐ Nonmetal stock free of tramp metal

WELDING AND CUTTING

☐ Areas surveyed for fire safety
☐ Combustibles removed or covered
☐ Permit issued

OPEN FLAMES

☐ Kept away from spray rooms and booths
☐ Portable torches clear of flammable surfaces
☐ No gas leaks

PORTABLE HEATERS

☐ Set up with ample horizontal and overhead clearances
☐ Secured against tipping or upset
☐ Combustibles removed or covered
☐ Safely mounted on noncombustible surface
☐ Not used as rubbish burners

HOT SURFACES

☐ Hot pipes clear of combustible materials
☐ Ample clearance around boilers and furnaces
☐ Soldering irons kept off combustible surfaces
☐ Ashes in metal containers
SMOKING AND MATCHES
- "No smoking" and "smoking" areas clearly marked
- Butt containers available and serviceable
- No discarded smoking materials in prohibited areas

SPONTANEOUS IGNITION
- Flammable waste material in closed metal containers
- Flammable waste material containers emptied frequently
- Piled material cool, dry, and well ventilated
- Trash receptacles emptied daily

STATIC ELECTRICITY
- Flammable liquid dispensing vessels grounded or banded
- Moving machinery grounded
- Proper humidity maintained

HOUSEKEEPING
- No accumulations of rubbish
- Safe storage of flammables
- Passageways clear of obstacles
- Premises free of unnecessary combustible materials
- No leaks or dripping of flammables and floor free of spills
- Fire doors unblocked and operating freely with fusible links intact

EXTINGUISHING EQUIPMENT
- Proper type
- In proper location
- Unobstructed
- Clearly marked
- In working order
- Service date current
- Personnel trained in use of equipment
Module Outline:

I. Major Factors in Working Safely
   A. Knowing what the records are
      1. Recognizing when things are not as they should be
   B. Attitude towards safety
      1. A state of mind that requires you to accept responsibility for your own and your coworkers’ safety
      2. A state of mind that does not compromise safety for production or speed
      3. A state of mind that would stop production rather than put an employee at unnecessary risk

II. Four Steps That Help Insure a Safe Job
   A. Preparing to do the job
      1. Research task to insure it can be performed
      2. Appropriate tools and help are available
      3. Proper lockout procedure
   B. Select appropriate safety equipment
   C. Once the job starts, maintain a clean work place
   D. Avoid unsafe practices
      1. Failing to use safety equipment
      2. Performing task you are not qualified to perform
      3. Rushing
      4. Practical joking
      5. Making do with a tool rather than getting the right tool

III. Employee Responsibility
   A. Assure responsibility for your own safety
   B. Notify crew and supervision of an unsafe condition
   C. Stop work if unsafe condition is identified

IV. Task That Have the Potential to Cause Injury
   A. Working with electricity
   B. Working near rotating equipment
   C. Working with chemicals and solvents
   D. Using pneumatic or hydraulic equipment
   E. Using ladders
   F. Lifting heavy objects
   G. Working in areas with harmful fumes
Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe typical safety equipment used when working aloft;
b. Describe how to set up a portable ladder for use;
c. Define basic safety concerns while working from scaffolding;
d. Identify the safety concerns to be addressed while working from a personal man basket;
e. Demonstrate use of a safety belt/harness; and,
f. Demonstrate proper set up and use of a portable ladder.

Reading Assignments:

The following chapters are assigned to read from textbook:

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<td>9</td>
<td>Manual Handling Methods; Lifting and Carrying; Equipment for Handing; Hand Trucks, Ropes, Chains and Slings; Fiber Ropes; Rope Slings</td>
</tr>
</tbody>
</table>

Module Outline:

I. Identify Safety Equipment Used When Working Aloft
   Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA
   A. Equipment common to most personnel when working aloft
      1. Safety glasses
II. Describe How to Set up a Portable Ladder for Use
A. Portable ladder are broken down in the CFRs as metal and wood ladders
B. Wood ladders see 29 CFR 1910.25
   1. Single section ladder
   2. Two section ladder
   3. Special use wood ladders
   4. Step ladder
C. Metal ladders see 29 CFR 1910.26
D. Set up 29 CFR 1910.26
   1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall

III. Basic Safety Concerns While Working from Scaffolding
Note: This module does not address scaffolding erection because special training is required
A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
C. Never lean over the handrails to perform work

IV. Concerns While Working from a Man Basket or Personnel Lift
A. Use basket or lift for employees and tools only, not freight
B. If basket has integral test weights insure weights are removed prior to lifting personnel
C. Hands must be inside basket while basket is moving
D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
E. Always inspect basket rigging prior to entry
F. Once the basket is in position it must be tied off if egress from the basket is required

V. Demonstrate Proper Set up and Use of an Extension Ladder
A. Determine wall to base of ladder distance
B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder

2. Hard hat
3. Safety belt or harness
Standards of Performance Safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Conduct:

1. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.
I. Identify Safety Equipment Used When Working Aloft
   Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA
   A. Equipment common to most personnel when working aloft
      1. Safety glasses
      2. Hard hat
      3. Safety belt or harness

II. Describe How to Set up a Portable Ladder for Use
   A. Portable ladder are broken down in the CFRs as metal and wood ladders
   B. Wood ladders see 29 CFR 1910.25
      1. Single section ladder
      2. Two section ladder
      3. Special use wood ladders
      4. Step ladder
   C. Metal ladders see 29 CFR 1910.26
   D. Set up 29 CFR 1910.26
      1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall

III. Basic Safety Concerns While Working from Scaffolding
    Note: This module does not address scaffolding erection because special training is required
    A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
    B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
    C. Never lean over the handrails to perform work

IV. Concerns While Working from a Man Basket or Personnel Lift
    A. Use basket or lift for employees and tools only, not freight
    B. If basket has integral test weights insure weights are removed prior to lifting personnel
    C. Hands must be inside basket while basket is moving
    D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
    E. Always inspect basket rigging prior to entry
    F. Once the basket is in position it must be tied off if egress from the basket is required

V. Demonstrate Proper Set up and Use of an Extension Ladder
   A. Determine wall to base of ladder distance
B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder
IMM-A4-HO
Fire Safety
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Identify the technicians responsibilities relative to fire safety;
b. List conditions required for fire to exist;
c. Name four classes of fires;
d. List four typical causes of industrial fires described in the lesson;
e. Match the correct class extinguishers to a given fuel source; and,
f. Demonstrate proper use of a fire extinguisher.

Reading Assignments:

The following chapters are assigned to read from textbook.

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<th>Chapter</th>
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<td>12</td>
<td>Basic Principles; Understanding Fire Chemistry; Determining Fire Hazards; Informing the Working Force; Causes of Fire: Electric Equipment, Friction; Special Fire-Hazard Materials; Welding and Cutting; Open Flames; Portable Heaters; Hot Surfaces; Smoking and Matches; Spontaneous Ignition; Static Electricity; Fire-Safe Housekeeping; Alarms; Equipment; Evacuation; Fire Alarms; What About Extinguishers?; Follow Up for Fire Safety; Fire Brigades; Special Fire Protection Problems</td>
</tr>
</tbody>
</table>

Module Outline:

I. Technician's Responsibility
A. Each employer will have company specific rules
B. Unless the technician is part of the company fire fighting crew or fire brigade
   1. Notify every one in the area to evacuate
   2. Get to a phone and notify appropriate department
   3. Something as simple as an ash tray or trash can can start fire that may be easily and safely extinguished. Appropriate department must be notified of the event
   4. Employees are responsible for keeping the workplace safe and for reporting unsafe conditions

II. Identify Conditions Required for a Fire to Exist
   A. Fuel
   B. Oxygen
   C. Heat

III. Four Classes of Fire
   A. Ordinary combustibles
   B. Flammable liquids
   C. Electrical
   D. Combustible metals

IV. List Four Typical Causes of Workplace Fires
   A. Careless smokers
   B. Electrical overloads
   C. Inadequate fire watch for welding and cutting operations
   D. Combustible dust in the atmosphere

V. Demonstrate to Class How to Match the Correct Extinguishers for the Class of Fire

VI. Demonstrate Proper Use of a Fire Extinguisher
Suitable for use on what type of fire: BC

Agent Characteristics:
- Regular or Ordinary Dry Chemical
- Basically Sodium Bicarbonate
- Discharges a white cloud
- Leaves residue
- Non-freezing

Average Size - 1 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.

Suitable for use on what type of fire: ABC or BC

Agent Characteristics:
- Multipurpose Dry Chemical
- Basically Ammonium Phosphate
- Discharges a yellow cloud
- Leaves residue
- Non-freezing
- Some extinguishers utilizing this agent do not have an “A” rating; however, they are designated as having “A” capability.

Average Size - 2 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.

Suitable for use on what type of fire: BC

Agent Characteristics:
- Purple-K Dry Chemical
- Basically Potassium Bicarbonate
- Discharges a bluish cloud
- Leaves residue
- Non-freezing

Average Size - 2 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.
Suitable for use on what type of fire: B C

Agent Characteristics:
- KCL Dry Chemical
- Basically Potassium Chloride
- Discharges a white cloud
- Leaves residue
- Non-freezing
- Potassium Chloride/Urea
  Average Size - 2 to 30 lbs. (11 to 23)
  Horizontal Range - 5 to 20 ft. (15 to 30)
  Discharge Time - 8 to 25 sec. (20 to 31)

Suitable for use on what type of fire: B C

Agent Characteristics:
- Carbon Dioxide
- Basically an inert gas that discharges a cold white cloud
- Leaves no residue
- Non-freezing
  Average Size - 2 ½ to 20 lbs.
  Horizontal Range - 3 to 8 ft.
  Discharge Time - 8 to 30 sec.

Suitable for use on what type of fire: B C

Agent Characteristics:
- Halogenated Agent
- Basically halogenated hydrocarbons
- Discharges a white vapor
- Leaves no residue
- Non-freezing
  Average Size - 2 ½ lbs.
  Horizontal Range - 4 to 8 ft.
  Discharge Time - 8 to 10 sec.
Suitable for use on what type of fire: A

Agent Characteristics:
- Water
- Basically tap water
- Discharges in a solid or spray stream
- May contain corrosion inhibitor which leaves a yellow residue
- Protect from freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute

Suitable for use on what type of fire: A

Agent Characteristics:
- Anti-Freeze Solution
- Basically a Calcium Chloride solution to prevent freezing
- Discharges a solid or spray stream
- Leaves residue
- Non freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute

Suitable for use on what type of fire: A B

Agent Characteristics:
- Loaded Stream
- Basically an alkali-metal-salt solution to prevent freezing
- Discharges a solid or spray stream
- Leaves residue
- Non freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute
Suitable for use on what type of fire: B

Agent Characteristics:
- Foam
- Basically a water and detergent
- Discharges a foamy solution
- After evaporation, leaves a powder residue
- Protect from freezing

Average Size - 18 oz.
Horizontal Range - 10 to 15 ft.
Discharge Time - 24 sec.

Suitable for use on what type of fire: D

Agent Characteristics:
- Dry Powder Special Compound
- Basically Sodium Chloride or Graphite materials
- Agent is discharged from an extinguisher in a solid stream or is applied with a scoop or shovel to smother combustible metal
- Leaves residue
- Non-freezing

Average Size - 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 25 to 30 sec.
Standards of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Conduct:

1. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.
IMM-A4-LW
Fire Safety
Attachment 3: MASTER Laboratory Worksheet

Standard of performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Worksheet:

1. Established standards for safety and conduct shall be followed

2. Equipment required:
   Dust Mask;
   Gloves;
   Fire extinguishers;
   Face shield; and,
   Side shields.

3. Instructor must confirm proficiency prior to student progressing

4. Practice exercises
   A. Instructor will demonstrate proper usage of fire extinguishers
   B. Student shall practice using fire extinguishers
Standards of Performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face-shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Identify the consequences of improper lifting techniques;
b. Recognize when it is unsafe to lift an object alone;
c. Demonstrate proper lifting techniques;
d. Identify safety concerns to be addressed when lifting rough, sharp or fragile items;
e. State formula for dealing with center of gravity;
f. Identify parts of hoist;
g. Safely demonstrate using a hoist; and,
h. Move a load using a hoist.

Reading Assignments:

The following chapters are assigned to read from Supervisor's Safety Manual textbook, Latest Edition:

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<tr>
<th>Chapter</th>
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<tr>
<td>9</td>
<td>Material Handling Problems; Manual Handling Methods; Lifting and Carrying; Handling Specific Shapes; Equipment for Handling; Hand Trucks; Powered Hand Trucks; Powered Industrial Trucks; Conveyors; Chains and Slings</td>
</tr>
</tbody>
</table>

The following chapters are assigned to read from Mechanics' and Millwrights' Guide, Carl Nelson, Audel Publishers, Latest Edition:
Module Outline:

I. Discuss the Importance of Lifting Safely
   A. Give each student a copy of the following attachments:
      1. Laboratory Aid
      2. Objectives, Reading Assignments, and Module Outline
      3. Laboratory Worksheet

II. Identify the Steps to Manually Lift Safely
    A. Estimate the load to be lifted. If it is heavier than one person should
      attempt, get help.
    B. Place feet properly. Spread your feet slightly (comfortably), with one
      foot slightly ahead of the other and alongside the object.
    C. Bend knees, kneel, or squat. Get close enough to the load to reach
      under it without bending the back.
    D. Use blocking under objects to get a handhold and to prevent crushed
      fingers.
    E. Get a good grip. Be sure you can maintain your grip on the object. Use
      gloves when handling sharp or rough objects.
    F. Let the legs do the lifting. To rise, straighten your legs, letting the
      powerful leg, arm, and shoulder muscles do the lifting.
    G. Do not turn the body at the waist while carrying a load.
    H. Lower the load to the floor from the carrying position by bending the
      knees while keeping the back straight. This keeps the load on the leg
      and arm muscles. Keep fingers and toes clear as the load is set.

III. Consequences of Improper Lifting
    A. Injury
    B. Loss time
    C. Possibility of becoming unemployed

IV. When Is It Unsafe to Lift an Object Alone
    A. Bulked load that restricts view
    B. When you would have to lift with your back rather than your legs
    C. When the object is too large to get a good grip

V. Discuss Handling Specific Shapes
    A. Locate center of gravity and use this area to lift
    B. Place as much weight as possible as close to lifting mechanism
    C. Place flat weight on button

VI. Safety Concerns When Lifting Rough, Sharp, or Fragile Objects
    A. Gloves
    B. Safety glasses
    C. Is the object being lifted a hazardous material?

VII. Discuss Equipment for Material Handling
A. Hand trucks
B. Powered trucks
C. Conveyers
D. Hoists

VIII. Discuss and Demonstrate Safe Use of Hand Trucks
A. Place most of the weight on bed of hand truck
B. May require two people if one object is difficult to lift on side
C. Hold object tightly as handle is pulled back
D. Adjust handle position so more weight is on hand end
E. After movement, hold object tightly as handle is moved upward
F. Lift object on one side so bed of truck can be moved away from object

IX. Discuss and Demonstrate Use of Powered Hand Trucks
A. Watch out for people
B. Drive unit slowly
C. Use manual lifting rules

X. Discuss and Demonstrate Safe Use of Conveyers
A. Watch for pinch points
B. Exercise caution when loading and unloading objects
C. Do not overload conveyers. Rollers may not move freely

XI. Discuss and Demonstrate Safe Use of Hoists
A. Formula for dealing with center of gravity
B. Identify parts of hoist
C. Safely demonstrate using a hoist
D. Identify types of loads
E. Discuss and demonstrate lifting techniques
F. Discuss and demonstrate moving techniques

XII. Discuss and Demonstrate Safe Use of Chains and Slings
A. Storage area should be clean and dry
B. Watch for pinch points
C. Inspect for defects before using:
   1. Chains
      a. Wear
      b. Stretch
      c. Distortion
      d. Nicks
      e. Cracks
      f. Gauges
   2. Slings
      a. Wear
      b. Stretch
      c. Distortion
      d. Flat, Sling Spots
D. Types
   1. Slings
      a. Choker
b. Double Choker

C. Bridle

d. Basket

e. Double Basket
Standards of performance safety:

Student shall demonstrate safe work habits in the workshop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horseplay or practical joking.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.
Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Worksheet:

1. Established standards for safety and conduct shall be followed.
2. Equipment required:
   Hand truck
   Conveyor
   Chains
   Sling
   Face shield
   Side shields
3. Exercises must be taken in sequence. Instructor must confirm
   proficiency prior to student's progressing to next exercise.
4. Practice manual lifting.
5. Practice using hand truck to carry objects.
6. Practice using powered truck to carry objects.
7. Practice using hoist to move objects.
8. Practice handling specific shapes.
9. Practice lifting with slings.
10. Practice lifting with chains.
11. Instructor will guide each exercise.
12. Instructor will grade each exercise.
Standards of performance:

Student shall demonstrate safe work habits in the workshop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Recognize the benefits of an effective lockout/tagout procedure;
b. Identify who is allowed to remove or install a lockout/tagout tag or lock;
c. Recognize who is responsible for assuring equipment is properly locked out or tagged-out prior to performing maintenance; and,
d. Determine if all emergency conditions are cleared for maintenance.

Module Outline:

I. Benefits of an Effective Lockout/Tagout Program
   A. Reduce employee injuries and death
   B. Reduce down time
   C. Increased awareness of employees' role in insuring safety in the workshop environment
   D. Less regulatory involvement
   E. Review 29 CFR 1910.147

II. Who May Hang, Remove a Lockout or Tagout Tag or Lock
   A. Identify when a lockout is needed
   B. Identify when a tagout is appropriate. This will also vary between industry clearance procedures.

III. Responsibility for Lockout/Tagout
   A. Typically it is the work crew leader who is also responsible for briefing the crew as to the clearance boundaries and what is locked out
   B. Carefully loosen a flange and break the seal (never remove the bolts). Only loosen slightly.
C. Open system relief valve

IV. Locking out or Clearing a Piping, Mechanical System or Component for Maintenance

A. Identify typical sources of force that may be present in a typical piping system
1. Static head pressure or induced thermal pressure
2. Incline accumulators
3. Unisolated automatic actuating valves, motors or relief
4. System pressure
5. Stress that any or all of these forces have the ability to injure or kill is not properly cleared lockout and depressurized prior to maintenance

B. Methods of relieving trapped pressure from a system or component
1. Vent and drain valves
2. Carefully loosen a flange and break the seal (never remove the bolts). Only loosen slightly.
3. Open system relief valve

C. Identify typical methods of disabling components prior to maintenance
1. Manual operated valves
2. Pneumatic operated valves (fail open or closed)
3. Hydraulic actuated valve
4. Relief valves
5. Fans
6. Rollers

Reading Assignments:

Read the handout titled “Lockout and Tagout Procedures.”
Lockout and Tagout Procedures

Lockout and tagout procedures are designed to prevent equipment from being energized while maintenance is taking place. The types and uses are defined by the Occupational Safety and Health Administration, CFR 1910.147.

To lockout is to place a locking device on an energy-isolating device — a manually operated circuit breaker, for instance. The energy-isolating device and the equipment being controlled cannot be operated until the lockout device is removed. See Figure 1.

![A Lockout Device](image)

1 - A Lockout Device

Remote or interlocking switches may not be used to control circuits. The use of emergency stops are prohibited for lockout-tagout by OSHA. They do not offer positive protection.

Tagouts are placed on an energy-isolating device. They indicate that the energy-isolating device and the equipment being controlled may not be operated. Tagouts are red and have black lettering. A tag must be signed and dated by the individual who placed it. OSHA has two additional requirements for these tags. The purpose of the lockout/tagout (the procedure performed) must be written on the tag. Most companies put this information on the back of a tag. See Figure 2.
2 - Tagout

When more than one person is involved, each individual must place a lockout/tagout device on the isolation device. If a lockout device is used, it should be capable of accepting multiple locks. This is so each individual can place a lock on the device. Each lock should have a tag similar to the one used in the tagout procedure. The individual who puts the lock in place signs the tag. See Figure 3.
3 – Multiple-Lock Lockout Device

The lockout physically prohibits the operation of a piece of equipment. The tagout relies on those who read it. They must recognize its significance.

Wherever lockout/tagouts are used, there must be an established procedure for all to follow. All personnel must understand the importance and the use of the lockout/tagout system. The lockout/tagout devices used within an organization are standardized. So, anyone within the organization will recognize what they are.

The restrictions indicated by lockouts and tagouts remain in force until they are removed. The person putting the tagout or lockout in place is the person who has the authority to remove it.

The Occupational Safety and Health Act sets standards that are administered by the Occupational Safety and Health Administration (OSHA). OSHA has standard lockout/tagout procedures. The lockout/tagout procedures apply to all energy systems — air, hydraulic, mechanical, and electrical.
Zero-Energy Concept

Your job may be to maintain electrical circuits and equipment. However, many of them are connected to mechanical, hydraulic, or pneumatic devices. So, the equipment you work on may involve other types of energy in addition to electricity. Zero energy means all forms of energy are neutralized.

There may be hydraulic or pneumatic pressure in hoses or lines. There may be stored energy in weights or springs. There may be the potential for movement, as when air might blow through a turbine or fan. All these forms of energy must be recognized and neutralized. They have the potential to injure you or damage equipment.

Before working on any type of equipment, release or neutralize all energy which might affect that equipment. This means taking whatever action is necessary — turning a valve or putting a jack under a weight, for instance. This is the zero-energy concept.
Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. The project will require the student to demonstrate skills and knowledge in the following:
   A. Practice safety
   B. Use approved eye protection.
   C. Remove energy source
   D. Place tag
   E. Place lock
   F. Sign tag
   G. Remove lock
   H. Remove tag

2. Established standards for safety and conduct shall be followed.

3. Equipment required:
   A. Lock
   B. Tag
   C. Safety Switch

4. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

5. Practice exercises:
   A. Use lock to lock energy supply. Instructor must demonstrate placing lock on energy supply.
   B. Use tag to tag energy supply. Instructor must demonstrate placing tag on energy supply.

6. Practice exercise:
   A. Student shall practice placing tag on energy source.
   B. Student shall practice placing lock on energy source.
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<td>B-1 Perform basic arithmetic functions</td>
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<td>Sheet Metal Parts</td>
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<td>B-4 Perform basic algebraic operations</td>
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<td>C-2 Identify basic layout of drawings</td>
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<td>D-2 Use precision measuring tools</td>
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<td>H-4 Troubleshoot positive displacement pumps</td>
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<td>H-8 Troubleshoot, maintain, and repair pneumatic systems</td>
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INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<td>K-3 Pipe assembly</td>
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<td>N-1 Perform basic word processing</td>
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<td>P Install/Align Machines</td>
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<td>Q Maintain Electrical Devices</td>
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<td>R-4 Simple machines</td>
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<td>R-5 Power</td>
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<td>S Fasteners and Preloading</td>
<td>S-1 Fasteners and nomenclature</td>
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<td>S-2 Application for various fasteners</td>
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<td>S-3 Techniques for removing damaged fasteners</td>
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<td>S-4 Cleaning and restoring threaded fasteners</td>
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<td>S-5 Torque preload theory</td>
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<td></td>
<td>S-6 Effects of lubricating threads prior to torquing</td>
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<tr>
<td></td>
<td>S-7 Demonstrates appropriate torquing technique</td>
</tr>
</tbody>
</table>
IMM-B1-HO
Perform Basic Arithmetic Functions
Attachment 1: MASTER Handout

Standards of performance safety:

Student shall demonstrate math skills acquired in this module by:
Actively participating in class; and,
Working problems in this module;

Objectives:

Upon completion of this unit the student will be able to:

a. Add whole numbers;
b. Subtract whole numbers;
c. Divide whole numbers;
d. Multiply whole numbers;
e. Add decimals;
f. Subtract decimals;
g. Multiply decimals;
h. Divide decimals;
i. Locate any decimal place to the millionths;
j. Read numbers containing decimals;
k. Write numbers containing decimals;
l. Round off a decimal to a specified place value;
m. Align decimal points before computation;
n. Add numbers containing decimals;
o. Subtract numbers containing decimals;
p. Multiply numbers containing decimals; and,
q. Divide numbers containing decimals.

Module Outline:

I. Add Whole Numbers
II. Subtract Whole Numbers
III. Multiply Whole Numbers
IV. Divide Whole Numbers
V. Decimal System Place Value
VI. Add Decimals
VII. Subtract Decimals
VIII. Multiply Decimals
IX. Divide Decimals
Worksheet:

Give the place value of the 5 in the numbers below:

1. 16.53
2. 0.4565
3. 51,345

Write the numbers below in words:

4. 0.000052
5. 0.013
6. 0.0008
7. 15,248

Write the numbers that are indicated by the following phrases:

8. Three thousandths
9. Seventy-five and sixty seven hundredths
10. Eighty-six hundred ten-thousandths

Round these numbers to the specified place value:

11. 2.75
12. 18.613
13. 0.22
14. 14.2343

15. When adding or subtracting decimals, be sure the decimal points are ________.

Add or subtract the following:
16. 0.7 + 14 + 16.2 = ______________
17. 74 + 890 + 0.0057 - 46.72 = ______________
18. 42.6 + 0.0131 = ______________

19. It is not necessary to align the ________ _________ in a multiplication problem.

20. The number of digits behind a decimal point in the ________ equals the number of digits behind decimal points in the ________ _________ in a multiplication problem.

Solve the problems below. Use zeros as place holders if necessary.
21. 254.8 x 14 = ______________
22. 6,000 x 0.021 = ______________
23. 152.33 x 3.5 = ______________
24. 16.8 x 101.6 = ______________

25. To multiply a number by a multiple of 10, simply count the number of zeros in the ________ and move the decimal point in the ________ the same number of places.

Use the short cut method to solve the following problems:
26. 15.1 x 10,0001 = ______________
27. 0.44 x 102 = ______________
Solve the following problems, using zeros as place holders if necessary:

28.  6099.6 divided by 16.5 = 

29.  1509.04 divided by 2.3 = 

30.  When dividing by a multiple of 10, move the decimal point to the 
    the same number if spaces as there are zeros in the 

Use the short cut method of dividing by multiples of 10 to solve the following problems:

31.  0.053 divided by 1000 = 

32.  14.954 divided by 10 = 

33.  110 divided by 1000 = 

34.  436.89 divided by 100 = 

Standards of performance safety:

Student shall demonstrate ability to work with fractions, convert fractions to decimals, and decimals to fractions.

Objective(s):

Upon completion of this module the student will be able to:

a. Define a fraction and its parts;

b. Reduce fractions to their lowest terms;

c. Define prime number and composite number;

d. Define common fractions and uncommon fractions;

e. Add fractions;

f. Find the common denominator of a number of fractions;

g. Subtract fractions;

h. Define mixed number;

i. Define improper fractions;

j. Change mixed numbers to improper fractions;

k. Change improper fractions to mixed numbers;

l. Reduce improper fractions to their lowest terms;

m. Add improper fractions;

n. Subtract improper fractions;

o. Multiply fractions; and,

p. Divide fractions.

Reading Assignments:

The following chapters are assigned to read from Math for Consumers, by D.S. Kaine and L.S. Kaine, Addison-Wesley Pub. Co., Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Fractions and Operations</td>
</tr>
</tbody>
</table>

Module Outline:

I. Introduction - Define Fractions
II. Reducing Fractions
III. Adding Fractions
IV. Subtracting Fractions
V. Improper Fractions
VI. Multiplying Fractions
VII. Dividing Fractions
VIII. Converting Fractions to Decimals
IX. Converting Decimals to Fractions

Glossary:

Composite Number
A number greater than one and divisible by one, itself, and other numbers.

Denominator
The number below (or to the right of) the fraction line for any proper or improper fraction.

Equivalent
Means “equal to” but not necessarily “identical to.”

Fraction
A number that represents a part of a whole.

Improper Fraction
Any fraction whose value is equal to or greater than one. The numerator of an improper fraction is always equal to or greater than the denominator.

Mixed Number
A mixed number is a combination of a whole number and a fraction.

Numerator
The number above (or to the left of) the fraction line for any proper or improper fraction.

Prime Number
A number greater than one and divisible only by one and itself.

Proper Fraction
Any fraction whose value is less than one. The numerator of a proper fraction is always less than the denominator.

Reduced Fraction
A fraction in its simplest form, whose numerator and denominator contain no common factors other than 1.
Worksheet:

Reduce the following fractions to their lowest terms:

1. \( \frac{4}{24} = \) 
2. \( \frac{8}{32} = \) 
3. \( \frac{2}{18} = \) 
4. \( \frac{36}{72} = \) 
5. \( \frac{10}{16} = \)

Change the mixed numbers to improper fractions.

1. \( 9 \frac{3}{4} = \) 
2. \( 5 \frac{7}{8} = \) 
3. \( 4 \frac{9}{32} = \)

Solve the following problems.

1. \( \frac{2}{7} \times \frac{6}{11} = \) 
2. \( \frac{5}{9} \times \frac{8}{3} = \) 
3. \( \frac{2}{3} \times \frac{1}{10} = \) 
4. \( \frac{5}{7} \text{ divided by } \frac{2}{3} = \) 
5. \( \frac{7}{8} \text{ divided by } \frac{1}{4} = \) 
6. \( \frac{3}{4} \text{ divided by } \frac{2}{9} = \)
Convert decimals to fractions or fractions to decimals.

1. \( \frac{12}{15} = \) ______

2. \( \frac{3}{5} = \) ______

3. \( \frac{11}{17} = \) ______

4. \( 0.6 = \) ______

5. \( 0.875 = \) ______

6. \( 0.88 = \) ______
Standards of Performance:

Student shall demonstrate ability to convert English units to metric units and convert metric units to English units.

Objectives:

Upon completion of this module the student will be able to:

a. Name the three basic units of metric system measurement;

b. Match the six most commonly used metric system prefixes with their meaning;

c. Determine where to place the decimal when writing the numerical equivalent of a metric measurement;

d. Add and subtract metric-system units;

e. Convert Celsius degrees to Fahrenheit and Fahrenheit to Celsius; and,

f. Convert metric units to English units and English units to metric units.

Conversion Chart:

Metric to English

<table>
<thead>
<tr>
<th>Metric to English</th>
<th>English To Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td><strong>Length</strong></td>
</tr>
<tr>
<td>1 mm = 0.04 in</td>
<td>1 in = 2.54 cm</td>
</tr>
<tr>
<td>1 cm = 0.39 in</td>
<td>1 ft = 30.48 cm = 0.305</td>
</tr>
<tr>
<td>1 m = 39.37 in = 3.28 ft</td>
<td>1 yd =0.914 m</td>
</tr>
<tr>
<td>1 m = 1.09 yd</td>
<td>1 mi = 1.609 km</td>
</tr>
<tr>
<td>1 km = 0.62 mi</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Weight</strong></th>
<th><strong>Weight</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 g = 0.035 oz</td>
<td>1 oz = 31.103 g</td>
</tr>
<tr>
<td>1 kg = 2.2 lb</td>
<td>1 lb = 0.453 kg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Volume</strong></th>
<th><strong>Volume</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ml = 0.2 tsp</td>
<td>1 tsp = 5 ml</td>
</tr>
<tr>
<td>1 l = 1.057 qt</td>
<td>1 c = 284 ml</td>
</tr>
<tr>
<td></td>
<td>1 qt = 0.946 l</td>
</tr>
<tr>
<td></td>
<td>1 gal = 3.785 l</td>
</tr>
</tbody>
</table>

1030
Common abbreviations used above:

\[
\begin{align*}
  c & = \text{cup} \\
  \text{cm} & = \text{centimeter} \\
  \text{ft} & = \text{foot} \\
  g & = \text{gram} \\
  \text{gal} & = \text{gallon} \\
  \text{in} & = \text{inch} \\
  \text{kg} & = \text{kilogram} \\
  \text{km} & = \text{kilometer} \\
  \text{l} & = \text{liter} \\
  \text{lb} & = \text{pound} \\
  \text{m} & = \text{meter} \\
  \text{mi} & = \text{mile} \\
  \text{ml} & = \text{milliliter} \\
  \text{mm} & = \text{millimeter} \\
  \text{oz} & = \text{ounce} \\
  \text{qt} & = \text{quart} \\
  \text{tsp} & = \text{teaspoon} \\
  \text{yd} & = \text{yard}
\end{align*}
\]

Reading Assignments:

The following chapters are assigned to read from *Math for Consumers*, by D.S. Kaine and L.S. Kaine, Advisor-Wesley Pub. Co., Latest Edition

Subject - Metric System

Module Outline:

I. English System
II. Metric System
III. Metric Prefixes
IV. Moving Decimal
V. Metric Length
VI. Metric Weight
VII. Metric Volume
VIII. Metric Temperature
IX. Converting English to Metric Units
X. Converting Metric to English
Glossary:

**Composite Number**
A number greater than one and divisible by one, itself, and other numbers.

**Denominator**
The number below (or to the right of) the fraction line for any proper or improper fraction.

**Equivalent**
Means “equal to” but not necessarily “identical to”.

**Fraction**
A number that represents a part of a whole.

**Improper Fraction**
Any fraction whose value is equal to or greater than one. The numerator of an improper fraction is always equal to or greater than the denominator.

