This package consists of course syllabi, an instructor's handbook, and a student laboratory manual for a 2-year vocational training program to prepare students for entry-level employment as tool and die makers. 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 10 duties (and supporting technical workplace competencies): practice safety; apply mathematical concepts; interpret engineering drawings and control documents; demonstrate knowledge of manufacturing materials; measure/inspect; demonstrate knowledge of manufacturing processes; use computers; perform CAD/CAM (computer-aided design/computer-aided manufacturing) and CNC (computer numerical control) programming tasks; perform tool and die making operations; and operate electrical discharge machine (EDM). 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 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 for duties A-J. Each module in the student manual includes some or all of the following: objectives, outline, laboratory exercises, laboratory aids, and handouts.

(KC)
Tool & Die and EDM Series
Educational Resources for the Machine Tool Industry
Course Syllabi
Instructor’s Handbook
Student Laboratory Manual
a consortium of educators and industry

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY

Tool & Die and EDM Series
COURSE SYLLABI

Supported by the National Science Foundation's Advanced Technological Education Program
EDUCATIONAL RESOURCES FOR THE MACHINE TOOL INDUSTRY

Tool & Die and EDM Series COURSE SYLLABI

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 ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -
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 Mississippi
Evolving from a previously agrarian economy, the region served by Itawamba Community College now contains a significant industrial base. Approximately 45% of employed adults in the surrounding area work in manufacturing, with the predominant industries including metal-working, machinery, paper products, rubber/plastics, electrical components, furniture, apparel, and wood products. About 35-40% of all manufacturing employees work in the furniture industry. After World War II, several major metal-working companies established branch plants in the Tupelo area, a trend that has continued into the 1990's. Between 1975 and 1980, pressures of competition and technology caused a number of these companies to reconsider their continued presence in northern Mississippi, spurring action by regional economic development organizations to preserve an employment and tax base essential to the community. Many of their economic development initiatives involved the community college, leading directly to the establishment of its Tool and Die Making Technology program and introduction of training in CAD, CNC, robotics, and lasers.

Itawamba Community College
Itawamba Community College (ICC) provides university transfer programs, associate degree career programs, non-credit customized industry training, and continuing education to a rural five-county area in northeast Mississippi. Of the local population of approximately 170,000 persons, 79% are white and 19% black; the student profile at the College roughly mirrors the racial composition of the general population, and a high percentage of students are from low-income households. The mission of the College includes the mandate to provide “educational services which contribute to the needs of new, expanding, or existing businesses and industries and to the training needs of the people.” Accordingly, the College’s instructional programs are designed with national trends and the needs of business and industry in mind, and the objective of all courses and training is to provide both students and companies with what they need to succeed. The main campus is in Fulton and the vocational-technical campus in Tupelo.

Development Team
• Project Director: Don Benjamin, Associate Dean of Career Education, served as program manager and academic coordinator for the MASTER project.
• Site Coordinator: Barry Emison was responsible for industrial assessment and skills validation, as well as development of skill standards and course/program materials for the Tool and Die Technology component of the MASTER project.
• Subject Matter Experts: Several college academic and technology instructors served as advisors for basic academic competencies, sharing responsibility with Mr. Emison for compiling data from industry surveys and interviews during the skill standards development process. Donald Taylor and Terry Kitchens, Tool and Die Technology Instructors, served as technical advisors for workplace competencies and developed course curricula and program materials. They also served as co-instructors and coordinators for the MASTER pilot program in Tool and Die Technology.
**Introduction**

MASTER research indicates that individuals working as Tool and Die Makers will preferably have received at least two years of training and education in both academic and technical courses covering tool and die production methods and processes. This training may have been conducted in a vocational institution or college. Our research indicates that a minimum of two years of vocational training will prepare students with entry level skills necessary to begin work as a Tool and Die Maker.

In this two year program, the students progress through a series of courses designed to both educate and train students with knowledge and skills in areas such as manufacturing materials and methods, conventional and CNC machining, computer-aided drafting and design, engineering mechanics and design, computer-aided manufacturing, and tool and die design and maintenance. Students receive a wide range of training which enables them to seek jobs in many different tool and die making areas. The Tool and Die Making Technology Program at Itawamba Community College has been training Tool and Die Makers 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 Associate of Applied Science degrees from Itawamba Community College. The Tool and Die Making Technology 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 Tool and Die Making students. The Tool and Die Making Department at Itawamba Community College is recognized throughout Mississippi by large and small manufacturing companies as a premier source for entry-level technicians. Upon graduation, students are able to interpret complex drawings, select the correct materials, and perform all necessary machining processes. The curriculum has been designed to prepare students to enter the workforce as entry-level Tool and Die Makers. Laboratory work is emphasized with actual industrial equipment in order to prepare students for interesting, rewarding work in a wide variety of industries. The Tool and Die Making Technology department has a practical blend of theoretical knowledge and practical application which directly corresponds to modern uses in tool and die making.

After many interviews with practitioners from industry and discussions with educators, managers, supervisors, and others involved with machine-related occupations (specifically tool and die making technology), the MASTER Consortium Partners have agreed to present our definition of a tool and die maker as follows:

**TOOL AND DIE MAKER - skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.**
This volume contains the justification, documentation, and course syllabi for the courses which we recommend as minimum training for individuals desiring to become tool and die makers.

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 Tool and Die Making Technology, as shown on the following pages.

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 Tool and Die Maker has been included on the following pages.
Tool and Die Maker
(includes Electrical Discharge Machine)
Competency Profile

Job Analysis conducted and prepared by

MASTER
Machine Tool Advanced Skills
Technology Educational Resources Program
Consortium
# Tool and Die Maker
(includes Electrical Discharge Machine)

## Technical Workplace Competencies

### Duties

<table>
<thead>
<tr>
<th>A</th>
<th>Practice Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A-1</strong></td>
<td>Follow safety manuals and all safety regulations/requirements</td>
</tr>
<tr>
<td><strong>A-2</strong></td>
<td>Maintain safe equipment and machinery</td>
</tr>
<tr>
<td><strong>A-3</strong></td>
<td>Use safe operating procedures for hand and machine tools</td>
</tr>
<tr>
<td><strong>A-4</strong></td>
<td>Maintain a clean and safe work environment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B</th>
<th>Apply Mathematical Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B-1</strong></td>
<td>Perform basic arithmetic functions</td>
</tr>
<tr>
<td><strong>B-2</strong></td>
<td>Perform basic algebraic operations</td>
</tr>
<tr>
<td><strong>B-3</strong></td>
<td>Use basic geometric principles</td>
</tr>
<tr>
<td><strong>B-4</strong></td>
<td>Perform basic trigonometric operations</td>
</tr>
<tr>
<td><strong>B-5</strong></td>
<td>Use and apply Cartesian coordinate system</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C</th>
<th>Interpret Engineering Drawings and Related Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C-1</strong></td>
<td>Interpret and understand basic layout/types of drawings</td>
</tr>
<tr>
<td><strong>C-2</strong></td>
<td>Interpret, review, &amp; apply blueprint notes, dimensions, &amp; tolerances</td>
</tr>
<tr>
<td><strong>C-3</strong></td>
<td>Use and apply Geometric Dimensioning and Tolerancing (GD&amp;T)</td>
</tr>
<tr>
<td><strong>C-4</strong></td>
<td>Demonstrate traditional mechanical drafting-and-sketching techniques</td>
</tr>
<tr>
<td><strong>C-5</strong></td>
<td>Understand and use quality systems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D</th>
<th>Demonstrate Knowledge of Manufacturing Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D-1</strong></td>
<td>Identify materials with desired properties</td>
</tr>
<tr>
<td><strong>D-2</strong></td>
<td>Identify materials and processes to produce a part</td>
</tr>
<tr>
<td><strong>D-3</strong></td>
<td>Discuss classification systems for metal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E</th>
<th>Measure/Inspect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>E-1</strong></td>
<td>Understand metrology terms</td>
</tr>
<tr>
<td><strong>E-2</strong></td>
<td>Select measurement tools</td>
</tr>
<tr>
<td><strong>E-3</strong></td>
<td>Measure with hand held instruments</td>
</tr>
<tr>
<td><strong>E-4</strong></td>
<td>Eliminate measurement variables</td>
</tr>
<tr>
<td><strong>E-5</strong></td>
<td>Measure/inspect using surface plate and accessories</td>
</tr>
<tr>
<td><strong>E-6</strong></td>
<td>Inspect using stationary equipment</td>
</tr>
</tbody>
</table>
# Tool and Die Maker

(includes Electrical Discharge Machine)

## Technical Workplace Competencies

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F</strong> Demonstrate Knowledge of Manufacturing Processes</td>
<td><strong>F-1</strong> Discuss metal cutting and metal cutting tools</td>
</tr>
<tr>
<td></td>
<td><strong>F-2</strong> Operate metal saws</td>
</tr>
<tr>
<td></td>
<td><strong>F-3</strong> Operate drill presses and tooling</td>
</tr>
<tr>
<td></td>
<td><strong>F-4</strong> Operate engine and turret lathes and tooling</td>
</tr>
<tr>
<td></td>
<td><strong>F-5</strong> Operate vertical and horizontal mills and tooling</td>
</tr>
<tr>
<td></td>
<td><strong>F-6</strong> Operate precision grinders</td>
</tr>
<tr>
<td></td>
<td><strong>F-7</strong> Operate heat treating equipment and processes</td>
</tr>
<tr>
<td></td>
<td><strong>F-8</strong> Operate sheet metal equipment</td>
</tr>
<tr>
<td></td>
<td><strong>F-9</strong> Operate welding equipment and processes</td>
</tr>
<tr>
<td></td>
<td><strong>F-10</strong> Estimate time required/cost to produce a part</td>
</tr>
<tr>
<td><strong>G</strong> Use Computers</td>
<td><strong>G-1</strong> Use computer operating systems</td>
</tr>
<tr>
<td></td>
<td><strong>G-2</strong> Understand computer terminology</td>
</tr>
<tr>
<td></td>
<td><strong>G-3</strong> Use file management systems</td>
</tr>
<tr>
<td></td>
<td><strong>G-4</strong> Install and use software packages</td>
</tr>
<tr>
<td><strong>H</strong> Perform CAD/ CAM and CNC Programming Tasks</td>
<td><strong>H-1</strong> Discuss fundamentals of CNC machines and controls</td>
</tr>
<tr>
<td></td>
<td><strong>H-2</strong> Program and operate CNC milling machine and machining center</td>
</tr>
<tr>
<td></td>
<td><strong>H-3</strong> Program and operate CNC lathe</td>
</tr>
<tr>
<td></td>
<td><strong>H-4</strong> Use Computer-Aided Drafting (CAD) system</td>
</tr>
<tr>
<td></td>
<td><strong>H-5</strong> Create 3-D solid models</td>
</tr>
<tr>
<td></td>
<td><strong>H-6</strong> Use Computer-Aided Manufacturing (CAM) system</td>
</tr>
<tr>
<td><strong>I</strong> Perform Tool and Die Making Operations</td>
<td><strong>I-1</strong> Discuss basic types and functions of jigs and fixtures</td>
</tr>
<tr>
<td></td>
<td><strong>I-2</strong> Utilize concepts of jig and fixture design</td>
</tr>
<tr>
<td></td>
<td><strong>I-3</strong> Demonstrate understanding of different types of industrial dies</td>
</tr>
<tr>
<td></td>
<td><strong>I-4</strong> Utilize basic die theory</td>
</tr>
<tr>
<td></td>
<td><strong>I-5</strong> Utilize principles of die design</td>
</tr>
<tr>
<td></td>
<td><strong>I-6</strong> Perform tool and die repair</td>
</tr>
<tr>
<td></td>
<td><strong>I-7</strong> Demonstrate tool and die making skills</td>
</tr>
<tr>
<td><strong>J</strong> Operate Electrical Discharge Machine (EDM)</td>
<td><strong>J-1</strong> Discuss fundamentals of EDM</td>
</tr>
<tr>
<td></td>
<td><strong>J-2</strong> Setup and operate conventional sinker EDM</td>
</tr>
<tr>
<td></td>
<td><strong>J-3</strong> Program, setup, and operate CNC sinker EDM and EDM drill</td>
</tr>
<tr>
<td></td>
<td><strong>J-4</strong> Program, setup, and operate CNC wire EDM</td>
</tr>
</tbody>
</table>
Tool and Die Maker
(includes Electrical Discharge Machine)
Skills, Traits and Trends