**Mixed Number**
A mixed number is a combination of a whole number and a fraction.

**Numerator**
The number above (or to the left of) the fraction line for any proper or improper fraction.

**Prime Number**
A number greater than one and divisible only by one and itself.

**Proper Fraction**
Any fraction whose value is less than one. The numerator of a proper fraction is always less than the denominator.

**Reduced Fraction**
A fraction in its simplest form, whose numerator and denominator contain no common factors other than 1.
Perform operations, as indicated.

1. There are _____ kilograms in a metric ton.
2. 100.9 g - 74.99 g = _____ g
3. 93.6 cg + 1,189 cg = _____ cg

Perform the conversions. Round your answer to two places.

1. 34 g = _____ oz
2. 92 cm = _____ ft
3. 890 l = _____ gal
4. 15 cm = _____ in
5. 58.5 kg = _____ lbs
Standards of performance safety:

Student shall demonstrate ability to use formulas to solve mathematical problems.

Objectives:

Upon completion of this module the student will be able to:

a. Define formula;
b. Define equation;
c. Define term;
d. Demonstrate that you understand what combinations of letters and numbers or letters indicate in formulas;
e. Demonstrate that you understand what parentheses or brackets indicate in formulas;
f. Change certain sentences about mathematical relationships into formulas; and,
g. Demonstrate that you can rearrange formulas in order to find various unknowns.

Rules for Dealing with Formulas:

1. A formula is a way of briefly expressing a rule, fact, or principle by the use of symbols or letters.

2. Formulas are equations. An equation is a statement that the quantities on each side of the equal sign equal the same thing.

3. Combinations of letters and/or numbers indicate multiplication.

4. Parentheses () or brackets [ ] are grouping symbols. They indicate that the quantities within them are to be grouped together, and are to be considered as one quantity. When working with formulas that have parentheses, first do the operation indicated within the parentheses. When both brackets and parentheses are present work within the brackets.

5. Formulas state relationships that have been tested and proven to be true. A formula is a sentence where letters, symbols, and numbers substitute for words.
6. Sometimes, you know the value of the quantity to the left of the equal sign, but not all the values to the right. You can still work the formula by reattaching it.

7. There are some rules of procedure you must follow when you rearrange equations. One important principle is cancellation. Cancellation removes a common element from a fraction's numerator and denominator on one side of an equation.

8. Another important principle states that what is done to one side an equation, must be done to the other side. Another principle used in solving formula is transposition. This states that when you move quantity from one side of an equation to the other, you change its sign or operation.

Reading Assignments:

The following chapters are assigned to read from *Math for Consumers*, D.S. Kaine and L.S. Kaine, Advisor-Wesley Pub. Co., Latest Edition

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
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<tbody>
<tr>
<td></td>
<td>Equation Solving</td>
</tr>
</tbody>
</table>

Module Outline:

I. Formula Components
   Terms, brackets, parentheses, letters, number
II. What a Formula Does
    State Relationships
III. Principles for Solving Formulas
IV. Ratio for Solving Formulas
V. Practice Using Formulas

Glossary:

Cancellation
   Removing a common element from a numerator and a denominator of a fraction on one side of an equation.

Equation
   A statement that two quantities are equal.
Formula
A way of briefly expressing a rule, fact, or principle by the use of symbols or letters. A formula is an equation.

Term
Numbers or symbols combined by multiplication, division, addition, or subtraction.

Transportation
The process of moving a quantity from one side of an equation to the other by changing its sign of operation.
Perform Basic Algebraic Operations
Attachment 2: MASTER Laboratory Worksheet

Worksheet:

1. Formulas:
   a. are equations.
   b. show how some quantities are related to each other.
   c. state relationships which have been tested and proven to be true.
   d. all of the above.

2. In a formula terms are:
   a. numbers or symbols combined by addition or subtraction.
   b. numbers or symbols combined by addition, subtraction, multiplication, or division.
   c. numbers or symbols.
   d. none of the above.

3. Parentheses or brackets in a formula mean:
   a. quantities within them are to be grouped together.
   b. quantities within them are to be considered one quantity.
   c. first do the work indicated within the parentheses.
   d. all of the above.

4. Write the formula for the following sentence. Profit (P) equals the margin (M) minus the overhead (O).

5. Write the formula for the following sentence. The amperage (A) of an electrical circuit is equal to the wattage (W) divided by the voltage (V).

6. Write the sentence for the following formula. I=PRT (I is interest on money, P is principal, R is rate, and T is time).

7. Write the sentence for the following formula. HP=VA/746 horsepower on an electric motor, V is volts, and a amperes.
Standards of performance safety:

Student shall demonstrate safe work habits in the workshop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Solve trigonometric functions use a Sin equation;
b. Solve trigonometric functions use a Cos equation;
c. Solve trigonometric functions use a Csc equation;
d. Solve trigonometric functions use a Tan equation;
e. Solve trigonometric functions use a Cot equation;
f. Solve trigonometric functions use a Sec equation;
g. Solve for unknown sides, angles or radians for a right triangle;
h. Convert radians to degrees; and,
i. Convert degrees to radians.

Reading Assignments:

The following chapters are assigned to read from Mathematics for Technicians by Edward Tronaas, Prentice Hall Publishers, Latest Edition:

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<th>Title</th>
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<tr>
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<td>Trigonometry</td>
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</table>

Module Outline:

I. Solve Trigonometric Functions Use a Sin Equation
II. Solve Trigonometric Functions Use a Cos Equation
III. Solve Trigonometric Functions Use a Csc Equation
IV. Solve Trigonometric Functions Use a Tan Equation
V. Solve Trigonometric Functions Use a Cot Equation
VI. Solve Trigonometric Functions Use a Sec Equation
VII. Solve For Unknown Sides, Angles or Radians For a Right Triangle
VIII. Convert Radians to Degrees
IX. Convert Degrees to Radians
Perform Basic Trigonometric Functions
Attachment 2: MASTER Laboratory Worksheet

Worksheet:
(Use Trig Function Tables)

Solve:

1. \( \sin 22^\circ 18' = \) ______________
2. \( \cot 22^\circ 18' = \) ______________
3. \( \sec 22^\circ 18' = \) ______________
4. \( \tan 22^\circ 18' = \) ______________
5. \( \csc 22^\circ 18' = \) ______________
6. \( \cos 22^\circ 18' = \) ______________
7. \( \cos A = 0.69675 \) ______________
8. \( \cot A = 1.1340 \) ______________
9. \( \sin A = 0.98531 \) ______________
10. \( \sec A = 1.5753 \) ______________
11. \( \tan A = 0.50587 \) ______________
12. \( 2\pi \) Radians = ______________ Degrees
13. 180 Degrees = ______________ Radians
14. \( \pi \) Radians = ______________ Degrees
Perform Basic Geometric Calculations
Attachment 1: MASTER Handout

Standards of Performance:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Calculate angles;
b. Calculate length of triangle sides;
c. Calculate radius, diameter, circumference, and area of a circle;
d. Calculate length of sphere;
e. Calculate area of a cone;
f. Calculate volume of a solid;
g. Calculate volume and area of a cylinder;
h. Calculate polygon dimension; and,
i. Calculate prism dimensions.
IMM-B6-LA
Perform Basic Geometric Calculations
Attachment 2: MASTER Laboratory Aid

Objective(s):

Upon completion of this module the student will be able to:

a. Calculate angles;
b. Calculate length of triangle sides;
c. Calculate radius, diameter, circumference, and area of a circle;
d. Calculate length of sphere;
e. Calculate area of a cone;
f. Calculate volume of a solid;
g. Calculate volume and area of a cylinder;
h. Calculate polygon dimension; and,
i. Calculate prism dimensions.

Reading Assignments:

The following chapters are assigned to read from *Math for Technician*, by Edward Trunaas, Prentice Hall Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Fundamentals of Geometry</td>
</tr>
</tbody>
</table>

Module Outline:

I. Angles
II. Triangle
III. Circle
IV. Sphere
V. Cone
VI. Solid
VII. Cylindrical
VIII. Polygon
IX. Prism
Practice Working Problems In The Following Areas:
   a. Angles;
   b. Triangle;
   c. Circle;
   d. Sphere;
   e. Cone;
   f. Solid;
   g. Cylindrical;
   h. Polygon; and,
   i. Prism.
**INDUSTRIAL MAINTENANCE MECHANIC** uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<th>Tasks</th>
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<td>Apply Mathematical Concepts</td>
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<td><strong>C</strong></td>
<td>Interpret Engineering Drawings and Control Documents</td>
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<td><strong>D</strong></td>
<td>Use Measuring Tools</td>
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<td><strong>E</strong></td>
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</tr>
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<td>Operate Machine Tools</td>
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<td>Perform Welding Operations</td>
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<td><strong>H</strong></td>
<td>Maintain/ Troubleshoot Equipment and Systems</td>
</tr>
<tr>
<td><strong>I</strong></td>
<td>Repair Power Transmission Systems</td>
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<td><strong>J</strong></td>
<td>Fabricate/ Install Sheet Metal Parts</td>
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<table>
<thead>
<tr>
<th>Tasks</th>
</tr>
</thead>
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<tr>
<td>A-1 Use protective equipment</td>
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<tr>
<td>A-2 Accidental prevention</td>
</tr>
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<td>A-3 Working aloft</td>
</tr>
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<td>A-4 Fire safety</td>
</tr>
<tr>
<td>A-5 Lifting safety</td>
</tr>
<tr>
<td>A-6 Lockout/ layout</td>
</tr>
<tr>
<td>B-1 Perform basic arithmetic functions</td>
</tr>
<tr>
<td>B-2 Convert fractions/ decimals</td>
</tr>
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<td>B-3 Convert Metric/ English measurements</td>
</tr>
<tr>
<td>B-4 Perform basic algebraic operations</td>
</tr>
<tr>
<td>B-5 Perform basic trigonometric functions</td>
</tr>
<tr>
<td>B-6 Perform basic geometric calculations</td>
</tr>
<tr>
<td>C-1 Identify basic types of drawings</td>
</tr>
<tr>
<td>C-2 Identify basic layout of drawings</td>
</tr>
<tr>
<td>C-3 Review blueprint notes and dimensions</td>
</tr>
<tr>
<td>D-1 Use non-precision measuring tools</td>
</tr>
<tr>
<td>D-2 Use precision measuring tools</td>
</tr>
<tr>
<td>E-1 Identify and use maintenance technician's hand tools</td>
</tr>
<tr>
<td>E-2 Identify and use hand held power tools</td>
</tr>
<tr>
<td>F-1 Use and care of milling machines</td>
</tr>
<tr>
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<td>H-7 Troubleshoot and repair blowers</td>
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<td>H-8 Troubleshoot, maintain, and repair hydraulic systems</td>
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INDUSTRIAL MAINTENANCE MECHANIC... uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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</tr>
<tr>
<td><strong>L</strong></td>
<td>Basic Rigging: L-1 Rigging fundamentals</td>
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<td><strong>M</strong></td>
<td>Bearing Maintenance: M-1 Plain bearings</td>
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<td><strong>N</strong></td>
<td>Use Computers: N-1 Perform basic word processing</td>
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<td><strong>O</strong></td>
<td>Align Shafts: O-1 Principles of alignment</td>
</tr>
<tr>
<td><strong>P</strong></td>
<td>Install/Align Machines: P-1 Install electrical connections</td>
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<tr>
<td><strong>Q</strong></td>
<td>Maintain Electrical Devices: Q-1 Use electrical test equipment</td>
</tr>
<tr>
<td><strong>R</strong></td>
<td>Basic Mechanical Concepts: R-1 Force</td>
</tr>
<tr>
<td><strong>S</strong></td>
<td>Fasteners and Preloading: S-1 Fasteners and nomenclature</td>
</tr>
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</table>

### Tasks

- **K-1** Perform basic pipefitting calculations
- **K-2** Cut, thread, and ream pipe
- **K-3** Pipe assembly
- **K-4** Install and adjust pipe support
- **K-5** Tubing
- **K-6** Fittings
- **K-7** Plastic pipe
- **K-8** Fittings

- **L-1** Rigging fundamentals
- **L-2** Demonstrate basic rigging skills
- **L-3** Rigging fundamentals
- **L-4** Demonstrate basic rigging skills

- **M-1** Plain bearings
- **M-2** Rolling element bearings

- **N-1** Perform basic spreadsheet operations
- **N-2** Perform basic spreadsheet operations

- **O-1** Principles of alignment
- **O-2** Methods of alignment

- **P-1** Install electrical connections
- **P-2** Setting and leveling
- **P-3** Grouting
- **P-4** Special mountings

- **Q-1** Use electrical test equipment
- **Q-2** Apply basic terms to electrical circuits
- **Q-3** Analyze series, parallel, and complex AC/DC circuits
- **Q-4** Check AC and DC motors
- **Q-5** Troubleshoot electrical devices

- **R-1** Force
- **R-2** Work
- **R-3** Mechanical motion and rate
- **R-4** Simple machines
- **R-5** Power

- **S-1** Fasteners and nomenclature
- **S-2** Application for various fasteners
- **S-3** Techniques for removing damaged fasteners
- **S-4** Cleaning and restoring threaded fasteners
- **S-5** Torque preload theory
- **S-6** Effects of lubricating threads prior to torquing
- **S-7** Demonstrate appropriate torquing technique
Standards of performance:

Student shall demonstrate how to identify basic types of drawings within 85% accuracy.

Objectives:

Upon completion of this module the student will be able to:

a. Identify mechanical drawings;
b. Identify electrical drawings;
c. Identify process drawings;
d. Identify welding drawings; and,
e. HVAC drawings.

Reading Assignments:

The following chapters are assigned to read from *Industrial Blueprint Reading and Sketching*, Kirk Patrick, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
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<tr>
<td>1</td>
<td>Introduction</td>
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<td>2</td>
<td>Drawing Formula</td>
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<td>21</td>
<td>Welding Assemblies</td>
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<tr>
<td>24</td>
<td>Reading Electrical and Electronics Schematic Diagrams</td>
</tr>
</tbody>
</table>

Module Outline:

I. Basic Types of Drawings.
   A. Mechanical
   B. Electrical
   C. Process
   D. Welding
   E. Sketch
   F. Plot plans
   G. Floor plans
   H. Contour maps
   I. Elevations
   J. Architectural
   K. Engineering Drawings

II. Mechanical
A. One view drawings
B. Two view drawings
C. Three view drawings
D. Auxiliary views
E. Isometric views
F. Orthographic views
G. Pictorial views
H. Oblique views
I. GD&T
J. Assembly
K. Hydraulic drawings
L. Pneumatic drawings
M. Machine drawings
N. Parts
O. Explored views

III. Electrical
A. Schematic diagrams
B. Single line diagrams
C. Wiring diagrams
D. Pictorial diagrams
E. Block diagrams
F. Symbols
G. Distribution
H. Plant wiring diagram

IV. Process
A. Block diagram
B. Flow diagram
C. P&ID or EFG diagram
D. Symbols
E. Piping diagrams

V. Welding
A. Symbols
B. Assembly
C. Views

VI. HVAC
A. Sheet metal
B. Ducts, duct sections
C. Diffusers
D. Triangulation
Objectives:

Upon completion of this module the student will be able to:

a. Draw a simple isometric sketch;
b. Using drawing ledger, draw a simple three dimensional drawing; and,
c. Draw a simple orthographic view.

Reading Assignments:

The following chapters are assigned to read from Industrial Blueprint Reading & Sketching, Kirk Patrick, Latest Edition:

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<td>Lines For Drawings</td>
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<td>12</td>
<td>Reading Two Dimensioning Drawings</td>
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<tr>
<td>15</td>
<td>Sectional Views</td>
</tr>
<tr>
<td>16</td>
<td>Auxiliary Views</td>
</tr>
</tbody>
</table>

Module Outline:

I. Drawing Lines Nomenclature
II. Two Dimensional Drawings
III. Sectional Views
IV. Auxiliary Views
V. Areas of a Drawing
Worksheet:

1. Draw an isometric sketch of an object furnished by instructor.

2. Draw a three dimensional sketch of an object furnished by instructor.

3. Draw an orthographic sketch of an object furnished by instructor.
Objectives:

Upon completion of this module the student will be able to:

a. Interpret notes on prints or mechanical drawings;
b. Identify scale on a print or mechanical drawing;
c. Demonstrate method of dimensioning a drawing;
d. Define tolerance assured in interpretation of drawings;
e. Identify document identification code;
f. Interpret drawing abbreviations and acronyms; and,
g. Interpret symbols used to illustrate surface finish.

Reading Assignments:

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<td>17</td>
<td>Dimensioning</td>
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<tr>
<td>18</td>
<td>Tolerances</td>
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Module Outline:

I. Major Types of Drawings
II. Major Areas on Blueprint Mechanical Drawing
III. Scales Used for Drawings
IV. Dimension
V. Tolerances
VI. Document Identification Codes
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<td><strong>B</strong></td>
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<td><strong>C</strong></td>
<td>Interpret Engineering Drawings and Control Documents</td>
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<td><strong>D</strong></td>
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<td><strong>E</strong></td>
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<td><strong>J</strong></td>
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A-1 Use protective equipment
A-2 Accident prevention
A-3 Working shift
A-4 Fire safety
A-5 Lifting safety
A-6 Lockout/Tagout

B-1 Perform basic arithmetic functions
B-2 Convert fractions to decimals
B-3 Convert from metric to English measurements
B-4 Perform basic algebraic operations
B-5 Perform basic trigonometric functions
B-6 Perform basic geometric calculations

C-1 Identify basic types of drawings
C-2 Identify basic layout of drawings
C-3 Review blueprint notes and dimensions
D-1 Use non-precision measuring tools
D-2 Use precision measuring tools
E-1 Identify and use maintenance technician's hand tools
E-2 Identify and use hand held power tools
F-1 Use and care of milling machines
F-2 Use and care of horizontal and vertical band saws
F-3 Use and care of surface grinder
F-4 Use and care of pedestal grinder
F-5 Operate lathes
F-6 Use and care of drill press

G-1 Weld with shielded metal arc welding (SMAW) process
G-2 Weld cut with acetylene gas
G-3 Perform gas cutting

H-1 Maintain air conditioning systems
H-2 Maintain pneumatic control circuits
H-3 Troubleshoot positive displacement pumps
H-4 Maintain gate, globe, ball, plug, and butterfly valves
H-5 Maintain check valves and relief valves
H-6 Maintain check valves and relief valves
H-7 Troubleshoot and repair blowers
H-8 Troubleshoot, maintain, and repair hydraulic systems
H-9 Troubleshoot, maintain, and repair pneumatic systems

I-1 Maintain and troubleshoot belt drive systems
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I-3 Maintain and troubleshoot chain power transmission drives
I-4 Maintain and troubleshoot clutches

J-1 Layout sheet metal parts
J-2 Form and/or bend sheet metal parts
J-3 Fasten sheet metal parts together
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Standards of performance:

Student shall demonstrate safe work habits in the workshop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Properly use steel rule;
b. Properly use folding rule;
c. Properly use steel tape;
d. Properly use outside calipers; and,
e. Properly use inside calipers.

Reading Assignments:

The following chapters are assigned to read from Technology of Machine Tools, by Krar, McGraw-Hill Company, Latest Edition:

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<tbody>
<tr>
<td>7</td>
<td>Measurement</td>
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</table>

Module Outline:

I. Introduction
II. Steel Rule
III. Folding Rule
IV. Steel Tape
V. Outside Calipers
VI. Inside Calipers
Standards of performance:

Student shall demonstrate safe work habits in the workshop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
1. Instructor will demonstrate use of the following non precision measuring tools:
   a. Steel Rule
   b. Folding Rule
   c. Steel Tape
   d. Outside Calipers
   e. Inside Calipers

2. Instructor will grade the student's use of the following non precision measuring tools:
   a. Steel Rule
   b. Folding Rule
   c. Steel Tape
   d. Outside Calipers
   e. Inside Calipers
Standards of performance:

Student shall demonstrate safe work habits in the workshop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Properly use vernier calipers;
b. Properly use outside and inside micrometers;
c. Properly use depth gauges; and,
d. Properly use dial indicators.

Reading Assignments:

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<td>10</td>
<td>Vernier Calipers</td>
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<tr>
<td>11</td>
<td>Inside, Depth and Height Measuring Instruments</td>
</tr>
</tbody>
</table>

Module Outline:

I. Vernier Calipers
II. Outside Micrometer
III. Inside Micrometer
IV. Depth Gauge
Standards of performance safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves; and,
Not wearing rings, watches, jewelry, or loose clothing while operating equipment.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.
Worksheet:

1. Instructor will demonstrate how to use the following precision measuring tools:
   a. Vernier Calipers
   b. Inside Micrometers
   c. Outside Micrometers
   d. Depth Gages
   e. Dial Indicators

2. Student will demonstrate how to use the following precision measuring tools:
   a. Vernier Calipers
   b. Inside Micrometers
   c. Outside Micrometers
   d. Depth Gages
   e. Dial Indicators

3. Instructor will grade student's ability to use the following precision measuring tools:
   a. Vernier Calipers
   b. Inside Micrometers
   c. Outside Micrometers
   d. Depth Gauges
   e. Dial Indicators
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<td>F-1 Operate Machine Tools</td>
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<td>J-1 Fabricate/Install Sheet Metal Parts</td>
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A-2 Accident prevention
A-3 Working shifts
A-4 Fire safety
A-5 Lifting safety
A-6 Lockout/lockup

B-1 Perform basic arithmetic functions
B-2 Convert fractions/decimals
B-3 Convert Metric/English measurements
B-4 Perform basic algebraic operations
B-5 Perform basic trigonometric functions
B-6 Perform basic geometric calculations

C-1 Identify basic types of drawings
C-2 Identify basic layout of drawings
C-3 Review blueprint notes and dimensions

D-1 Use non-precision measuring tools
D-2 Use precision measuring tools

E-1 Identify and use maintenance technician's hand tools
E-2 Identify and use hand held power tools

F-1 Use and care of milling machines
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F-4 Use and care of surface grinder
F-5 Operate lathes

G-1 Weld with shielded metal arc welding (SMAW) process
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H-1 Maintain air conditioning systems
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</table>
| **K** Piping Operations | K-1 Perform basic piping calculations  
|                 | K-2 Cut, thread, and ream pipe  
|                 | K-3 Pipe assembly  
|                 | K-4 Install and adjust pipe support  
|                 | K-5 Tubing  
|                 | K-6 Fittings  
|                 | K-7 Plastic pipe  |
| **L** Basic Rigging | L-1 Rigging fundamentals  
|                 | L-2 Demonstrate basic rigging skills  |
| **M** Bearing Maintenance | M-1 Plain bearings  
|                 | M-2 Rolling element bearings  |
| **N** Use Computers | N-1 Perform basic computer operations  
|                 | N-2 Perform spreadsheet operations  |
| **O** Align Shafts | O-1 Principles of alignment  
|                 | O-2 Methods of alignment  |
| **P** Install/Align Machines | P-1 Install electrical connections  
|                 | P-2 Setting and leveling  
|                 | P-3 Grouting  
|                 | P-4 Special mountings  |
| **Q** Maintain Electrical Devices | Q-1 Use electrical test equipment  
|                 | Q-2 Apply basic terms to electrical circuits  
|                 | Q-3 Analyze series, parallel, and complex AC/DC circuits  
|                 | Q-4 Check AC and DC motors  
|                 | Q-5 Troubleshoot electrical devices  |
| **R** Basic Mechanical Concepts | R-1 Force  
|                 | R-2 Work  
|                 | R-3 Mechanical motion and rate  
|                 | R-4 Simple machines  
|                 | R-5 Power  |
| **S** Fasteners and Preloading | S-1 Fasteners and nomenclature  
|                 | S-2 Application for various fasteners  
|                 | S-3 Techniques for removing damaged fasteners  
|                 | S-4 Cleaning and restoring threaded fasteners  
|                 | S-5 Torque preload theory  
|                 | S-6 Effects of lubricating threads prior to torquing  
|                 | S-7 Demonstrate appropriate torquing technique  |
Standards of performance:

Student shall identify the two major factors in working safely by:
Listing four steps you can take prior to performing work that will insure a safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
Selecting specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will demonstrate the:

a. Proper use of pliers;
b. Proper use of hammers;
c. Proper use of punches;
d. Proper use of wrenches;
e. Proper use of chisels;
f. Proper use of bars; and,
g. Proper use of screwdrivers.

Module Outline:

I. Proper Use of Pliers
II. Proper Use of Hammers
III. Proper Use of Punches
IV. Proper Use of Wrenches
V. Proper Use of Chisels
VI. Proper Use of Bars
VII. Proper Use of Screwdrivers
Standards of performance safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves; and,
Not wearing rings, watches, jewelry, or loose clothing while operating equipment.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.
Worksheet:

1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   - Ear Plugs
   - Ear Muffs

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercise inserting and removing ear plugs.

5. Practice using ear plugs.

6. Practice exercise using ear muffs.
IMM-E2-HO
Identify and Use Hand Held Power Tools
Attachment 1: MASTER Handout

Standards of performance:

Student shall identify the two major factors in working safely by:
Listing four steps you can take prior to performing work that will insure a safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
Selecting specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to:
a. Identify typical use and application of a hand drill and a hand power screwdriver;
b. Identify typical use and application of a reciprocating saw;
c. Identify typical use and application of a circular saw;
d. Identify typical use and application of hand held high-speed pneumatic tools;
e. Identify typical use and application of a hand held electric or pneumatic side grinder;
f. Identify typical use and application of electric or pneumatic impact tools; and,
g. Demonstrate safe operation of hand held power tools to established performance measures.

Module Outline:

I. Identify Typical Use and Application of a Hand Drill and a Hand Power Screwdriver
   A. Safety
   B. Selecting proper bits
   C. Operation
   D. Application

II. Identify Typical Use and Application for a Reciprocating Saw
    A. Safety
    B. Selecting proper blade
    C. Operation
    D. Application

III. Identify Typical Use and Application of a Circular Saw
     A. Safety
B. Selecting proper blade
C. Operation
D. Application

IV. Identify Typical Use and Application of Hand Held High-Speed Pneumatic Tools
A. Safety
B. Selecting proper tool bits
C. Operation
D. Application

V. Identify Typical Use and Application of a Hand Held Electric or Pneumatic Side Grinder
A. Safety
B. Selecting proper grit wheel
C. Operation
D. Application

VI. Identify Typical Use and Application of Electric or Pneumatic Impact Tools
A. Safety
B. Selecting proper blade
C. Operation
D. Application

VII. Demonstrate Correct Setup and Operation of Hand Held Power Tools and Accessories to Established Lab Exercise and Performance Measures
Standards of performance safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves; and,
Not wearing rings, watches, jewelry, or loose clothing while operating equipment.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.
Worksheet:

1. Established standards for safety and conduct shall be followed.

2. Safety glasses  
   Leather gloves  
   Face shields  
   Ground fault protector  
   Safety curtains lab equipment

3. Lab Equipment:  
   Hand drill and power screwdriver  
   Assorted drill bits  
   Assorted screwdriver bits  
   Chuck key  
   Material suitable for practice and demonstration  
   Reciprocating saw.  
   Assorted blades  
   Material suitable for practice and demonstration  
   Allen wrench  
   Circular saw.  
   Assorted blades  
   Material suitable for practice and demonstration  
   Wrench appropriate to install blade  
   Hand held electric-speed pneumatic pencil/pewee grinder  
   Assorted cut off, grinding and polishing wheels  
   Assorted carbide burrs  
   Hand held electric or pneumatic side grinder.  
   Assorted grit grinding wheels  
   Electric/pneumatic impact tools.  
   Material suitable for practice and demonstration  
   Impact socket set  
   Impact chisel

4. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

5. Practice exercise using each tool in No. 3 above.
INDUSTRIAL MAINTENANCE MECHANIC... uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
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<tbody>
<tr>
<td>A</td>
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<td>A-2 Accident prevention</td>
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<td>A-3 Working at height</td>
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<td>A-4 Fire safety</td>
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<td></td>
<td>A-5 Lifting safety</td>
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<td></td>
<td>A-6 Lockout/Tagout</td>
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<tr>
<td>B</td>
<td>B.1 Perform basic mathematical concepts</td>
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<tr>
<td></td>
<td>B-2 Convert fractions to decimals</td>
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<td>B-3 Convert basic layout of drawings</td>
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<td></td>
<td>B-4 Use precision measuring tools</td>
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<td></td>
<td>B-5 Use maintenance technician's hand tools</td>
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<td></td>
<td>B-6 Use hand held power tools</td>
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<tr>
<td>C</td>
<td>C.1 Identify basic types of drawings</td>
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<td>C-2 Identify basic layout of drawings</td>
</tr>
<tr>
<td></td>
<td>C-3 Review blueprint notes and dimensions</td>
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<tr>
<td></td>
<td>D.1 Use non-precision measuring tools</td>
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<td>D-2 Use basic layout of drawings</td>
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<td></td>
<td>E.1 Identify and use basic types of drawings</td>
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<td></td>
<td>E-2 Identify and use hand held power tools</td>
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<tr>
<td></td>
<td>F.1 Use and care of milling machines</td>
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<tr>
<td></td>
<td>F-2 Use and care of horizontal and vertical band saws</td>
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<td>F-3 Use and care of surface grinder</td>
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<td>F-4 Use and care of basic types of drawings</td>
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<td>F-5 Use and care of basic types of drawings</td>
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<td>F-6 Use and care of basic types of drawings</td>
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<td>F-7 Use and care of basic types of drawings</td>
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<td>F-8 Use and care of basic types of drawings</td>
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<tr>
<td></td>
<td>G.1 Use precision measuring tools</td>
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<td>G-2 Use precision measuring tools</td>
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<td>G-3 Perform basic mathematical concepts</td>
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<td>H.1 Maintain basic layout of drawings</td>
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<td>H-2 Maintain basic layout of drawings</td>
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<td>H-9 Maintain basic layout of drawings</td>
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<tr>
<td></td>
<td>I.1 Layout parts</td>
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<tr>
<td></td>
<td>I-2 Maintenance and troubleshooting</td>
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<td></td>
<td>I-3 Maintain and troubleshooting</td>
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<tr>
<td></td>
<td>I-4 Maintain and troubleshooting</td>
</tr>
<tr>
<td></td>
<td>J.1 Install parts</td>
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<td>J-2 Form and/or bend metal parts</td>
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<tr>
<td></td>
<td>J-3 Fasten sheet metal parts together</td>
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</table>
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
</table>
| K Piping /a | K-1 Perform basic pipefitting calculations  
L Basic Rigging | L-1 Rigging fundamentals  
M Bearing Maintenance | M-1 Plain bearings  
N Use Computers | N-1 Perform basic word processing  
O Align Shafts | O-1 Principles of alignment  
P Install /Align Machines | P-1 Install electrical connections  
Q Maintain Electrical Devices | Q-1 Use electrical test equipment  
R Basic Mechanical Concepts | R-1 Force  
S Fasteners and Preloading | S-1 Fasteners and nomenclature |

|            | K-2 Cut, thread, andreas pipe  
K-3 Pipe assembly | K-4 Install and adjust pipe support  
K-5 Tubing | K-6 Fittings  
K-7 Plastic pipe |  
L-2 Demonstrate basic rigging skills  
M-2 Rolling element bearings  
N-2 Perform basic spreadsheet operations  
O-2 Methods of alignment  
P-2 Setting and leveling  
P-3 Grouting  
P-4 Special mountings  
Q-2 Apply basic terms to basic electrical circuits  
S-2 Application for various fasteners  
S-3 Techniques for removing damaged fasteners  
S-4 Cleaning and restoring threaded fasteners  
S-5 Torque preload theory  
S-6 Effects of lubricating threads prior to torquing  
S-7 Demonstrate appropriate torquing technique |
Standards of performance:

Student shall:
1. Identify the two major factors in working safely;
2. List four steps you can take prior to performing work that will insure a safe outcome;
3. Identify the employees responsibility if a potential accident or unsafe condition exist; and,
4. Select specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to demonstrate proper use of milling machines to include:
a. Milling cutters;
b. Milling machine setups;
c. Milling machine operations (horizontal);
d. Indexing operation;
e. Gear cutting;
f. Helical milling; and,
g. Vertical milling machine operation.

Reading Assignments:

The following chapters are assigned to read from Technology of Machine Tools, by Krar, McGraw-Hill Pub., Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Milling Machine</td>
</tr>
</tbody>
</table>

Module Outline:

I. Milling Machine and Accessories
II. Milling Cutters
III. Speeds, Feeds and Dept of Cut
IV. Setups
V. Operations (Horizontal)
VI. Indexing
VII. Gear Cutting
VIII. Helical Milling
IX. Cam, Worm Milling
X. Vertical Milling Machine
Standards of performance:

Student shall identify the two major factors in working safely by:
Listing four steps you can take prior to performing work that will insure a safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
Selecting specific task that have the potential to cause an injury.
Worksheet:

1. Instructor will demonstrate:
   A. Milling Machine and Accessories
   B. Milling Cutters
   C. Speeds, Feeds and Dept of Cut
   D. Setups
   E. Operations (Horizontal)
   F. Indexing
   G. Gear Cutting
   H. Helical Milling
   I. Cam, Worm Milling
   J. Vertical Milling Machine

2. Student will be graded on proper operation and part fabrication by milling machine.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment;
Not participating in horse play or practical joking;
Identifying the two major factors in working safely;
Listing four steps you can take prior to performing work that will insure a safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe condition exists; and,
Selecting specific tasks that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to:
a. Demonstrate proper use and care of horizontal band saw; and,
b. Demonstrate proper use and care of vertical band saw.

Reading Assignments:

The following chapters are assigned to read from Technology of Machine Tools, by Krar, McGraw-Hill Publishing, Latest Edition:

<table>
<thead>
<tr>
<th>Unit</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>Types of Metal Saws</td>
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<tr>
<td>36</td>
<td>Bandsaw Parts and Accessories</td>
</tr>
<tr>
<td>37</td>
<td>Bandsaw Operations</td>
</tr>
</tbody>
</table>

Module Outline:

I. Identify the Component Parts of a Horizontal and Vertical Band Saw
   A. Blade
   B. Blade guard
   C. Coolant system (if used)
II. Describe the Purpose and Operation of the Components of a Horizontal and Vertical Band Saw

A. Blade
   1. Different types

B. Blade guard
   1. Adjustment techniques

C. Coolant system (if used)
   1. Types of coolant
   2. When coolant is needed
   3. Adjusting flow control

D. Work clamp (if used)
   1. Purpose
   2. How to adjust

E. Blade tensioning device
   1. How to tighten and loosen
   2. Recognizing proper tension

F. On/off and feed controls
   1. On-off and remote power switches
   2. Setting feed by adjusting spring tension (typically for cutoff saw)

III. Demonstrate How to Remove, Install and Adjust the Blade Tension of a Horizontal and Vertical Band Saw

IV. Demonstrate How to Adjust the Blade Guards and Guides of a Horizontal and Vertical Band Saw

A. How to loosen
B. Correct operating position
C. How to tighten

V. Identify the Safety Concerns Associated with Band Saw Operation

A. Airborne derbies
B. Exposed cutting surface
C. Sharp edges

VI. Demonstrate How to Setup and Operate a Band Saw to a Designated Tolerance Without Endangering Personnel or Equipment

VII. Demonstrate How to Use Weld Saw Blades
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment;
Not participating in horse play or practical joking;
Identifying the two major factors in working safely;
Listing four steps you can take prior to performing work that will insure a safe outcome;
Identifying the employee's responsibility if a potential accident or unsafe condition exists; and,
Selecting specific tasks that have the potential to cause an injury.
Worksheet:

1. Instructor will demonstrate how to setup and operate a band saw to a designated tolerance without endangering personnel or equipment by:
   A. Selecting proper blade;
   B. Installing and properly adjusting the blade;
   C. Adjusting the blade guides and guard;
   D. Adjusting the coolant flow if or as appropriate;
   E. Adjusting feed control (if applicable);
   F. Properly securing the work and making a cut to specified tolerances; and,
   G. Shutting down the machine and cleaning up work area.

2. Student will demonstrate how to setup and operate a band saw to a designated tolerance without endangering personnel or equipment by:
   A. Selecting proper blade;
   B. Installing and properly adjusting the blade;
   C. Adjusting the blade guides and guard;
   D. Adjusting the coolant flow if or as appropriate;
   E. Adjusting feed control (if applicable);
   F. Properly securing the work and making a cut to specified tolerances; and,
   G. Shutting down the machine and cleaning up work area.

3. Instructor will grade student’s performance.
Standards of performance:

Student shall identify the two major factors in working safely by:
1. Listing four steps you can take prior to performing work that will insure a safe outcome;
2. Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
3. Selecting specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to:
a. Demonstrate proper use and care of pedestal grinder;
b. Identify the component parts of a pedestal grinder;
c. Describe the correct method of dressing a grinding wheel;
d. Describe the relationship between feed speed and surface quality;
e. Describe the correct method of adjusting the tool rest of a pedestal grinder;
f. Describe the correct method of removing, testing and installing a grinding wheel on a pedestal grinder;
g. Identify the safety concerns relative to operation of a pedestal grinder; and,
h. Set up and operate a pedestal grinder without endangering personnel or equipment.

Reading Assignments:

The following chapters are assigned to read from Technology of Machine Tools, by Krar, McGraw-Hill Publications, Latest Edition

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
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<tbody>
<tr>
<td>85</td>
<td>Cylinder Grinder</td>
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</tbody>
</table>

Module Outline:

I. Identify the Component Parts of a Pedestal Grinder
   A. Pedestal
   B. Motor
   C. Spindle
   D. Toolrest (guard)
E. Grinding wheel and vibration pads
F. Coolant supply

II. Describe the Correct Method of Dressing a Grinding Wheel
   A. Different types of dressing tools
   B. Distinction between a properly and an improperly dressed wheel

III. Describe the Relationship Between Feed Speed and Surface Quality
   A. Fast feed-rapid metal abrasion with course finish
   B. Slow feed-slower metal removal and finer finish

IV. Describe the Correct Method of Adjusting the Tool Rest of a Pedestal Grinder
   A. Distance from wheel position in relation to horizontal axis of the spindle

V. Describe the Correct Method of Removing, Testing and Installing a Grinding Wheel on a Pedestal Grinder
   A. Blocking spindle rotation
   B. Removing guards
   C. Removing mounting nut and washers
   D. Sounding a wheel for flaws
   E. Mounting the wheel, vibration pads, washer and nut
   F. Replacing guards

VI. Identify the Safety Concerns Relative to Operation of a Pedestal Grinder
   A. Flying grinding dust
   B. Disintegrating wheel
   C. Wheel may throw small parts
   D. Danger of hand or fingers being pulled into wheel if small parts are improperly secured

VII. Set up and Operate a Pedestal Grinder Without Endangering Personnel or Equipment (This will be performed in the lab.)
Standards of performance:

Student shall identify the two major factors in working safely by:
1. Listing four steps you can take prior to performing work that will insure a safe outcome;
2. Identifying the employee's responsibility if a potential accident or unsafe condition exist; and,
3. Selecting specific task that have the potential to cause an injury.
Worksheet:

1. Instructor will:
   A. Demonstrate proper use and care of pedestal grinder; and,
   B. Set up and operate a pedestal grinder without endangering personnel or equipment.

2. Student will:
   A. Demonstrate proper use and care of pedestal grinder; and,
   B. Set up and operate a pedestal grinder without endangering personnel or equipment.

3. Instructor will grade student's performance on:
   A. Demonstrating proper use and care of pedestal grinder; and,
   B. Set up and operating a pedestal grinder without endangering personnel or equipment.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Identify the importance of the surface grinder to the maintenance mechanic;
b. Identify the component parts of a surface grinder;
c. Describe the purpose and operation of the major components of a surface grinder;
d. Identify how to mount a part for grinding, using a magnetic base and using dog clamps;
e. Describe the relationship between speed, feed and surface quality;
f. Identify safety concerns relative to using a surface grinder; and,
g. Setup and operate a surface grinder to a tolerance of .002 without endangering personnel of equipment.

Reading Assignments:

The following chapters are assigned to read from Technology of Machine Tools by Krar, McGraw-Hill Publisher, Latest Edition:

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<td>Types of Abrasives</td>
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<td>83</td>
<td>Surface Grinders and Accessories</td>
</tr>
<tr>
<td>84</td>
<td>Surface Grinding Operations</td>
</tr>
</tbody>
</table>
Module Outline:

I. Identify the Importance of the Surface Grinder to the Maintenance Mechanic
   A. Removes small predetermined amount of metal
   B. Makes surfaces parallel
   C. Makes surface flat

II. Identify the Component Parts of a Surface Grinder
   A. Control levers
   B. Bed table
   C. Compound rest
   D. Wheel grinding
   E. Coolant system

III. Describe the Purpose and Operation of the Major Components of a Surface Grinder
   A. Control levers
   B. Bed table
   C. Compound rest
   D. Wheel grinding
   E. Coolant system

IV. Identify How to Mount a Part for Grinding, Using a Magnetic Base and Using Dog Clamps
    A. Clamping using a magnetic base
    B. Clamping using dogs

V. Describe the Relationship Between Speed, Feed and Surface Quality.
   A. Typical speed and feed charts
   B. Setting speed and feed controls
   C. Light cut at high feed speed
   D. Heavy cut at high feed speed
   E. Heavy cut at low feed speed

VI. Identify Safety Concerns Relative to Using a Surface Grinder
   A. Work coming loose
   B. Flying debris
   C. Wheel disintegrating
   D. Moving parts

VII. Setup and Operate a Surface Grinder to a Tolerance of .002" Without Endangering Personnel or Equipment
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. Instructor will demonstrate how to setup and operate a surface grinder to a tolerance of .002 without endangering personnel of equipment.

2. Student will demonstrate how to setup and operate a surface grinder to a tolerance of .002 without endangering personnel of equipment.

3. Instructor will grade student's performance on setup and operating a surface grinder to a tolerance of .002 without endangering personnel of equipment.
Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves; and,
Not wearing rings, watches, jewelry, or loose clothing while operating equipment.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.
MASTER Video Tape (IMM-F5-VT1)

“Feeds and Speeds”
Objective(s):

Upon completion of this unit the student will be able to:

a. Identify major component parts of an engine lathe;
b. Properly set up and use lathe accessories required for basic lathe operation;
c. Determine correct speed and feed for a given metal;
d. Identify safety concerns relative to lathe operation;
e. Demonstrate set up and use of lathe operation;
f. Identify and use different types of lathe cutting tools;
g. Face cut and turn stock between centers to a specified tolerance; and,
h. Demonstrate method of drilling, boring and reaming a hole to obtain specified tolerance.

Reading Assignments:

The following chapters are assigned to read from *Technology of Machine Tools*, Krar, McGraw-Hill Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>Component Parts</td>
</tr>
<tr>
<td>46</td>
<td>Accessories</td>
</tr>
<tr>
<td>47</td>
<td>Feeds and Speeds</td>
</tr>
<tr>
<td>48</td>
<td>Safety</td>
</tr>
<tr>
<td>49</td>
<td>Mounting and Removing Centers</td>
</tr>
<tr>
<td>50</td>
<td>Grinding Lathe Tools</td>
</tr>
<tr>
<td>51</td>
<td>Facing Between Centers</td>
</tr>
<tr>
<td>52</td>
<td>Machining Between Centers</td>
</tr>
<tr>
<td>54</td>
<td>Turning Tapers Using Compound Rest</td>
</tr>
</tbody>
</table>

Module Outline:

I. Discuss the Importance of the Lathe to the Maintenance Mechanic
   A. Give each student a copy of the following attachments:
      1. Laboratory aid and required video tapes
      2. Objectives, reading assignments, and module outline
      3. Laboratory worksheet 1 and 2
      4. Project 2 drawing and duties/tasks profile

II. Identify and Discuss Component Parts of an Engine Lathe
   A. Control panel
B. Bed & ways
C. Head stock
D. Gear box
E. Carriage
F. Tailstock

III. Identify, Setup and Demonstrate Use of Lathe Accessories
A. Centers
B. Chucks
C. Faceplates
D. Mandrels
E. Steady and follower rest
F. Lathe dogs
G. Driver plates
H. Tool holders
I. Boring bars

IV. Discuss and Demonstrate How to Select the Correct Speed and Feed for Various Metals
A. Steel
B. Aluminum
C. Brass

V. Discuss Lathe Safety
A. Clamping of work
B. Watches & rings
C. Housekeeping
D. Chuck wrenches
E. Removing chips
F. Measurements

VI. Discuss and Demonstrate Use of Lathe Centers
A. Mounting
B. Removing
C. Aligning

VII. Discuss and Demonstrate Use of Cutting Tools
A. Grinding a toolbit
B. Conditioning point of bits
C. Types of cutting tools

VIII. Discuss and Demonstrate Turning Between Centers
A. Why face cut
B. Center drill
C. Using a tailstock center
E. Using steady rest
F. Using chucks

IX. Discuss and Demonstrate Method of Drilling, Boring and Reaming Using a Lathe
1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   - Tool grinder
   - Hand tools as required to operate lathe
   - Set of inside and outside micrometers up to 3"
   - Telescoping gages
   - Dial calipers
   - Toolstock
   - Face shield
   - Side shields
   - 3-6" sections of bar stock for practice
   - Drill and sleeve appropriate to hole required
   - Reamer appropriate for hole required
   - Lathe with accessories suitable for project

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercises tool grinding:
   A. Grind lathe cutting tool appropriate to metal being turned.
      (Instructor must see lathe tool prior to proceeding.)

5. Practice exercise lathe familiarization.
   A. Student shall practice using lathe controls until familiar.
      (1) Selecting speeds & feeds (use of S & L chart).
      (2) Start and stopping of machine and emergency stop.
      (3) Engage and disengage feed controls.
      (4) Positioning tool in tool holder.
   B. Student shall practice using accessories.
      (1) Centering stock in available chucks.
      (2) Setting up stock between centers.
      (3) Running machine with stock mounted in the chuck.
   C. Lathe operation.
      (1) Practice taking cuts using manual feed
      (2) Practice taking cuts using the engine driven feed and speed controls.
      (3) Practice center drilling.
(4) Practice drilling with the drill bit mounted in the tail stock.
(5) Practice reaming.
(6) Practice cutting a taper using the compound rest (manual feed).

D. Fabricate a part to tolerances specified on the drawing provided.
WORKSHEET 2:

1. This exercise will combine the skills and knowledge practices in previous lab exercises to fabricate the component described by attachment V.

2. Pre-established safety concerns by the drawing.

3. Maintain tolerances by the drawing.

The project will require the student to demonstrate skills and knowledge in the following:
- Practice safety
- Basic math
- Blueprint reading
- Measuring instruments
- Pedestal grinder operation
- Lathe operation
Attachment 5 consists of a drawing of project 2.

NOTE
ALL DIA. + OR - .003"
ALL LENGTH + OR -.015"
ALL DIM. IN INCHES
Standards of performance:

Student shall identify the two major factors in working safely by:
1. Listing four steps you can take prior to performing work that will insure a safe outcome;
2. Identifying the employee's responsibility if a potential accident or unsafe condition exist;
3. Selecting specific task that have the potential to cause an injury.

Objectives:

Upon completion of this module the student will be able to:
a. Demonstrate use and care of drill press;
b. Identify major components;
c. Describe the function and operation of all controls;
d. Describe typical accessories found on most radial arm drills;
e. Describe the safety concerns associated with operation of a radial arm drill; and,
f. Setup and safely operate a drill press to a specified standard.

Reading Assignments:

The following chapters are assigned to read from Technology of Machine Tools by Krar, McGraw-Hill Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>Drill Press</td>
</tr>
<tr>
<td>39</td>
<td>Drilling Machine Accessories</td>
</tr>
<tr>
<td>40</td>
<td>Twist Drills</td>
</tr>
<tr>
<td>41</td>
<td>Cutting Speeds and Feeds</td>
</tr>
<tr>
<td>42</td>
<td>Drilling Holes</td>
</tr>
<tr>
<td>43</td>
<td>Reaming</td>
</tr>
<tr>
<td>44</td>
<td>Drill Press Operations</td>
</tr>
</tbody>
</table>

Module Outline:

I. Identify Major Components
   A. Bed/table
   B. Motor
   C. Speed/feed/directional controls
D. Start/stop/emergency stop
E. Coolant system
F. Drill head
G. Column
H. Spindle
I. Radial arm

II. Describe the Function and Demonstrate Operations of All Controls
   A. Speed, feed and directional control
   B. Raise, lower and position drill head

III. Describe and Demonstrate the Use of Accessories Found on Most Radial Arm Drills
    A. Compound rest
    B. Clamping dogs
    C. Tapered shank drill sleeves
    D. Drill chuck
    E. Fly cutter

IV. Describe the Safety Concerns Associated with Operation of a Radial Arm Drill
    A. Hot chips
    B. Sharp edges
    C. Flying derbies

V. Demonstrate the Setup and Safely Operate a Radial Arm Drill Press to a Specified Standard
Standards of performance:

Student shall identify the two major factors in working safely by:
1. Listing four steps you can take prior to performing work that will insure a safe outcome;
2. Identifying the employee’s responsibility if a potential accident or unsafe condition exist;
3. Selecting specific task that have the potential to cause an injury.
Worksheet:

1. **The Instructor will:**
   A. **Identify major components.**
      (1) Bed/table
      (2) Motor
      (3) Speed/feed/directional controls
      (4) Start/stop/Emergency Stop
      (5) Coolant system
      (6) Drill head
      (7) Column
      (8) Spindle
      (9) Radial arm
   B. **Describe the function and demonstrate operations of all controls.**
      (1) Speed, feed and directional control
      (2) Raise, lower and position drill head
   C. **Describe and demonstrate the use of accessories found on most radial arm drills.**
      (1) Compound rest
      (2) Clamping dogs
      (3) Tapered shank drill sleeves
      (4) Drill chuck
      (5) Fly cutter
   D. **Describe the safety concerns associated with operation of a radial arm drill.**
      (1) Hot chips
      (2) Sharp edges
      (3) Flying derbies
   E. **Demonstrate the setup and safely operate a radial arm drill press to a specified standard.**

2. **Student will:**
   A. **Identify major components.**
      (1) Bed/table
      (2) Motor
      (3) Speed/feed/directional controls
      (4) Start/stop/Emergency Stop
      (5) Coolant system
      (6) Drill head
      (7) Column
B. Describe the function and demonstrate operations of all controls.
   (1) Speed, feed and directional control
   (2) Raise, lower and position drill head
C. Describe and demonstrate the use of accessories found on most radial arm drills.
   (1) Compound rest
   (2) Clamping dogs
   (3) Tapered shank drill sleeves
   (4) Drill chuck
   (5) Fly cutter
D. Describe the safety concerns associated with operation of a radial arm drill.
   (1) Hot chips
   (2) Sharp edges
   (3) Flying derbies
E. Demonstrate the setup and safely operate a radial arm drill press to a specified standard.

3. Instructor will grade student on:
A. Identify major components.
   (1) Bed/table
   (2) Motor
   (3) Speed/feed/directional controls
   (4) Start/stop/Emergency Stop
   (5) Coolant system
   (6) Drill head
   (7) Column
   (8) Spindle
   (9) Radial arm
B. Describe the function and demonstrate operations of all controls.
   (1) Speed, feed and directional control
   (2) Raise, lower and position drill head
C. Describe and demonstrate the use of accessories found on most radial arm drills.
   (1) Compound rest
   (2) Clamping dogs
   (3) Tapered shank drill sleeves
   (4) Drill chuck
   (5) Fly cutter
D. Describe the safety concerns associated with operation of a radial arm drill.
   (1) Hot chips
   (2) Sharp edges
(3) Flying derbies

E. Demonstrate the setup and safely operate a radial arm drill press to a specified standard.
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Practice Safety</td>
</tr>
<tr>
<td>B</td>
<td>Apply Mathematical Concepts</td>
</tr>
<tr>
<td>C</td>
<td>Interpret Engineering Drawings and Control Documents</td>
</tr>
<tr>
<td>D</td>
<td>Use Measuring Tools</td>
</tr>
<tr>
<td>E</td>
<td>Use Hand Tools</td>
</tr>
<tr>
<td>F</td>
<td>Operate Machine Tools</td>
</tr>
<tr>
<td>G</td>
<td>Perform Welding Operations</td>
</tr>
<tr>
<td>H</td>
<td>Maintain/ Troubleshoot Equipment and Systems</td>
</tr>
<tr>
<td>I</td>
<td>Repair Power Transmission Systems</td>
</tr>
<tr>
<td>J</td>
<td>Fabricate/ Install Sheet Metal Parts</td>
</tr>
</tbody>
</table>
INDUSTRIAL MAINTENANCE MECHANIC....uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>K: Piping</td>
<td>K-1 Perform basic piping calculations</td>
</tr>
<tr>
<td>L: Basic Rigging</td>
<td>L-1 Rigging fundamentals</td>
</tr>
<tr>
<td>M: Bearing Maintenance</td>
<td>M-1 Plain bearings</td>
</tr>
<tr>
<td>N: Use Computers</td>
<td>N-1 Perform basic word processing</td>
</tr>
<tr>
<td>O: Align Shafts</td>
<td>O-1 Principles of alignment</td>
</tr>
<tr>
<td>P: Install/Align Machines</td>
<td>P-1 Install electrical connections</td>
</tr>
<tr>
<td>Q: Maintain Electrical Devices</td>
<td>Q-1 Use electrical test equipment</td>
</tr>
<tr>
<td>R: Basic Mechanical Concepts</td>
<td>R-1 Force</td>
</tr>
<tr>
<td>S: Fasteners and Preloading</td>
<td>S-1 Fasteners and nomenclature</td>
</tr>
</tbody>
</table>
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
1. Using OSHA required safety equipment for the shop;
   Safety glasses;
   Hearing protection;
   Face shields;
   Gloves;
2. Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
3. Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Weld with shielded metal arc (SMAW) process.

Reading Assignments:

The following chapters are assigned for read from *Welding Skills and Practices*, by Week, Published by ATS, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Topic</th>
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</thead>
<tbody>
<tr>
<td>5</td>
<td>Machines and Accessories</td>
</tr>
<tr>
<td>6</td>
<td>Selecting the Electrode</td>
</tr>
<tr>
<td>7</td>
<td>Striking an Arc</td>
</tr>
<tr>
<td>8</td>
<td>Running Continuous Beads</td>
</tr>
<tr>
<td>9</td>
<td>The Flat Position</td>
</tr>
<tr>
<td>10</td>
<td>The Horizontal Position</td>
</tr>
<tr>
<td>11</td>
<td>The Vertical Position</td>
</tr>
<tr>
<td>12</td>
<td>The Overhead Position</td>
</tr>
<tr>
<td>13</td>
<td>Cast Iron</td>
</tr>
<tr>
<td>14</td>
<td>Carbon Steels</td>
</tr>
<tr>
<td>15</td>
<td>Alloy Steels</td>
</tr>
<tr>
<td>16</td>
<td>Non-Ferrous Metals</td>
</tr>
</tbody>
</table>

Module Outline:

I. Machines and Accessories
   A. Selecting the electrode
II. Striking an Arc

III. Running Continuous

IV. The Flat Position
   A. The horizontal position
   B. The vertical position
   C. The overhead position
   D. Cast iron
   E. Carbon steels
   F. Alloy steels
   G. Non-ferrous metals
The shielded metal arc welding (SMAW) process has a number of serious safety hazards associated with it:

**CAUTION:** Specific safety precautions must be taken to ensure a proper breathing atmosphere in all welding areas.

A. Weld only in ventilated areas. Welding shielding gases can displace the air needed for breathing. These gases are odorless and colorless, and most are heavier than air.

B. Weld in a position that will allow your head to be out of the welding plume, but will still give a good view of the welding arc. The welding plume could contain harmful fumes and gases.

C. Provide enough ventilation wherever welding and cutting are performed. Welding in confined spaces may require special procedures, such as the use of an air-supplied hood or hose mask.

D. Do not weld on dirty plate or plate contaminated with an unknown material. The fumes and gases which are formed could be hazardous to health.

**CAUTION:** Electrical shock can be avoided by following specific safety precautions.

A. Do not touch live electrical parts.

B. Ground all electrical equipment and the work-piece to prevent accidental electrical shocks.

C. Use the correct welding cable size for both the ground lead and the welding lead. Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard.

D. Be sure all electrical connections are tight, clean, and dry. Poor electrical connections can heat up and even melt, causing dangerous arcs and sparks.

E. Keep dry. Moisture and water can conduct electricity. Fix water leaks immediately.

F. Keep welding cables and connectors in good condition. Improper or worn electrical connections can cause short circuits and can increase the chance of an electrical shock.

G. Avoid open-circuit voltage. Open-circuit voltage is much higher than welding voltage.
H. Shut off electrical power when working on welding equipment.

CAUTION: Ultraviolet and infrared rays emitted by the welding arc, as well as the spatter from the welding arc, can injure eyes and burn skin. Specific safety precautions must be followed to ensure adequate protection.

A. Wear 100% cotton clothing. It will not catch fire easily, it offers good protection from light welding spatter, and it is cooler in the summer and warmer in the winter.
B. Cover all skin surfaces. Keep shirt sleeves rolled down.
C. Wear cuffless pants to eliminate spatter traps.
D. Wear leather boots. Pant legs should cover boot tops.
E. Wear clean clothing. Oil and grease stained clothes will tend to ignite from welding spatter.
F. For more severe welding conditions, wear protective clothing such as heat resistant jackets, aprons, and leggings.
G. Wear safety glasses to protect from arc flashes, mechanical injury, or other mishaps.
H. Wear ear protection, not only where there is noise but where there is a chance that spatter or sparks could get into the ears.
I. Wear a 100% cotton cap to protect the head from sparks or spatter.
J. Wear long gauntlet leather gloves.
K. Do not touch hot metal with bare hands. Use pliers and wear leather gloves.
L. Protect nearby workers from exposure to the welding arc by putting up shields.
M. Wear a welding helmet with the correct shade of welding lens. Choose the correct lens from a filter recommendations table (see Figure 2).
FILTER RECOMMENDATIONS
(adapted from ANSI Safety Standard Z49.1-88)
SMAW

<table>
<thead>
<tr>
<th>Application</th>
<th>Minimum Shade No.</th>
<th>Suggested Shade*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 60 amps</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>60 to 160 amps</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>160 to 250 amps</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>250 to 500 amps</td>
<td>11</td>
<td>14</td>
</tr>
</tbody>
</table>

* As a general rule, start with a shade that is too dark to see the arc zone. Then go to a lighter shade which gives sufficient view of the arc zone without exerting a strain on your eyes.

FIGURE 2 FILTER RECOMMENDATIONS

CAUTION: Specific precautions must be taken to ensure that there is no loss of property due to welding sparks, spatter, and heat.

A. If possible, weld in specially designated areas or enclosures of noncombustible construction.
B. Remove combustibles from the work area by at least 35 feet if possible.
C. Cover combustibles that cannot be removed from the welding area with tight-fitting flame-resistant material. Items that should be covered include combustible walls, floors, ceilings, and any cracks or other openings that might let a spark pass through it.
D. If welding is to be performed on or adjacent to a metal wall, ceiling, or partition, move combustibles on the other side to a safe location.
E. If combustibles cannot be adequately sealed off or removed, station a fire watcher at that location. The fire watcher must have adequate fire extinguishing capabilities.
F. Do not weld on materials having either a coating or internal structure that is combustible.
G. Place hot scrap and slag in non-combustible containers.
H. Ensure that fire extinguishers are available nearby.
I. Conduct a thorough examination for evidence of a fire before leaving the work area, and continue a fire check for at least 30 minutes after the welding operation has been completed.

J. Follow all company safety procedures regarding welding in hazardous areas.

CAUTION: NEVER carry a butane lighter into a welding area. These are considered to be mini-Molotov cocktails. DON'T CARRY A BOMB IN YOUR POCKET.
Worksheet:

1. Choose Proper Power Source
   Step 1. With the procedures and electrodes used at maintenance and fabrication facilities, choose a constant current (CC) power source for the Shielded Metal Arc Welding process. Some units are a combination of constant current (CC) and constant voltage (CV). This type of power source will have one or two switches to change from constant current to constant voltage.
   Step 2. An alternating current (AC) welding power source could be used with the low-hydrogen family of electrodes, but choose a constant current (CC) power source if possible.

2. Choose a Proper Electrode
   Step 1. Choose the proper electrode for the job.
   NOTE: The maintenance technician uses E6010 and E7018 electrodes for most SMAW applications. The E6010 belongs to the fast-freeze family of electrodes and the E7018 belongs to the low-hydrogen family of electrodes. The E6010 provides a deep digging, deep penetrating type of weld and may be used for non-critical fabrication.

   The E7018 low-hydrogen is used as the primary electrode for fabrication and other code-quality welds. The low-hydrogen family also includes E7015, E7016, and E7048. Hydrogen in the weld deposit causes brittleness called hydrogen embrittlement, which leads to cracking and potential weld failure.

   Step 2. Store the electrodes properly.
   a. Low-hydrogen electrodes:
      (1) These electrodes are packaged in hermetically sealed (watertight) cans. Be careful not to damage the cans which would allow air and moisture to attack the electrodes in the cans.
      (2) Once the cans are opened, store the electrodes in a rod oven at 150°F to 300°F.
Step 3.

(3) Re-dry electrodes that have been outside a sealed container or a properly heated rod oven for several hours by baking them one hour at 700°F to 800°F and storing them in a rod oven.

NOTE: Some welding procedures also set a time limit on the number of hours that low-hydrogen electrodes can be kept out of a rod oven prior to use. Times vary from two to four hours, depending on the type of base metal to be welded and the humidity levels of the environment.

b. Do not store the E6010 fast-freeze electrodes in rod ovens. Fast-freeze electrodes require the presence of small amounts of moisture in order to run smoothly.

Match the low-hydrogen family members with the polarities that are used with them (see Figure 5).

<table>
<thead>
<tr>
<th>ROD DESIGNATION</th>
<th>DC+</th>
<th>DC-</th>
<th>AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>E6010</td>
<td>YES</td>
<td>NEVER</td>
<td>NEVER</td>
</tr>
<tr>
<td>E7015</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>E7016</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>E7018</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>E7048</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
</tbody>
</table>

FIGURE 5 WELDING ROD POLARITIES

Definitions:

AC Alternating Current
DC+(DCRP) Direct Current Reverse Polarity
DC-(DCSP) Direct Current Straight Polarity
<table>
<thead>
<tr>
<th>Electrode Diameter (in.)</th>
<th>Current Range (amp)</th>
<th>Electrode Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E6010, E6011 DC+</td>
<td>E6012, E6013, E6020, E6027, E7014, E7015, E7016, E7018, E7024, E7028</td>
</tr>
<tr>
<td>1/16</td>
<td>--</td>
<td>20-40</td>
</tr>
<tr>
<td>5/32</td>
<td>--</td>
<td>25-60</td>
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<td>40-80</td>
<td>45-90</td>
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<td>110-170</td>
<td>105-180</td>
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<td>7/32</td>
<td>170-250</td>
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<td>1/4</td>
<td>210-320</td>
<td>250-400</td>
</tr>
<tr>
<td>5/16</td>
<td>275-425</td>
<td>300-500</td>
</tr>
</tbody>
</table>

FIGURE 6 TYPICAL CURRENT RANGES FOR ELECTRODES

3. Prepare Weldment for Welding

Step 1. Oxyacetylene cut, carbon air arc gouge/cut, or machine cut/mill material to the desired shape/contour for each type of weld joint configuration needed for each welding task at hand.

a. Weld joint configuration will depend upon:
   (1) Product design
   (2) Material thickness
   (3) Design strength requirements
   (4) Welding process employed

b. SMAW weld joint configuration may be a:
   (1) Lap joint
   (2) Tee joint
   (3) Corner joint
   (4) Edge joint
   (5) Butt joint with backing
   (6) Butt joint without backing

Step 2. Clean the areas to be welded prior to fit-up

a. Remove rust, paint, and any other coatings by wire brushing, grinding, sanding, or filing

b. Remove oils and greases with a safe, suitable solvent

Step 3. Turn on the power source and set the current range (amps) on
the machine at the lower end of the setting as suggested for the electrode size.

Step 4. Obtain a piece of scrap metal of the approximate type and thickness for the weld joint to be made.

Step 5. Practice welding on the scrap metal and adjust the current setting as needed to produce a good weld.

4. Complete Welding Operation

Step 1. Tack weld a joint that is defect free and can be incorporated into the finished product.

Step 2. Use any preheat that may be required by welding codes or company procedures.

Step 3. Make the required weld to be defect free and pleasing in appearance.