Skills and Knowledge
Communication Skills
Technical Reading/Writing Skills
Ability to Comprehend Written/Verbal Instruction
Leadership Skills
Organizational Skills
Knowledge of Company Policies/Procedures
Knowledge of Employee/Employer Responsibilities
Ability to Work as Part of a Team
Knowledge of Company Quality Assurance Activities
Knowledge of Safety Regulations/Responsibilities
Project/Task Management Skills
Logical/Systematic Problem Solving Skills
Computer Skills
Numerical/Mathematical Skills
Use Measurement Tools
Use Inspection Devices
Drafting Skills
Knowledge of Industrial Materials
Knowledge of Manufacturing Processes
Mechanical Aptitude

Tool/Equipment Proficiency
Machinist’s Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Metal Layout Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Band Saws
Power Drills
Hydraulic/Arbor Press
Heat Treating Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
CNC Machining Center and Turning Center
Jig Boring Machines
Alignment/Calibration Tools
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Coordinate Measurement Machine

Traits and Attitudes
Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Consciousness
Motivation
Responsibility
Physical Ability
Professionalism
Trustworthiness
Personal Ethics
Innovative

Current Trends
Composites
In-Process Gauging
Rapid Tool Changing
Expanded Communication with Shop Floor
Multi-Axis Equipment
Computer-Integrated Manufacturing
Adaptive Controls
Conversational Programming
Artificial Intelligence
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**  
**Tool and Die Making Technology**  
(Associate of Applied Science Degree Program)

### First Semester*

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>LEC</th>
<th>LAB</th>
<th>CR</th>
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<tbody>
<tr>
<td>TLD 1016</td>
<td>Machine Tool Technology</td>
<td>3</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>TLD 1114</td>
<td>Introduction to Die Making Procedures</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>DDT 1113</td>
<td>Blueprint Reading and Drawing</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>CPT 1113</td>
<td>Introduction to Computers</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>MATH 1233</td>
<td>Applied Mathematics for Engineering Technicians</td>
<td>3</td>
<td>0</td>
<td>3</td>
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### Second Semester*

<table>
<thead>
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<tbody>
<tr>
<td>TLD 1133</td>
<td>Die Design I</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>TLD 1146</td>
<td>Die Making I</td>
<td>3</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>TLD 2713</td>
<td>Computer Numerical Control Operations I</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>DDT 1313</td>
<td>Principles of CAD</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 1113</td>
<td>English Composition I</td>
<td>3</td>
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### Third Semester*

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>TLD 2153</td>
<td>Die Design II</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>TLD 2166</td>
<td>Die Making II</td>
<td>3</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>TLD 2723</td>
<td>Computer Numerical Control Operations II</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>MATH 1323</td>
<td>Trigonometry</td>
<td>3</td>
<td>0</td>
<td>3</td>
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<tr>
<td>SPT 1113</td>
<td>Oral Communications</td>
<td>3</td>
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### Fourth Semester*

<table>
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<tbody>
<tr>
<td>TLD 2174</td>
<td>Die Making III</td>
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<td>TLD 2733</td>
<td>Computer Numerical Control Operations III</td>
<td>2</td>
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<td>TLD 2183</td>
<td>Special Project</td>
<td>1</td>
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<td>Social or Behavioral Science Elective</td>
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### Program Totals

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### Optional Courses:

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<td>TLD 2113</td>
<td>Fundamentals of EDM</td>
<td>2</td>
<td>2</td>
<td>3</td>
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<tr>
<td>TLD 2123</td>
<td>Advanced EDM</td>
<td>2</td>
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</tbody>
</table>
MASTER Course Descriptions
Tool and Die Making Technology
(Associate of Applied Science Degree Program)

First Semester

TLD 1016  Machine Tool Technology (3-6-6) is composed of fundamental skills related to machine tool operations. Topics covered in the course include safety, precision measurement, blueprint reading, hand and bench work, metallurgy, and the operation of a variety of machine tools.

TLD 1114  Introduction to Die Making Procedures (2-4-4) introduces tool and die making procedures including an orientation to metallurgy and die repair. Students are instructed and given practice in the inspection, disassembly, fabrication, and reassembly of die components.

DDT 1113  Blueprint Reading and Drawing (2-2-3) prepares students to read and interpret industrial drawings. Emphasis is placed on line identification, abbreviations, symbols, orthographic projection, auxiliary views, sectional views, drafting conventional practices, and sketching.

CPT 1113  Introduction to Computers (2-2-3) introduces information processing concepts including operating systems, word processing, spreadsheets, data management, graphics, and BASIC programming.

MATH 1233  Applied Mathematics for Engineering Technicians (3-0-3) equips the student with the mathematical skills and knowledge required for complex calculations in the machine tool trades. Emphasis is on the application of common mathematical concepts in a typical shop environment. Topics covered are basic arithmetic functions, algebraic operations, geometric principles, trigonometric operations, and the Cartesian coordinate system.

Second Semester

TLD 1133  Die Design I (2-2-3) covers the fundamentals of industrial dies and the machining characteristics of die components. This course serves as a continuation of Introduction to Die Making Procedures and Machine Tool Technology. The student is introduced to additional machining skills that will be encountered in typical die shops in the building of dies, jigs, fixtures, and precision machine parts.
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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Course Description</th>
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</thead>
<tbody>
<tr>
<td>TLD 1146</td>
<td>Die Making I (3-6-6)</td>
<td>continues Introduction to Die Making Procedures with instruction and practice in building a complete functional die from a blueprint. Emphasis is placed on analyzing requirements, managing the project toward completion, and becoming proficient in shop practices and procedures.</td>
</tr>
<tr>
<td>TLD 2713</td>
<td>Computer Numerical Control Operations I (2-2-3)</td>
<td>introduces computer numerical control machines. Includes instruction and practice related to the use of the Cartesian coordinate system, programming codes and styles, and operation of basic CNC machines.</td>
</tr>
<tr>
<td>DDT 1313</td>
<td>Principles of CAD (2-2-3)</td>
<td>uses CAD machines to design and draw various problems in the architectural, mechanical, and civil drafting areas. Emphasis is placed on the operations of the CAD system to solve these problems.</td>
</tr>
<tr>
<td>ENGL 1113</td>
<td>English Composition I (3-0-3)</td>
<td>is a study of grammar and composition, with emphasis on the sentence and the paragraph. The course includes reading and writing frequent themes.</td>
</tr>
<tr>
<td>TLD 2153</td>
<td>Die Design II (2-2-3)</td>
<td>continues Die Design I with more emphasis on actual die design and construction. Stresses the considerations involved in developing die components, such as calculation of clearances, cutting force, and press tonnage requirements.</td>
</tr>
<tr>
<td>TLD 2166</td>
<td>Die Making II (3-6-6)</td>
<td>augments Die Making I with instruction and practice in building a progressive die from a blueprint. Emphasis is placed on the application of the die building procedures learned in Die Making I toward fabricating more complex dies.</td>
</tr>
<tr>
<td>TLD 2723</td>
<td>Computer Numerical Control Operations II (2-2-3)</td>
<td>continues Computer Numerical Control Operations I with additional instruction in writing and editing CNC code manually utilizing more advanced commands and cycles. Additionally, students will be introduced to the use of a Computer-Aided Manufacturing (CAM) system for creation of code.</td>
</tr>
<tr>
<td>MATH 1323</td>
<td>Trigonometry (3-0-3)</td>
<td>studies solutions of right and oblique triangles, identities, trigonometric equations, and polar and parametric equations.</td>
</tr>
<tr>
<td>SPT 1113</td>
<td>Oral Communication (3-0-3)</td>
<td>covers correct and effective English; correct pronunciation; breath control; study and practice in making speeches for all occasions with its major emphasis on organization of material; and practice in speaking before the group.</td>
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</tbody>
</table>
Fourth Semester

TLD 2174
Die Making III (2-4-4) completes Die Making II with instruction and practice in building a compound die from a blueprint. Emphasis is placed on the application of the die building procedures learned in Die Making I and Die Making II toward fabricating more complex dies. Instruction and practice is also given on the use of the Wire Electrical Discharge Machine in the construction of die components.

TLD 2733
Computer Numerical Control Operations III (2-2-3) completes Computer Numerical Control Operations I and II with additional instruction and practice in the use of the Computer–Aided Manufacturing (CAM) system for creation of code. Also, the student will be introduced to the Wire Electrical Discharge Machine (EDM) and the Coordinate Measuring Machine (CMM).

TLD 2183
Special Project (1-4-3) provides the student with practical application of skills and knowledge gained through other courses in the Tool and Die Technology program. Students will apply material learned in previous and concurrent classes to design, produce, and test an industrial quality die. Emphasis is placed on the students making decisions, setting priorities and time lines, and realizing the overall responsibility of producing a high–quality product in a given amount of time.

Optional Courses

TLD 2113
Fundamentals of EDM (2-2-3) is an introduction to Electrical Discharge Machining. It includes instruction and practice in the principles of EDM technology as well as the set–up, programing, and operation of sinker and wire EDM.