Step 4. Use proper weld bead placement according to the weld joint design.
   a. When making seam welds, produce the weld beads by using very little oscillation or some oscillation.
   b. When making fillet welds, produce the weld beads by using some oscillation. Fillet welds in the vertical position can also be run using a weaving technique.
   c. When making groove welds, produce the weld beads by using some oscillation and/or by weaving. When making groove welds on butt joints, the amount of weaving will depend on the welding position and the weld joints. It may also be limited by applicable welding codes and/or company standards.

Step 5. Maintain the correct welding travel speed. Weld bead size can be changed by varying the arc travel speed. Bead size and travel speed are inversely related: a decrease in travel speed will result in an increase in the weld bead height and width, and an increase in travel speed will result in a decrease in the weld bead height and width.
   a. As the material thickness increases, the travel speed must slow down.
   b. For a given material thickness and joint design, as the welding amperage is increased so is the arc travel speed. Conversely, as the amperage is decreased, the arc travel is slowed.
   c. Higher welding speeds are attainable by using the forehand (pushing) technique.

5. Troubleshoot Welding Problems

Step 1. Be aware of the welding variables and how they can affect the weld. Below is a list of eleven welding variables for the SMAW
Step 2. Be aware of general welding variables and how they can affect the weld:
   a. Type of base metal
   b. Thickness of base metal
   c. Surface condition of base metal (clean, rusty, or painted)
   d. Atmospheric conditions

Step 3. Be aware of any weld discontinuity and the relevant welding variables that may have caused it (see Figure 7).
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Select proper cylinder;
b. Select proper regulator;
c. Select proper valve;
d. Fabricate cutting equipment;
e. Weld with oxyacetylene equipment;
f. Prepare to cut;
g. Light the torch;
h. Cut the metal with the torch; and,
i. Extinguish the torch.

READING ASSIGNMENTS:

The following chapters are assigned to read from Basic Oxyacetylene Welding, Griffin, Delmar Publishers, Latest Edition.

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**Module Outline:**

I. Gas Cutting Safety  
II. Gas Cutting Fundamentals  
III. Gasses  
IV. Cylinders  
V. Regulators  
VI. Valves  
VII. Oxygen  
VIII. Oxygen Hoses  
IX. Acetylene  
X. Acetylene Hoses  
XI. Cutting Torch and Tips  
XII. Flame  
XIII. Setting Up Equipment
XIV. Light Torch
XV. Cutting Procedure
XVI. Welding Procedure
Caution: Specific preventive and protective safety measures must be followed when using oxyacetylene equipment.

a. Use goggles or shield with a number five shade.
b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots, and soft cotton caps.
c. When lighting the torch, direct the torch away from yourself and other personnel.
d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
f. Never cut on containers that have contained flammable or toxic substances.
g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
h. When cutting, cover concrete floors with sheet metal where sarks and molten metal are being directed.
i. Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.
j. Cut in a well-ventilated area. If adequate ventilation is not possible, use a respirator.
k. Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

Caution: Handle acetylene and oxygen cylinders carefully:

a. Keep acetylene operating pressures at or below 15 psi.
b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burnback or a fire at a leak in the hose or at a connection.
c. Do not open the acetylene torch valve where acetylene could flow into a bucket or other container and cause a fire.
d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left-hand threaded and usually notched.
e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.

f. Do not use pipe-fitting compounds or thread lubricants for making connections.

g. Never use a cylinder that is leaking.

h. Store and transport cylinders in the upright position.

i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.

j. Never tamper with fusible plugs or other safety devices on cylinders.

k. To open and close acetylene cylinder valves not provided with handwheels always use the special wrench or key. When cutting leave the key in place for rapid shutdown in case of fire.

l. Never use any cylinder, full or empty, as a roller or support.

m. Never use oxygen as though it were compressed air.

n. Do not handle oxygen cylinders on the same platform with oil.

o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.

p. Store oxygen cylinders separately from fuel gas cylinders.

q. Always keep empty cylinders separate from full cylinders.

r. Mark all empty cylinders as such after use.

s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.

t. Never bring any arc or flame close to or directly into contact with a cylinder.

u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder’s current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.
Answer the following questions and compare your answers to those listed below.

1. What are the precautions recommended to prevent accidents and protect the welder during oxyacetylene cutting?

2. What are the precautions for safely handling and storing acetylene and oxygen cylinders?

3. What are the precautions for minimizing the risk of R.B.O.?

4. What are the steps in preparing to cut with oxyacetylene?

5. What are the steps in lighting the torch?

6. What are the steps in cutting metal with the torch?

7. What are the steps in extinguishing the torch?

8. What are the steps in closing down the welding station?

Answers:

1. Precautions recommended to prevent accidents and to protect the welder during oxyacetylene cutting:
   a. Use goggles or shield with a number five shade.
   b. Wear gloves, long sleeve shirts, pants of high cotton or wool content, leather boots and soft cotton caps.
   c. When lighting the torch, direct the torch away from yourself and other personnel.
   d. Never leave a lit torch unattended. When leaving your work station, always extinguish your torch.
   e. Never use matches or butane lighters for lighting a torch. Only use spark or friction lighters.
   f. Never cut on containers that have contained flammable or toxic substances.
   g. Either move work away from or protect wooden or other flammable materials which may be close to the work.
When cutting, cover concrete floors with sheet metal where sparks and molten metal are being directed.

Before beginning to work, locate the nearest fire alarm and the nearest fire extinguisher.

Cut in a well ventilated area. If adequate ventilation is not possible, use a respirator.

Keep all petroleum products away from oxyacetylene equipment and operations. The combination of pure oxygen and oil is explosive.

2. Precautions for safely handling oxygen and acetylene cylinders:
   a. Keep acetylene operating pressures at or below 15 psi.
   b. Open the acetylene cylinder valve one-half to one full turn when using a portable rig to be sure that the cylinder can be quickly turned off in the event of burn-back or a fire at a leak in the hose or at a connection.
   c. Do not open an acetylene torch's valve where acetylene could flow into a bucket or other container and cause a fire.
   d. Never attempt to connect an acetylene hose to an oxygen torch connection. Damage to the torch or an explosion could result. Acetylene hoses are colored red and acetylene fittings are left hand threaded and usually notched.
   e. Never use oxygen or fuel gas from a cylinder except through an approved pressure-reducing regulator.
   f. Do not use pipe-fitting compounds or thread lubricants for making connections.
   g. Never use a cylinder that is leaking.
   h. Store and transport cylinders in the upright position.
   i. Secure all cylinders with chain when storing, transporting, or using, to prevent them from being turned over by accident.
   j. Never tamper with fusible plugs or other safety devices on cylinders.
   k. To open and close acetylene cylinder valves not provided with handwheels, always use the special wrench or key. When cutting, leave the key in place for rapid shutdown in case of fire.
   l. Never use any cylinder, full or empty, as a roller or support.
   m. Never use oxygen as though it were compressed air.
   n. Do not handle oxygen cylinders on the same platform with oil.
   o. Never use wire-rope slings or electromagnets for lifting cylinders. Do not lift cylinders by the protective cap alone.
   p. Store oxygen cylinders separately from fuel gas cylinders.
   q. Always keep empty cylinders separate from full cylinders.
   r. Mark all empty cylinders as such after use.
   s. Keep all cylinders stored inside buildings at least 20 feet away from combustible materials.
   t. Never bring any arc or flame close to or directly into contact with a cylinder.
u. Never exceed the maximum safe withdrawal rate for acetylene cylinders (one seventh of the cylinder's current contents per hour). If acetylene is withdrawn from the cylinder at a greater rate, acetone will also be withdrawn from the cylinder, damaging the cutting equipment. If additional flow is needed, then manifold the required number of cylinders together.

3. Precautions for minimizing the risks of R.B.O.
   a. "Crack" the oxygen cylinder valve before attaching the regulator. Stand to one side or the rear of the cylinder outlet. Open the cylinder valve slightly for an instant and then close it to clean the valve of dust and dirt which may have accumulated during storage. Dirt can damage an oxygen regulator and may cause R.B.O.
   b. Use only oxygen regulators to control oxygen supply. A pressure-reducing regulator must be connected to the oxygen cylinder valve. Make certain the regulator is clean, free of grease and oil, and has a clean filter installed in its inlet nipple. Oil, grease, coal dust, and other combustibles can cause regulator burnouts. Never use an oxygen regulator for other gases.
   c. Before opening an oxygen cylinder valve, make sure the oxygen regulator pressure-adjusting screw is released. This is done by rotating the screw counterclockwise until it turns freely. This closes the regulator valve and prevents damage due to a sudden pressure surge.
   d. While opening the oxygen cylinder valve, stand to one side of the oxygen regulator. Do not stand in line with the front or the back of the pressure-adjusting screw. Open the cylinder valve as slowly as possible, until the high pressure gauge reaches cylinder pressure. Never open a cylinder valve suddenly. Sudden surges of high pressure can cause R.B.O.

4. Steps in preparing to cut with oxyacetylene:
   a. Obtain the proper size cutting tip.
      (1) Consult the equipment manufacturer's cutting tip data charts. The charts match up the thickness of the steel being cut with the cutting tip size and also give recommended pressure settings for oxygen and acetylene.
      (2) Be sure that the metal can be cut with an oxyacetylene torch. Oxy-fuel cutting is not used on metals like aluminum, copper, magnesium, and chromium, where the oxide of that metal melts at a higher temperature than the metal itself. Also, stainless steels cannot be easily cut with oxy-fuel because they contain relatively large amounts of chromium and/or nickel.
   b. Screw the cutting torch head in place, hand-tight only.
c. Before attaching the regulators to the cylinder valves, crack the valves to blow out any dirt and debris.
d. Attach the regulators, hoses, torch, and correct-sized torch tip.
e. Make sure the pressure adjusting screws of the acetylene and oxygen regulators are backed out. (That is, that they have been turned counter-clockwise until there is a little free play.)
f. Make sure all cutting torch valves are initially closed.
g. Open the oxygen cylinder valve all the way. Open the acetylene cylinder valve one full turn only.
h. Open the acetylene torch valve. Turn the acetylene torch valve off.
i. Turn the acetylene regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
j. Turn the acetylene torch valve off.
k. Turn both oxygen torch valves on.
l. Turn the oxygen regulator pressure-adjusting screw clockwise until the needle on the regulator dial indicates the proper pressure.
m. Turn off the oxygen torch valve on the torch head only.

5. Steps in lighting the torch:
a. Put on gloves.
b. Put on welding goggles.
c. Open the torch acetylene valve one-half turn.
d. *Immediately* light the torch with a *friction lighter only*.
e. Reduce the acetylene flow at the torch's acetylene valve until the flame just starts to produce black smoke around its edges. Then increase the acetylene flow just enough to get rid of the black smoke.
f. Open the torch's oxygen valve slowly until the desired type flame is obtained.

(1) The preheat flame needs to be of the *neutral* type, which means that equal parts of oxygen and acetylene are being burnt.
(2) The preheat flame needs to be the right size. Set the pressure correctly, and then follow the directions in "Step e" again. If the preheat flame is too large, there will be or tend to be slag or dross hanging onto the bottom of the cut—assuming that travel speed, tip size, etc., are all correct.

6. Steps in cutting metal with the torch:
a. Follow the steps in Operation 1 and Operation 2 for the following oxyacetylene cutting variables:
   (1) Cutting tip size.
   (2) Oxygen operating pressure.
   (3) Acetylene operating pressure.
   (4) Preheat flame type.
   (5) Size of preheat flame
b. Clean the cutting tip. Be sure that the preheat and cutting orifices of the tip are clean. A dirty tip, especially a dirty cutting orifice, will adversely affect the quality of the cut. Dirty orifices can produce such defects as wide kerfs, adherent slag, and rough appearance.

c. Select the correct flame-to-work distance. The bottom of the preheat flame should be 1/16" to 1/2" from the base metal. Right-handed people should progress from right to left and left-handed people should cut left to right.

d. Select the correct torch angle.
   (1) For square cuts, the torch should be perpendicular (at 90°) to the base metal and tipped slightly in the direction of travel.
   (2) For beveled cuts, the torch should be held at the angle of the bevel throughout the cutting procedure.
   (3) For holes, the torch must be held perpendicular to the base metal throughout the cut.

e. Cut at the proper travel speed. At the correct travel speed, the lines of the cut which project through the thickness of the base metal will be in a straight line. At too fast a travel speed, the lines of the cut will curve back from the progress of the cut and form clearly defined lines termed lag or drag lines. (The amount of drag is often expressed as a percent.)

f. Assure the oxygen level. Although it is possible to make a good weld with an oxygen purity level of only 95%, in order to make good oxy-fuel cut, an oxygen purity level of 99.5% is required. Where leaks in oxygen lines or hoses allow air to be mixed with the oxygen, the quality of the cut can be very seriously affected.

7. Steps in extinguishing the torch:
   a. Close the torch acetylene valve, thus extinguishing the flame.
   b. Close the torch oxygen valve.

8. Steps in closing down the welding station:
   a. Close the oxygen cylinder valve.
   b. Close the acetylene cylinder valve.
   c. Open the torch acetylene valve and bleed the acetylene from the line.
   d. Close the torch acetylene valve.
   e. Turn the acetylene regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
   f. Open the torch oxygen valve and bleed the oxygen from the line.
   g. Close the torch oxygen valve.
   h. Turn the oxygen regulator pressure adjusting screw counterclockwise until there is a little free play. Avoid backing out the pressure adjusting screws so much that they come totally out.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Identify soldering, brazing and braze welding;
b. Describe the advantages of soldering and brazing;
c. Demonstrate methods of cleaning and assembling metals;
d. Preform required soldering, brazing and braze welding joints; and,
e. Determine the proper fluxes for the soldering, brazing and braze weld joints.

Reading Assignments:

The following chapters are assigned to read from *Basic Oxyacetylene Welding*, by Griffin, Delmar Publishers, Latest Edition

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**Module Outline:**

I. Oxyacetylene Soldering Safety  
II. Soldering with Oxyacetylene  
III. Equipment Set Up  
IV. Light Torch  
V. Torch and Rod Control  
VI. Soldering with Filter Material  
VII. Soldering a But Joint  
VIII. Soldering in a Vertical Position
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
1. Instructor will demonstrate how to:
   - Braze with bronze rod;
   - Run a bead with a bronze rod;
   - Square butt braze on light steel plate;
   - Braze lap joints;
   - Braze tee joints;
   - Braze beveled butt joints on heavy steel plate;
   - Braze beveled joints on cast iron;
   - Silver soldering of nonferrous metals; and,
   - Silver soldering of ferrous and nonferrous metals.

2. Student will practice:
   - Brazing with bronze rod;
   - Running beads with bronze rod;
   - Square butt brazing on light steel plate;
   - Brazed lap joints;
   - Brazing tee joints;
   - Brazing beveled butt joints on heavy steel plate;
   - Brazing beveled joints on cast iron;
   - Silver soldering nonferrous metals; and,
   - Silver soldering ferrous and nonferrous metals.

3. Instructor will grade students performance on:
   - Brazing with bronze rod;
   - Running beads with bronze rod;
   - Square butt brazing on light steel plate;
   - Brazed lap joints;
   - Brazing tee joints;
   - Brazing beveled butt joints on heavy steel plate;
   - Building-up on cast iron;
   - Brazing beveled joints on cast iron;
   - Silver soldering nonferrous metals; and,
   - Silver soldering ferrous and nonferrous metals.
INDUSTRIAL MAINTENANCE MECHANIC uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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**Tasks**
- A-2 Accident prevention
- A-3 Working shift
- A-4 Fire safety
- A-5 Lifting safety
- A-6 Lockout/tagout
- B-2 Convert fractions/decimals
- B-3 Convert Metric/English measurements
- B-4 Perform basic algebraic operations
- B-5 Perform basic trigonometric functions
- B-6 Perform basic geometric calculations
- C-2 Identify basic layout of drawings
- C-3 Review blueprint notes and dimensions
- D-2 Use precision measuring tools
- E-2 Identify and use hand held power tools
- F-2 Use and care of horizontal and vertical band saws
- F-3 Use and care of horizontal and vertical band saws
- F-4 Use and care of surface grinder
- F-5 Operate lathes
- F-6 Use and care of drill press
- G-2 Weld with oxyacetylene torch
- G-3 Perform gas soldering
- H-2 Maintain pneumatic control circuits
- H-3 Troubleshoot centrifugal pumps
- H-4 Troubleshoot positive displacement pumps
- H-5 Maintain check valves and relief valves
- H-6 Maintain check valves and relief valves
- H-7 Troubleshoot and repair blowers
- H-8 Troubleshoot, maintain, and repair hydraulic systems
- H-9 Troubleshoot, maintain, and repair pneumatic systems
- I-2 Maintain and troubleshoot gear power transmission drives
- I-3 Maintain and troubleshoot chain power transmission drives
- I-4 Maintain and troubleshoot clutches
- J-2 Form and/or bend sheet metal parts
- J-3 Fasten sheet metal parts together
INDUSTRIAL MAINTENANCE MECHANIC uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
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| K Piping Operations | K-1 Perform basic pipelining calculations  
| L Basic Rigging     | L-1 Rigging fundamentals  
| M Bearing Maintenance | M-1 Plain bearings  
| N Use Computers   | N-1 Perform basic word processing  
| O Align Shafts    | O-1 Principles of alignment  
| P Install/Align Machines | P-1 Install electrical connections  
| Q Maintain Electrical Devices | Q-1 Use electrical test equipment  
| R Basic Mechanical Concepts | R-1 Force  
| S Fasteners and Preloading | S-1 Fasteners and nomenclature  

- K-2 Cut thread, and ream pipe  
- K-3 Pipe assembly  
- K-4 Install and adjust pipe support  
- K-6 Tubing  
- K-7 Plastic pipe  
- L-2 Demonstrate basic rigging skills  
- M-2 Rolling element bearings  
- N-2 Perform basic spreadsheet operations  
- O-2 Methods of alignment  
- P-2 Setting and leveling  
- P-3 Grouting  
- P-4 Special mountings  
- Q-2 Apply basic terms to electrical circuits  
- Q-3 Analyze series, parallel, and complex AC/DC circuits  
- Q-4 Check AC and DC motors  
- Q-5 Troubleshoot electrical devices  
- R-2 Work  
- R-3 Mechanical motion and rate  
- R-4 Simple machines  
- R-5 Power  
- S-2 Application for various fasteners  
- S-3 Techniques for removing damaged fasteners  
- S-4 Cleaning and restoring threaded fasteners  
- S-5 Torque preload theory  
- S-6 Effects of lubricating threads prior to torquing  
- S-7 Demonstrate appropriate torquing technique
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wear rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Draw and explain operation of basic refrigeration cycle;
b. Discuss air properties and how psychrometrics are used;
c. List HVAC basic components and their explain sequence of operation;
d. List typical HVAC instrumentation and test equipment;
e. Draw mechanical and electrical diagrams of compressors;
f. List sequence of operation for control and protective devices for compressors;
g. List procedures for maintenance and repair of compressors; and,
h. List procedures for maintenance and repair of HVAC systems.

Reading Assignments:

The following chapters are assigned to read from Air Conditioning and Refrigeration Compressors, TPC Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Compressors</td>
</tr>
<tr>
<td>4</td>
<td>Control and Protective Devices</td>
</tr>
<tr>
<td>5</td>
<td>Maintenance and Repair</td>
</tr>
</tbody>
</table>

Module Outline:

I. Basic Refrigeration Cycle
II. Air Properties and Psychometrics
III. HVAC Basic Components and Their Operation
IV. HVAC Instrumentation and Test Equipment
V. Compressors
VI. Control and Protective Devices for Compressors
VII. Maintenance and Repair of Compressors
VIII. Maintenance and Repair of HVAC Systems
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
IMM-H1-LW
Maintain Air Conditioning Systems
Attachment 3: MASTER Laboratory Worksheet

1. Instructor will demonstrate how to:
   a. Draw and explain operation of basic refrigeration cycle;
   b. Discuss air properties and how phychrometrics are used;
   c. List HVAC basic components and their explain sequence of operation;
   d. List typical HVAC instrumentation and test equipment;
   e. Draw mechanical and electrical diagrams of compressors;
   f. List sequence of operation for control and protective devices for compressors;
   g. List procedures for maintenance and repair of compressors; and,
   h. List procedures for maintenance and repair of HVAC systems.

2. Student will demonstrate how to:
   a. Draw and explain operation of basic refrigeration cycle;
   b. Discuss air properties and how phychrometrics are used;
   c. List HVAC basic components and their explain sequence of operation;
   d. List typical HVAC instrumentation and test equipment;
   e. Draw mechanical and electrical diagrams of compressors;
   f. List sequence of operation for control and protective devices for compressors;
   g. List procedures for maintenance and repair of compressors; and,
   h. List procedures for maintenance and repair of HVAC systems.

3. Instructor will grade students ability to:
   a. Draw and explain operation of basic refrigeration cycle;
   b. Discuss air properties and how phychrometrics are used;
   c. List HVAC basic components and their explain sequence of operation;
   d. List typical HVAC instrumentation and test equipment;
   e. Draw mechanical and electrical diagrams of compressors;
   f. List sequence of operation for control and protective devices for compressors;
   g. List procedures for maintenance and repair of compressors; and,
   h. List procedures for maintenance and repair of HVAC systems.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Maintain control valves; and,
b. Maintain pneumatic control circuit.

Reading Assignments:

The following chapters are assigned to read from Fluid Power, by Parker Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Energy Transmission Using A Pneumatic System</td>
</tr>
<tr>
<td>11</td>
<td>Simple Pressure Control Valves</td>
</tr>
</tbody>
</table>

Module Outline:

I. Shut-Off Valve
II. Check Valve
III. One-Way Valve
IV. Two-Way Valve
V. Three-Way Valve
VI. Four-Way Valve
VII. Quick-Release Valve
VIII. Maintenance
    A. General
    B. Disassemble and rework
IX. Basic Circuit
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Practice Disassembling:
1. Shut-Off Valve
2. Check Valve
3. One-Way Valve
4. Two-Way Valve
5. Three-Way Valve
6. Four-Way Valve
7. Quick-Release Valve
8. Maintenance
   A. General
   B. Disassemble and rework
9. Basic Circuit
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Describe the principles of hydraulics;
b. Describe hydrodynamics and water flow;
c. Describe the operation of a centrifugal pump;
d. List the classifications of a centrifugal pump;
e. Identify and describe the parts of a centrifugal;
f. Demonstrate the installation of a centrifugal pump;
g. Set-up and operate a centrifugal pump safely;
h. Identify problems by troubleshooting centrifugal pumps;
i. Describe maintenance and repair of centrifugal pumps;
j. Demonstrate corrosion resisting centrifugal pumps; and,
k. Describe impeller design consideration.

Reading Assignments:

The following chapters are assigned to read from Pumps, Stewart/Miller and Macmillian, Audel Publishing Company, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Principles of Hydraulics</td>
</tr>
<tr>
<td>3</td>
<td>Centrifugal Pumps</td>
</tr>
</tbody>
</table>

Module Outline:

I. Describe the Principles of Hydraulics
   A. Introduction
II. Describe Hydrodynamics and Water Flow
A. Dynamic head
B. Dynamic lift
C. Total column
D. Friction of water in pipes
E. Measurement of water flow
F. Siphon
G. Flow through orifices
H. Specific gravity
I. Summary

III. Describe the Operation of a Centrifugal Pump
A. Basic principles
B. Straight vane pumps
C. Curved vane pumps
D. Volute (curve)
E. Effects of the curvature

IV. Discuss the Classifications of Centrifugal Pump
A. Single-stage
B. Multistage
C. Impellers
D. Balancing

V. Identify and Describe the Parts of a Centrifugal Pump
A. House or casting
B. Impeller
C. Stuffing box assembly
D. Bearings and housing
E. Shaft assembly
F. Drive

VI. Demonstrate the Installation of a Centrifugal Pump
A. Location
B. Foundation
C. Leveling-aligning
D. Grouting
E. Inlet pipe
F. Discharge pipe
G. High temperature material pumping

VII. Set-Up and Operate a Centrifugal Pump
A. First check
1. Rotation
2. Lubrication
3. Bearing cooling water
4. Inspect all parts

B. Priming
C. Starting the pump
D. Stopping the pump
E. Abnormal conditions

VIII. Identify Problems by Troubleshooting Centrifugal Pumps
A. Reduced capacity or pressure and failure to deliver material
B. Loses water after starting
C. Pump overloads driver
D. Pump vibrates
E. Pointers on pump operation

IX. Describe Maintenance and Repair of Centrifugal Pumps
A. Lateral end clearances
B. Parts renewals
C. Points on assembly

X. Demonstrate Corrosion Resisting Centrifugal Pumps
A. Typical application
B. Corrosion resisting pump installation
C. Maintenance
D. Troubleshooting

XI. Describe Impeller Design Considerations
A. Introduction
B. Velocity of impeller
C. Total hydraulic load and lift
D. Velocity head
IMM-H3-LA
Troubleshoot Centrifugal Pumps
Attachment 2: MASTER Laboratory Aid

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical object;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Set-up and operate a centrifugal pump;
   c. Troubleshoot a centrifugal pump;
   d. Stop the centrifugal pump;
   e. Disassemble, replace needed parts, reassemble the centrifugal pump;
   f. Reinstall the centrifugal pump;
   g. Operate and troubleshoot the centrifugal pump; and,
   h. Repeat steps a. through g. on other types of centrifugal pumps.
1. Instructor will observe the safe and proper procedures for the following:
   a. Set-up and operate a centrifugal pump;
   b. Troubleshoot a centrifugal pump;
   c. Stop the centrifugal pump;
   d. Disassemble, replace needed parts, and reassemble the centrifugal pump;
   e. Reinstall the centrifugal pump; and,
   f. Operate and troubleshoot the centrifugal pump.

2. Student will:
   a. Set-up and operate a centrifugal pump;
   b. Troubleshoot a centrifugal pump;
   c. Stop the centrifugal pump;
   d. Disassemble, replace needed parts, and reassemble the centrifugal pump;
   e. Reinstall the centrifugal pump;
   f. Operate and troubleshoot the centrifugal pump; and,
   g. Repeat steps a. through f. on other types of centrifugal pumps.

3. Instructor will grade student’s performance on the following:
   a. Set-up and operate a centrifugal pump;
   b. Troubleshoot a centrifugal pump;
   c. Stop the centrifugal pump;
   d. Disassemble, replace needed parts, and reassemble the centrifugal pump;
   e. Reinstall the centrifugal pump; and,
   f. Operate and troubleshoot the centrifugal pump.
IMM-H4-HO
Troubleshoot Positive Displacement Pumps
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Set-up and operate a positive displacement pump;
b. Troubleshoot a positive displacement pump;
c. Stop the positive displacement pump;
d. Disassemble, replace needed parts, reassemble the positive displacement pump;
e. Reinstall the positive displacement pump; and,
f. Operate and troubleshoot the positive displacement pump.

Reading Assignments:

The following chapters are assigned to read from Pumps (Audel), Stewart/Miller, Macmillian Publishing Company, Latest Edition

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>4</td>
<td>Rotary Pumps</td>
</tr>
<tr>
<td>5</td>
<td>Reciprocating Pumps</td>
</tr>
<tr>
<td>6</td>
<td>Special Service Pumps</td>
</tr>
</tbody>
</table>

Module Outline:

I. Describe the Principles of Operation of Rotary Pumps
   A. Gear-type pumps
   B. Vane-type pumps
   C. Piston-type pumps
II. Describe the Construction of Rotary Pumps
A. Gear-type pumps
B. Vane-type pumps
C. Piston-type pumps

III. Demonstrate the Installation and Operation of Rotary Pumps
A. Introduction of installation
B. Alignment
C. Drives for rotary gear pumps
D. Power for driving pumps
E. Piping
F. Direction of rotating
G. Starting and operating the pump
H. Practical installation
I. Types of gear pumps
J. Pressure relief valve

IV. Identify Problems in Troubleshooting Rotary Pumps
A. No liquid delivered
B. Insufficient liquid delivered
C. Pump delivers for a short period, then quits
D. Rapid wear
E. Pump requires too much power
F. Noisy operation

V. Describe Rotary Pump Calculations
A. Correct pipe size
B. Friction of water in pipe
C. Friction loss in rubber hose
D. Dynamic column or total load
E. Dynamic lift
F. Dynamic head
G. Horsepower required

VI. Describe the Principles of Operation of a Reciprocating Pump
A. Lift pump
B. Force pump
C. Self-priming or siphon pump

VII. Describe the Construction of a Reciprocating Pump
A. Uses
B. Operations

VIII. Perform Reciprocating Pump Calculations
A. Lift
B. Size of pipe
C. Head
D. Displacement
E. Piston speed
F. Slip
G. Capacity
H. Efficiency
IX. Identify and Describe Special Service Pumps
   A. Introduction to special service pumps
   B. Chemical and process pumps
   C. Pumps for handling of sewage
   D. Magma pumps
   E. Sump pumps
   F. Irrigation pumps
   G. Diaphragm type pumps
   H. Shallow and deep well pumps
   I. Turbine pumps
   J. Rubber impeller pumps
   K. Tubing pumps
IMM-H4-LA
Troubleshoot Positive Displacement Pumps
Attachment 2: MASTER Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop.
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. Instructor will demonstrate how to:
   a. Set-up and operate a positive displacement pump;
   b. Troubleshoot a positive displacement pump;
   c. Stop the positive displacement pump;
   d. Disassemble, replace needed parts, reassemble the positive displacement pump;
   e. Reinstall the positive displacement pump; and,
   f. Operate and troubleshoot the positive displacement pump.

2. Student will:
   a. Set-up and operate a positive displacement pump;
   b. Troubleshoot a positive displacement pump;
   c. Stop the positive displacement pump;
   d. Disassemble, replace needed parts, reassemble the positive displacement pump;
   e. Reinstall the positive displacement pump; and,
   f. Operate and troubleshoot the positive displacement pump.

3. Instructor will grade the student's performance on:
   a. Set-up and operation of a positive displacement pump;
   b. Troubleshooting a positive displacement pump;
   c. Stopping the positive displacement pump;
   d. Disassembling, replacing needed parts, reassembling the positive displacement pump;
   e. Reinstalling the positive displacement pump; and,
   f. Operating and troubleshooting the positive displacement pump.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Maintain gate valve;
b. Maintain globe valve;
c. Maintain ball valve;
d. Maintain plug valve; and,
e. Maintain butterfly valve.

Reading Assignments:

The following chapters are assigned to read from Piping Systems, Schoolcraft Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Common Valves</td>
</tr>
</tbody>
</table>

Module Outline:

I. Valve Function
II. Gate Valve
III. Globe Valve
IV. Ball Valve
V. Plug Valve
VI. Butterfly Valve
VII. Maintenance Procedures
VIII. Valve Replacement
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment;
Not participating in horse play or practical joking.
1. **Instructor** will demonstrate how to maintain:
   a. Gate valve
   b. Globe valve
   c. Ball valve
   d. Plug valve
   e. Butterfly valve

2. **Student** will demonstrate how to maintain:
   a. Gate valve
   b. Globe valve
   c. Ball valve
   d. Plug valve
   e. Butterfly valve

3. **Instructor** will grade student’s ability to maintain:
   a. Gate valve
   b. Globe valve
   c. Ball valve
   d. Plug valve
   e. Butterfly valve
Maintain Check Valves and Relief Valves

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participate in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain check valve; and,
b. Maintain relief valve.

Reading Assignments:

The following chapters are assigned to read from Piping Systems, Schoolcraft Publishers, Latest Edition

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Common Valves</td>
</tr>
</tbody>
</table>

Module Outline:

I. Valve Function
II. Check Valve Function
III. Relief Valve Function
IV. Maintenance Procedures
V. Valve Replacement
IMM-H6-LA
Maintain Check Valves and Relief Valves
Attachment 2: MASTER Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. **Instructor will demonstrate how to:**
   - Properly use check valve;
   - Properly use relief valve;
   - Maintain check valve;
   - Maintain relief valve;
   - Replace check valve; and,
   - Replace relief valve.

2. **Student will demonstrate how to:**
   - Properly use check valve;
   - Properly use relief valve;
   - Maintain check valve;
   - Maintain relief valve;
   - Replace check valve; and,
   - Replace relief valve.

3. **Instructor will grade student’s ability to:**
   - Properly use check valve;
   - Properly use relief valve;
   - Maintain check valve;
   - Maintain relief valve;
   - Replace check valve; and,
   - Replace relief valve.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Troubleshoot blowers; and,
b. Repair blowers.

Reading Assignments:

The following chapters are assigned to read from Industrial Motor Control, Alerich, Delmar Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>Motor</td>
</tr>
</tbody>
</table>

Module Outline:

I. Blower Functions
II. Combustion Control
III. Cooling Control
IV. Induced Draft
V. Forced Draft
VI. Maintain Blowers
VII. Troubleshoot Blowers
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and
Not participating in horse play or practical joking.
Worksheet:

1. Instructor will demonstrate how to:
   Troubleshoot blowers; and,
   Repair blowers.

2. Student will demonstrate how to:
   Troubleshoot blowers; and,
   Repair blowers.

3. Instructor will grade student's ability to:
   Troubleshoot blowers; and,
   Repair blowers.
IMM-H8-HO
Troubleshoot, Maintain, and Repair Hydraulic Systems
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Troubleshoot hydraulic system;
b. Maintain hydraulic system; and
c. Repair hydraulic system.

Reading Assignments:

The following chapters are assigned to read from Fluid Power 1, by Parker Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Energy Transmission Using a Hydraulic System</td>
</tr>
<tr>
<td>4</td>
<td>Control of Hydraulic Energy</td>
</tr>
<tr>
<td>7</td>
<td>Hydraulic Pumps</td>
</tr>
<tr>
<td>8</td>
<td>Check Valves, Cylinders and Motors</td>
</tr>
<tr>
<td>10</td>
<td>Directional Control Valves</td>
</tr>
<tr>
<td>12</td>
<td>Pilot Operated Pressure Control Valves</td>
</tr>
</tbody>
</table>

Module Outline:

I. Hydraulic Theory
II. Storage Devices
III. Pumps-Prime Movers
IV. Actuators
V. Control Devices
VI. Accumulators
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. Student will practice:
   a. Troubleshooting hydraulic system;
   b. Maintaining hydraulic system; and,
   c. Repairing hydraulic system.

2. Instructor will grade student’s performance.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain pneumatic system;
b. Troubleshoot pneumatic system; and,
c. Repair pneumatic system.

Reading Assignments:

The following chapters are assigned to read from *Fluid Power 1*, by Parker
Publisher, Latest Edition:

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Energy Transmission Using A Pneumatic System</td>
</tr>
<tr>
<td>11</td>
<td>Simple Pressure Control Valves</td>
</tr>
</tbody>
</table>

Module Outline:

I. Pneumatic Theory
II. Compressor
III. Regulators
IV. Valves
V. Actuators
VI. Safety
VII. Prevention Maintenance
VIII. Troubleshooting Pneumatic Devices
IX. Repair Pneumatic Devices
IMM-H9-LA
Troubleshoot, Maintain, and Repair Pneumatic Systems
Attachment 2: MASTER Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. Draw a circuit utilizing a single acting cylinder, gravity return, as the load. Use a directional control valve. Make the cylinder extend. Have the instructor approve the diagram. Construct the circuit. Have the instructor approve the circuit. Run the circuit.

2. Same as Problem #1, except use double acting cylinder.

3. Practice PM on an existing pneumatic system. Instructor will go over typical PM procedures.

4. Same as Problem #1, except use meter-out circuit.

5. Same as Problem #1, except use a quick exhaust circuit.
INDUSTRIAL MAINTENANCE MECHANIC... uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice Safety</td>
<td>A-1 Use protective equipment</td>
</tr>
<tr>
<td>B-1 Perform basic arithmetic functions</td>
<td></td>
</tr>
<tr>
<td>B-2 Convert fractions/decimals</td>
<td></td>
</tr>
<tr>
<td>B-3 Convert metric/english measurements</td>
<td></td>
</tr>
<tr>
<td>B-4 Perform basic algebraic operations</td>
<td></td>
</tr>
<tr>
<td>B-6 Perform basic trigonometric functions</td>
<td></td>
</tr>
<tr>
<td>B-6 Lockout/tagout</td>
<td></td>
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<tr>
<td>Apply Mathematical Concepts</td>
<td>A-2 Accident prevention</td>
</tr>
<tr>
<td>A-3 Working shift</td>
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</tr>
<tr>
<td>A-4 Fire safety</td>
<td></td>
</tr>
<tr>
<td>A-5 Lifting safety</td>
<td></td>
</tr>
<tr>
<td>C-1 Identify basic types of drawings</td>
<td></td>
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<tr>
<td>C-2 Identify basic layout of drawings</td>
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</tr>
<tr>
<td>C-3 Review blueprint notes and dimensions</td>
<td></td>
</tr>
<tr>
<td>D-1 Use non-precision measuring tools</td>
<td></td>
</tr>
<tr>
<td>D-2 Use precision measuring tools</td>
<td></td>
</tr>
<tr>
<td>E-1 Identify and use maintenance technician's hand tools</td>
<td></td>
</tr>
<tr>
<td>E-2 Identify and use hand held power tools</td>
<td></td>
</tr>
<tr>
<td>F-1 Use and care of milling machines</td>
<td></td>
</tr>
<tr>
<td>F-2 Use and care of horizontal and vertical band saws</td>
<td></td>
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<td>F-3 Use and care of surface grinder</td>
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<td>F-4 Use and care of horizontal and vertical band saws</td>
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<td>F-5 Operate lathes</td>
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<tr>
<td>F-6 Use and care of drill press</td>
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<tr>
<td>Interpret Engineering Drawings and Control Documents</td>
<td>F-6 Use and care of drill press</td>
</tr>
<tr>
<td>G-1 Weld with shielded metal arc welding (SMAW) process</td>
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<tr>
<td>G-2 Weld with oxyacetylene</td>
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<tr>
<td>G-3 Perform gas soldering</td>
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<tr>
<td>Use Measuring Tools</td>
<td>H-1 Maintain air conditioning systems</td>
</tr>
<tr>
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<td>H-3 Troubleshoot centrifugal pumps</td>
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<tr>
<td>H-5 Maintain and trouble shoot check valves and relief valves</td>
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<td>H-6 Maintain and troubleshoot gate, globe, ball, plug, and butterfly valves</td>
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<tr>
<td>H-7 Troubleshoot and repair blowers</td>
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<tr>
<td>H-8 Maintain, maintain, and repair hydraulic systems</td>
<td></td>
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<tr>
<td>H-9 Trouble shoot, maintain, and repair pneumatic systems</td>
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<tr>
<td>E-1 Use and care of hand tools</td>
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<tr>
<td>E-2 Use and care of hand held power tools</td>
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<tr>
<td>Use Hand Tools</td>
<td>J-1 Layout sheet metal parts</td>
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<tr>
<td>J-2 Form and/or bend sheet metal parts</td>
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<td>J-3 Fasten sheet metal parts together</td>
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<td>F-1 Use and care of milling machines</td>
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<tr>
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<tr>
<td>I-2 Maintain and troubleshoot gear power transmission drives</td>
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<td>I-3 Maintain and troubleshoot chain power transmission drives</td>
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<tr>
<td>I-4 Maintain and troubleshoot clutches</td>
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<tr>
<td>Repair Power Transmission Systems</td>
<td>J-1 Layout sheet metal parts</td>
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<tr>
<td>J-3 Fasten sheet metal parts together</td>
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INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
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<tr>
<td>L Basic Rigging</td>
<td>L-1 Rigging fundamentals</td>
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<td>M Bearing Maintenance</td>
<td>M-1 Plain bearings</td>
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<tr>
<td>N Use Computers</td>
<td>N-1 Perform basic processing</td>
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<td>O Align Shafts</td>
<td>O-1 Principles of alignment</td>
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<td>P Install/Align Machines</td>
<td>P-1 Install electrical connections</td>
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<td>Q Maintain Electrical Devices</td>
<td>Q-1 Use electrical test equipment</td>
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<td>R Basic Mechanical Concepts</td>
<td>R-1 Force</td>
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<tr>
<td>S Fasteners and Preloading</td>
<td>S-1 Fasteners and nomenclature</td>
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BEST COPY AVAILABLE
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Maintain belt drive systems; and,
b. Troubleshoot belt drive systems.

Reading Assignments:

The following chapters are assigned to read from Industrial Motor Control, Alerich, Delmar Publishers, Latest Edition

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<thead>
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<td>60</td>
<td>Pulley Drives</td>
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Module Outline:

I. Belt Drives
II. Pulleys
III. Sheaves
IV. Types of Belts
V. Belt Tension
VI. Belt Friction
VII. Variable Belts
VIII. Belt Maintenance
IX. Belt Replacement
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.
Worksheet:

1. Instructor will demonstrate how to:
   Maintain belt drive systems; and,
   Troubleshoot belt drive systems.

2. Student will demonstrate how to:
   Maintain belt drive systems; and,
   Troubleshoot belt drive systems.

3. Instructor will grade student's ability to:
   Maintain belt drive systems; and,
   Troubleshoot belt drive systems.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain gear power transmission drives; and,
b. Troubleshoot gear power transmission drives.

Reading Assignments:

The following chapters are assigned to read from *Mechanics' and Millwrights' Guide*, Nelson, Audel Publishers, Latest Edition:

<table>
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<td>Gears</td>
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</table>

Module Outline:

I. Define Gear
II. Bevel
III. Ring and Pinion
IV. Spur
V. Gear Maintenance
VI. Gear Troubleshooting
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. Instructor will demonstrate how to:
   Maintain gear power transmission drives; and,
   Troubleshoot gear power transmission drives.

2. Student will demonstrate how to:
   Maintain gear power transmission drives; and,
   Troubleshoot gear power transmission drives.

3. Instructor will grade student’s ability to:
   Maintain gear power transmission drives; and,
   Troubleshoot gear power transmission drives.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Maintain chain power transmission drives; and,
b. Troubleshoot chain driven power transmission drives.

Reading Assignments:

The following chapters are assigned to read from Mechanics' and Millwrights' Guide, Nelson, Audel Publishers, Latest Edition:

<table>
<thead>
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<td>7</td>
<td>Chain Drives</td>
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</table>

Module Outline:

I. Chains
II. Single Link
III. Double Link
IV. Roller Chain
V. Silent Chain
VI. Chain Maintenance
VII. Troubleshoot Chains
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. Instructor will demonstrate how to:
   Maintain chain power transmission drives; and,
   Troubleshoot chain driven power transmission drives.

2. Student will demonstrate how to:
   Maintain chain power transmission drives; and,
   Troubleshoot chain driven power transmission drives.

3. Instructor will grade student’s ability to:
   Maintain chain power transmission drives; and,
   Troubleshoot chain driven power transmission drives.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Maintain clutches; and,
b. Troubleshoot clutches.

Reading Assignments:

The following chapters are assigned to read from Mechanics' and Millwrights’ Guide, Nelson, Audel Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
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<tbody>
<tr>
<td>3</td>
<td>Mechanical Power Transmission</td>
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</table>

Module Outline:

I. Clutch
II. Mechanical Clutch
III. Electrical Clutch
IV. Hydraulic Clutch
V. Pneumatic Clutch
VI. Clutch-Brake Assembly

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Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
IMM-I4-LW
Maintain and Troubleshoot Clutches
Attachment 3: MASTER Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to:
   A. Maintain:
      (1) Clutch
      (2) Mechanical clutch
      (3) Electrical clutch
      (4) Hydraulic clutch
      (5) Pneumatic clutch
      (6) Clutch-brake assembly
   B. Troubleshoot:
      (1) Clutch
      (2) Mechanical clutch
      (3) Electrical clutch
      (4) Hydraulic clutch
      (5) Pneumatic clutch
      (6) Clutch-brake assembly

2. Student will demonstrate how to:
   A. Maintain:
      (1) Clutch
      (2) Mechanical clutch
      (3) Electrical clutch
      (4) Hydraulic clutch
      (5) Pneumatic clutch
      (6) Clutch-brake assembly
   B. Troubleshoot:
      (1) Clutch
      (2) Mechanical clutch
      (3) Electrical clutch
      (4) Hydraulic clutch
      (5) Pneumatic clutch
      (6) Clutch-brake assembly

3. Instructor will grade student’s ability to:
   A. Maintain:
      (1) Clutch
      (2) Mechanical clutch
      (3) Electrical clutch
      (4) Hydraulic clutch

(5) Pneumatic clutch
(6) Clutch-brake assembly

B. Troubleshoot:
(1) Clutch
(2) Mechanical clutch
(3) Electrical clutch
(4) Hydraulic clutch
(5) Pneumatic clutch
(6) Clutch-brake assembly
**INDUSTRIAL MAINTENANCE MECHANIC** uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<tbody>
<tr>
<td><strong>A</strong> Practice Safety</td>
<td>A-1 Use protective equipment&lt;br&gt; A-2 Accident prevention&lt;br&gt; A-5 Working alone&lt;br&gt; A-4 Fire safety&lt;br&gt; A-6 Lifting safety&lt;br&gt; A-8 Lockout/Tagout</td>
</tr>
<tr>
<td><strong>B</strong> Apply Mathematical Concepts</td>
<td>B-1 Perform basic arithmetic functions&lt;br&gt; B-2 Convert fractions/decimals&lt;br&gt; B-3 Convert metric/English measurements&lt;br&gt; B-4 Perform basic algebraic operations&lt;br&gt; B-5 Perform basic trigonometric functions&lt;br&gt; B-6 Perform basic geometric calculations</td>
</tr>
<tr>
<td><strong>C</strong> Interpret Engineering Drawings and Control Documents</td>
<td>C-1 Identify basic types of drawings&lt;br&gt; C-2 Identify basic layout of drawings&lt;br&gt; C-3 Review blueprint notes and dimensions</td>
</tr>
<tr>
<td><strong>D</strong> Use Measuring Tools</td>
<td>D-1 Use non-precision measuring tools&lt;br&gt; D-2 Use precision measuring tools</td>
</tr>
<tr>
<td><strong>E</strong> Use Hand Tools</td>
<td>E-1 Identify and use maintenance technician's hand tools&lt;br&gt; E-2 Identify and use hand held power tools</td>
</tr>
<tr>
<td><strong>F</strong> Operate Machine Tools</td>
<td>F-1 Use and care of milling machines&lt;br&gt; F-2 Use and care of horizontal and vertical band saws&lt;br&gt; F-3 Use and care of surface grinder&lt;br&gt; F-4 Use and care of lathe&lt;br&gt; F-5 Operate lathes&lt;br&gt; F-6 Use and care of drill press</td>
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<td><strong>G</strong> Perform Welding Operations</td>
<td>G-1 Weld with shielded metal arc welding (SMAW) process&lt;br&gt; G-2 Weldwith oxyacetylene&lt;br&gt; G-3 Perform gas welding&lt;br&gt;</td>
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<tr>
<td><strong>H</strong> Maintain/Troubleshoot Equipment and Systems</td>
<td>H-1 Maintain air conditioning systems&lt;br&gt; H-2 Maintain pneumatic control circuits&lt;br&gt; H-3 Troubleshoot centrifugal pumps&lt;br&gt; H-4 Troubleshoot positive displacement pumps&lt;br&gt; H-5 Maintain check valves and relief valves&lt;br&gt; H-7 Troubleshoot and repair blowers&lt;br&gt; H-8 Troubleshoot, maintain, and repair hydraulic systems&lt;br&gt; H-9 Troubleshoot, maintain, and repair pneumatic systems&lt;br&gt;</td>
</tr>
<tr>
<td><strong>I</strong> Repair Power Transmission Systems</td>
<td>I-1 Maintain and troubleshoot belt drive systems&lt;br&gt; I-2 Maintain and troubleshoot gear power transmission drives&lt;br&gt; I-3 Maintain and troubleshoot chain power transmission drives&lt;br&gt; I-4 Maintain and troubleshoot clutches&lt;br&gt;</td>
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<td><strong>J</strong> Fabricate/Install Sheet Metal Parts</td>
<td>J-1 Layout sheet metal parts&lt;br&gt; J-2 Form and/or bend sheet metal parts&lt;br&gt; J-3 Fasten sheet metal parts together&lt;br&gt;</td>
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<td><strong>K</strong></td>
<td>Piping Operations</td>
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<tr>
<td><strong>L</strong></td>
<td>Basic Rigging</td>
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<tr>
<td><strong>M</strong></td>
<td>Bearing Maintenance</td>
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<td><strong>N</strong></td>
<td>Use Computers</td>
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<td><strong>O</strong></td>
<td>Align Shafts</td>
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<td><strong>P</strong></td>
<td>Install/Align Machines</td>
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<tr>
<td><strong>Q</strong></td>
<td>Maintain Electrical Devices</td>
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<td><strong>R</strong></td>
<td>Basic Mechanical Concepts</td>
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<td><strong>S</strong></td>
<td>Fasteners and Preloading</td>
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</table>

| **K-1** | Perform basic pipefitting calculations |
| **K-2** | Cut, thread, and ream pipe |
| **K-3** | Pipe assembly |
| **K-4** | Install and adjust pipe support |
| **K-5** | Tubing |
| **K-6** | Fittings |
| **K-7** | Plastic pipe |

| **L-1** | Rigging fundamentals |
| **L-2** | Demonstrate basic rigging skills |
| **L-3** | Rigging fundamentals |
| **L-4** | Demonstrate basic rigging skills |

| **M-1** | Plain bearings |
| **M-2** | Rolling element bearings |

| **N-1** | Perform basic word processing |
| **N-2** | Perform basic spreadsheet operations |

| **O-1** | Principles of alignment |
| **O-2** | Methods of alignment |

| **P-1** | Install electrical connections |
| **P-2** | Setting and leveling |
| **P-3** | Grouting |
| **P-4** | Special mountings |

| **Q-1** | Use electrical test equipment |
| **Q-2** | Apply basic terms to electrical circuits |
| **Q-3** | Analyze series, parallel, and complex AC/DC circuits |
| **Q-4** | Check AC and DC motors |
| **Q-5** | Trouble shoot electrical devices |

| **R-1** | Force |
| **R-2** | Work |
| **R-3** | Mechanical motion and rate |
| **R-4** | Simple machines |
| **R-5** | Power |

| **S-1** | Fasteners and nomenclature |
| **S-2** | Apply techniques for various fasteners |
| **S-3** | Techniques for removing damaged fasteners |
| **S-4** | Cleaning and restoring threaded fasteners |
| **S-5** | Torque preload theory |
| **S-6** | Effect of lubricating threads prior to torquing |
| **S-7** | Demonstrate appropriate torquing techniques |
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Identify sheet metal sizes and products;
b. Describe sheet metal patterns and patternmaking; and,
c. Describe sheet metal and wire size.

Reading Assignments:

The following chapters are assigned to read from Metal Technology and Practice, Pepp/MeCarthy, Glencoe/McMillan/McGraw-Hill Publishers, Latest Edition

<table>
<thead>
<tr>
<th>Chapters</th>
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<tbody>
<tr>
<td>8</td>
<td>Sheet Metal Processing</td>
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</tbody>
</table>

Module Outline:

I. Identify Sheet Metal Sizes and Products
   A. Sizes
   B. Products

II. Describe Sheet Metal Patterns and Patternmaking
   A. Introduction
   B. Types of pattern development
   C. Hem and seam allowances on patterns
   D. Bending sequence
   E. Bend allowance

III. Describe Sheet Metal and Wire Sizes
A. Sheet metal and wire gages
B. Manufacturers' standard gages and sheet steel
C. Brown and Sharp or American Standard gage
1. Instructor will:
   a. Demonstrate the proper layout procedures for sheet metal layout;
   b. Insure proper tools are available for layout;
   c. Insure proper tools are construction of project are available;
   d. Insure proper techniques are used for layout; and,
   e. Insure proper techniques are used in safely constructing the projects.

2. Student will:
   a. Layout and construct sheet metal patterns on paper;
   b. Practice making parallel line pattern of a rectangular pan;
      (1) Use necessary drawing tools;
      (2) Use necessary tools and materials for safe assembly;
   c. Practice making parallel line development for a cylinder;
      (1) Use necessary drawing tools;
      (2) Use necessary tools and materials for safe assembly;
   d. Practice making parallel line development of a truncated cylinder;
      (1) Use necessary drawing tools; and,
      (2) Use necessary tools and materials for a safe assembly.
<table>
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<tr>
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<th>AMERICAN OR BROWN &amp; SHARPE'S A.W.G. OR B&amp;S</th>
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<th>MANUFACTURERS' STANDARD FOR SHEET METAL</th>
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DRAW AND CONSTRUCT
ALLOW 3/8" FOR OPEN TOP SINGLE HEM
ALLOW 3/8" FOR OUTSIDE CORNER LAP SEAM
45 DEGREES ON ALL HEMS AND SEAMS

DATE 9-26-97
DRAWN BY: REW
APPROVED BY: REW
MASTER

TITLE J1PAN
 PAN
MATERIAL: PAPER

SCALE 1-1
DRAW #
REV. #
DRAW AND CONSTRUCT NO TOP OR BOTTOM ALLOW 3/8" FOR LAP SEAM

DATE 9-26-97
DRAWN BY:REW
APPROVED BY:REW

MASTER
SCALE 1-1

DRAWN
REVIEWED
TITLE: TRUNCATED CYLINDER
REVISION: N
MATERIAL: PAPER

1263
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify sheet metal hand tools;
b. Describe sheet metal cutting tools;
c. Set up and operate sheet metal tools bending machines;
d. Set up and operate sheet metal tools for performing of cylindrical parts; and,
e. Demonstrate sheet metal hand bending stakes.

Reading Assignments:

The following chapters are assigned to read from *Metal Work Technology and Practice*, Repp/McCarthy, Glencoe/McMillan/McGraw-Hill Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Sheet Metal Processing</td>
</tr>
</tbody>
</table>

Module Outline:

I. Identify Sheet Metal Hand Tools
   A. Layout blue and removers
   B. Layout tools
   C. Hammers
   D. Pliers
   E. Hand seamers
   F. Hand groovers
II. Describe Sheet Metal Cutting Tools
   A. Hand hole punches
   B. Turret punch
   C. Tin snips
   D. Aviation snips
   E. Double-cutting shear
   F. Squaring shear
   G. Notcher
   H. Ring and circle shear
   I. Lever shear
   J. Electric and pneumatic nibblers and sheers

III. Set-up and Operate Sheet Metal Bending Machines
   A. Bar folder
   B. Cornice brake
   C. Press brake
   D. Box and pan brake

IV. Set-up and Operate Sheet Metal Tools Forming of Cylindrical Parts
   A. Slip roll forming machine
   B. Turning machines and wiring machine
   C. Burring, setting down and double seaming machines
   D. Crimping and beading machines
   E. Grooving machines
   F. Pittsburgh lock forming machines

V. Demonstrate Sheet Metal Hand Bending Stakes
   A. Bench plate
   B. Double seaming stake
   C. Beakhorn stake
   D. Bevel-edge square stake
   E. Hatchet stake
   F. Needle-case stake
   G. Blowhorn stake
   H. Hollow mandrel stake
1. Instructor will:
   a. Insure proper procedures are used to construct the pan project;
   b. Insure proper tools and materials are available for the pan project;
   c. Proper techniques are used in layout; and,
   d. Proper techniques and safety procedures are followed in construction of the pan project.

2. Student will:
   a. Layout and construct sheet metal pan project;
   b. Layout pan project on 20 gauge sheet metal using the proper layout and handtools following proper safe procedures;
   c. Cut the pan layout to proper size and shape using the proper cutting tools;
   d. Bend the pan project using the proper machines and procedures safely; and,
   e. Safely punch or drill the holes using the proper procedures.
IMM-J2-LW
Form and/or Bend Sheet Metal Parts
Attachment 3: MASTER Laboratory Worksheet

DRAW AND CONSTRUCT
ALLOW 3/8" FOR OPEN TOP SINGLE HEM
ALLOW 3/8" FOR OUTSIDE CORNER LAP SEAM
45 DEGREES ON ALL HEMS AND SEAMS

DATE
9-26-97

DRAWN BY:
REW

APPROVED BY:
REW

MATERIAL: 20 GAGE
GALVANIZED SHEET METAL

MASTER
IMM-J3-HO
Fasten Sheet Metal Parts Together
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Identify sheet metal self threading screws;
b. Describe rivets and riveting;
c. Demonstrate soldering sheet metal; and,
d. Set up demonstrate brazing and braze welding of sheet metal.

Reading Assignments:

The following chapters are assigned to read from Metal Technology and Practice, Repp/McCarthy, Glencoe/McMillan/McGraw-Hill Publishers, Latest Edition

<table>
<thead>
<tr>
<th>Chapters</th>
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<tbody>
<tr>
<td>7</td>
<td>Fitting and Assembling</td>
</tr>
</tbody>
</table>

Module Outline:

I. Identify Sheet Metal Self Threading Screws
   A. Thread forming screws
   B. Thread cutting screws
   C. Head styles used on threaded fasteners
   D. Driver recesses used on screw heads
   E. Drive screw

II. Describe Rivets and Riveting
    A. Introduction
    B. Riveting
C. Rivet size
D. Tanners rivets
E. Choosing a rivet
F. Rivet spacing
G. The rivet set
H. How to rivet
I. Hot and cold rivets
J. Removing rivets
K. Tubular and special rivets
L. Blind rivets

III. Demonstrate Soldering Sheet Metal
A. Introduction to soldering
B. Soft soldering
C. Heat for soft soldering
D. Soldering copper
E. Tin a soldering copper
F. Preparing the workpiece
G. Joints for soft soldering
H. Soft soldering techniques
I. Hard soldering techniques

IV. Set up and Demonstrate Brazing and Braze Welding of Sheet Metal
A. Introduction
B. Difference between brazing and braze welding
C. Brazing and braze welding fluxes
D. Rods for brazing and braze welding
E. How to braze with a torch
1. Instructor will:
   a. Insure proper procedures are used to assemble sheet metal parts;
   b. Insure proper tools and materials are available for projects; and,
   c. Proper techniques and safety procedures are followed in constructing projects.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the projects;
   b. Secure sheet metal using self threading screws;
   c. Secure sheet metal using rivets and riveting;
   d. Secure sheet metal using soldering;
   e. Secure sheet metal using brazing; and,
   f. Secure pan project using pop rivets.
Fasten Sheet Metal Parts Together
Attachment 3: MASTER Laboratory Worksheet

DRAW AND CONSTRUCT
ALLOW 3/8" FOR OPEN TOP SINGLE HEM
ALLOW 3/8" FOR OUTSIDE CORNER LAP SEAM
45 DEGREES ON ALL HEMS AND SEAMS

DATE: 9-26-97
DRAWN BY: REW
APPROVED BY: REW

MASTER
TITLE: J2&3PAN
PAN

MATERIAL: 20 GAGE
GALVANIZED SHEET METAL

SCALE: 1-1
DRAW #: 1
REV. #: 0.750 1/8 DRILL TYP ALL SEAMS
ASSEMBLE 2 EA. WITH SELF THREADING SCREWS
ASSEMBLE 2 EA. WITH RIVETS
ASSEMBLE 2 EA. BY SOLDERING
ASSEMBLE 2 EA. BY BRAZING

20 GA. GAL.
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
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<tbody>
<tr>
<td>A <strong>Practice Safety</strong></td>
<td>A-1 Use protective equipment</td>
</tr>
<tr>
<td>B <strong>Apply Mathematical Concepts</strong></td>
<td>B-1 Perform basic arithmetic functions</td>
</tr>
<tr>
<td>C <strong>Interpret Engineering Drawings and Control Documents</strong></td>
<td>C-1 Identify basic types of drawings</td>
</tr>
<tr>
<td>D <strong>Use Measuring Tools</strong></td>
<td>D-1 Use non-precision measuring tools</td>
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<tr>
<td>E <strong>Use Hand Tools</strong></td>
<td>E-1 Identify and use maintenance technician's hand tools</td>
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<tr>
<td>F <strong>Operate Machine Tools</strong></td>
<td>F-1 Use and care of milling machines</td>
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<tr>
<td>G <strong>Perform Welding Operations</strong></td>
<td>G-1 Weld with shielded metal arc welding (SMAW) process</td>
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<tr>
<td>H <strong>Maintain/Trussleshoot Equipment and Systems</strong></td>
<td>H-1 Maintain air conditioning systems</td>
</tr>
<tr>
<td>I <strong>Repair Power Transmission Systems</strong></td>
<td>I-1 Maintain and troubleshoot belt drive systems</td>
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<tr>
<td>J <strong>Fabricate/Install Sheet Metal Parts</strong></td>
<td>J-1 Layout sheet metal parts</td>
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**Tasks:**
- A-2 Accident prevention
- A-3 Working aloft
- A-4 Fire safety
- A-5 Lifting safety
- A-6 Lockout/tagout
- B-2 Convert fractional decimals
- B-3 Convert Metric/English measurements
- B-4 Perform basic algebraic operations
- B-5 Perform basic trigonometric functions
- B-6 Perform basic geometric calculations
- C-2 Identify basic layout of drawings
- C-3 Review blueprint notes and dimensions
- D-2 Use precision measuring tools
- E-2 Identify and use hand held power tools
- F-2 Use and care of horizontal and vertical band saws
- G-2 Welding with oxy-acetylene
- H-2 Maintain pneumatic control circuits
- H-3 Troubleshoot centrifugal pumps
- H-4 Troubleshoot positive displacement systems
- H-5 Maintain gate, globe, ball, plug, and butterfly valves
- H-6 Maintain check valves and relief valves
- H-7 Troubleshoot and repair blowers
- H-8 Troubleshoot, maintain, and repair hydraulic systems
- H-9 Troubleshoot, maintain, and repair pneumatic systems
- I-2 Maintain and troubleshoot gear power transmission drives
- I-3 Maintain and troubleshoot chain power transmission drives
- I-4 Maintain and troubleshoot clutches
- J-2 Form and/or bend sheet metal parts
- J-3 Fasten sheet metal parts together

**Additional Tasks:**
- **A-1** Use protective equipment
- **A-2** Accident prevention
- **B-1** Perform basic arithmetic functions
- **B-2** Convert fractional decimals
- **B-3** Convert Metric/English measurements
- **B-4** Perform basic algebraic operations
- **B-5** Perform basic trigonometric functions
- **B-6** Perform basic geometric calculations
- **C-1** Identify basic types of drawings
- **C-2** Identify basic layout of drawings
- **C-3** Review blueprint notes and dimensions
- **D-1** Use non-precision measuring tools
- **E-1** Identify and use maintenance technician's hand tools
- **E-2** Identify and use hand held power tools
- **F-1** Use and care of milling machines
- **F-2** Use and care of horizontal and vertical band saws
- **G-1** Weld with shielded metal arc welding (SMAW) process
- **G-2** Welding with oxy-acetylene
- **H-1** Maintain air conditioning systems
- **H-2** Maintain pneumatic control circuits
- **H-3** Troubleshoot centrifugal pumps
- **H-4** Troubleshoot positive displacement systems
- **H-5** Maintain gate, globe, ball, plug, and butterfly valves
- **H-6** Maintain check valves and relief valves
- **H-7** Troubleshoot and repair blowers
- **H-8** Troubleshoot, maintain, and repair hydraulic systems
- **H-9** Troubleshoot, maintain, and repair pneumatic systems
- **I-1** Maintain and troubleshoot belt drive systems
- **I-2** Maintain and troubleshoot gear power transmission drives
- **I-3** Maintain and troubleshoot chain power transmission drives
- **I-4** Maintain and troubleshoot clutches
- **J-1** Layout sheet metal parts
- **J-2** Form and/or bend sheet metal parts
- **J-3** Fasten sheet metal parts together

**Additional Skills:**
- Apply Mathematical Concepts
- Perform Welding Operations
- Maintain Trouble shoot Equipment and Systems
- Troubleshoot and repair systems
- Use Measuring Tools
- Use Hand Tools
- Operate Machine Tools
- Perform Welding Operations
- Maintain Trouble shoot Equipment and Systems
- Repair Power Transmission Systems
- Fabricate/Install Sheet Metal Parts
INDUSTRIAL MAINTENANCE MECHANIC... uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<td>N-2 Perform basic spreadsheet operations</td>
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<td>Q-1 Use electrical test equipment</td>
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<td>Q-2 Apply basic terms to electrical circuits</td>
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<td>Q-3 Analyze series, parallel, and complex AC/DC circuits</td>
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<td>Q-4 Check AC and DC motors</td>
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<td>Q-5 Troubleshoot electrical devices</td>
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<td>S-2 Application for various fasteners</td>
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<td>S-4 Cleaning and restoring threaded fasteners</td>
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<td>S-5 Torque preload theory</td>
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<td>S-6 Effects of lubricating threads prior to torquing</td>
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<td>S-7 Demonstrate appropriate torquing technique</td>
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</table>
Standards of performance:

Student will demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify terms frequently used in pipe fitting formulas;
b. Identify various calculations and measurements required of a pipe fitter;
c. Identify conditions that will require these calculations to be performed; and,
d. Layout on paper piping system consisting of typical runs and offsets to a tolerance of 1/8".