TLD 2123
Advanced EDM (2-2-3) is a continuation of Fundamentals of EDM Technology with emphasis on 4–axis machining with the CNC wire EDM. Students will be given instruction and practice in the programming of complex parts which utilize the 3rd and 4th axis positioning capabilities of wire EDMs.
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 Tool and Die Making Technology. 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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<td>Rarely</td>
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<td>Routinely with Supervision</td>
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<td>Routinely with Limited</td>
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<td>Supervision</td>
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<td>Routinely Without Supervision</td>
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<td>Initiates/Improves/Modifies</td>
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<td>and Supervises Others</td>
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</table>

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.
### TOOL AND DIE MAKER

(includes Electrical Discharge Machine)

**Technical Workplace Competencies and Course Crosswalk**

<table>
<thead>
<tr>
<th>A. PRACTICE SAFETY</th>
<th>B. APPLY MATHEMATICAL CONCEPTS</th>
<th>C. INTERPRET ENGINEERING DRAWINGS AND RELATED DOCUMENTS</th>
<th>D. DEMONSTRATE KNOWLEDGE OF MANUFACTURING MATERIALS</th>
<th>E. MEASURE/INSPECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1 Follow Safety Manuals and All Safety Regulations/Requirements</td>
<td>B-1 Perform Basic Arithmetic Functions</td>
<td>C-1 Interpret and Understand Basic Layout/Types of Drawings</td>
<td>D-1 Identify Materials With Desired Properties</td>
<td>E-1 Understand Metrology Terms</td>
</tr>
<tr>
<td>A-2 Maintain Safe Equipment and Machinery</td>
<td>B-2 Perform Basic Algebraic Operations</td>
<td>C-2 Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances</td>
<td>D-2 Identify Materials and Processes to Produce a Part</td>
<td>E-2 Select Measurement Tools</td>
</tr>
<tr>
<td>A-3 Use Safe Operating Procedures for Hand and Machine Tools</td>
<td>B-3 Use Basic Geometric Principles</td>
<td>C-3 Use and Apply Geometric Dimensioning and Tolerancing (GD&amp;T)</td>
<td>D-3 Discuss Classification Systems for Metal</td>
<td></td>
</tr>
<tr>
<td>A-4 Maintain a Clean and Safe Work Environment</td>
<td>B-4 Perform Basic Trigonometric Operations</td>
<td>C-4 Demonstrate Traditional Mechanical Drafting and Sketching Techniques</td>
<td></td>
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</tr>
<tr>
<td>A-5 Use Safe Material Handling Practices</td>
<td>B-5 Use and Apply Cartesian Coordinate System</td>
<td>C-5 Understand and Use Quality Systems</td>
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<tr>
<td>A-6 Consult and Apply MSDS for Hazards of Various Materials</td>
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</table>

**Exit Proficiency Level**

- **I** = Introduced and Taught
- **R** = Repeated and Reinforced
- **M** = Mastered
### TOOL AND DIE MAKER
*(includes Electrical Discharge Machine)*

#### Technical Workplace Competencies and Course Crosswalk

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Intro to Die Making Procedures</th>
<th>Die Design I</th>
<th>CNC Operations I</th>
<th>CNC Operations II</th>
<th>CNC Operations III</th>
<th>Die Making I</th>
<th>Die Making II</th>
<th>Special Project</th>
<th>Blueprint Reading</th>
<th>Principles of CAD</th>
<th>Introduction to Computers</th>
<th>Trigonometry</th>
<th>Fundamentals of EDM</th>
<th>Advanced EDM</th>
<th>Exit Proficiency Level</th>
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<tbody>
<tr>
<td>E-3 Measure With Hand Held Instruments</td>
<td>I R R R R R R R R R R M M M M</td>
<td>R R R R R R R R</td>
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<tr>
<td>E-4 Eliminate Measurement Variables</td>
<td>I R R R R R R R R R R M M M M</td>
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<tr>
<td>E-5 Measure/Inspect Using Surface Plate and Accessories</td>
<td>I R R R R R R R R R R R M M M M</td>
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<tr>
<td>E-6 Inspect Using Stationary Equipment</td>
<td>I R R R R R R R R R R R R R R</td>
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#### F. DEMONSTRATE KNOWLEDGE OF MANUFACTURING PROCESSES

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<th>CNC Operations II</th>
<th>CNC Operations III</th>
<th>Die Making I</th>
<th>Die Making II</th>
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<th>Blueprint Reading</th>
<th>Principles of CAD</th>
<th>Introduction to Computers</th>
<th>Trigonometry</th>
<th>Fundamentals of EDM</th>
<th>Advanced EDM</th>
<th>Exit Proficiency Level</th>
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<tbody>
<tr>
<td>F-1 Discuss Metal Cutting and Metal Cutting Tools</td>
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<td>R R R R R R R R</td>
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<tr>
<td>F-2 Operate Metal Saws</td>
<td>I R R R R R R R R R R R R R R</td>
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<tr>
<td>F-3 Operate Drill Presses and Tooling</td>
<td>I R R R R R R R R R R R R R R</td>
<td>R R R R R R R R</td>
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<tr>
<td>F-4 Operate Engine and Turret Lathes and Tooling</td>
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<tr>
<td>F-5 Operate Vertical and Horizontal Mills and Tooling</td>
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<tr>
<td>F-6 Operate Precision Grinders</td>
<td>I R R R R R R R R R R R R R R</td>
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<tr>
<td>F-7 Operate Heat Treating Equipment and Processes</td>
<td>I R R R R R R R R R R R R R R</td>
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<tr>
<td>F-8 Operate Sheet Metal Equipment</td>
<td>I R R R R R R R R R R R R R R</td>
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<tr>
<td>F-9 Operate Welding Equipment and Processes</td>
<td>I R R R R R R R R R R R R R R</td>
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<tr>
<td>F-10 Estimate Time Required/Cost to Produce a Part</td>
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#### G. USE COMPUTERS

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Intro to Die Making Procedures</th>
<th>Die Design I</th>
<th>CNC Operations I</th>
<th>CNC Operations II</th>
<th>CNC Operations III</th>
<th>Die Making I</th>
<th>Die Making II</th>
<th>Special Project</th>
<th>Blueprint Reading</th>
<th>Principles of CAD</th>
<th>Introduction to Computers</th>
<th>Trigonometry</th>
<th>Fundamentals of EDM</th>
<th>Advanced EDM</th>
<th>Exit Proficiency Level</th>
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<tbody>
<tr>
<td>G-1 Use Computer Operating Systems</td>
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<tr>
<td>G-2 Understand Computer Terminology</td>
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<td>G-3 Use File Management Systems</td>
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<td>G-4 Install and Use Software Packages</td>
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#### H. PERFORM CAD/CAM AND CNC PROGRAMMING TASKS

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Intro to Die Making Procedures</th>
<th>Die Design I</th>
<th>CNC Operations I</th>
<th>CNC Operations II</th>
<th>CNC Operations III</th>
<th>Die Making I</th>
<th>Die Making II</th>
<th>Special Project</th>
<th>Blueprint Reading</th>
<th>Principles of CAD</th>
<th>Introduction to Computers</th>
<th>Trigonometry</th>
<th>Fundamentals of EDM</th>
<th>Advanced EDM</th>
<th>Exit Proficiency Level</th>
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<tbody>
<tr>
<td>H-1 Discuss Fundamentals of CNC Machines and Controls</td>
<td>I R R R R R R R R R R R R R R</td>
<td>R R R R R R R R</td>
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<tr>
<td>H-2 Program and Operate CNC Milling Machine and Machining Center</td>
<td>I R R R R R R R R R R R R R R</td>
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<tr>
<td>H-3 Program and Operate CNC Lathe</td>
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<tr>
<td>H-4 Use Computer-Aided Drafting (CAD) System</td>
<td>I R R R R R R R R R R R R R R</td>
<td>R R R R R R R R</td>
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<tr>
<td>H-5 Create 3-D Solid Models</td>
<td>I R R R R R R R R R R R R R R</td>
<td>R R R R R R R R</td>
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</tr>
<tr>
<td>H-6 Use Computer-Aided Manufacturing (CAM) System</td>
<td>I R R R R R R R R R R R R R R</td>
<td>R R R R R R R R</td>
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</table>

* I=Introduced and Taught  R=Repeated and Reinforced  M=Mastered

**BEST COPY AVAILABLE**
## TOOL AND DIE MAKER
*(includes Electrical Discharge Machine)*

**Technical Workplace Competencies and Course Crosswalk**

<table>
<thead>
<tr>
<th>I. PERFORM TOOL AND DIE MAKING OPERATIONS</th>
<th>I-1 Discuss Basic Types and Functions of Jigs and Fixtures</th>
<th>I-2 Utilize Concepts of Jig and Fixture Design</th>
<th>I-3 Demonstrate Understanding of Different Types of Industrial Dies</th>
<th>I-4 Utilize Basic Die Theory</th>
<th>I-5 Utilize Principles of Die Design</th>
<th>I-6 Perform Tool and Die Repair</th>
<th>I-7 Demonstrate Tool and Die Making Skills</th>
</tr>
</thead>
<tbody>
<tr>
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<table>
<thead>
<tr>
<th>J. OPERATE ELECTRICAL DISCHARGE MACHINE (EDM)</th>
<th>J-1 Discuss Fundamentals of EDM</th>
<th>J-2 Setup and Operate Conventional Sinker EDM</th>
<th>J-3 Program, Setup, and Operate CNC Sinker EDM and EDM Drill</th>
<th>J-4 Program, Setup, and Operate CNC Wire EDM</th>
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</table>

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SCANS

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:**
- **Resources:** Identifies, organizes, plans, and allocates resources
- **Interpersonal:** Works with others
- **Information:** Acquires and uses information
- **Systems:** Understands complex inter-relationships
- **Technology:** Works with a variety of technologies

**FOUNDATION SKILLS:**
- **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens, and speaks well
- **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn, and reasons
- **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, integrity, and honesty

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 Tool and Die Making Technology

## (Associate of Applied Science Degree Program)

### First Semester*

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>LEC</th>
<th>LAB</th>
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<tbody>
<tr>
<td>TLD 1016</td>
<td>Machine Tool Technology</td>
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<tr>
<td>TLD 1114</td>
<td>Introduction to Die Making Procedures</td>
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<td>4</td>
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<tr>
<td>DDT 1113</td>
<td>Blueprint Reading and Drawing</td>
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<td>CPT 1113</td>
<td>Introduction to Computers</td>
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<td>MATH 1233</td>
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Total Credits: 12

### Second Semester*

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<td>TLD 1133</td>
<td>Die Design I</td>
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<td>TLD 1146</td>
<td>Die Making I</td>
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<td>TLD 2713</td>
<td>Computer Numerical Control Operations I</td>
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<td>DDT 1313</td>
<td>Principles of CAD</td>
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<td>English Composition I</td>
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Total Credits: 12

### Third Semester*

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<td>TLD 2166</td>
<td>Die Making II</td>
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<td>TLD 2723</td>
<td>Computer Numerical Control Operations II</td>
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<td>MATH 1323</td>
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<td>SPT 1113</td>
<td>Oral Communications</td>
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Total Credits: 13

### Fourth Semester*

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<tr>
<td>TLD 2174</td>
<td>Die Making III</td>
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<td>TLD 2733</td>
<td>Computer Numerical Control Operations III</td>
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<td>TLD 2183</td>
<td>Special Project</td>
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<td>Humanities/Fine Arts Elective</td>
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<td>Social or Behavioral Science Elective</td>
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Total Credits: 11

Program Totals: 48, 46, 71

### Optional Courses:

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<tr>
<th>Course</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>TLD 2113</td>
<td>Fundamentals of EDM</td>
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<td>3</td>
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<tr>
<td>TLD 2123</td>
<td>Advanced EDM</td>
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</table>

Total Credits: 71
MASTER PROGRAM
Machine Tool Technology
COURSE SYLLABUS

Total lecture hours: 48  Total lab hours: 96  Credit hours: 6

COURSE DESCRIPTION:
Is composed of fundamental skills related to machine tool operations. Topics covered in the course include safety, precision measurement, blueprint reading, hand and bench work, metallurgy, and the operation of a variety of machine tools.

PREREQUISITES:  NONE

COURSE OBJECTIVES:
After successful completion of this course, the students will be able to:
1. Practice safety in the machine shop;
2. Perform accurate measurements using precision measuring tools;
3. Discuss the physics of metal cutting and metal cutting tools;
4. Set-up and operate engine lathes;
5. Set-up and operate milling machines;
6. Set-up and operate metal saws;
7. Set-up and operate drilling machines;
8. Set-up and operate precision grinders;
9. Discuss the basics of welding technology; and,
10. Discuss the basics of sheet metal processes.