Reading Assignments:

The following chapters are assigned to read from Millwright's Handbook, Audel Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
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<tbody>
<tr>
<td>14</td>
<td>Fittings</td>
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</tbody>
</table>

Module Outline:

I. Identify Terms Frequently Used in Pipe Fitting Formulas
   A. Run
   B. Set
   C. Travel
   D. Offset

II. Identify Conditions That Will Require the Use of Pipe Fitting Formulas
    A. Obstructions to be worked around
1. Other pipe
2. Wall
3. Equipment

III. Identify and Demonstrate Various Calculations and Measurements Required of a Pipe Fitter
A. Center line measurements. (point to point)
B. Simple offset
   1. Using table of multipliers for calculating simple offsets
   2. Discuss the concept that an offset is nothing more than the missing side of a right triangle
C. Equal spread offset
   1. Two-pipe spread using 22-1/2 degree threaded fittings
   2. Review formula and tables from pipe fitting hand book
D. Rolling offset
   1. Use of trigonometric tables in calculation of rolling offset
   2. Demonstrate simplified method of finding a rolling offset using a framing square

IV. Demonstrate How to Lay out on Paper a Piping System Consisting of Horizontal Runs, Vertical Runs and a Simple Rolling Offset to a Tolerance of 1/8"
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Identify two methods of cutting, reaming and threading pipe;
b. Identify equipment required to cut, thread and ream pipe;
c. Describe the use and care of equipment required when cutting,
threading and reaming pipe;
d. Identify safety concerns that apply to use of cutting, threading and
reaming equipment; and,
e. Fabricate from pipe stock, a NPT threaded nipple that is cut, square
and properly reamed.

Module Outline:

I. Identify Safety Concerns That Apply to Use of Cutting, Threading and
Reaming Equipment
   A. High torque rotating equipment
   B. Sharp edges and metal shavings
   C. Sharp tools
   D. Flying particles
II. Practice Hand Cutting, Reaming and Threading Pipe
III. Practice Using the Electric Pipe Cutting, Threading and Reaming Equipment
IV. Practice Fabricating from Pipe Stock, Using a NPT Threaded Nipple That Is
Cut Square and Properly Reamed
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and
Not participating in horse play or practical joking.
Practice:

1. Identifying methods of cutting, reaming and threading pipe.

   

2. Identify equipment required to cut thread and ream pipe.

   

3. Identify safety concerns that apply to use of cutting, threading and reaming equipment.

   

4. Demonstrate how to fabricate from pipe stock.

   

5. Demonstrate how a NPT threaded nipple is cut.

   

1284
Demonstrate how to square and properly ream a NPT threaded nipple.

Instructor will use the following to generate a practical exam:

1. Identify two methods of cutting, reaming and threading pipe.

2. Identify equipment required to cut thread and ream pipe.

3. Identify safety concerns that apply to use of cutting, threading and reaming equipment.

4. Demonstrate how to fabricate from pipe stock, a NPT threaded nipple that is cut square and properly reamed.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify two types of threaded companion flanges;
b. Identify typical materials from which threaded flanges are made;
c. Identify how threaded flanges are assembled;
d. Identify safety concerns that apply to assembling a threaded flange; and,
e. Assemble a threaded flange connection from threaded pipe flanges.

Reading Assignments:

The following chapters are assigned to read from Millwright's Handbook, Audel Publishers, Latest Edition:

<table>
<thead>
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<tbody>
<tr>
<td>14</td>
<td>Fittings</td>
</tr>
</tbody>
</table>

Module Outline:

I. Identify Two Types of Threaded Companion Flanges
   A. Standard
   B. Heavy

II. Identify Typical Materials from Which Threaded Flanges Are Made
   A. Iron
   B. Cast Iron
   C. Stainless Steel
   D. Various types of plastic
III. Identify How Threaded Flanges Are Assembled (Assume Pipe Is Already Threaded)
   A. Apply pipe compound appropriate for the system to the pipe threads
   B. Install first flange half snug but not tight
   C. Install last flange half snug
   D. Tighten both flanges until bolt holes are in line

IV. Identify Safety Concerns That Apply to Assembling a Threaded Flange
   A. Sharp threads
   B. Heavy components in awkward positions
   C. Heavy gloves
   D. Safety glasses with side shields

V. Demonstrate the Assembly of a Threaded Flange Connection
   A. Explain why a pipe should not be over threaded
   B. Correct amount of compound
   C. Correct assembly technique
   D. Gasket type and position
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
Worksheet:

1. Practice identifying types of threaded companies flanges.
2. List materials that threaded flanges are made up of.
3. List steps to assemble threaded flanges.
4. Assemble a threaded flange.
5. List safety concerns when assembling a threaded flange.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Describe the purpose of pipe supports;
b. Identify the types of pipe supports;
c. Describe the distance between hangers; and,
d. Identify the pipe support fastener.

Reading Assignments:

The following chapters are assigned to read from Basic Plumbing, Harry Slater & Lee Smith, Delmar Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Section</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-Plumbing Hardware</td>
<td>28-Pipe Hangers</td>
</tr>
<tr>
<td>5-Plumbing Hardware</td>
<td>29-Fastenings</td>
</tr>
</tbody>
</table>

Module Outline:

I. Describe the Purpose of Pipe Supports
   A. Position
   B. Materials the support may be attached to
   C. Reasons for pipe supports

II. Identify the Types of Pipe Supports
   A. Reznor hook
   B. Pipe strap
   C. Perforated iron strap
   D. Clevis hanger
E. F&M hanger
F. Coil hanger
G. Spring cushion
H. Special hangers
I. Split ring hanger

III. Describe the Distance Between Hangers
A. Type of pipe
B. Type of joints

IV. Identify the Pipe Support Fastener
A. Fastening to different materials
B. The type and procedure for each fastener
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Instructor will grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Support the side of the piping project to a vertical wood 2x4 using proper hardware; and,
   c. Support the top of the piping project 12" from a horizontal wood 2x4 using proper hardware.
1. Instructor will:
   a. Demonstrate how to install pipe supports; and,
   b. Demonstrate how to adjust pipe supports.

2. Student will:
   a. Demonstrate how to install pipe supports; and,
   b. Demonstrate how to adjust pipe supports.

3. Instructor will grade student's ability to:
   a. Install pipe supports; and,
   b. Adjust pipe supports.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Describe the differences of tubing to pipe;
b. Demonstrate how to join tubing;
c. Identify types of tubing; and,
d. Describe tubing maintenance.

Reading Assignments:

The following chapters are assigned to read from Piping Systems, Mechanical Equipment Series 736, Schoolcraft Publishing, 750 Lake Cook Road, Suite 250, Buffalo Grove, IL 60089, 1-800-837-1255, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Tubing</td>
</tr>
</tbody>
</table>

Module Outline:

I. Describe the Difference of Tubing to Pipe
   A. Introduction
   B. Advantages of tubing
II. Demonstrate How to Join Tubing
    A. Cutting
    B. Deburring
    C. Soldering
    E. Flared and ferrule fittings
    E. Bending
III. Identify Types of Tubing
   A. Copper
   B. Steel
   C. Aluminum
   D. Plastic
   E. Other applications

IV. Describe Tubing Maintenance
   A. Check system
   B. Repair system
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing
      the project; and,
   d. Instructor will grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the
      project;
   b. Cut type M rigid copper tubing;
   c. Debur solder proper fittings to type M rigid 1/2 inch copper tubing;
   d. Bend, cut, and debur 1/4 inch soft copper tubing; and,
   e. Flair one end and use a ferrule on the tee end of 1/4 inch soft copper
      tubing.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
- Using OSHA required safety equipment for the shop;
- Safety glasses;
- Hearing protection;
- Face shields;
- Gloves;
- Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
- Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Describe the purpose of fittings;
b. Identify the function of fittings;
c. Demonstrate how fittings are connected; and,
d. Identify drawing symbols.

Reading Assignments:

The following chapters are assigned to read from *Piping Systems, Mechanical Equipment Series 736*, Schoolcraft Publishing, 750 Lake Cook Road, Suite 250, Buffalo Grove, IL. 60089, 1-800-837-1255, Latest Edition:

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<tbody>
<tr>
<td>6</td>
<td>Fittings</td>
</tr>
</tbody>
</table>

Module Outline:

I. Describe the Purpose of Fittings
   A. Connect sections
   B. Change the flow
   C. Pipe and tubing

II. Identify the Function of Fittings
   A. Change the direction of flow
   B. Providing branch connections
   C. Change line size
   D. Caps, plugs and couplings
III. Demonstrate How Fittings Are Connected
   A. Screwed
   B. Flanged
   C. Welded
   D. Tubing

IV. Identify Drawing Symbols
   A. Flanged
   B. Screwed
   C. Welded
   D. Bell and spigot
   E. Soldered
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Instructor will grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Join pipe in piping project;
   c. Join copper tubing by soldering in piping project;
   d. Join copper tubing with fittings, ferrule and flare in piping project; and,
   e. Join plastic tubing in piping project.
Attachment 3: MASTER Laboratory Worksheet

- 3/4 BL. STEEL PIPE
- 1/4 SOFT COPPER TUBING
- 1/2 CPVC
- 1/2" HARD COPPER
- 45 DEGREE ELBOW
- 4" SOFT COPPER TUBING
- 1" R TYP.
- 1/4" HARD COPPER
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. Describe plastic pipe;
b. Demonstrate joining plastic pipe; and,
c. Identify plastic pipe maintenance procedures.

Reading Assignments:

The following chapters are assigned to read from Piping Systems, Mechanical Equipment Series 736, Schoolcraft Publishing, Latest Edition

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
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<tbody>
<tr>
<td>3</td>
<td>Plastic Piping</td>
</tr>
</tbody>
</table>

Module Outline:

I. Describe Plastic Pipe
   A. Advantages
   B. Thermoplastic piping
   C. Thermosetting plastics
   D. Limitations
II. Demonstrate Joining Plastic Pipe
    A. Welding
    B. Threaded joints
III. Identify Plastic Pipe Maintenance Procedures
     A. Identify
     B. Repair
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Instructor will grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Join a coupling to plastic pipe by solvent welding;
   c. Install a cap to CPVC by solvent welding; and,
   d. Install plastic pipe to pipe project.
1. Instructor will demonstrate how to:
   a. Join a coupling to plastic pipe by solvent welding;
   b. Install a cap to CPVC by solvent welding; and,
   c. Install plastic pipe to pipe project.

2. Student will demonstrate how to:
   a. Join a coupling to plastic pipe by solvent welding;
   b. Install a cap to CPVC by solvent welding; and,
   c. Install plastic pipe to pipe project.

3. Instructor will grade student's ability to:
   a. Join a coupling to plastic pipe by solvent welding;
   b. Install a cap to CPVC by solvent welding; and,
   c. Install plastic pipe to pipe project.
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
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<tbody>
<tr>
<td>A Practice Safety</td>
<td>A-1 Use protective equipment</td>
</tr>
<tr>
<td>B Apply Mathematical Concepts</td>
<td>A-2 Accident prevention</td>
</tr>
<tr>
<td>C Interpret Engineering Drawings and Control Documents</td>
<td>A-3 Working shift</td>
</tr>
<tr>
<td>D Use Measuring Tools</td>
<td>A-4 Fire safety</td>
</tr>
<tr>
<td>E Use Hand Tools</td>
<td>A-5 Lifting safety</td>
</tr>
<tr>
<td>F Operate Machine Tools</td>
<td>A-6 Lockout/</td>
</tr>
<tr>
<td>G Perform Welding Operations</td>
<td>B-1 Perform basic arithmetic functions</td>
</tr>
<tr>
<td>H Maintain/ Troubleshoot Equipment and Systems</td>
<td>B-2 Convert fractions/ decimals</td>
</tr>
<tr>
<td>I Repair/ Power Transmission Systems</td>
<td>B-3 Convert Metric/ English measurements</td>
</tr>
<tr>
<td>J Fabricate/ Install Sheet Metal Parts</td>
<td>B-4 Perform basic algebraic operations</td>
</tr>
<tr>
<td></td>
<td>B-5 Perform trigonometric functions</td>
</tr>
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<td></td>
<td>B-6 Perform basic geometric calculations</td>
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<td></td>
<td>C-1 Identify basic types of drawings</td>
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<td></td>
<td>C-2 Identify basic layout of drawings</td>
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<td></td>
<td>C-3 Review blueprint notes and dimensions</td>
</tr>
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<td></td>
<td>D-1 Use non-precision measuring tools</td>
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<td></td>
<td>D-2 Use precision measuring tools</td>
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<td>E-1 Identify and use maintenance technician's hand tools</td>
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<td>E-2 Identify and use hand held power tools</td>
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<td></td>
<td>F-1 Use and care of milling machines</td>
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<td></td>
<td>F-2 Use and care of horizontal and vertical band saws</td>
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<td>F-3 Use and care of surface grinder</td>
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<tr>
<td></td>
<td>F-4 Use and care of surface grinder</td>
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<td></td>
<td>F-5 Operate lathes</td>
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<td>F-6 Use and care of drill press</td>
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<td></td>
<td>G-1 Weld with shielded metal arc welding (GMAW process)</td>
</tr>
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<td></td>
<td>G-2 Weld with oxyacetylene</td>
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<td>G-3 Perform gas welding</td>
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<tr>
<td></td>
<td>H-1 Maintain air conditioning systems</td>
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<td></td>
<td>H-2 Maintain pneumatic control circuits</td>
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<tr>
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<td>H-3 Maintain centrifugal pumps</td>
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<td>H-4 Troubleshoot positive displacement pumps</td>
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<tr>
<td></td>
<td>H-5 Maintain gate, globe, ball, plug, and butterfly valves</td>
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<td>H-6 Maintain check valves and relief valves</td>
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<td>H-7 Troubleshoot and repair blowers</td>
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<td></td>
<td>H-8 Troubleshoot, maintain, and repair hydraulic systems</td>
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<td>H-9 Troubleshoot, maintain, and repair pneumatic systems</td>
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<tr>
<td></td>
<td>I-1 Maintain and troubleshoot belt drive systems</td>
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<tr>
<td></td>
<td>I-2 Maintain and troubleshoot gear power transmission drives</td>
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<td></td>
<td>I-3 Maintain and troubleshoot chain power transmission drives</td>
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<tr>
<td></td>
<td>I-4 Maintain and troubleshoot clutches</td>
</tr>
<tr>
<td></td>
<td>J-1 Layout sheet metal parts</td>
</tr>
<tr>
<td></td>
<td>J-2 Form and/or bend sheet metal parts</td>
</tr>
<tr>
<td></td>
<td>J-3 Fasten sheet metal parts together</td>
</tr>
</tbody>
</table>
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
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<th>Duties</th>
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<td>K-1 Perform basic pipelining calculations</td>
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<td>K-2 Cut, thread, and steam pipe</td>
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<td>K-3 Pipe assembly</td>
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<td>K-4 Install and adjust pipe support</td>
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<td>K-5 Tubing</td>
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<td>K-6 Fittings</td>
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<td>K-7 Plastic pipe</td>
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<td>L</td>
<td>Basic Rigging</td>
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<td>L-1 Rigging fundamentals</td>
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<td>L-2 Demonstrate basic rigging skills</td>
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<td>M</td>
<td>Bearing Maintenance</td>
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<td>M-1 Plain bearings</td>
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<td>M-2 Rolling element bearings</td>
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<td>Use Computers</td>
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<td>N-1 Perform basic word processing</td>
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<td>N-2 Perform basic spreadsheet operations</td>
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<td>Align Shafts</td>
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<td>O-1 Principles of alignment</td>
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<td>O-2 Methods of alignment</td>
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<td>Install/Align Machines</td>
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<td>P-1 Install electrical connections</td>
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<td>P-2 Setting and leveling</td>
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<td>P-3 Grouting</td>
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<td>P-4 Special mountings</td>
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<tr>
<td>Q</td>
<td>Maintain Electrical Devices</td>
</tr>
<tr>
<td></td>
<td>Q-1 Use electrical test equipment</td>
</tr>
<tr>
<td></td>
<td>Q-2 Apply basic terms to electrical circuits</td>
</tr>
<tr>
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<td>Q-3 Analyze series, parallel, and complex AC/DC circuits</td>
</tr>
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<td>Q-4 Check AC and DC motors</td>
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<td>Q-5 Troubleshoot electrical devices</td>
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<td>R-1 Force</td>
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<td>R-2 Work</td>
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<td>R-3 Mechanical motion and rate</td>
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<td>R-5 Power</td>
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<td>S-2 Application for various fasteners</td>
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<td>S-3 Techniques for removing damaged fasteners</td>
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<td>S-4 Cleaning and restoring threaded fasteners</td>
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<td></td>
<td>S-5 Torque preload theory</td>
</tr>
<tr>
<td></td>
<td>S-6 Effects of lubricating threads prior to torquing</td>
</tr>
<tr>
<td></td>
<td>S-7 Demonstrate appropriate torquing technique</td>
</tr>
</tbody>
</table>
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. State formula for dealing with center of gravity;
b. Compare wire rope to fiber rope usage;
c. Compare chain to block and tackle usage; and,
d. List two ways to construct a sling.

Reading Assignments:

The following chapters are assigned to read from *Mechanics' and Millwrights' Guide*, Anderson, Audel Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>21</td>
<td>Rigging</td>
</tr>
</tbody>
</table>

Module Outline:

I. Center of Gravity
II. Fiber Ropes and Lines
III. Wire Ropes and Lines
IV. Chains
V. Slings
VI. Block and Tackle
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:
a. State formula for dealing with center of gravity;
b. Compare wire rope to fiber rope usage;
c. Compare chain to block and tackle usage;
d. List two ways to construct a sling; and,
e. Demonstrate basic rigging skills.

Reading Assignments:

The following chapters are assigned to read from Mechanics' and Millwrights' Guide, Anderson, Audel Publishers, Latest Edition::

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Module Outline:

I. Center of Gravity
II. Fiber Ropes and Lines
III. Wire Ropes and Lines
IV. Chains
V. Slings
VI. Block and Tackle
IMM-L2-LA
Demonstrate Basic Rigging Skills
Attachment 2: MASTER Laboratory Aid

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
1. Instructor will demonstrate how to:
   a. Calculate center of gravity;
   b. Treat fiber ropes and lines;
   c. Treat wire ropes and lines;
   d. Use chains for rigging;
   e. Use slings safety to lift loads; and,
   f. Use block and tackle safely to lift loads.

2. Student will demonstrate how to:
   a. Calculate center of gravity;
   b. Treat fiber ropes and lines;
   c. Treat wire ropes and lines;
   d. Use chains for rigging;
   e. Use slings safety to lift loads; and,
   f. Use block and tackle safely to lift loads.

3. Instructor will grade student's ability to:
   a. Calculate center of gravity;
   b. Treat fiber ropes and lines;
   c. Treat wire ropes and lines;
   d. Use chains for rigging;
   e. Use slings safety to lift loads; and,
   f. Use block and tackle safely to lift loads.
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<tr>
<td></td>
<td>A-2 Accident prevention</td>
</tr>
<tr>
<td><strong>B</strong> Apply Mathematical Concepts</td>
<td>B-1 Perform basic arithmetic functions</td>
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<tr>
<td></td>
<td>B-2 Convert fractions/decimals</td>
</tr>
<tr>
<td><strong>C</strong> Interpret Engineering Drawings and Control Documents</td>
<td>C-1 Identify basic types of drawings</td>
</tr>
<tr>
<td></td>
<td>C-2 Identify basic layout of drawings</td>
</tr>
<tr>
<td><strong>D</strong> Use Measuring Tools</td>
<td>D-1 Use non-precision measuring tools</td>
</tr>
<tr>
<td></td>
<td>D-2 Use precision measuring tools</td>
</tr>
<tr>
<td><strong>E</strong> Use Hand Tools</td>
<td>E-1 Identify and use maintenance technician's hand tools</td>
</tr>
<tr>
<td></td>
<td>E-2 Identify and use hand held power tools</td>
</tr>
<tr>
<td><strong>F</strong> Operate Machine Tools</td>
<td>F-1 Use and care of milling machines</td>
</tr>
<tr>
<td></td>
<td>F-2 Use and care of horizontal and vertical band saws</td>
</tr>
<tr>
<td><strong>G</strong> Perform Welding Operations</td>
<td>G-1 Weld with shielded metal arc welding (SMAW)</td>
</tr>
<tr>
<td></td>
<td>G-2 Welding with oxyacetylene</td>
</tr>
<tr>
<td><strong>H</strong> Maintain/Troubleshoot Equipment and Systems</td>
<td>H-1 Maintain air conditioning systems</td>
</tr>
<tr>
<td></td>
<td>H-2 Maintain pneumatic central circuits</td>
</tr>
<tr>
<td><strong>I</strong> Repair Power Transmission Systems</td>
<td>I-1 Maintain and troubleshoot belt drive systems</td>
</tr>
<tr>
<td></td>
<td>I-2 Maintain and troubleshoot gear power transmission drives</td>
</tr>
<tr>
<td><strong>J</strong> Fabricate/Install Sheet Metal Parts</td>
<td>J-1 Lay out sheet metal parts</td>
</tr>
<tr>
<td></td>
<td>J-2 Form and/or bend sheet metal parts</td>
</tr>
<tr>
<td></td>
<td>J-3 Fasten sheet metal parts together</td>
</tr>
</tbody>
</table>

**Tasks**

- Apply Mathematical Concepts
- Perform Welding Operations
- Use Measuring Tools
- Use Hand Tools
- Operate Machine Tools
- Perform Welding Operations
- Maintain/Troubleshoot Equipment and Systems
- Repair Power Transmission Systems
- Fabricate/Install Sheet Metal Parts
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>K  Piping Operations</td>
<td>K-1 Perform basic pipelining calculations</td>
</tr>
<tr>
<td>L  Basic Rigging</td>
<td>L-1 Rigging fundamentals</td>
</tr>
<tr>
<td>M  Bearing Maintenance</td>
<td>M-1 Plain bearings</td>
</tr>
<tr>
<td>N  Use Computers</td>
<td>N-1 Perform basic word processing</td>
</tr>
<tr>
<td>O  Align Shafts</td>
<td>O-1 Principles of alignment</td>
</tr>
<tr>
<td>P  Install/Align Machines</td>
<td>P-1 Install electrical connections</td>
</tr>
<tr>
<td>Q  Maintain Electrical Devices</td>
<td>Q-1 Use electrical test equipment</td>
</tr>
<tr>
<td>R  Basic Mechanical Concepts</td>
<td>R-1 Force</td>
</tr>
<tr>
<td>S  Fasteners and Preloading</td>
<td>S-1 Fasteners and nomenclature</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-2 Cut, thread, and ream pipe</td>
</tr>
<tr>
<td>K-3 Pipe assembly</td>
</tr>
<tr>
<td>K-4 Install and adjust pipe support</td>
</tr>
<tr>
<td>K-5 Tubing</td>
</tr>
<tr>
<td>K-6 Fittings</td>
</tr>
<tr>
<td>K-7 Plastic pipe</td>
</tr>
<tr>
<td>L-2 Demonstrate basic rigging skills</td>
</tr>
<tr>
<td>M-2 Rolling element bearings</td>
</tr>
<tr>
<td>N-2 Perform basic spreadsheet operations</td>
</tr>
<tr>
<td>O-2 Methods of alignment</td>
</tr>
<tr>
<td>P-2 Setting and leveling</td>
</tr>
<tr>
<td>P-3 Grouting</td>
</tr>
<tr>
<td>P-4 Special mountings</td>
</tr>
<tr>
<td>Q-2 Apply basic terms to electrical circuits</td>
</tr>
<tr>
<td>Q-3 Analyze series, parallel, and complex AC/DC circuits</td>
</tr>
<tr>
<td>Q-4 Check AC and DC motors</td>
</tr>
<tr>
<td>Q-5 Troubleshoot electrical devices</td>
</tr>
<tr>
<td>R-2 Work</td>
</tr>
<tr>
<td>R-3 Mechanical motion and rate</td>
</tr>
<tr>
<td>R-4 Simple machines</td>
</tr>
<tr>
<td>R-5 Power</td>
</tr>
<tr>
<td>S-2 Applications for various fasteners</td>
</tr>
<tr>
<td>S-3 Techniques for removing damaged fasteners</td>
</tr>
<tr>
<td>S-4 Cleaning and restoring threaded fasteners</td>
</tr>
<tr>
<td>S-5 Torque preload theory</td>
</tr>
<tr>
<td>S-6 Effects of lubricating threaded prior to torquing</td>
</tr>
<tr>
<td>S-7 Demonstrate appropriate torquing technique</td>
</tr>
</tbody>
</table>
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the principles of operation of plain bearings;
b. Identify the types and materials of plain bearings;
c. Demonstrate maintenance practices for plain bearings; and,
d. Identify failure patterns of plain bearings.

Reading Assignments:

The following chapters are assigned to read from Principles of Machine Operation and Maintenance, Dick Jeffrey, ISBN 0170087050, Delmar/I.T.P., Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Plain Bearings</td>
</tr>
</tbody>
</table>

Module Outline:

I. Describe the Principles of Plain Bearings
   A. Introduction of bearings
   B. Lubrication
   C. Reason for soft bearing materials

II. Identify the Types and Materials of Plain Bearings
   A. Journal bearings
   B. Thrust bearings
   C. Linear bearings
   D. Material characteristics
E. Material types and uses

III. Demonstrate Maintenance Practices for Plain Bearings
   A. General
   B. Assembly
   C. Cleaning
   D. Relining journal bearings
   E. Start-up

IV. Identify Failure Patterns of Plain Bearings
   A. Operating symptoms
   B. Symptoms found on inspection
   C. Causes of failure
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Install shaft in two plain pillows block bearings;
   c. Align, secure bearings to table and secure shaft to bearings;
   d. Remove old bearing and press plain bearing in housing using proper tools and procedures;
   e. Check inside diameter and shaft for proper fit;
   f. Hone to size if necessary;
   g. Lubricate bearings; and,
   h. Run and troubleshoot bearing and shaft assemblies.
Review the general section under maintenance practices pages of text (reading assignment) prior to performing practical applications.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the principles of operation of rolling element bearings;
b. Identify the types of rolling element bearings;
c. Describe rolling element bearing assembly design;
d. Demonstrate maintenance practices of rolling element bearings; and,
e. Identify failure patterns of rolling element bearings.

Reading Assignments:

The following chapters are assigned to read from Principles of Machine Operation and Maintenance, Dick Jeffrey, Delmar/ITP Publishing, Latest Edition

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2</td>
<td>Rolling Element Bearings</td>
</tr>
</tbody>
</table>

Module Outline:

I. Describe the Principle of Operation of Rolling Element Bearings
   A. Introduction
   B. Ball bearings
   C. Roller bearings
   D. Linear bearings

II. Identify the Types of Rolling Elements Bearings
    A. Journal bearings
    B. Thrust bearings
III. Describe Roller Element Bearing Assembly Design
   A. Shaft and housing fits
   B. Thermal expansion
   C. Types of mountings

IV. Demonstrate Maintenance Practices of Roller Element Bearings
   A. General
   B. Tools and equipment
   C. Mounting procedures
   D. Pre-lubrication
   E. Selection of mounting method
   F. Special considerations
   G. Dismounting procedures

V. Identify Failure Patterns of Rolling Element Bearings
   A. Operating symptoms
   B. Symptoms found on inspection
   C. Cause of failure
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Install a shaft in two self aligning pillow block bearing with rolling element bearings;
   c. Change the rolling element bearing in a self aligning pillow block to a different size;
   d. Remove a rolling element bearing from a shaft and install another bearing;
   e. Remove a rolling element bearing form a housing and install another bearing; and,
   f. Clean and pre-lubricate a rolling element bearing.
Review the general section, under maintenance practices pages of text (reading assignment) prior to performing practical applications.
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1 Use protective equipment</td>
<td>A-1 Use protective equipment</td>
</tr>
<tr>
<td>A-2 Accident prevention</td>
<td>A-2 Accident prevention</td>
</tr>
<tr>
<td>A-3 Working safely</td>
<td>A-3 Working safely</td>
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<tr>
<td>A-4 Fire safety</td>
<td>A-4 Fire safety</td>
</tr>
<tr>
<td>A-5 Lifting safety</td>
<td>A-5 Lifting safety</td>
</tr>
<tr>
<td>A-6 Lockout/tagger</td>
<td>A-6 Lockout/tagger</td>
</tr>
<tr>
<td>B-1 Perform basic arithmetic functions</td>
<td>B-1 Perform basic arithmetic functions</td>
</tr>
<tr>
<td>B-2 Convert fractions/decimals</td>
<td>B-2 Convert fractions/decimals</td>
</tr>
<tr>
<td>B-3 Convert Metric/English measurements</td>
<td>B-3 Convert Metric/English measurements</td>
</tr>
<tr>
<td>B-4 Perform basic algebraic operations</td>
<td>B-4 Perform basic algebraic operations</td>
</tr>
<tr>
<td>B-5 Perform basic trigonometric functions</td>
<td>B-5 Perform basic trigonometric functions</td>
</tr>
<tr>
<td>B-6 Perform basic geometric calculations</td>
<td>B-6 Perform basic geometric calculations</td>
</tr>
<tr>
<td>C-1 Identify basic types of drawings</td>
<td>C-1 Identify basic types of drawings</td>
</tr>
<tr>
<td>C-2 Identify basic layout of drawings</td>
<td>C-2 Identify basic layout of drawings</td>
</tr>
<tr>
<td>C-3 Review blueprint notes and dimensions</td>
<td>C-3 Review blueprint notes and dimensions</td>
</tr>
<tr>
<td>D-1 Use non-precision measuring tools</td>
<td>D-1 Use non-precision measuring tools</td>
</tr>
<tr>
<td>D-2 Use precision measuring tools</td>
<td>D-2 Use precision measuring tools</td>
</tr>
<tr>
<td>E-1 Identify and use maintenance technician's hand tools</td>
<td>E-1 Identify and use maintenance technician's hand tools</td>
</tr>
<tr>
<td>E-2 Identify and use hand held power tools</td>
<td>E-2 Identify and use hand held power tools</td>
</tr>
<tr>
<td>F-1 Use and care of rolling machines</td>
<td>F-1 Use and care of rolling machines</td>
</tr>
<tr>
<td>F-2 Use and care of horizontal and vertical band saws</td>
<td>F-2 Use and care of horizontal and vertical band saws</td>
</tr>
<tr>
<td>F-3 Use and care of surface grinder</td>
<td>F-3 Use and care of surface grinder</td>
</tr>
<tr>
<td>F-4 Use and care of surface grinder</td>
<td>F-4 Use and care of surface grinder</td>
</tr>
<tr>
<td>F-5 Operate lathes</td>
<td>F-5 Operate lathes</td>
</tr>
<tr>
<td>F-6 Operate and care of drill press</td>
<td>F-6 Operate and care of drill press</td>
</tr>
<tr>
<td>G-1 Weld with shielded metal arc welding (SMAW) process</td>
<td>G-1 Weld with shielded metal arc welding (SMAW) process</td>
</tr>
<tr>
<td>G-2 Weldcut with oxyacetylene</td>
<td>G-2 Weldcut with oxyacetylene</td>
</tr>
<tr>
<td>G-3 Perform gas soldering</td>
<td>G-3 Perform gas soldering</td>
</tr>
<tr>
<td>H-1 Maintain air conditioning systems</td>
<td>H-1 Maintain air conditioning systems</td>
</tr>
<tr>
<td>H-2 Maintain pneumatic control circuits</td>
<td>H-2 Maintain pneumatic control circuits</td>
</tr>
<tr>
<td>H-3 Troubleshoot centrifugal pumps</td>
<td>H-3 Troubleshoot centrifugal pumps</td>
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<tr>
<td>H-4 Troubleshoot positive displacement pumps</td>
<td>H-4 Troubleshoot positive displacement pumps</td>
</tr>
<tr>
<td>H-5 Maintain gate, globe, ball, plug, and butterfly valves</td>
<td>H-5 Maintain gate, globe, ball, plug, and butterfly valves</td>
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<tr>
<td>H-6 Maintain check valves and relief valves</td>
<td>H-6 Maintain check valves and relief valves</td>
</tr>
<tr>
<td>H-7 Troubleshoot, maintain, and repair hydraulic systems</td>
<td>H-7 Troubleshoot, maintain, and repair hydraulic systems</td>
</tr>
<tr>
<td>H-8 Troubleshoot, maintain, and repair pneumatic systems</td>
<td>H-8 Troubleshoot, maintain, and repair pneumatic systems</td>
</tr>
<tr>
<td>I-1 Maintain and troubleshoot belt drive systems</td>
<td>I-1 Maintain and troubleshoot belt drive systems</td>
</tr>
<tr>
<td>I-2 Maintain and troubleshoot gear power transmission drives</td>
<td>I-2 Maintain and troubleshoot gear power transmission drives</td>
</tr>
<tr>
<td>I-3 Maintain and troubleshoot chain power transmission drives</td>
<td>I-3 Maintain and troubleshoot chain power transmission drives</td>
</tr>
<tr>
<td>I-4 Maintain and troubleshoot clutches</td>
<td>I-4 Maintain and troubleshoot clutches</td>
</tr>
<tr>
<td>J-1 Layout sheet metal parts</td>
<td>J-1 Layout sheet metal parts</td>
</tr>
<tr>
<td>J-2 Form and/or bend sheet metal parts</td>
<td>J-2 Form and/or bend sheet metal parts</td>
</tr>
<tr>
<td>J-3 Fasten sheet metal parts together</td>
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</table>
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                       | K-2 Cut, thread, and ream pipe  
                       | K-3 Pipe assembly  
                       | K-4 Install and adjust pipe support  
                       | K-5 Tubing  
                       | K-6 Fittings  
                       | K-7 Plastic pipe |
| **L** Basic Rigging | L-1 Rigging fundamentals  
                       | L-2 Demonstrate basic rigging skills  
                       | M-1 Plain bearings  
                       | M-2 Rolling element bearings  
                       | N-1 Perform basic pipe welding  
                       | N-2 Perform basic sheet metal operations  
                       | O-1 Principles of alignment  
                       | O-2 Methods of alignment  
                       | P-1 Install electrical connections  
                       | P-2 Setting and leveling  
                       | P-3 Grouting  
                       | P-4 Special mountings  
                       | Q-1 Use basic test equipment  
                       | Q-2 Apply basic terms to electrical circuits  
                       | Q-3 Analyze series, parallel, and complex AC/DC circuits  
                       | Q-4 Check AC and DC motors  
                       | Q-5 Trouble shoot electrical devices  
                       | R-1 Force  
                       | R-2 Work  
                       | R-3 Mechanical motion and rate  
                       | R-4 Simple machines  
                       | R-5 Power  
                       | S-1 Fasteners and nomenclature  
                       | S-2 Application for various fasteners  
                       | S-3 Techniques for removing damaged fasteners  
                       | S-4 Cleaning and restoring threaded fasteners  
                       | S-5 Torque preload theory  
                       | S-6 Effects of lubricating threads prior to torquing  
                       | S-7 Demonstrate appropriate torqueing technique  