REQUIRED COURSE MATERIALS:


Hand Tools/Quantity Required:
Safety Glasses 1 pair
6 inch Ruler 1/8, 1/16, 1/32, and 1/64 inch

METHOD OF INSTRUCTION:

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

Laboratory: Laboratory will be a hands-on machining 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:

Lecture Topics Contact Hrs.
Introduction to Machine Tools
Shop Safety
Blueprint Reading
Precision Measurement & Inspection
Physics of Metal Cutting
Cutting Tool Materials
The Engine Lathe
Layout
The Bandsaw
Hand Tools and Bench Work
The Milling Machine
Cutting Fluids
Drilling Machines
The Grinding Machine
Metallurgy
Other Manufacturing Processes Total Lecture Hours 48
### LAB OUTLINE:

<table>
<thead>
<tr>
<th>Lab Topics</th>
<th>Contact Hrs.</th>
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</thead>
<tbody>
<tr>
<td>Shop Orientation and Safety</td>
<td>2</td>
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<tr>
<td>Inspection and Measurement</td>
<td>2</td>
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<tr>
<td>Grinding a Lathe Tool</td>
<td>2</td>
</tr>
<tr>
<td>Use of the Engine Lathe</td>
<td>3</td>
</tr>
<tr>
<td>Project (Turned Shaft)</td>
<td>9</td>
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<tr>
<td>Thread Cutting on the Lathe</td>
<td>3</td>
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<tr>
<td>Layout</td>
<td>2</td>
</tr>
<tr>
<td>Use of the Bandsaw</td>
<td>2</td>
</tr>
<tr>
<td>Hand Tools and Bench Work</td>
<td>2</td>
</tr>
<tr>
<td>Use of the Milling Machine</td>
<td>3</td>
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<tr>
<td>Project (T-Bolts)</td>
<td>6</td>
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<tr>
<td>Use of the Drilling Machine</td>
<td>2</td>
</tr>
<tr>
<td>Project (Parallel Clamp)</td>
<td>9</td>
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<tr>
<td>Use of the Grinding Machine</td>
<td>2</td>
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<tr>
<td>Heat Treatment of Steel</td>
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<tr>
<td>Project (V-Block)</td>
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<tr>
<td>Project (Mini-Vise)</td>
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<tr>
<td><strong>Total Lab Hours</strong></td>
<td><strong>96</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 oral messages and other cues
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral 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 oral classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential oral 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:
   TLD-A1 through TLD-A6;
   TLD-B1 through TLD-B5;
   TLD-C1 through TLD-C3;
   TLD-C5;
   TLD-D1 through TLD-D3;
   TLD-E1 through TLD-E6; and,
   TLD-F1 through TLD-F10.

MASTER PROGRAM
Introduction to Die Making Procedures
COURSE SYLLABUS

Total lecture hours: 32  Total lab hours: 64  Credit hours: 4

COURSE DESCRIPTION:
Introduces tool and die making procedures including an orientation to metallurgy and die repair. Students are instructed and given practice in the inspection, disassembly, fabrication, and reassembly of die components.

PREREQUISITES:  NONE

COURSE OBJECTIVES:
After successful completion of this course, the students will be able to:
1. Understand die terminology;
2. Identify die components;
3. Explain the operation of industrial dies;
4. Practice safety in the die shop;
5. Explain basic die making procedures;
6. Properly transport and handle dies;
7. Perform disassembly and assembly of die components; and,
8. Repair or replace die components.

REQUIRED COURSE MATERIALS:

Lab Manual:  None

Hand Tools/Quantity Required:
Safety Glasses  1 pair
6 inch Ruler  1/8, 1/16, 1/32, and 1/64 grad.

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>Introduction to Dies</td>
<td></td>
</tr>
<tr>
<td>Safety in Handling and Transport of Dies</td>
<td></td>
</tr>
<tr>
<td>Die Terminology and Components</td>
<td></td>
</tr>
<tr>
<td>Die Operation and Performance</td>
<td></td>
</tr>
<tr>
<td>Part Inspection for Identification of Die Problems</td>
<td></td>
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<tr>
<td>Disassembly and Assembly of Die Set</td>
<td></td>
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<tr>
<td>Inspection of Die Set and Die Components</td>
<td></td>
</tr>
<tr>
<td>Die Block Construction and Repair</td>
<td></td>
</tr>
<tr>
<td>Die Block Mounting Procedures</td>
<td></td>
</tr>
<tr>
<td>Construction, Sharpening, and Mounting of Punches</td>
<td></td>
</tr>
<tr>
<td>Purpose and Construction of Pilots</td>
<td></td>
</tr>
<tr>
<td>Purpose and Construction of Backing Plates</td>
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Total Lecture Hours 32

LAB OUTLINE:

<table>
<thead>
<tr>
<th>Lab Topics</th>
<th>Contact Hrs.</th>
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<tbody>
<tr>
<td>Orientation to Die Sets</td>
<td>2</td>
</tr>
<tr>
<td>Safety with Die Sets and in Machine Shop</td>
<td>2</td>
</tr>
<tr>
<td>Operation of Die Set in Punch Press</td>
<td>2</td>
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<tr>
<td>Project (Disassembly and Assembly of Die Set)</td>
<td>4</td>
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<tr>
<td>Inspect Die Components</td>
<td>3</td>
</tr>
<tr>
<td>Project (Sharpen Die Components)</td>
<td>9</td>
</tr>
<tr>
<td>Project (Construction of Die Block)</td>
<td>12</td>
</tr>
<tr>
<td>Project (Punch and Pilot)</td>
<td>12</td>
</tr>
<tr>
<td>Project (V-Form Die Block)</td>
<td>18</td>
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</tbody>
</table>

Total Lab Hours 64
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 oral 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 oral classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential oral 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:**
   - TLD-A1 through TLD-A6;
   - TLD-B1 through TLD-B5;
   - TLD-C1 through TLD-C3;
   - TLD-D1 through TLD-D3;
   - TLD-E1 through TLD-E6;
   - TLD-F1 through TLD-F9; and,
   - TLD-I1 through TLD-I7.


MASTER PROGRAM
Blueprint Reading and Drawing
COURSE SYLLABUS

Total lecture hours: 32  Total lab hours: 32  Credit hours: 3

COURSE DESCRIPTION:

Prepares students to read and interpret industrial drawings. Emphasis is placed on line identification, abbreviations, symbols, orthographic projection, auxiliary views, sectional views, drafting conventional practices, and sketching.

PREREQUISITES:  NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Interpret and understand basic layout/types of drawings;
2. Interpret and apply blueprint notes, dimensions, and tolerances;
3. Use and apply geometric dimensioning and tolerancing (GD&T) methodology; and,
4. Demonstrate traditional mechanical drafting skills.

REQUIRED COURSE MATERIALS:

Lab Manual:  None

Supplies:
Triangular Engineer's Scale
45° Triangle
30° X 60° Triangle
Circle Template
Compass
Mechanical Pencils

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 lab rules and safety regulations.

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<tr>
<th>Lecture Topics</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Blueprint Reading</td>
<td>2</td>
</tr>
<tr>
<td>A. Parts of the Blueprint</td>
<td></td>
</tr>
<tr>
<td>B. Standards Used in Blueprints</td>
<td></td>
</tr>
<tr>
<td>C. Types of Drawings</td>
<td></td>
</tr>
<tr>
<td>The Alphabet of Lines</td>
<td>2</td>
</tr>
<tr>
<td>Orthographic Projection</td>
<td>4</td>
</tr>
<tr>
<td>Auxiliary Views</td>
<td>2</td>
</tr>
<tr>
<td>Sectional Views</td>
<td>2</td>
</tr>
<tr>
<td>Notes and Dimensions</td>
<td>4</td>
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<tr>
<td>Tolerances and Limits</td>
<td>4</td>
</tr>
<tr>
<td>Geometric Dimensioning and Tolerancing (GD&amp;T)</td>
<td>4</td>
</tr>
<tr>
<td>Technical Sketching and Drafting</td>
<td>8</td>
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<tr>
<td><strong>Total Lecture Hours</strong></td>
<td><strong>32</strong></td>
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LAB OUTLINE:

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<thead>
<tr>
<th>Lab Topics</th>
<th>Contact Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifying Parts of a Blueprint; Line Identification</td>
<td>1</td>
</tr>
<tr>
<td>Multi-View Drawings; Auxiliary Views</td>
<td>6</td>
</tr>
<tr>
<td>Notes and Dimensions</td>
<td>5</td>
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<tr>
<td>Tolerances and Limits</td>
<td>5</td>
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<tr>
<td>Sectional Views</td>
<td>2</td>
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<tr>
<td>GD&amp;T</td>
<td>4</td>
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<tr>
<td>Technical Sketching</td>
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<tr>
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   1. Participates as a member of the team, contributing to group effort
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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 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
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   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
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   d. Demonstrates ability to read, interpret, and use standard measuring devices
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4. Listening: Receives, attends to, interprets, and responds to oral messages and other cues
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral 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 oral classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential oral 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:
   - TLD-B1 through TLD-B5; and,
   - TLD-C1 through TLD-C4.
COURSE DESCRIPTION:

Introduces information processing concepts including operating systems, word processing, spreadsheets, data management, graphics, and BASIC programming.

PREREQUISITES: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Use computer operating systems;
2. Understand computer terminology;
3. Use file management systems;
4. Install and use software packages; and,
5. Perform backup on personal computer.

REQUIRED COURSE MATERIALS:

Textbook: None
Lab Manual: Provided by Instructor

Hand Tools/Quantity Required:
3½" Data Diskette

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 lab rules and safety regulations.

LECTURE OUTLINE:

<table>
<thead>
<tr>
<th>Lecture Topic</th>
<th>Contact Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Computers</td>
<td></td>
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<tr>
<td>Hardware and Software</td>
<td></td>
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<tr>
<td>Hardware Components and Terminology</td>
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<tr>
<td>Computer Operating Systems</td>
<td></td>
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<tr>
<td>Directory Structure and File Management</td>
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<tr>
<td>Word Processing Software</td>
<td></td>
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<tr>
<td>Spreadsheet Software</td>
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<tr>
<td>Databases</td>
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<tr>
<td>Using Peripheral Devices</td>
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<tr>
<td>Backup and Restore Functions</td>
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<tr>
<td>Installation of Software</td>
<td></td>
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<tr>
<td>Introduction to Use of Networking</td>
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Total Lecture Hours 32

LAB OUTLINE:

<table>
<thead>
<tr>
<th>Lab Topics</th>
<th>Contact Hrs.</th>
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<tbody>
<tr>
<td>Lab Orientation and Safety</td>
<td>1</td>
</tr>
<tr>
<td>Demonstration of Hardware</td>
<td>2</td>
</tr>
<tr>
<td>Use Computer Operating Systems</td>
<td>2</td>
</tr>
<tr>
<td>Create Directories and Save Files</td>
<td>2</td>
</tr>
<tr>
<td>Create Document using Word Processor Software</td>
<td>4</td>
</tr>
<tr>
<td>Create Spreadsheet</td>
<td>4</td>
</tr>
<tr>
<td>Create Database</td>
<td>6</td>
</tr>
<tr>
<td>Printing (in each software program and DOS)</td>
<td>3</td>
</tr>
<tr>
<td>Perform Backup and Restore of Selected Files</td>
<td>3</td>
</tr>
<tr>
<td>Install Software</td>
<td>3</td>
</tr>
<tr>
<td>Log in to Network</td>
<td>2</td>
</tr>
</tbody>
</table>

Total Lab Hours 32
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
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 oral messages and other cues
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral 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 oral classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential oral 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 spontaneously organize and present appropriate answers and/or short presentations for classroom and/or assessment purposes

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 shared 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:
   TLD-G1 through TLD-G4
MASTER PROGRAM
Applied Mathematics for Engineering Technicians
COURSE SYLLABUS

Total lecture hours: 48  Total lab hours: 0  Credit hours: 3

COURSE DESCRIPTION:
Equips the student with the mathematical skills and knowledge required for complex calculations in the machine tool trades. Emphasis is on the application of common mathematical concepts in a typical shop environment. Topics covered are basic arithmetic functions. Algebraic operations, geometric principles, trigonometric operations, and the Cartesian coordinate system.

PREREQUISITE: None

COURSE OBJECTIVES:
After successful completion of this course, the students will be able to:
1. Perform basic arithmetic functions;
2. Perform basic algebraic operations;
3. Use basic geometric principles;
4. Perform basic trigonometric operations; and,
5. Use and apply the Cartesian coordinate system.

REQUIRED COURSE MATERIALS:


Supplies: Scientific Calculator

METHODS OF INSTRUCTION:
Lecture: Didactic presentations will include lecture, video and demonstrations.
**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 assignments;
2. Apply theory to assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments, including writing assignments, and oral presentations;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
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<thead>
<tr>
<th>Lecture Topics</th>
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</thead>
<tbody>
<tr>
<td><strong>Section A</strong></td>
<td></td>
</tr>
<tr>
<td>Operations on Whole Numbers</td>
<td>8</td>
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<tr>
<td>Operations on Fractions</td>
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<tr>
<td>Operations on Decimal Fractions</td>
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<tr>
<td>Metric/English Conversions</td>
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<tr>
<td><strong>Section B</strong></td>
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<tr>
<td>Evaluating Algebraic Expressions</td>
<td>15</td>
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<tr>
<td>Signed Numbers</td>
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<tr>
<td>Equations with One Unknown Variable</td>
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<td>Ratio and Proportion Problems</td>
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<tr>
<td><strong>Section C</strong></td>
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<tr>
<td>Angular Geometric Principles</td>
<td>8</td>
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<tr>
<td>Perimeter of Geometric Figures</td>
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<tr>
<td>Area of Geometric Figures</td>
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<tr>
<td>Volume of Geometric Figures</td>
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<tr>
<td>Lateral Surface Area of Geometric Figures</td>
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<tr>
<td><strong>Section D</strong></td>
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<tr>
<td>The Pythagorean Theorem</td>
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<tr>
<td>Trigonometric Functions</td>
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<tr>
<td>Isosceles Triangles</td>
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<tr>
<td><strong>Section E</strong></td>
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<tr>
<td>The Cartesian Coordinate System</td>
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<tr>
<td>Plotting Points</td>
<td></td>
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<tr>
<td>Calculating Bolt Hole Circles</td>
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<td><strong>Total Lecture Hours</strong></td>
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COURSE OBJECTIVES: SCANS COMPETENCIES

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      1. Acquires and evaluates information
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      1. Chooses relevant procedures, tools, and equipment
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A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

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   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
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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
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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
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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:
   TLD-B1 through TLD-B5.
# MASTER Curriculum

**Tool and Die Making Technology**  
(Associate of Applied Science Degree Program)

### First Semester*

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>LEC</th>
<th>LAB</th>
<th>CR</th>
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<tbody>
<tr>
<td>TLD 1016</td>
<td>Machine Tool Technology</td>
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<td>DDT 1113</td>
<td>Blueprint Reading and Drawing</td>
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<tr>
<td>CPT 1113</td>
<td>Introduction to Computers</td>
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<td>MATH 1233</td>
<td>Applied Mathematics for Engineering Technicians</td>
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**Program Totals**: 48 46 71

### Second Semester*

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<td>Die Design I</td>
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<td>TLD 1146</td>
<td>Die Making I</td>
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<td>TLD 2713</td>
<td>Computer Numerical Control</td>
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<td>DDT 1313</td>
<td>Principles of CAD</td>
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<td>ENGL 1113</td>
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**Program Totals**: 12 14 19

### Third Semester*

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<td>MATH 1323</td>
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**Program Totals**: 13 10 18

### Fourth Semester*

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<td>Social or Behavioral Science Elective</td>
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**Program Totals**: 11 10 16

### Optional Courses:

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<tr>
<td>TLD 2113</td>
<td>Fundamentals of EDM</td>
<td>2</td>
<td>2</td>
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<tr>
<td>TLD 2123</td>
<td>Advanced EDM</td>
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</table>
COURSE DESCRIPTION:

Covers the fundamentals of design of industrial dies and the machining characteristics of die components. This course serves as a continuation of Introduction to Die Making Procedures and Machine Tool Technology. The student is introduced to additional machining skills that will be encountered in typical die shops in the building of dies, jigs, fixtures, and precision machine parts.

PREREQUISITES:

Machine Tool Technology; Introduction to Die Making Procedures

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Practice safety in the die shop;
2. Make advanced set-ups using milling machine accessories (indexing head, rotary head, etc.);
3. Make advanced set-ups using lathe accessories (taper attachment, four-jaw chuck, etc.);
4. Make advanced set-ups using grinding machine accessories (sine bar or chuck, form wheels, etc.); and,
5. Set-up and operate tool and cutter grinder.

REQUIRED COURSE MATERIALS:

Hand Tools/Quantity Required:
Safety Glasses 1 pair
6 inch Ruler 1/8, 1/16, 1/32, and 1/64 grad.

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>
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</thead>
<tbody>
<tr>
<td>Introduction to Die and Fixture Design</td>
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</tr>
<tr>
<td>Safety in a Die Shop</td>
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</tr>
<tr>
<td>Stamping Designs</td>
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</tr>
<tr>
<td>Die Engineering — Planning and Design</td>
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<td>Special Characteristics of Die Components</td>
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</tr>
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<td>Special Milling Operations</td>
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</tr>
<tr>
<td>Tool and Cutter Grinder</td>
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<tr>
<td>Indexing or Dividing Head</td>
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<tr>
<td>Special Grinding Operations</td>
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<tr>
<td>Special Turning Operations</td>
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<tr>
<td>Punch and Die Shoe Construction</td>
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<tr>
<td>Sine Bar and Vises</td>
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<tr>
<td>Construction of V–Dies</td>
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<td>Hardness Testing of Metal</td>
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Total Lecture Hours 32
LAB OUTLINE:

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<td>Safety in the Die Shop</td>
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<tr>
<td>Visual Survey of Stampings</td>
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<tr>
<td>Project (Mill T-Slot and Dovetail in Block)</td>
<td>3</td>
</tr>
<tr>
<td>Project (Grind Radius Tool)</td>
<td>3</td>
</tr>
<tr>
<td>Project (Mill Convex and Concave Radius in Block)</td>
<td>3</td>
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<tr>
<td>Project (Grind Radius Tool)</td>
<td>6</td>
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<tr>
<td>Project (Dress Grinding Wheel)</td>
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<tr>
<td>Project (Grind Radius on Block)</td>
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<tr>
<td>Project (Tapered Punch)</td>
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<td>Project (V-Die Block)</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 oral 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 oral classroom as well as other auditory instruction

d. Demonstrates ability to discriminate between essential and non-essential oral 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**:
   
   - TLD-A1 through TLD-A6;
   - TLD-B1 through TLD-B5;
   - TLD-C1 through TLD-C3;
   - TLD-D1 through TLD-D3;
TLD-E1 through TLD-E6;
TLD-F1 through TLD-F9; and,
TLD-I1 through TLD-I7.

MASTER PROGRAM
Die Making I
COURSE SYLLABUS

Total lecture hours: 48  Total lab hours: 96  Credit hours: 6

COURSE DESCRIPTION:
Continues Introduction to Die Making Procedures with instruction and practice in building a complete functional die from a blueprint. Emphasis is placed on analyzing requirements, managing the project toward completion, and becoming proficient in shop practices and procedures.

PREREQUISITES:  Introduction to Die Making Procedures

COURSE OBJECTIVES:
After successful completion of this course, the students will be able to:
1. Practice safety in the die shop;
2. Interpret die blueprint;
3. Purchase stock material and buy components;
4. Manufacture and assemble component parts; and,

REQUIRED COURSE MATERIALS:

Lab Manual:  None

Hand Tools/Quantity Required:
Safety Glasses  1 pair
6 inch Ruler  1/8, 1/16, 1/32, and 1/64 grad.

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>
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</thead>
<tbody>
<tr>
<td>Introduction to Die Building</td>
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<tr>
<td>Safety in the Die Shop</td>
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<tr>
<td>The Die Blueprint</td>
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<td>Component Requirements</td>
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<td>Material Requirements and Specifications</td>
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<td>Planning Machining Events</td>
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<td>Importance of Inspection and Accuracy</td>
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<td>The Die Shoes, Guide Posts and Bushings</td>
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<td>Die Block Construction</td>
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<td>Calculations for V-Form Dies</td>
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<td>Heat Treatment of Die Components</td>
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<td>Mounting Procedures</td>
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<td>Overview of the Punch Press</td>
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Total Lecture Hours 48

LAB OUTLINE:

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<tr>
<td>Material Inventory</td>
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<td>Material Requisitioning for V-Form Die</td>
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<td>Project (V-Form Die)</td>
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<tr>
<td>Tryout of V-Form Die</td>
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</table>

Total Lab Hours 96
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
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 oral 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 oral classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential oral 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
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:
   TLD-A1 through TLD-A6;
   TLD-B1 through TLD-B5;
   TLD-C1 through TLD-C3;
   TLD-D1 through TLD-D3;
   TLD-E1 through TLD-E6;
   TLD-F1 through TLD-F7; and,
   TLD-I1 through TLD-I7.


COURSE SYLLABUS

Total lecture hours: 32  Total lab hours: 32  Credit hours: 3

COURSE DESCRIPTION:

Introduces computer numerical control machines. Includes instruction and practice related to the use of the Cartesian coordinate system, programming codes and styles, and operation of basic CNC machines.

PREREQUISITES:  Machine Tool Technology

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Explain principles of CNC;
2. Practice safety with CNC equipment;
3. Plan sequence of machining events;
4. Set-up, program, and operate CNC training lathe; and,
5. Set-up, program, and operate CNC training mill.