| **M** Bearing Maintenance | M-1 Plain bearings  
                       | M-2 Rolling element bearings  
                       | N-1 Perform basic pipe welding  
                       | N-2 Perform basic sheet metal operations  
                       | O-1 Principles of alignment  
                       | O-2 Methods of alignment  
                       | P-1 Install electrical connections  
                       | P-2 Setting and leveling  
                       | P-3 Grouting  
                       | P-4 Special mountings  
                       | Q-1 Use basic test equipment  
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                       | S-4 Cleaning and restoring threaded fasteners  
                       | S-5 Torque preload theory  
                       | S-6 Effects of lubricating threads prior to torquing  
                       | S-7 Demonstrate appropriate torqueing technique  

| **N** Use Computers | N-1 Perform basic computer operations  
                       | N-2 Perform basic word processing  
                       | O-1 Principles of alignment  
                       | O-2 Methods of alignment  
                       | P-1 Install electrical connections  
                       | P-2 Setting and leveling  
                       | P-3 Grouting  
                       | P-4 Special mountings  
                       | Q-1 Use basic test equipment  
                       | Q-2 Apply basic terms to electrical circuits  
                       | Q-3 Analyze series, parallel, and complex AC/DC circuits  
                       | Q-4 Check AC and DC motors  
                       | Q-5 Trouble shoot electrical devices  
                       | R-1 Force  
                       | R-2 Work  
                       | R-3 Mechanical motion and rate  
                       | R-4 Simple machines  
                       | R-5 Power  
                       | S-1 Fasteners and nomenclature  
                       | S-2 Application for various fasteners  
                       | S-3 Techniques for removing damaged fasteners  
                       | S-4 Cleaning and restoring threaded fasteners  
                       | S-5 Torque preload theory  
                       | S-6 Effects of lubricating threads prior to torquing  
                       | S-7 Demonstrate appropriate torqueing technique  

| **O** Align Shafts | O-1 Principles of alignment  
                       | O-2 Methods of alignment  
                       | P-1 Install electrical connections  
                       | P-2 Setting and leveling  
                       | P-3 Grouting  
                       | P-4 Special mountings  
                       | Q-1 Use basic test equipment  
                       | Q-2 Apply basic terms to electrical circuits  
                       | Q-3 Analyze series, parallel, and complex AC/DC circuits  
                       | Q-4 Check AC and DC motors  
                       | Q-5 Trouble shoot electrical devices  
                       | R-1 Force  
                       | R-2 Work  
                       | R-3 Mechanical motion and rate  
                       | R-4 Simple machines  
                       | R-5 Power  
                       | S-1 Fasteners and nomenclature  
                       | S-2 Application for various fasteners  
                       | S-3 Techniques for removing damaged fasteners  
                       | S-4 Cleaning and restoring threaded fasteners  
                       | S-5 Torque preload theory  
                       | S-6 Effects of lubricating threads prior to torquing  
                       | S-7 Demonstrate appropriate torqueing technique  

| **P** Install/Align Machines | P-1 Install electrical connections  
                       | P-2 Setting and leveling  
                       | P-3 Grouting  
                       | P-4 Special mountings  
                       | Q-1 Use basic test equipment  
                       | Q-2 Apply basic terms to electrical circuits  
                       | Q-3 Analyze series, parallel, and complex AC/DC circuits  
                       | Q-4 Check AC and DC motors  
                       | Q-5 Trouble shoot electrical devices  
                       | R-1 Force  
                       | R-2 Work  
                       | R-3 Mechanical motion and rate  
                       | R-4 Simple machines  
                       | R-5 Power  
                       | S-1 Fasteners and nomenclature  
                       | S-2 Application for various fasteners  
                       | S-3 Techniques for removing damaged fasteners  
                       | S-4 Cleaning and restoring threaded fasteners  
                       | S-5 Torque preload theory  
                       | S-6 Effects of lubricating threads prior to torquing  
                       | S-7 Demonstrate appropriate torqueing technique  

| **Q** Maintain Electrical Devices | Q-1 Use basic test equipment  
                       | Q-2 Apply basic terms to electrical circuits  
                       | Q-3 Analyze series, parallel, and complex AC/DC circuits  
                       | Q-4 Check AC and DC motors  
                       | Q-5 Trouble shoot electrical devices  
                       | R-1 Force  
                       | R-2 Work  
                       | R-3 Mechanical motion and rate  
                       | R-4 Simple machines  
                       | R-5 Power  
                       | S-1 Fasteners and nomenclature  
                       | S-2 Application for various fasteners  
                       | S-3 Techniques for removing damaged fasteners  
                       | S-4 Cleaning and restoring threaded fasteners  
                       | S-5 Torque preload theory  
                       | S-6 Effects of lubricating threads prior to torquing  
                       | S-7 Demonstrate appropriate torqueing technique  

| **R** Basic Mechanical Concepts | R-1 Force  
                       | R-2 Work  
                       | R-3 Mechanical motion and rate  
                       | R-4 Simple machines  
                       | R-5 Power  
                       | S-1 Fasteners and nomenclature  
                       | S-2 Application for various fasteners  
                       | S-3 Techniques for removing damaged fasteners  
                       | S-4 Cleaning and restoring threaded fasteners  
                       | S-5 Torque preload theory  
                       | S-6 Effects of lubricating threads prior to torquing  
                       | S-7 Demonstrate appropriate torqueing technique  

| **S** Fasteners and Preloading | S-1 Fasteners and nomenclature  
                       | S-2 Application for various fasteners  
                       | S-3 Techniques for removing damaged fasteners  
                       | S-4 Cleaning and restoring threaded fasteners  
                       | S-5 Torque preload theory  
                       | S-6 Effects of lubricating threads prior to torquing  
                       | S-7 Demonstrate appropriate torqueing technique  

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BEST COPY AVAILABLE
Standards of performance:

Student shall demonstrate safe work habits in the computer laboratory by not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Create a document;
b. Edit a document;
c. Select fonts;
d. Cut, copy, and paste;
e. Select tab and indent;
f. Get help;
g. Use speller and thesaurus;
h. Find and replace;
i. Create header and footer;
j. Create tables;
k. Use columns; and,
l. Import and export graphics.

Reading Assignments:

The following chapters are assigned to read from Learning WordPerfect by Corel Corp., Latest Edition:

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Creating a Document</td>
</tr>
<tr>
<td>1</td>
<td>Editing a Document</td>
</tr>
<tr>
<td>1</td>
<td>Selecting Fonts</td>
</tr>
<tr>
<td>1</td>
<td>Using Cut, Copy, and Paste</td>
</tr>
<tr>
<td>2</td>
<td>Using Tab and Indent</td>
</tr>
<tr>
<td>2</td>
<td>Using Help</td>
</tr>
<tr>
<td>3</td>
<td>Using Speller and Thesaurus</td>
</tr>
<tr>
<td>3</td>
<td>Find and Replace</td>
</tr>
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<td>3</td>
<td>Headers and Footers</td>
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<td>3</td>
<td>Tables</td>
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<tr>
<td>4</td>
<td>Columns</td>
</tr>
<tr>
<td>4</td>
<td>Graphics</td>
</tr>
</tbody>
</table>
Module Outline:

I. Create a Document
II. Edit a Document
III. Select Fonts
IV. Cut, Copy, and Paste
V. Tab and Indent
VI. Help
VII. Speller
VIII. Thesaurus
IX. Replace
X. Header
XI. Footer
XII. Table
XIII. Columns
XIV. Graphics
The students will:
a. Follow housekeeping rules set up by instructor and school;
b. Follow closely instructions given by instructor;
c. Do not go faster than instructor, this could create problems;
d. If unable to follow instructor, let instructor know; and,
e. Ask questions if steps are not clear.
The students will:

a. Practice using software commands;

b. After practicing setting up spreadsheet, proceed to creating charts; and,

c. After practicing creating charts, let instructor know that you are ready to take performance measure.
IMM-N2-HO
Perform Basic Spreadsheet Operations
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the computer lab.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate how to use file menu commands;
b. Demonstrate how to use edit menu commands;
c. Demonstrate how to use format menu commands;
d. Demonstrate how to use print spreadsheet; and,
e. Demonstrate how to develop chart from spreadsheet.

Reading Assignments:

The following chapters are assigned to read from PFS: Window Works by Spinnaker Publishing Co., Latest Edition:

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>File Menu Commands</td>
</tr>
<tr>
<td>11</td>
<td>Edit Menu Commands</td>
</tr>
<tr>
<td>11</td>
<td>Format Menu Commands</td>
</tr>
<tr>
<td>11</td>
<td>Create Chart</td>
</tr>
</tbody>
</table>

Module Outline:

I. File Menu Commands
II. Edit Menu Commands
III. Format Menu Commands
IV. Print Spreadsheet
V. Develop Chart from Spreadsheet
1. Follow housekeeping rules set up by instructor and school;
2. Follow closely instructions given by instructor;
3. Do not go faster than instructor; this could create problems;
4. If unable to follow instructor, let instructor know; and,
5. Ask questions if steps are not clear.
Perform Basic Spreadsheet Operations
Attachment 3: MASTER Laboratory Worksheet

1. Practice using software commands;
2. After practicing setting up spreadsheet, proceed to creating charts; and,
3. After practicing creating charts, let instructor know that you are ready to take Self-Assessment.
INDUSTRIAL MAINTENANCE MECHANIC... uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> Use Protective Equipment</td>
<td>A-1 Use protective equipment</td>
</tr>
<tr>
<td><strong>B</strong> Apply Mathematical Concepts</td>
<td>B-1 Perform basic arithmetic functions</td>
</tr>
<tr>
<td><strong>C</strong> Interpret Engineering Drawings and Control Documents</td>
<td>C-1 Identify basic types of drawings</td>
</tr>
<tr>
<td><strong>D</strong> Use Measuring Tools</td>
<td>D-1 Use non-precision measuring tools</td>
</tr>
<tr>
<td><strong>E</strong> Use Hand Tools</td>
<td>E-1 Identify and use maintenance technician's hand tool</td>
</tr>
<tr>
<td><strong>F</strong> Operate Machine Tools</td>
<td>F-1 Use and care of milling machines</td>
</tr>
<tr>
<td><strong>G</strong> Perform Welding Operations</td>
<td>G-1 Weld with shielded metal arc welding (SMAW) process</td>
</tr>
<tr>
<td><strong>H</strong> Maintain/Troubleshoot Equipment and Systems</td>
<td>H-1 Maintain air conditioning systems</td>
</tr>
<tr>
<td><strong>I</strong> Repair Power Transmission Systems</td>
<td>I-1 Maintain and troubleshoot belt drive systems</td>
</tr>
<tr>
<td><strong>J</strong> Fabricate/Install Sheet Metal Parts</td>
<td>J-1 Layout sheet metal parts</td>
</tr>
</tbody>
</table>

**Tasks:**
- Use protective equipment
- Perform basic arithmetic functions
- Identify basic types of drawings
- Use non-precision measuring tools
- Identify and use maintenance technician's hand tool
- Use and care of milling machines
- Weld with shielded metal arc welding (SMAW) process
- Maintain air conditioning systems
- Maintain and troubleshoot belt drive systems
- Layout sheet metal parts
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>K</strong> Piping Operations</td>
<td>K-1 Perform basic piping calculations</td>
</tr>
<tr>
<td>L Basic Rigging</td>
<td>L-1 Rigging fundamentals</td>
</tr>
<tr>
<td>M Bearing Maintenance</td>
<td>M-1 Plain bearings</td>
</tr>
<tr>
<td>N Use Computers</td>
<td>N-1 Perform basic word processing</td>
</tr>
<tr>
<td>O Align Shafts</td>
<td>O-1 Principles of alignment</td>
</tr>
<tr>
<td>P Install/Align Machines</td>
<td>P-1 Install electrical connections</td>
</tr>
<tr>
<td>Q Maintain Electrical Devices</td>
<td>Q-1 Use electrical test equipment</td>
</tr>
<tr>
<td>R Basic Mechanical Concepts</td>
<td>R-1 Force</td>
</tr>
<tr>
<td>S Fasteners and Preloading</td>
<td>S-1 Fasteners and nomenclature</td>
</tr>
</tbody>
</table>

- K-2 Cut, thread, and ream pipe
- K-3 Pipe assembly
- K-4 Install and adjust pipe support
- K-5 Tubing
- K-6 Fittings
- K-7 Plastic pipe
- L-2 Demonstrate basic rigging skills
- M-2 Rolling element bearings
- N-2 Perform basic spreadsheet operations
- O-2 Methods of alignment
- P-2 Setting and leveling
- P-3 Grouting
- P-4 Special mountings
- Q-2 Apply basic terms to electrical circuits
- Q-3 Analyze series, parallel, and complex AC/DC circuits
- Q-4 Check AC and DC motors
- Q-5 Troubleshoot electrical devices
- R-2 Work
- R-3 Mechanical motion and rate
- R-4 Simple machines
- R-5 Power
- S-2 Application for various fasteners
- S-3 Techniques for removing damaged fasteners
- S-4 Cleaning and restoring threaded fasteners
- S-5 Torque preload theory
- S-6 Effects of lubricating threads prior to torquing
- S-7 Demonstrate appropriate torquing technique
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
- Using OSHA required safety equipment for the shop;
- Safety glasses;
- Hearing protection;
- Face shields;
- Gloves;
- Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
- Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
- Describe misalignment;
- Identify tolerances for alignment;
- Describe adjustments procedures;
- Demonstrate how to align using a dial indicators;
- Describe thermal growth; and,
- Demonstrate doweling after alignment.

Reading Assignments:

The following chapters are assigned to read from Principles of Machine Operations and Maintenance, Dick Jeffrey, Delmar Publishing/ATP, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Shaft Alignment</td>
</tr>
</tbody>
</table>

Module Outline:

I. Describe Misalignment
   A. Parallel misalignment
   B. Angular misalignment
   C. Combination misalignment

II. Identify Tolerances for Alignment
   A. Coupling manufacturers
   B. Machinery manufacturers
C. Special conditions

III. Describe Adjustment Procedures
A. Unit to adjust
B. Distance and soft foot
C. Equipment rocking (soft-foot)
D. Vertical alignment first

IV. Determine How to Align Using a Dial Indicator
A. Introduction to a dial indicator
B. Total indicator run-out

V. Describe Thermal Growth
A. Effects of temperature
B. Aligning steam turbines

VI. Demonstrate Doweling after Alignment
A. Purpose
B. Location
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Mount a pump and a motor to a bed plate or two shafts in pillow block bearings; and,
   c. Secure 2 each, 2" x 1/4" x 6" long steel plates, using dowel pins.
2.000

2 ea. Plates, drill, ream and dowel
Use 2 ea. 1/4" X 1/2" dowel pins

6.000

250 REAM 2 HOLES
IMM-O2-HO
Methods of Alignment
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate the straight edge and feeler gage method;
b. Describe the face and rim method of aligning couplings;
c. Set-up and align couplings using the reverse indicators method; and,
d. Describe the general hints on alignment.

Reading Assignments:

The following chapters are assigned to read from *Principles of Machine Operations and Maintenance*, Dick Jeffrey, Delmar Publishing, ATP, Latest Edition:

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<tr>
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</table>

Module Outline:

I. Demonstrate the Straight Edge and Feeler Gage Method
   A. Angular misalignment
   B. Parallel misalignment
   C. Tolerances

II. Describe the Face and Rim Method of Aligning Couplings
   A. Introduction
   B. Short comings

III. Set-Up and Align Couplings Using the Reverse Indicator Method
    A. Advantages of
B. Procedures for aligning

IV. Describe the General Hints on Alignment
A. Measuring tools and shims
B. Equipment
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Align a coupling using the straight edge and feeler gage method; and,
   c. Align a coupling using dial indicators.
Review:
  a. General hints on alignment; and,
  b. Pages in textbook on alignment.
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>B-1 Perform basic arithmetic functions</td>
<td>B-2 Convert fractions/ decimals</td>
</tr>
<tr>
<td>C-1 Identify basic types of drawings</td>
<td>C-2 Identify basic layout of drawings</td>
</tr>
<tr>
<td>D-1 Use non-precision measuring tools</td>
<td>D-2 Use precision measuring tools</td>
</tr>
<tr>
<td>E-1 Identify and use maintenance technician's hand tools</td>
<td>E-2 Identify and use hand held power tools</td>
</tr>
<tr>
<td>F-1 Use and care of milling machines</td>
<td>F-2 Use and care of horizontal and vertical band saws</td>
</tr>
<tr>
<td>G-1 Weld with shielded metal arc welding (SMAW) process</td>
<td>G-2 Weldcut with oxyacetylene</td>
</tr>
<tr>
<td>H-1 Maintain air-conditioning systems</td>
<td>H-2 Maintain pneumatic control circuits</td>
</tr>
<tr>
<td>I-1 Maintain and troubleshoot belt drive systems</td>
<td>I-2 Maintain and troubleshoot gear power transmission drives</td>
</tr>
<tr>
<td>J-1 Layout sheet metal parts</td>
<td>J-2 Form and/or bend sheet metal parts</td>
</tr>
</tbody>
</table>
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<tr>
<th>Duties</th>
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</table>
| **K** Piping Operations | K-1 Perform basic pipfitting calculations  
|                 | K-2 Cut, thread, and ream pipe  
|                 | K-3 Pipe assembly  
|                 | K-4 Install and adjust pipe support  
|                 | K-6 Tubing  
|                 | K-8 Fittings  
|                 | K-7 Plastic pipe  |
| **L** Basic Rigging | L-1 Rigging fundamentals  
|                 | L-2 Demonstrate basic rigging skills  |
| **M** Bearing Maintenance | M-1 Plain bearings  
|                 | M-2 Rolling element bearings  |
| **N** Use Computers | N-1 Perform basic pipefitting calculations  
|                 | N-2 Perform basic spreadsheet operations  |
| **O** Align Shafts | O-1 Principles of alignment  
|                 | O-2 Methods of alignment  |
| **P** Install/Align Machines | P-1 Install electrical connections  
|                 | P-2 Setting and leveling  
|                 | P-3 Grouting  
|                 | P-4 Special mountings  |
| **Q** Maintain Electrical Devices | Q-1 Use electrical test equipment  
|                 | Q-2 Apply basic terms to electrical circuits  
|                 | Q-3 Analyze series, parallel, and complex AC/DC circuits  
|                 | Q-4 Check AC and DC motors  
|                 | Q-5 Troubleshoot electrical devices  |
| **R** Basic Mechanical Concepts | R-1 Force  
|                 | R-2 Work  
|                 | R-3 Mechanical motion and rate  
|                 | R-4 Simple machines  
|                 | R-6 Power  |
| **S** Fasteners and Preloading | S-1 Fasteners and nomenclature  
|                 | S-2 Application for various fasteners  
|                 | S-3 Techniques for removing damaged fasteners  
|                 | S-4 Cleaning and restoring threaded fasteners  
|                 | S-5 Torque preload theory  
|                 | S-6 Effects of lubricating threads prior to torquing  
|                 | S-7 Demonstrate appropriate torquing technique  |
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Install electrical connections;
b. Install crimp connections;
c. Install butt connections;
d. Install proper layers of insulation;
e. Install twist connectors;
f. Install torque connections; and,
g. Install underground connections.

Reading Assignments:

The following chapters are assigned to read from Westinghouse Electrical Maintenance Hints, Westinghouse Electrical Corporation, publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Cable Contraction and Application</td>
</tr>
<tr>
<td>41</td>
<td>Insulation Materials</td>
</tr>
</tbody>
</table>

Module Outline:

I. Reasons for Proper Electrical Connections
II. Types of Electrical Connections
III. Insulation Techniques
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
1. Instructor will demonstrate how to:
   a. Install electrical connections;
   b. Install crimp connections;
   c. Install butt connections;
   d. Install proper layers of insulation;
   e. Install twist connectors;
   f. Install torque connections; and,
   g. Install underground connections.

2. Student will demonstrate how to:
   a. Install electrical connections;
   b. Install crimp connections;
   c. Install butt connections;
   d. Install proper layers of insulation;
   e. Install twist connectors;
   f. Install torque connections; and,
   g. Install underground connections.

3. Instructor will grade students ability to:
   a. Install electrical connections;
   b. Install crimp connections;
   c. Install butt connections;
   d. Install proper layers of insulation;
   e. Install twist connectors;
   f. Install torque connections; and,
   g. Install underground connections.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Describe the importance of setting and leveling machinery;
b. Identify shim shapes and locations; and,
c. Demonstrate the procedures for setting and leveling machines.

Reading Assignments:

The following chapters are assigned to read from Principles of Machine Operation and Maintenance, Dick Jeffrey, Delmar/ATP Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Machinery Mounting</td>
</tr>
</tbody>
</table>

Module Outline:

I. Describe the Importance of Setting and Leveling Machinery  
   A. Bedplate  
   B. Foundation  
II. Identify Shim Shapes and Locations  
   A. Flat shims  
   B. Wedge-shaped shims  
   C. Check for bedplate distortion  
III. Demonstrate the Procedures for Setting and Leveling Machines  
   A. Setting  
   B. Leveling
C. Shim thickness
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Mount pillow block bearings, shaft and coupling to a suitable bedplate; and,
   c. Mount the bedplate to the floor or pre-poured foundation with anchor bolts installed and level.

Suggestion: Use 2x4's to make a form. Pour concrete on plastic and around anchor bolts or drill concrete after hardening. Foundation will break up with sledge hammer after use of it is necessary to remove it.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe the purpose of grouting.
b. Demonstrate grouting procedures.

Reading Assignments:

The following chapters are assigned to read from Principles of Machine Operation and Maintenance, Dick Jeffrey, Delmar/ITP Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Machinery Mounting</td>
</tr>
</tbody>
</table>

Module Outline:

I. Describe the Purpose of Grouting
   A. Effect on the shims
   B. Effect on bed plate
II. Demonstrate Grouting Procedures
    A. Grout dam
IMM-P3-LA
Grouting
Attachment 2: MASTER Laboratory Aid

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Build a dam around the mounted unit in IMM-P2, “Setting and Leveling” practical application section; and,
   c. Grout mounted unit in IMM-P2, “Setting and Leveling” practical outline application section.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe adjustable mountings; and,
b. Identify vibration isolators.

Reading Assignments:

The following chapters are assigned to read from *Principles of Machine Operation and Maintenance*, Dick Jeffrey, Delmar/ITP Publishers, Latest Edition:

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<tr>
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<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Machinery Mounting</td>
</tr>
</tbody>
</table>

Module Outline:

I. Describe Adjustable Mountings
   A. Applications
   B. Pre-installation
   C. Maintenance

II. Identify Vibration Isolators
   A. Absorbent materials
   B. Spring mountings
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Mount bedplate on adjustable mountings; and,
   c. Mount bedplate on vibration isolators.
Review the special mountings pages in the textbook.
INDUSTRIAL MAINTENANCE MECHANIC uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Duties</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.1 Welding and layout</td>
<td>A.1 Use protective equipment</td>
</tr>
<tr>
<td>A.2 Welding and layout</td>
<td>A.2 Perform basic mathematical operations</td>
</tr>
<tr>
<td>A.3 Welding and layout</td>
<td>A.3 Perform basic arithmetic functions</td>
</tr>
<tr>
<td>A.4 Welding and layout</td>
<td>A.4 Perform basic algebraic operations</td>
</tr>
<tr>
<td>A.5 Welding and layout</td>
<td>A.5 Perform basic trigonometric functions</td>
</tr>
<tr>
<td>A.6 Welding and layout</td>
<td>A.6 Perform basic geometric calculations</td>
</tr>
<tr>
<td>B.1 Welding and layout</td>
<td>B.1 Use non-precision measuring tools</td>
</tr>
<tr>
<td>B.2 Welding and layout</td>
<td>B.2 Use precision measuring tools</td>
</tr>
<tr>
<td>B.3 Welding and layout</td>
<td>B.3 Identify and use basic drawing tools</td>
</tr>
<tr>
<td>B.4 Welding and layout</td>
<td>B.4 Review basic dimensioning and tolerancing standards</td>
</tr>
<tr>
<td>B.5 Welding and layout</td>
<td>B.5 Use and care of milling machines</td>
</tr>
<tr>
<td>B.6 Welding and layout</td>
<td>B.6 Use and care of horizontal and vertical band saws</td>
</tr>
<tr>
<td>B.7 Welding and layout</td>
<td>B.7 Use and care of pedestal grinders</td>
</tr>
<tr>
<td>B.8 Welding and layout</td>
<td>B.8 Use and care of surface grinders</td>
</tr>
<tr>
<td>B.9 Welding and layout</td>
<td>B.9 Operate lathes</td>
</tr>
<tr>
<td>B.10 Welding and layout</td>
<td>B.10 Use and care of drill presses</td>
</tr>
<tr>
<td>C.1 Welding and layout</td>
<td>C.1 Identify and use basic hand tools</td>
</tr>
<tr>
<td>C.2 Welding and layout</td>
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<td>D.1 Welding and layout</td>
<td>D.1 Use non-precision measuring tools</td>
</tr>
<tr>
<td>D.2 Welding and layout</td>
<td>D.2 Use precision measuring tools</td>
</tr>
<tr>
<td>D.3 Welding and layout</td>
<td>D.3 Use and care of basic drawing tools</td>
</tr>
<tr>
<td>D.4 Welding and layout</td>
<td>D.4 Use and care of basic drawing tools</td>
</tr>
<tr>
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<tr>
<td>D.7 Welding and layout</td>
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</tr>
<tr>
<td>H.1 Welding and layout</td>
<td>H.1 Maintain and troubleshoot belt drive systems</td>
</tr>
<tr>
<td>H.2 Welding and layout</td>
<td>H.2 Maintain and troubleshoot gear power transmission drives</td>
</tr>
<tr>
<td>H.3 Welding and layout</td>
<td>H.3 Maintain and troubleshoot chain power transmission drives</td>
</tr>
<tr>
<td>H.4 Welding and layout</td>
<td>H.4 Maintain and troubleshoot clutches</td>
</tr>
<tr>
<td>H.5 Welding and layout</td>
<td>H.5 Maintain and troubleshoot plug valves</td>
</tr>
<tr>
<td>H.6 Welding and layout</td>
<td>H.6 Maintain and troubleshoot butterfly valves</td>
</tr>
<tr>
<td>H.7 Welding and layout</td>
<td>H.7 Maintain and troubleshoot check valves</td>
</tr>
<tr>
<td>H.8 Welding and layout</td>
<td>H.8 Maintain and troubleshoot hydraulic and pneumatic systems</td>
</tr>
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</tr>
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<td>H.10 Welding and layout</td>
<td>H.10 Maintain and troubleshoot hydraulic systems</td>
</tr>
<tr>
<td>I.1 Welding and layout</td>
<td>I.1 Maintain and troubleshoot air conditioning systems</td>
</tr>
<tr>
<td>I.2 Welding and layout</td>
<td>I.2 Maintain and troubleshoot pneumatic control circuits</td>
</tr>
<tr>
<td>I.3 Welding and layout</td>
<td>I.3 Maintain and troubleshoot centrifugal pumps</td>
</tr>
<tr>
<td>I.4 Welding and layout</td>
<td>I.4 Maintain and troubleshoot positive displacement pumps</td>
</tr>
<tr>
<td>I.5 Welding and layout</td>
<td>I.5 Maintain and troubleshoot gate, globe, ball, plug, and butterfly valves</td>
</tr>
<tr>
<td>I.6 Welding and layout</td>
<td>I.6 Maintain and troubleshoot blowers</td>
</tr>
<tr>
<td>I.7 Welding and layout</td>
<td>I.7 Maintain and troubleshoot hydraulic systems</td>
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<td>I.10 Maintain and troubleshoot pneumatic systems</td>
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<td>J.10 Maintain and troubleshoot hydraulic systems</td>
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</table>
INDUSTRIAL MAINTENANCE MECHANIC...uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

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<tr>
<th>Duties</th>
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<tbody>
<tr>
<td>K Piping Operations</td>
<td>K-1 Perform basic pipefitting calculations</td>
</tr>
<tr>
<td>L Basic Rigging</td>
<td>L-1 Rigging fundamentals</td>
</tr>
<tr>
<td>M Maintenance</td>
<td>M-1 Plain bearings</td>
</tr>
<tr>
<td>N Use Computers</td>
<td>N-1 Perform basic computer operations</td>
</tr>
<tr>
<td>O Align Shafts</td>
<td>O-1 Principles of alignment</td>
</tr>
<tr>
<td>P Install/Align Machines</td>
<td>P-1 Install electrical connections</td>
</tr>
<tr>
<td>Q Maintain Electrical Devices</td>
<td>Q-1 Use electrical test equipment</td>
</tr>
<tr>
<td>R Basic Mechanical Concepts</td>
<td>R-1 Force</td>
</tr>
<tr>
<td>S Fasteners and Preloading</td>
<td>S-1 Fasteners and nomenclature</td>
</tr>
</tbody>
</table>

### Tasks

- **K**
  - K-1 Perform basic pipefitting calculations
  - K-2 Cut, thread, and repair pipe
  - K-3 Pipe assembly
  - K-4 Install and adjust pipe support
  - K-6 Tubing
  - K-8 Fittings
  - K-7 Plastic pipe

- **L**
  - L-1 Rigging fundamentals
  - L-2 Demonstrate basic rigging skills

- **M**
  - M-1 Plain bearings
  - M-2 Rolling element bearings

- **N**
  - N-1 Perform basic computer operations
  - N-2 Perform basic spreadsheet operations

- **O**
  - O-1 Principles of alignment
  - O-2 Methods of alignment

- **P**
  - P-1 Install electrical connections
  - P-2 Setting and leveling
  - P-3 Grouting
  - P-4 Special mountings

- **Q**
  - Q-1 Use electrical test equipment
  - Q-2 Apply basic terms to electrical circuits
  - Q-3 Analyze series, parallel, and complex AC/DC circuits
  - Q-4 Check AC and DC motors
  - Q-5 Troubleshoot electrical devices

- **R**
  - R-1 Force
  - R-2 Work
  - R-3 Mechanical motion and rate
  - R-4 Simple machines
  - R-6 Power

- **S**
  - S-1 Fasteners and nomenclature
  - S-2 Applications for various fasteners
  - S-3 Techniques for removing damaged fasteners
  - S-4 Cleaning and restoring threaded fasteners
  - S-5 Torque and preload theory
  - S-6 Effects of lubricating threads prior to torquing
  - S-7 Demonstrate appropriate torqueing technique
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Properly use electrical test equipment;
b. Measure ohms;
c. Measure DC volts;
d. Measure AC volts; and,
e. Measure DC amps.