REQUIRED COURSE MATERIALS:

Lab Manual:  Instructor Provided Materials

Hand Tools/Quantity Required:
Safety Glasses  1 pair
6 inch Ruler  1/8, 1/16, 1/32, and 1/64 inch

METHOD OF INSTRUCTION:

Lecture:  Didactic presentations will include lecture, video and demonstrations.
Laboratory: Laboratory will be a hands-on machining 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>Orientation to CNC Machines</td>
<td></td>
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<td>Safety with CNC Equipment</td>
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<td>CNC versus Conventional Machining</td>
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<tr>
<td>Cartesian Coordinate System</td>
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<tr>
<td>Introduction to CNC Lathe (Training Lathe)</td>
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<tr>
<td>Planning Turning Operations</td>
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<td>Basic Program Structure</td>
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<td>Manual Data Input</td>
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<tr>
<td>Tool Positioning and Offsets</td>
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<tr>
<td>Introduction to CNC Mill (Training Mill)</td>
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<tr>
<td>Planning CNC Milling Operations</td>
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<tr>
<td>Basic Program Structure</td>
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<tr>
<td>Tool Positioning, Offsets, and Registers</td>
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<tr>
<td>Magnetic and Paper Tape Operation</td>
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<tr>
<td>Introduction to Direct Numerical Control (DNC)</td>
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Total Lecture Hours 32

LAB OUTLINE:

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<tr>
<th>Lab Topics</th>
<th>Contact Hrs.</th>
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<tr>
<td>Introduction to CNC Machines and Safety</td>
<td>2</td>
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<tr>
<td>Demonstration of CNC Equipment</td>
<td>2</td>
</tr>
<tr>
<td>Operation of CNC Training Lathe</td>
<td>2</td>
</tr>
<tr>
<td>Project (Turn and Journal Shaft)</td>
<td>3</td>
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<tr>
<td>Project (Turn Part with Radii, Angles, and Grooves)</td>
<td>3</td>
</tr>
<tr>
<td>Project (Threaded Shaft)</td>
<td>3</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
      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 oral messages and other cues

   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral 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 oral classroom as well as other auditory instruction

   d. Demonstrates ability to discriminate between essential and non-essential oral 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:**
   - TLD-A1 through TLD-A6;
   - TLD-B1 through TLD-B5;
   - TLD-C1 through TLD-C3;
   - TLD-E1 through TLD-E6;
   - TLD-F1 through TLD-F5; and
   - TLD-H1 through TLD-H3.


MASTER PROGRAM
Principles of CAD
COURSE SYLLABUS

Total lecture hours: 32  Total lab hours: 32  Credit hours: 3

COURSE DESCRIPTION:
Uses CAD machines to design and draw various problems in the architectural, mechanical, and civil drafting areas. Emphasis is placed on the operations of the CAD system to solve these problems.

PREREQUISITES:  NONE

COURSE OBJECTIVES:
After successful completion of this course, the students will be able to:
1. Explain the components and requirements of a CAD system;
2. Create geometry using CAD system;
3. Dimension geometry in CAD system;
4. Practice file management;
5. Use peripheral devices (plotters, printers); and,
6. Export geometry to accepted data exchange formats.

REQUIRED COURSE MATERIALS:
Textbook:  None
Lab Manual:  Supplied by Instructor

Hand Tools/Quantity Required:
3½" Floppy Disk  1
3–Ring Binder  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 lab rules and safety regulations.

LECTURE OUTLINE:

<table>
<thead>
<tr>
<th>Lecture Topic</th>
<th>Contact Hrs.</th>
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<tbody>
<tr>
<td>Computers in Drafting and Design</td>
<td></td>
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<tr>
<td>CAD Hardware and Software</td>
<td></td>
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<tr>
<td>CAD Commands — Getting Started</td>
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<tr>
<td>Lines, Circles and Arcs</td>
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<tr>
<td>Trimming and Editing</td>
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<tr>
<td>Special Geometric Shapes</td>
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<td>Moving, Copying, and Rotating</td>
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<td>Viewpoint and Layer Control</td>
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<td>Configuration Settings</td>
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<td>Dimensioning</td>
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<td>Sectioning</td>
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<td>Peripheral Devices</td>
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Total Lecture Hours 32

LAB OUTLINE:

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<th>Lab Topics</th>
<th>Contact Hrs.</th>
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<tbody>
<tr>
<td>Introduction to CAD System and Safety</td>
<td>1</td>
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<tr>
<td>Getting Started with CAD System</td>
<td>2</td>
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<tr>
<td>Creation of Lines, Arc, and Circles</td>
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<tr>
<td>Editing Geometry</td>
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<tr>
<td>Moving, Copying, and Rotating</td>
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<tr>
<td>Viewpoint and Layer Control</td>
<td>2</td>
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<tr>
<td>Project (Drawing—No Dimensions)</td>
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<td>Project (Drawing—No Dimensions)</td>
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<tr>
<td>Dimensioning</td>
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<tr>
<td>Project</td>
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<td>Sectioning</td>
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<tr>
<td>Project</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 oral 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 oral classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential oral 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:
   TLD-B1 through TLD-B5;
   TLD-C1 through TLD-C2;
   TLD-G1 through TLD-G4; and,
   TLD-H4 through TLD-H5.
MASTER PROGRAM
English Composition I
COURSE SYLLABUS

Total lecture hours: 48  Total lab hours: 0  Credit hours: 3

COURSE DESCRIPTION:
Is a study of grammar and composition, with emphasis on the sentence and the paragraph. The course includes reading and writing frequent themes.

PREREQUISITE: None

COURSE OBJECTIVES:
After successful completion of this course, the students will be able to:
1. Select a clearly defined subject and address it to a specific audience in a logical manner;
2. Develop a unified and coherent theme that uses standard American grammar;
3. Use a handbook and a dictionary as resources for writing;
4. Compose written assignments using various strategies of informative and persuasive prose;
5. Compose well organized answers to questions posed on written examinations; and,
6. Critically analyze assigned essays.

REQUIRED COURSE MATERIALS:


Supplies: College Level Dictionary
          Theme folder
          Theme paper
METHODS OF INSTRUCTION:

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

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 assignments;
2. Apply theory to assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments, including writing assignments, and oral presentations;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations.

LECTURE OUTLINE:

<table>
<thead>
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<th>Lecture Topics</th>
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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
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   h. 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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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
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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
c. Demonstrates ability to generate alternatives or options for problem solution
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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
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d. Demonstrates knowledge of good study skills and learning habits

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

**Tool and Die Making Technology**  
_(Associate of Applied Science Degree Program)_

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Program Totals 48 46 71

### Optional Courses:

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MASTER PROGRAM

Die Design II
COURSE SYLLABUS

Total lecture hours: 32     Total lab hours: 32     Credit hours: 3

COURSE DESCRIPTION:

Continues Die Design I with more emphasis on actual die design and construction. Stresses the considerations involved in developing die components, such as calculation of clearances, cutting force, and press tonnage requirements.

PREREQUISITES:

Die Design I

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Distinguish between a jig and a fixture and identify types of each;
2. Understand principles of jig and fixture design;
3. Understand principles of die design and theory; and,
4. Make calculations for die design (clearances, tonnage requirements, etc.).

REQUIRED COURSE MATERIALS:

Lab Manual: None

Hand Tools/Quantity Required:
Safety Glasses 1 pair
6 inch Ruler 1/8, 1/16, 1/32, and 1/64 grad.

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>Introduction to Die and Fixture Design</td>
<td></td>
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<tr>
<td>Safety in a Die Shop</td>
<td></td>
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<tr>
<td>Die Engineering — Planning and Design</td>
<td></td>
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<tr>
<td>Shear Action in Metal Cutting</td>
<td></td>
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<tr>
<td>Principles of Blanking/Piercing Dies</td>
<td></td>
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<tr>
<td>Punch Design and Construction</td>
<td></td>
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<tr>
<td>Die Block Construction</td>
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<tr>
<td>Bending of Metals</td>
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<tr>
<td>Bending and Forming Die Design and Construction</td>
<td></td>
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<tr>
<td>Strippers and Stock Guides</td>
<td></td>
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<tr>
<td>Shedders and Knockouts</td>
<td></td>
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<tr>
<td>Nest Gages, Pushers, and Die Stops</td>
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<tr>
<td>Compound and Combination Dies</td>
<td></td>
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<tr>
<td>Progressive Dies</td>
<td></td>
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<tr>
<td>Stock Material Utilization and Strip Layouts</td>
<td></td>
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<tr>
<td>Other Types of Industrial Dies</td>
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Total Lecture Hours 32

LAB OUTLINE:

<table>
<thead>
<tr>
<th>Lab Topics</th>
<th>Contact Hrs.</th>
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<tbody>
<tr>
<td>Introduction to the Design of Dies</td>
<td>1</td>
</tr>
<tr>
<td>Safety in the Die Shop</td>
<td>1</td>
</tr>
<tr>
<td>Stampings and Their Dies (Visual Survey)</td>
<td>1</td>
</tr>
<tr>
<td>Visualization of Die Construction</td>
<td>2</td>
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<tr>
<td>Project (Make Drawing of Existing Die)</td>
<td>5</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 oral 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 oral classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential oral 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
Recognizes that attitudes, skills, and practice are essential to productivity

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**: Assess 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**:
   - TLD-B1 through TLD-B5;
   - TLD-C1 through TLD-C3;
   - TLD-D1 through TLD-D3;
   - TLD-F1; and,
   - TLD-I1 through TLD-I5.

MASTER PROGRAM

Die Making II
COURSE SYLLABUS

Total lecture hours: 48          Total lab hours: 96          Credit hours: 6

COURSE DESCRIPTION:

Augments Die Making I with instruction and practice in building a progressive die from a blueprint. Emphasis is placed on the application of the die building procedures learned in Die Making I toward fabricating more complex dies.

PREREQUISITES: Die Making I

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Practice safety in the die shop;
2. Interpret die blueprints;
3. Purchase stock material and buy components;
4. Manufacture and assemble component parts; and,

REQUIRED COURSE MATERIALS:

Lab Manual: None

Hand Tools/Quantity Required:
Safety Glasses 1 pair
6 inch Ruler 1/8, 1/16, 1/32, and 1/64 grad.

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;
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<tbody>
<tr>
<td>Introduction and Safety</td>
<td></td>
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<tr>
<td>The Progressive Die</td>
<td></td>
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<tr>
<td>The Die Blueprint</td>
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<tr>
<td>Component Requirements</td>
<td></td>
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<tr>
<td>Material Requirements and Specifications</td>
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<tr>
<td>Calculations Required</td>
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<tr>
<td>Planning Events</td>
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</table>

Total Lecture Hours 48

LAB OUTLINE:

<table>
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<tr>
<th>Lab Topics</th>
<th>Contact Hrs.</th>
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<tbody>
<tr>
<td>Orientation and Safety</td>
<td>2</td>
</tr>
<tr>
<td>Material Inventory</td>
<td>2</td>
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<tr>
<td>Material Requisitioning for Die</td>
<td>2</td>
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<tr>
<td>Project (Progressive Blank/Pierce Die)</td>
<td>84</td>
</tr>
<tr>
<td>Tryout of Die</td>
<td>6</td>
</tr>
</tbody>
</table>

Total Lab Hours 96

COURSE OBJECTIVES: SCANS COMPETENCIES

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      2. Provides individual assistance/direction to peers as requested
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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
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      2. Monitors and corrects performance of system during operation
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   A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
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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 oral 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 oral classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential oral 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
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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
   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:
   - TLD-A1 through TLD-A6;
   - TLD-B1 through TLD-B5;
   - TLD-C1 through TLD-C3;
   - TLD-D1 through TLD-D3;
   - TLD-E1 through TLD-E6;
   - TLD-F1 through TLD-F7; and,
   - TLD-I1 through TLD-I17.


MASTER PROGRAM

Computer Numerical Control Operations II

COURSE SYLLABUS

Total lecture hours: 32  Total lab hours: 32  Credit hours: 3

COURSE DESCRIPTION:

Continues Computer Numerical Control Operations I with additional instruction in writing and editing CNC code manually utilizing more advanced commands and cycles. Additionally, students will be introduced to the use of a Computer-Aided Manufacturing (CAM) system for creation of code.

PREREQUISITES:

Computer Numerical Control Operations I

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Practice safety with CNC equipment;
2. Determine proper tooling, fixtures, and accessories for CNC equipment;
3. Plan sequence of machining events;
4. Set-up, program, and operate CNC machining center (mill);
5. Set-up, program, and operate CNC turning center (lathe); and
6. Use CAM system for programming.

REQUIRED COURSE MATERIALS:


Lab Manual: Instructor Provided Materials

Hand Tools/Quantity Required:
Safety Glasses 1 pair
6 inch Ruler 1/8, 1/16, 1/32, and 1/64 inch

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.
Laboratory: Laboratory will be a hands-on machining 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>Safety with CNC Equipment</td>
<td></td>
</tr>
<tr>
<td>Introduction to CNC Lathe (Industrial Lathe)</td>
<td></td>
</tr>
<tr>
<td>Tooling Systems for CNC Lathes</td>
<td></td>
</tr>
<tr>
<td>Advanced Programming Cycles (CANNED)</td>
<td></td>
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<tr>
<td>Introduction to CNC Mill (Industrial Mill)</td>
<td></td>
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<tr>
<td>Tooling Systems for CNC Mills</td>
<td></td>
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<tr>
<td>Advanced Programming Cycles (CANNED)</td>
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<tr>
<td>Jigs and Fixtures for CNC Equipment</td>
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<tr>
<td>Programming for Production and Efficiency</td>
<td></td>
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<tr>
<td>Introduction to Computer-Aided Manufacturing (CAM)</td>
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<td>Total Lecture Hours</td>
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LAB OUTLINE:

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<th>Lab Topics</th>
<th>Contact Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNC Machines and Safety</td>
<td>1</td>
</tr>
<tr>
<td>Operation of CNC Industrial Lathe</td>
<td>2</td>
</tr>
<tr>
<td>Tooling Systems</td>
<td>1</td>
</tr>
<tr>
<td>Project (Turn and Journal Shaft)</td>
<td>2</td>
</tr>
<tr>
<td>Project (Turn Part with Radii, Angles, and Grooves)</td>
<td>3</td>
</tr>
<tr>
<td>Project (Threaded Shaft with Tapped End Hole)</td>
<td>3</td>
</tr>
<tr>
<td>Operation of CNC Industrial Mill</td>
<td>2</td>
</tr>
<tr>
<td>Tooling Systems</td>
<td>1</td>
</tr>
<tr>
<td>Project (Drilled and Milled Plate)</td>
<td>2</td>
</tr>
<tr>
<td>Project (Milled Plate with Pocket and Name)</td>
<td>3</td>
</tr>
<tr>
<td>Project (Production Part for Lathe)</td>
<td>4</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
      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 oral messages and other cues
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral 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 oral classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential oral 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:**  
   TLD-A1 through TLD-A6;  
   TLD-B1 through TLD-B5;  
   TLD-C1 through TLD-C3;  
   TLD-E1 through TLD-E6;  
   TLD-F1 through TLD-F5;  
   TLD-G1 through TLD-G4;  
   TLD-H1 through TLD-H3;  
   TLD-H6; and,  
   TLD-I1 through TLD-I2.  

COURSE DESCRIPTION:

Studies solutions of right and oblique triangles, identities, trigonometric equations, and polar and parametric equations.

PREREQUISITE: Intermediate Algebra

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Sketch an angle in standard position, approximate its measure in degree and radians, and determine the sign of its trigonometric functions;
2. Convert from degree to radian and radian to degree measure;
3. Find the trigonometric functions of a given angle using tables or calculator;
4. Use exact values for trigonometric functions of angles whose reference angle is 30, 45, 60, 0, or 90 degrees;
5. Find the arc length, radius, central angle of a circle;
6. Convert from linear speed to angular velocity and angular velocity to linear speed;
7. Use trigonometric ratios to solve right triangles;
8. Sketch the graphs of trigonometric functions determining amplitude, period, phase shift where applicable;
9. Apply and use in proofs the following identities:
   a. Fundamental identities;
   b. Sum and difference identities;
   c. Double angle identities;
   d. Half angle identities;
   e. Product and factor identities;
10. Define, evaluate, apply the inverse trigonometric functions;
11. Solve trigonometric equations;
12. Apply the law of sine and law of cosines to solving triangles;
13. Find the area of triangles;
14. Use vectors to solve problems in which both magnitude and direction are involved; 
15. Convert from rectangular to polar and polar to rectangular coordinates; and, 
16. Sketch selected polar functions.

REQUIRED COURSE MATERIALS:


Supplies: Notebook Paper, Pencils, Scientific Calculator

METHODS OF INSTRUCTION:

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

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 assignments;
2. Apply theory to assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments, including writing assignments, and oral presentations;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations.

LECTURE OUTLINE:

<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Contact Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Trigonometric Functions</td>
<td></td>
</tr>
<tr>
<td>A. Basic Terms of Trigonometry</td>
<td></td>
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<tr>
<td>B. Definitions of the Trigonometric Functions</td>
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<tr>
<td>C. Trigonometric Functions of Acute Angles</td>
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<tr>
<td>D. Trigonometric Functions of Special Angles</td>
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<tr>
<td>E. Using Reference Angles and the Trigonometric Tables</td>
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<tr>
<td>F. Solving Right Triangles</td>
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<tr>
<td>G. Applications of Right Triangles</td>
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<tr>
<td>Radian Measure</td>
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</table>
A. Radian Measure Conversions  
B. Formulae for Arc Length and Area of a Sector  
C. Linear and Angular Velocity Formulae  
D. Circular Functions of Real Numbers  

**Graphs of Trigonometric Functions**  
A. Graphs of the Sine and Cosine Functions  
B. Horizontal Translations: Phase Shift  
C. Graphs of other Trigonometric Functions  

**Trigonometric Identities**  
A. Fundamental Identities  
B. Verifying Trigonometric Identities  
C. Identities Involving Sums and Differences of Two Angles  
D. Double and Half-Angle Identities  

**Inverse Trigonometric Functions and Trigonometric Equations**  
A. Inverse Functions  
B. Inverse Trigonometric Functions  
C. Trigonometric Equations  
D. Inverse Trigonometric Equations  

**Oblique Triangles and Vectors**  
A. Law of Sines  
B. The Ambiguous Case: SSA  
C. Law of Cosines  
D. Vector Applications  

**Complex Numbers and Polar Coordinates**  
A. Operations with Complex Numbers  
B. Trigonometric Form of a Complex Number  
C. Product and Quotient Theorems  
D. Powers and Roots of Complex Numbers  

**Final Exam**  

Total Lecture Hours 48

**COURSE OBJECTIVES: SCANS COMPETENCIES**

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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:

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      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
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II. FOUNDATION SKILLS
   A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
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e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

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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

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b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
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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
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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   a. Demonstrates appropriate listening and speaking skills in personal conversations
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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

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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
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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
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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
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f. Accepts positive reinforcement in an appropriate manner

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   a. Demonstrates appropriate and acceptable social behaviors in interactions
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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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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:
   TLD-B1 through TLD-B5.
COURSE DESCRIPTION:

Covers correct and effective English; correct pronunciation; breath control; study and practice in making speeches for all occasions with its major emphasis on organization of material; and practice in speaking before the group.

PREREQUISITE: None

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Employ models to demonstrate communication effectiveness;
2. Develop a self-concept that enhances communication;
3. Engage in effective perception-checking;
4. Distinguish between debilitative and facilitative emotions and demonstrate methods for managing them;
5. Recognize the role of nonverbal behavior in decoding messages;
6. Demonstrate the use of several effective listening response styles;
7. Identify and describe key aspects of interpersonal relationships;
8. Use feedback to confirm messages;
9. Demonstrate non-defensive responses to criticism; and,
10. Demonstrate the ability to make effective oral presentations.

REQUIRED COURSE MATERIALS:


SUPPLIES: Folder
3 brads
METHODS OF INSTRUCTION:

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

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 assignments;
2. Apply theory to assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments, including writing assignments, and oral presentations;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations.

LECTURE OUTLINE

<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Contact Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation and Overview</td>
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<tr>
<td>Introduction to Public Speaking</td>
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<tr>
<td>Controlling Nervousness</td>
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<tr>
<td>Listening</td>
<td></td>
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<tr>
<td>Review for Quiz</td>
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<tr>
<td>Quiz #1</td>
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<tr>
<td>INTRODUCTORY SPEECH PRESENTATIONS</td>
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<tr>
<td>Reaching the Audience</td>
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<tr>
<td>Selecting Topic, Purpose, and Central Idea</td>
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<tr>
<td>Finding Materials</td>
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<tr>
<td>Review for Quiz</td>
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<td>Quiz #2</td>
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<tr>
<td>Supporting Your Ideas</td>
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<td>Visual Aids</td>
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<td>The Body of the Speech</td>
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<td>Quiz #3</td>
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<td>SUPPORT A POINT SPEECH PRESENTATION</td>
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<td>Introductions and Conclusions</td>
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<td>Outlining the Speech</td>
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<td>Speaking to Inform</td>
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<td>Review for Quiz</td>
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<td>Quiz #4</td>
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<tr>
<td>INFORMATIVE SPEECH PRESENTATION</td>
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</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
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      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
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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
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   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
## MASTER Curriculum

**Tool and Die Making Technology**

*(Associate of Applied Science Degree Program)*

<table>
<thead>
<tr>
<th>First Semester*</th>
<th>LEC</th>
<th>LAB</th>
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<tbody>
<tr>
<td>TLD 1016 Machine Tool Technology</td>
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<tr>
<td>TLD 1114 Introduction to Die Making Procedures</td>
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<tr>
<td>DDT 1113 Blueprint Reading and Drawing</td>
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<tr>
<td>CPT 1113 Introduction to Computers</td>
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<td>MATH 1233 Applied Mathematics for Engineering Technicians</td>
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<td>TLD 1146 Die Making I</td>
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<tr>
<td>TLD 2713 Computer Numerical Control Operations I</td>
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<td>DDT 1313 Principles of CAD</td>
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<td>ENGL 1113 English Composition I</td>
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<tr>
<td>TLD 2153 Die Design II</td>
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<td>TLD 2166 Die Making II</td>
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<td>TLD 2723 Computer Numerical Control Operations II</td>
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<td>MATH 1323 Trigonometry</td>
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<td>SPT 1113 Oral Communications</td>
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<td>TLD 2174 Die Making III</td>
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<tr>
<td>TLD 2733 Computer Numerical Control Operations III</td>
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<td>TLD 2183 Special Project</td>
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Program Totals | 48 | 46 | 71 |

### Optional Courses:

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<td>TLD 2113</td>
<td>Fundamentals of EDM</td>
<td>2</td>
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<td>TLD 2123</td>
<td>Advanced EDM</td>
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</table>
Die Making III
COURSE SYLLABUS

Total lecture hours: 32          Total lab hours: 64          Credit hours: 4

COURSE DESCRIPTION:
Completes Die Making II with instruction and practice in building a compound die from a blueprint. Emphasis is placed on the application of the die building procedures learned in Die Making I and Die Making II toward fabricating more complex dies. Instruction and practice is also given on the use of the Wire Electrical Discharge Machine in the construction of die components.