Reading Assignments:

The following chapters are assigned to read from Electricity I, Kubala, Delmar Publishing, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
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<tbody>
<tr>
<td>6</td>
<td>Circuits</td>
</tr>
</tbody>
</table>

Module Outline:

I. DC Voltage Measurement
II. AC Voltage Measurement
III. DC Current Measurement
IV. Resistance Measurement
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
1. Student will practice performing.
   a. DC voltage measurement;
   b. AC voltage measurement;
   c. DC current measurement; and,
   d. Resistance measurement.

2. Instructor will grade student's performance on.
   a. DC voltage measurement;
   b. AC voltage measurement;
   c. DC current measurement; and,
   d. Resistance measurement.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Polarity;
b. Electron;
c. Proton;
d. Neutrons;
e. Coulomb;
f. Atom;
g. Voltage (potential difference);
h. Resistance;
g. Amperage (current);
i. Closed circuit;
j. Open circuit;
k. Sources of electricity;
l. Ohm’s Law; and,
m. Power.

Reading Assignments:

The following chapters are assigned to read from *Basic Electronics*, Bernard Grab, McGraw-Hill Publishers, Latest Edition

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
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<tbody>
<tr>
<td>1</td>
<td>Survey of Electronics</td>
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<tr>
<td>2</td>
<td>Electricity</td>
</tr>
<tr>
<td>3</td>
<td>Ohm’s Law</td>
</tr>
</tbody>
</table>
Module Outline:

I. Polarity
II. Electron
III. Proton
IV. Neutrons
V. Coulomb
VI. Atom
VII. Voltage (Potential Difference)
VIII. Resistance
IX. Amperage (Current)
X. Closed Circuit
XI. Open Circuit
XII. Sources of Electricity
XIII. Ohm’s Law
XIV. Power
IMM-Q3-HO
Analyze Series, Parallel, and Complex AC/DC Circuits
Attachment 1: MASTER Handout

Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Calculate series circuit;
b. Construct series circuit safely;
c. Calculate parallel circuit;
d. Construct parallel circuit safely;
e. Calculate series-parallel circuit;
f. Construct series-parallel circuit safely;
g. Calculate AC single phase circuit; and,
h. Construct AC single phase circuit.

Reading Assignments:

The following chapters are assigned to read from Electrical Circuits, Bernard Grob, McGraw-Hill Publishers, Latest Edition

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
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<tbody>
<tr>
<td>3</td>
<td>Series Circuits</td>
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<tr>
<td>4</td>
<td>Parallel Circuits</td>
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<tr>
<td>5</td>
<td>Series-Parallel Circuits</td>
</tr>
<tr>
<td>7</td>
<td>Voltage Dividers</td>
</tr>
<tr>
<td>8</td>
<td>DC Meters</td>
</tr>
</tbody>
</table>

Module Outline:

I. Series Circuits
II. Parallel Circuits

1377
III. Series-Parallel Circuits
IV. Voltage Dividers
V. DC Meters
VI. AC Circuits
VII. AC Meters
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
1. The student will practice:
   a. Calculating series circuit;
   b. Constructing series circuit safely;
   c. Calculating parallel circuit;
   d. Constructing parallel circuit safely;
   e. Calculating series-parallel circuit;
   f. Constructing series-parallel circuit safely;
   g. Calculating AC single phase circuit; and,
   h. Constructing AC single phase circuit.

2. Instructor will grade student’s performance.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to install, maintain
and troubleshoot:
  a. Capacitor motors;
  b. Repulsion motors;
  c. Three phase motors;
  d. Direct current motors;
  e. Universal motors;
  f. Shaded pole motors;
  g. Generator; and,
  h. Alternator.

Reading Assignments:

The following chapters are assigned to read from Electrical Motors, by Audel

Module Outline:

I. Capacitor Motors
II. Repulsion Motors
III. Three Phase Motors
IV. Direct Current Motors
V. Universal Motors
VI. Shaded Pole Motors
VII. Generator
VIII. Alternator
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
1. Student will practice installing, maintaining and troubleshooting the following motors:
   a. Capacitor motors;
   b. Repulsion motors;
   c. Three phase motors;
   d. Direct current motors;
   e. Universal motors;
   f. Shaded pole motors;
   g. Generator; and,
   h. Alternator.

2. Instructor will grade performance of student.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to troubleshoot the following devices:

a. Resistors;
b. Capacitors;
c. Inductors;
d. Motors; and,
e. Relays.

Reading Assignments:

The following chapters are assigned to read from Basic Electronics, Grob, McGraw-Hill Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
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<tbody>
<tr>
<td>17</td>
<td>Capacitance</td>
</tr>
<tr>
<td>20</td>
<td>Inductance</td>
</tr>
</tbody>
</table>

Module Outline:

I. Resistors
II. Capacitors
III. Inductors
IV. Motors
V. Relays
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
IMM-Q5-LW
Troubleshoot Electrical Devices
Attachment 3: MASTER Laboratory Worksheet

1. Student will practice troubleshooting:
   a. Resistors;
   b. Capacitors;
   c. Inductors;
   d. Motors; and,
   e. Relays.

2. Instructor will grade students performance.
INDUSTRIAL MAINTENANCE MECHANIC... uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

<table>
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<tbody>
<tr>
<td><strong>B</strong> Apply Mathematical Concepts</td>
<td>B-1 Perform basic arithmetic functions</td>
</tr>
<tr>
<td><strong>C</strong> Interpret Engineering Drawings and Control Documents</td>
<td>C-1 Identify basic types of drawings</td>
</tr>
<tr>
<td><strong>D</strong> Use Measuring Tools</td>
<td>D-1 Use non-precision measuring tools</td>
</tr>
<tr>
<td><strong>E</strong> Use Hand Tools</td>
<td>E-1 Identify and use maintenance technician's hand tools</td>
</tr>
<tr>
<td><strong>F</strong> Operate Machine Tools</td>
<td>F-1 Use and care of milling machines</td>
</tr>
<tr>
<td><strong>G</strong> Perform Welding Operations</td>
<td>G-1 Weld with shielded metal arc welding (SMAW) process</td>
</tr>
<tr>
<td><strong>H</strong> Maintain/Troubleshoot Equipment and Systems</td>
<td>H-1 Maintain air conditioning systems</td>
</tr>
<tr>
<td><strong>I</strong> Repair Power Transmission Systems</td>
<td>I-1 Maintain and troubleshoot belt drive systems</td>
</tr>
<tr>
<td><strong>J</strong> Fabricate/Install Sheet Metal Parts</td>
<td>J-1 Layout sheet metal parts</td>
</tr>
</tbody>
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# INDUSTRIAL MAINTENANCE MECHANIC

Uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

## Duties

<table>
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<th>K</th>
<th>Piping Operations</th>
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<td>L</td>
<td>Basic Rigging</td>
</tr>
<tr>
<td>M</td>
<td>Bearing Maintenance</td>
</tr>
<tr>
<td>N</td>
<td>Use Computers</td>
</tr>
<tr>
<td>O</td>
<td>Align Shafts</td>
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<td>P</td>
<td>Install/Align Machines</td>
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<tr>
<td>Q</td>
<td>Maintain Electrical Devices</td>
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<tr>
<td>R</td>
<td>Basic Mechanical Concepts</td>
</tr>
<tr>
<td>S</td>
<td>Fasteners and Preloading</td>
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</tbody>
</table>

## Tasks

<table>
<thead>
<tr>
<th>K-1 Perform basic pipefitting calculations</th>
<th>K-2 Cut, thread, and ream pipe</th>
<th>K-3 Pipe assembly</th>
<th>K-4 Install and adjust pipe support</th>
<th>K-5 Tubing</th>
<th>K-6 Fittings</th>
<th>K-7 Plastic pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-1 Rigging fundamentals</td>
<td>L-2 Demonstrate basic rigging skills</td>
<td>M-1 Plain bearings</td>
<td>M-2 Rolling element bearings</td>
<td>N-1 Perform basic word processing</td>
<td>N-2 Perform basic spreadsheet operations</td>
<td></td>
</tr>
<tr>
<td>O-1 Principles of alignment</td>
<td>O-2 Methods of alignment</td>
<td>P-1 Install electrical connections</td>
<td>P-2 Setting and leveling</td>
<td>P-3 Grouting</td>
<td>P-4 Special mountings</td>
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<td>Q-1 Use electrical test equipment</td>
<td>Q-2 Apply basic terms to electrical circuits</td>
<td>Q-3 Analyze series, parallel, and complex AC/DC circuits</td>
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<td>Q-5 Troubleshoot electrical devices</td>
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<tr>
<td>R-1 Force</td>
<td>R-2 Work</td>
<td>R-3 Mechanical motion and rate</td>
<td>R-4 Simple machines</td>
<td>R-5 Power</td>
<td></td>
<td></td>
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<tr>
<td>S-1 Fasteners and nomenclature</td>
<td>S-2 Application for various fasteners</td>
<td>S-3 Techniques for removing damaged fasteners</td>
<td>S-4 Cleaning and restoring threaded fasteners</td>
<td>S-5 Torque preload theory</td>
<td>S-6 Effects of lubricating threads prior to torquing</td>
<td>S-7 Demonstrate appropriate torquing technique</td>
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Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
  a. Define force;
  b. Describe linear force;
  c. Describe rotational force;
  d. Calculate linear force; and,
  e. Calculate rotational force.

Reading Assignments:

The following chapters are assigned to read from *Introduction to Physical Science*, James T. Shipman, D.C. Heath Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Force and Motion</td>
</tr>
</tbody>
</table>

Module Outline:

I. Introduction
II. Define Force
III. Measuring Force
IV. Basic Types and Effects of Force
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define work;
b. Compare force to work;
c. Define kinetic energy;
d. Define potential energy; and,
e. List forms of energy.

Reading Assignments:

The following chapters are assigned to read from *Introduction to Physical Science*, James Shipman, DC Heath Publishes, Latest Edition:

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Work and Energy</td>
</tr>
</tbody>
</table>

Module Outline:

I. Define Work
II. Work in Mechanical System
III Calculating Work
IV. Effects of Mechanical Work
V. Work and Efficiency
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
  a. Define motion;
  b. Define rate; and,
  c. Compare motion to rate.

Reading Assignments:

The following chapters are assigned to read from Mechanism Analysis, Barton, Dekker Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Types of Motion</td>
</tr>
</tbody>
</table>

Module Outline:

I. Introduction
II. Define Rate
III. Define Mechanical Motion
IV. Mechanical Motion and Rate
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Demonstrate mechanical motion; and,
   c. Demonstrate how a different rate effects speeds.
1. Instructor will design a series of experiments to demonstrate:
   a. Linear motion;
   b. Rotational motion;
   c. Transnational motion;
   d. Rectangular motion;
   e. Curvilinear motion;
   f. Three dimensional motion;
   g. Linear displacement;
   h. Angular displacement;
   i. Velocity;
   j. Acceleration;
   k. Speed; and,
   l. Cyclic motion.

2. Student will be graded on his/her ability to demonstrate:
   a. Linear motion;
   b. Rotational motion;
   c. Transnational motion;
   d. Rectangular motion;
   e. Curvilinear motion;
   f. Three dimensional motion;
   g. Linear displacement;
   h. Angular displacement;
   i. Velocity;
   j. Acceleration;
   k. Speed; and,
   l. Cyclic motion.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a.Calculate force;
b. Properly install and adjust levers;
c. Properly use wedges;
d. Properly adjust cams; and,
e. Properly install and adjust pulleys.

Reading Assignments:

The following chapters are assigned to read from *Industrial Trades Handbook*, Basarnba, IPT Publishers, Latest Edition

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Pulleys</td>
</tr>
</tbody>
</table>

Module Outline:

I. Force Transforming
II. Levers
III. Incline Planes
IV. Wedge
V. Cam
VI. Pulleys
VII. Combining Simple Machines
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.
1. Instructor will demonstrate how to:
   a. Calculate force;
   b. Properly install and adjust levers;
   c. Properly use wedges;
   d. Properly adjust cams; and,
   e. Properly install and adjust pulleys.

2. Student will be graded on:
   a. Calculating force;
   b. Properly installing and adjusting levers;
   c. Properly using wedges;
   d. Properly adjusting cams; and,
   e. Properly installing and adjusting pulleys.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Define power;
b. Compare power to work;
c. Define mechanical power; and,
d. Compare mechanical power to electrical power.

Reading Assignments:

The following chapters are assigned to read from *Introduction to Physical Science*, James Shipman, D. C. Heath Co. Publishers, Latest Edition

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
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<tbody>
<tr>
<td>4.2</td>
<td>Power</td>
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</tbody>
</table>

Module Outline:

I. Define Power
II. Power in Linear Mechanical System
III. Circuits of Mechanical Power
IV. Power Efficiency
V. Calculating Mechanical Power
# INDUSTRIAL MAINTENANCE MECHANIC

Uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

## Duties

<table>
<thead>
<tr>
<th>A</th>
<th>Practice Safety</th>
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<tbody>
<tr>
<td>B</td>
<td>Apply Mathematical Concepts</td>
</tr>
<tr>
<td>C</td>
<td>Interpret Engineering Drawings and Control Documents</td>
</tr>
<tr>
<td>D</td>
<td>Use Measuring Tools</td>
</tr>
<tr>
<td>E</td>
<td>Use Hand Tools</td>
</tr>
<tr>
<td>F</td>
<td>Operate Machine Tools</td>
</tr>
<tr>
<td>G</td>
<td>Perform Welding Operations</td>
</tr>
<tr>
<td>H</td>
<td>Maintain/Troubleshoot Equipment and Systems</td>
</tr>
<tr>
<td>I</td>
<td>Repair Power Transmission Systems</td>
</tr>
<tr>
<td>J</td>
<td>Fabricate/Install Sheet Metal Parts</td>
</tr>
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</table>

## Tasks

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<thead>
<tr>
<th>A-1</th>
<th>Use protective equipment</th>
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<tbody>
<tr>
<td>B-1</td>
<td>Perform basic arithmetic functions</td>
</tr>
<tr>
<td>C-1</td>
<td>Identify basic types of drawings</td>
</tr>
<tr>
<td>D-1</td>
<td>Use precision measuring tools</td>
</tr>
<tr>
<td>E-1</td>
<td>Identify and use maintenance technician's hand tools</td>
</tr>
<tr>
<td>F-1</td>
<td>Use and care of milling machines</td>
</tr>
<tr>
<td>G-1</td>
<td>Weld with shielded metal arc welding (SMAW) process</td>
</tr>
<tr>
<td>H-1</td>
<td>Maintain air conditioning systems</td>
</tr>
<tr>
<td>I-1</td>
<td>Maintain and troubleshoot bell drive systems</td>
</tr>
<tr>
<td>J-1</td>
<td>Layout sheet metal parts</td>
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</table>

<table>
<thead>
<tr>
<th>A-2</th>
<th>Accident prevention</th>
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<tbody>
<tr>
<td>B-2</td>
<td>Convert fractions/decimals</td>
</tr>
<tr>
<td>C-2</td>
<td>Identify basic layout of drawings</td>
</tr>
<tr>
<td>D-2</td>
<td>Use precision measuring tools</td>
</tr>
<tr>
<td>E-2</td>
<td>Identify and use hand held power tools</td>
</tr>
<tr>
<td>F-2</td>
<td>Use and care of horizontal and vertical band saws</td>
</tr>
<tr>
<td>G-2</td>
<td>Weld with exothermic gas</td>
</tr>
<tr>
<td>H-2</td>
<td>Maintain pneumatic control circuits</td>
</tr>
<tr>
<td>I-2</td>
<td>Maintain and troubleshoot gear power transmission drives</td>
</tr>
<tr>
<td>J-2</td>
<td>Form and/or bend sheet metal parts</td>
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</table>

<table>
<thead>
<tr>
<th>A-3</th>
<th>Working shift</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-3</td>
<td>Convert metric/English measurements</td>
</tr>
<tr>
<td>C-3</td>
<td>Review blueprint notes and dimensions</td>
</tr>
<tr>
<td>D-3</td>
<td>Basic shop mathematics</td>
</tr>
<tr>
<td>E-3</td>
<td>Identify and use maintenance technician's hand tools</td>
</tr>
<tr>
<td>F-3</td>
<td>Use and care of horizontal and vertical band saws</td>
</tr>
<tr>
<td>G-3</td>
<td>Perform gas welding</td>
</tr>
<tr>
<td>H-3</td>
<td>Troubleshoot and repair centrifugal pumps</td>
</tr>
<tr>
<td>I-3</td>
<td>Maintain and troubleshoot gear power transmission drives</td>
</tr>
<tr>
<td>J-3</td>
<td>Fasten sheet metal parts together</td>
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<table>
<thead>
<tr>
<th>A-4</th>
<th>Fire safety</th>
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<tbody>
<tr>
<td>B-4</td>
<td>Perform basic algebraic operations</td>
</tr>
<tr>
<td>C-4</td>
<td>Review blueprint notes and dimensions</td>
</tr>
<tr>
<td>D-4</td>
<td>Basic trigonometric functions</td>
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<tr>
<td>E-4</td>
<td>Identify maintenance technician's hand tools</td>
</tr>
<tr>
<td>F-4</td>
<td>Use and care of horizontal and vertical band saws</td>
</tr>
<tr>
<td>G-4</td>
<td>Perform gas welding</td>
</tr>
<tr>
<td>H-4</td>
<td>Troubleshoot and repair positive displacement pumps</td>
</tr>
<tr>
<td>I-4</td>
<td>Maintain and troubleshoot clutch systems</td>
</tr>
<tr>
<td>J-4</td>
<td>Form and/or bend sheet metal parts</td>
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</table>

<table>
<thead>
<tr>
<th>A-5</th>
<th>Lifting safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-5</td>
<td>Perform basic trigonometric functions</td>
</tr>
<tr>
<td>C-5</td>
<td>Review blueprint notes and dimensions</td>
</tr>
<tr>
<td>D-5</td>
<td>Basic geometric calculations</td>
</tr>
<tr>
<td>E-5</td>
<td>Identify maintenance technician's hand tools</td>
</tr>
<tr>
<td>F-5</td>
<td>Use and care of horizontal and vertical band saws</td>
</tr>
<tr>
<td>G-5</td>
<td>Perform gas welding</td>
</tr>
<tr>
<td>H-5</td>
<td>Maintain gate, globe, ball, plug, and butterfly valves</td>
</tr>
<tr>
<td>I-5</td>
<td>Maintain and troubleshoot clutch systems</td>
</tr>
<tr>
<td>J-5</td>
<td>Form and/or bend sheet metal parts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A-6</th>
<th>Lockout/Tagout</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-6</td>
<td>Perform basic geometric calculations</td>
</tr>
<tr>
<td>C-6</td>
<td>Review blueprint notes and dimensions</td>
</tr>
<tr>
<td>D-6</td>
<td>Basic geometric calculations</td>
</tr>
<tr>
<td>E-6</td>
<td>Identify maintenance technician's hand tools</td>
</tr>
<tr>
<td>F-6</td>
<td>Use and care of horizontal and vertical band saws</td>
</tr>
<tr>
<td>G-6</td>
<td>Perform gas welding</td>
</tr>
<tr>
<td>H-6</td>
<td>Maintain gate, globe, ball, plug, and butterfly valves</td>
</tr>
<tr>
<td>I-6</td>
<td>Maintain and troubleshoot clutch systems</td>
</tr>
<tr>
<td>J-6</td>
<td>Form and/or bend sheet metal parts</td>
</tr>
</tbody>
</table>

## Skills

- A-1: Use protective equipment
- A-2: Accident prevention
- A-3: Working shift
- A-4: Fire safety
- A-5: Lifting safety
- A-6: Lockout/Tagout
- B-1: Perform basic arithmetic functions
- B-2: Convert fractions/decimals
- B-3: Convert metric/English measurements
- B-4: Perform basic algebraic operations
- B-5: Perform basic trigonometric functions
- B-6: Perform basic geometric calculations
- C-1: Identify basic types of drawings
- C-2: Identify basic layout of drawings
- C-3: Review blueprint notes and dimensions
- D-1: Use precision measuring tools
- D-2: Use precision measuring tools
- D-3: Basic shop mathematics
- D-4: Basic trigonometric functions
- D-5: Basic geometric calculations
- E-1: Identify and use maintenance technician's hand tools
- E-2: Identify and use hand held power tools
- E-3: Identify and use maintenance technician's hand tools
- E-4: Identify and use hand held power tools
- F-1: Use and care of milling machines
- F-2: Use and care of horizontal and vertical band saws
- F-3: Use and care of horizontal and vertical band saws
- F-4: Use and care of horizontal and vertical band saws
- F-5: Operate lathes
- F-6: Use and care of drill press
- G-1: Weld with shielded metal arc welding (SMAW) process
- G-2: Weld with exothermic gas
- G-3: Perform gas welding
- H-1: Maintain air conditioning systems
- H-2: Maintain pneumatic control circuits
- H-3: Troubleshoot positive displacement pumps
- H-4: Maintain gate, globe, ball, plug, and butterfly valves
- H-5: Maintain gate, globe, ball, plug, and butterfly valves
- H-6: Maintain gate, globe, ball, plug, and butterfly valves
- H-7: Troubleshoot and repair blowers
- H-8: Troubleshoot, maintain, and repair hydraulic systems
- H-9: Troubleshoot, maintain, and repair pneumatic systems
- I-1: Maintain and troubleshoot bell drive systems
- I-2: Maintain and troubleshoot gear power transmission drives
- I-3: Maintain and troubleshoot gear power transmission drives
- I-4: Maintain and troubleshoot clutch systems
- J-1: Layout sheet metal parts
- J-2: Form and/or bend sheet metal parts
- J-3: Fasten sheet metal parts together
- J-4: Form and/or bend sheet metal parts
- J-5: Fasten sheet metal parts together
- J-6: Form and/or bend sheet metal parts

## Notes

- A-8: Lockout/Tagout
- B-8: Convert fractions/decimals
- C-8: Convert metric/English measurements
- D-8: Perform basic algebraic operations
- E-8: Perform basic geometric calculations
- F-8: Operate lathes
- G-8: Operate lathes
- H-8: Troubleshoot positive displacement pumps
- I-8: Maintain gate, globe, ball, plug, and butterfly valves
- J-8: Fasten sheet metal parts together

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**End of Document**
**INDUSTRIAL MAINTENANCE MECHANIC** uses mechanical, pneumatic, hydraulic, and electrical skills to maintain, repair, and install equipment and machinery used in industry.

### Duties

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<thead>
<tr>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>S</th>
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</thead>
<tbody>
<tr>
<td><strong>Piping Operations</strong></td>
<td><strong>Basic Rigging</strong></td>
<td><strong>Bearing Maintenance</strong></td>
<td><strong>Use Computers</strong></td>
<td><strong>Align Shafts</strong></td>
<td><strong>Install/Align Machines</strong></td>
<td><strong>Maintain Electrical Devices</strong></td>
<td><strong>Basic Mechanical Concepts</strong></td>
<td><strong>Fasteners and Preloading</strong></td>
</tr>
</tbody>
</table>

### Tasks

<table>
<thead>
<tr>
<th>K-1 Perform basic piping fitting calculations</th>
<th>K-2 Cut, thread, and ream pipe</th>
<th>K-3 Pipe assembly</th>
<th>K-4 Install and adjust pipe support</th>
<th>K-5 Tubing</th>
<th>K-6 Fittings</th>
<th>K-7 Plastic pipe</th>
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</thead>
<tbody>
<tr>
<td>L-1 Rigging fundamentals</td>
<td>L-2 Demonstrate basic rigging skills</td>
<td>M-1 Plain bearings</td>
<td>M-2 Rolling element bearings</td>
<td>N-1 Perform basic pipe fitting operations</td>
<td>N-2 Perform spreadsheet operations</td>
<td>O-1 Principles of alignment</td>
</tr>
<tr>
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<tr>
<td>P-1 Install electrical connections</td>
<td>P-2 Setting and leveling</td>
<td>P-3 Grouting</td>
<td>P-4 Special mountings</td>
<td>Q-1 Use electrical test equipment</td>
<td>Q-2 Apply basic terms to electrical circuits</td>
<td>Q-3 Analyze series, parallel, and complex AC/DC circuits</td>
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<td>R-1 Force</td>
<td>R-2 Work</td>
<td>R-3 Mechanical motion and rate</td>
<td>R-4 Simple machines</td>
<td>R-5 Power</td>
<td>S-1 Fasteners and nomenclature</td>
<td>S-2 Application for various fasteners</td>
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</tbody>
</table>

**BEST COPY AVAILABLE**
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
- Using OSHA required safety equipment for the shop;
- Safety glasses;
- Hearing protection;
- Face shields;
- Gloves;
- Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
- Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify and describe common bolts and screws;
b. Give examples of common bolts and screws;
c. Describe how bolts and screws are sized;
d. List shapes of heads for common bolts and screws;
e. Identify and describe common nuts, washers, pins and rivets; and,
f. Identify and describe common keys, retaining rings, and self threading screws.

Reading Assignments:

The following chapters are assigned to read from Metal Work, Cupples, Glencoe Publishers, Latest Edition

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>26</td>
<td>Fasteners</td>
</tr>
</tbody>
</table>

Module Outline:

I. Introduction
II. Bolts
   A. Head
   B. Body
III. Screws
   A. Cap
   B. Machine
IV. Nuts
   A. Machine screw
   B. Jam
V. Washers
   A. Plain
   B. Lock
   C. Pre-assembled screw and washer
VI. Pins
   A. Cotter
   B. Tapered
VII. Keys
     A. Square
     B. Gib
     C. Woodruff
VIII. Retaining Ring
      A. Internal
      B. External
IX. Rivets
     A. Head
     B. Size
     C. Length
     D. Tinner
     E. Material
     F. Tubular
     G. Blind
X. How to Specify Fasteners
   A. Name
   B. Quantity
   C. Kind
   D. Size
   E. Shape
   F. Catalog
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Identify all fasteners displayed in lab; and,
   c. Identify all tools displayed in lab.
1. Instructor will demonstrate how to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

2. Student will demonstrate how to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

3. Instructor will grade student's ability to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

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Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Identify and describe common bolts and screws;
b. Give examples of common bolts and screws;
c. Describe how bolts and screws are sized;
d. List shapes of heads for common bolts and screws;
e. Identify and describe common nuts, washers, pins and rivets; and,
f. Identify and describe common keys, retaining rings, and self threading screws.

Reading Assignments:

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</thead>
<tbody>
<tr>
<td>26</td>
<td>Fasteners</td>
</tr>
</tbody>
</table>

Module Outline:

I. Introduction
II. Bolts
   A. Head
   B. Body
III. Screws
   A. Cap
   B. Machine
IV. Nuts
   A. Machine screw
   B. Jam

V. Washers
   A. Plain
   B. Lock
   C. Pre-assemble screw and washer

VI. Pins
    A. Cotter
    B. Tapered

VII. Keys
     A. Square
     B. Gib
     C. Woodruff

VIII. Retaining Ring
      A. Internal
      B. External

IX. Rivets
    A. Head
    B. Size
    C. Length
    D. Tinner
    E. Material
    F. Tubular
    G. Blind

X. How to Specify Fasteners
   A. Name
   B. Quantity
   C. Kind
   D. Size
   E. Shape
   F. Catalog
IMM-S2-LA
Application for Various Fasteners
Attachment 2: MASTER Laboratory Aid

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Student will demonstrate how to specify fasteners.
IMM-S2-LW
Application for Various Fasteners
Attachment 3: MASTER Laboratory Worksheet

1. Instructor will demonstrate how to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

2. Student will demonstrate how to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.

3. Instructor will grade student's ability to:
   a. Identify and describe common bolts and screws;
   b. Give examples of common bolts and screws;
   c. Describe how bolts and screws are sized;
   d. List shapes of heads for common bolts and screws;
   e. Identify and describe common nuts, washers, pins and rivets; and,
   f. Identify and describe common keys, retaining rings, and self threading screws.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to use screw extractors to remove a broken bolt.

Reading Assignments:

The following chapters are assigned to read from *Metal Work*, Cupples, Glencoe Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>25</td>
<td>Fasteners</td>
</tr>
</tbody>
</table>

Module Outline:

I. Screw Extractor Components
   A. Screw extractor
   B. Tap wrench

II. Procedure for Removing a Broken Bolt
   A. Use hand drill
   B. Deduct drill bit
   C. Secure drill bit in hand drill
   D. Drill hole in broken bolt
   E. Place tap wrench onto screw extractor
   F. Turn screw extractor counter clock wise
   G. When force to firm, stop turning and pull extract out, plus broken bolt
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Student will use screw extractor to remove broken bolt; and,
   c. Student will use diamond point chisel to remove broken bolt.
1. Instructor will demonstrate how to use screw extractors to remove a broken bolt.

2. Student will demonstrate how to use screw extractors to remove a broken bolt.

3. Instructor will grade student’s ability to use screw extractors to remove a broken bolt.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating
equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Clean threaded fasteners; and,
b. Restore threaded fasteners.

Reading Assignments:

The following chapters are assigned to read from Metal Work, Cupples, Glencoe Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
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<tbody>
<tr>
<td>15</td>
<td>Fasteners</td>
</tr>
</tbody>
</table>

Module Outline:

I. Cleaning Technique
   A. Air
   B. Liquid
   C. Cloth
II. Restoring Threads
IMM-S4-LA
Cleaning and Restoring Threaded Fasteners
Attachment 2: MASTER Laboratory Aid

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Student will demonstrate how to clean threaded fasteners; and,
   c. Student will demonstrate how to restore threaded fasteners.
1. Instructor will demonstrate how to:
   a. Clean threaded fasteners; and,
   b. Restore threaded fasteners.

2. Student will demonstrate how to:
   a. Clean threaded fasteners; and,
   b. Restore threaded fasteners.

3. Instructor will grade student's ability to:
   a. Clean threaded fasteners; and,
   b. Restore threaded fasteners.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Define torque;
b. Define preload;
c. List common torque pattern;
d. Define retorquing; and,
e. List common torque technique.

Reading Assignments:

The following chapters are assigned to read from Mechanics' and Millwrights' Guide, Nelson, Audel Publishers, Latest Edition:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Torque Wrench</td>
</tr>
</tbody>
</table>

Module Outline:

I. Torque
II. Preload
III. Torque Patterns
IV. Retorquing
V. Layout
VI. Standard Torquing Technique
VII. Non-Standard Torquing Techniques
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Demonstrate what effects are seen by lubricating threads prior to torquing; and,
b. Demonstrate what effects are seen by not lubricating threads prior to torquing.

Reading Assignments:

The following chapters are assigned to read from Mechanics’ and Millwrights’ Guide, Nelson, Audel Publishers, Latest Edition:

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<tr>
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</thead>
<tbody>
<tr>
<td>13</td>
<td>Mechanical Fasteners</td>
</tr>
</tbody>
</table>

Module Outline:

I. Lubrication
II. Torquing
III. Torquing Without Lubricating
IV. Lubrication Plus Torquing
IMM-S6-LA
Effects of Lubricating Threads Prior to Torquing
Attachment 2: MASTER Laboratory Aid

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Demonstrate what effects are seen by lubricating threads prior to torquing; and,
   c. Demonstrate what effects are seen by not lubricating threads prior to torquing.
Effects of Lubricating Threads Prior to Torquing
Attachment 3: MASTER Laboratory Worksheet

1. Instructor will demonstrate how lubrication affects torquing.

2. Student will demonstrate how lubrication affects torquing.

3. Instructor will grade student’s ability to demonstrate how lubrication affects torquing.
Standards of performance:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to demonstrate appropriate torquing technique.

Reading Assignments:

The following chapters are assigned to read from *Mechanics' and Millwrights' Guide*, Nelson, Audel Publishers, Latest Edition:

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</thead>
<tbody>
<tr>
<td>11</td>
<td>Torque Wrench</td>
</tr>
</tbody>
</table>

Module Outline:

I. Types of Torque Wrenches
II. Torque Wrench Selection
III. Use of Torque Wrench
IV. Care of Torque Wrench
V. Fastener Torquing
1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Student will demonstrate appropriate torquing technique.
IMM-S7-LW
Demonstrate Appropriate Torquing Technique
Attachment 3: MASTER Laboratory Worksheet

1. Instructor will demonstrate:
   a. Types of torque wrenches;
   b. Torque wrench selection;
   c. Use of torque wrench;
   d. Care of torque wrench; and,
   e. Fastener torquing.

2. Student will demonstrate:
   a. Types of torque wrenches;
   b. Torque wrench selection;
   c. Use of torque wrench;
   d. Care of torque wrench; and,
   e. Fastener torquing.

3. Instructor will grade student's ability to:
   a. List types of torque wrenches;
   b. Select appropriate torque wrench selection;
   c. Properly use torque wrench;
   d. Properly care of torque wrench; and,
   e. Torque fasteners.
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