PREREQUISITES:  Die Making II

COURSE OBJECTIVES:
After successful completion of this course, the students will be able to:
1. Practice safety in the die shop;
2. Interpret die blueprint;
3. Purchase stock material and buy components;
4. Manufacture and assemble component parts; and,

REQUIRED COURSE MATERIALS:

Lab Manual:  None

Hand Tools/Quantity Required:
Safety Glasses  1 pair
6 inch Ruler  1/8, 1/16, 1/32, and 1/64 grad.

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.

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<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Contact Hrs.</th>
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<tbody>
<tr>
<td>Introduction and Safety</td>
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<tr>
<td>The Compound Die</td>
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<tr>
<td>The Die Blueprint</td>
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<tr>
<td>Capabilities of the Wire EDM in Die Building</td>
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<tr>
<td>Assistance Planning Material</td>
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<tr>
<td>Requirements and Events</td>
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<tr>
<td>Assistance with Required Calculations</td>
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<td>Operation of the Wire EDM</td>
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<tr>
<td><strong>Total Lecture Hours</strong></td>
<td><strong>32</strong></td>
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LAB OUTLINE:

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<th>Lab Topics</th>
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<td>Orientation and Safety</td>
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<td>Material Inventory</td>
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<td>Material Requisitioning for Die</td>
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<td>Project (Compound Die)</td>
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<tr>
<td>Operation of the Wire EDM</td>
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<tr>
<td>Tryout of Die</td>
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<tr>
<td><strong>Total Lab Hours</strong></td>
<td><strong>64</strong></td>
</tr>
</tbody>
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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
   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:
   TLD-A1 through TLD-A6;
   TLD-B1 through TLD-B5;
   TLD-C1 through TLD-C3;
   TLD-D1 through TLD-D3;
   TLD-E1 through TLD-E6;
   TLD-F1 through TLD-F7;
   TLD-H2 through TLD-H3;
   TLD-H6; and,
   TLD-I1 through TLD-I7.


COURSE SYLLABUS

Total lecture hours: 32  
Total lab hours: 32  
Credit hours: 3

COURSE DESCRIPTION:

Completes Computer Numerical Control Operations I and II with additional instruction and practice in the use of the Computer-Aided Manufacturing (CAM) system for creation of code. Also, the student will be introduced to the Wire Electrical Discharge Machine (EDM) and the Coordinate Measuring Machine (CMM).

PREREQUISITES:  
Computer Numerical Control Operations II

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Practice safety with CNC equipment;
2. Determine proper tooling, fixtures, and accessories for CNC equipment;
3. Plan sequence of machining events;
4. Set-up, program, and operate CNC wire EDM; and,
5. Use CAM system for programming.

REQUIRED COURSE MATERIALS:

Textbook:  
An Introduction to CNC Machining and Programming,  
David Gibbs and Thomas M. Crandell, Industrial Press, Latest Edition

Lab Manual:  
Instructor Provided Materials

Hand Tools/Quantity Required:  
Safety Glasses  
1 pair  
6 inch Ruler  
1/8, 1/16, 1/32, and 1/64 inch

METHOD OF INSTRUCTION:

Lecture:  
Didactic presentations will include lecture, video and demonstrations.
Laboratory: Laboratory will be a hands-on machining 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>Safety with CNC Equipment</td>
<td></td>
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<tr>
<td>Overview of CAM System</td>
<td></td>
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<tr>
<td>Creating Geometric Elements and Toolpath</td>
<td></td>
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<tr>
<td>Macros and Automated Roughing Commands</td>
<td></td>
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<tr>
<td>Postprocessors and Creating Code</td>
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<tr>
<td>Importing CAD Data into CAM System</td>
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<tr>
<td>Introduction to Electrical Discharge Machining</td>
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<tr>
<td>Setup and Operation of the Wire EDM</td>
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<tr>
<td>Programming the Wire EDM</td>
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<tr>
<td>Operation of the Coordinate Measuring Machine (CMM)</td>
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<tr>
<td>Quality Systems and Reverse Engineering</td>
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<td><strong>Total Lecture Hours</strong></td>
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LAB OUTLINE:

<table>
<thead>
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<th>Lab Topics</th>
<th>Contact Hrs.</th>
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<tbody>
<tr>
<td>CNC Machines and Safety</td>
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<tr>
<td>Installing, Configuring and Modules of CAM System</td>
<td>3</td>
</tr>
<tr>
<td>Creating Toolpath with CAM System</td>
<td>6</td>
</tr>
<tr>
<td>Project (Lathe Part)</td>
<td>3</td>
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<tr>
<td>Project (Mill Part)</td>
<td>3</td>
</tr>
<tr>
<td>Project (Create and Import CAD File to Create Code)</td>
<td>2</td>
</tr>
<tr>
<td>Operation of Wire EDM</td>
<td>4</td>
</tr>
<tr>
<td>Project (Die Block)</td>
<td>4</td>
</tr>
<tr>
<td>Project (Pinion Gear)</td>
<td>4</td>
</tr>
<tr>
<td>Project (Die Block with Compound Angles)</td>
<td>6</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
   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 oral messages and other cues
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to oral 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 oral classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential oral 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
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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
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:**
   - TLD-A1 through TLD-A6;
   - TLD-B1 through TLD-B5;
   - TLD-C1 through TLD-C3;
   - TLD-C5;
   - TLD-E1 through TLD-E6;
   - TLD-F1 through TLD-F5;
   - TLD-G1 through TLD-G4;
   - TLD-H1 through TLD-H3;
   - TLD-H6;
   - TLD-I1 through TLD-I2;
   - TLD-J1; and,
   - TLD-J4.


MASTER PROGRAM
Special Project
COURSE SYLLABUS

Total lecture hours: 16  Total lab hours: 64  Credit hours: 3

COURSE DESCRIPTION:

Provides the student with practical application of skills and knowledge gained through other courses in the Tool and Die Technology Program. Students will apply material learned in previous and concurrent classes to design, produce, and test an industrial quality die. Emphasis is placed on the students making decisions, setting priorities and time lines, and realizing the overall responsibility of producing a high-quality product in a given amount of time.

PREREQUISITES:  Die Making II

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Practice safety in the die shop;
2. Interpret die blueprints;
3. Purchase stock material and buy components;
4. Plan sequence of machining events;
5. Set-up and operate all conventional machines in die shop;
6. Set-up, program, and operate CNC machining center, turning center, and wire EDM;
7. Manufacture and assemble component parts; and
8. Trial run tool and/or die.

REQUIRED COURSE MATERIALS:

Lab Manual:  None

Hand Tools/Quantity Required:
Safety Glasses  1 pair
6 inch Ruler  1/8, 1/16, 1/32, and 1/64 grad.
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>Introduction and Safety</td>
<td></td>
</tr>
<tr>
<td>Assignment of Project</td>
<td></td>
</tr>
<tr>
<td>Instructor Assistance as Needed</td>
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<tr>
<td>Total Lecture Hours</td>
<td>16</td>
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LAB OUTLINE:

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<th>Lab Topics</th>
<th>Contact Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation and Safety</td>
<td>1</td>
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<tr>
<td>Project (Design of Progressive Die)</td>
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<tr>
<td>Project (Fabrication of Die)</td>
<td>50</td>
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<tr>
<td>Tryout of Die</td>
<td>4</td>
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<tr>
<td>Total Lab Hours</td>
<td>64</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**

I. **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

194
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.

195
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:**
   - TLD-A1 through TLD-A6;
   - TLD-B1 through TLD-B5;
   - TLD-C1 through TLD-C5;
   - TLD-D1 through TLD-D3;
   - TLD-E1 through TLD-E6;
   - TLD-F1 through TLD-F10;
   - TLD-G1 through TLD-G4;
   - TLD-H2 through TLD-H6; and,
   - TLD I1 through TLD-I7.


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TLD 2183
03/022068
# MASTER Curriculum
## Tool and Die Making Technology
(Associate of Applied Science Degree Program)

### First Semester*

<table>
<thead>
<tr>
<th>Course</th>
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<th>LEC</th>
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<td>Blueprint Reading and Drawing</td>
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<td>Operations III</td>
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### Optional Courses:

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<td>TLD 2113</td>
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<td>TLD 2123</td>
<td>Advanced EDM</td>
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MASTER PROGRAM
Fundamentals of EDM
COURSE SYLLABUS

Total lecture hours: 32  Total lab hours: 32  Credit hours: 3

COURSE DESCRIPTION:
This course is an introduction to Electrical Discharge Machining. It includes instruction and practice in the principles of EDM technology as well as the set-up, programming, and operation of sinker and wire EDM.

PREREQUISITES:  Computer Numerical Control Operations III

COURSE OBJECTIVES:
After successful completion of this course, the students will be able to:
1. Explain the principles of Electrical Discharge Machining;
2. Practice safety in the EDM shop;
3. Set-up and operate conventional sinker EDM;
4. Set-up, program, and operate CNC sinker EDM and EDM drill;
5. Set-up, program, and operate CNC wire EDM for 2-axis parts; and,
6. Use the CAM system.

REQUIRED COURSE MATERIALS:
Textbook:  None
Lab Manual:  Instructor provided

Hand Tools/Quantity Required:
  Safety Glasses

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>Safety in the EDM shop</td>
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<tr>
<td>Principles of EDM</td>
<td></td>
</tr>
<tr>
<td>Components of the EDM process</td>
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<tr>
<td>Set-up and operation of the conventional sinker EDM</td>
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</tr>
<tr>
<td>Set-up and operation of the CNC sinker EDM</td>
<td></td>
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<tr>
<td>Programming the CNC sinker EDM</td>
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<tr>
<td>Set-up and operation of the CNC wire EDM</td>
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<tr>
<td>Programming the CNC wire EDM</td>
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<tr>
<td>Using the CAM system for programming EDM systems</td>
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<tr>
<td><strong>Total Lecture Hours</strong></td>
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</table>

LAB OUTLINE:

<table>
<thead>
<tr>
<th>Lab Topics</th>
<th>Contact Hrs.</th>
</tr>
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<tr>
<td>EDM safety</td>
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<tr>
<td>Demonstration of EDM machines, operation, and components</td>
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</tr>
<tr>
<td>Set-up and operation of sinker EDM</td>
<td></td>
</tr>
<tr>
<td>Project (EDM holes in steel block)</td>
<td></td>
</tr>
<tr>
<td>Project (EDM simple part with machined electrode)</td>
<td></td>
</tr>
<tr>
<td>Set-up and operation of CNC sinker EDM or drill</td>
<td></td>
</tr>
<tr>
<td>Project (Half-moon electrode)</td>
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</tr>
<tr>
<td>Project (Simple gear)</td>
<td></td>
</tr>
<tr>
<td>Set-up and operation of CNC wire EDM</td>
<td></td>
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</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

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 oral 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 oral classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential oral 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
Recognizes that attitudes, skills, and practice are essential to productivity

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

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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:
   TLD-A1 through TLD-A6;
   TLD-B1 through TLD-B5;
   TLD-C1 through TLD-C3;
   TLD-D1 through TLD-D3;
   TLD-E1 through TLD-E6;
   TLD-F1;
   TLD-G1 through TLD-G4;
   TLD-H1;
   TLD-I1 through TLD-I2; and,
   TLD-J1 through TLD-J4.


MASTER PROGRAM
Advanced EDM
COURSE SYLLABUS

Total lecture hours: 32  Total lab hours: 32  Credit hours: 3

COURSE DESCRIPTION:

This course is a continuation of Fundamentals of EDM Technology with emphasis on 4-axis machining with the CNC wire EDM. Students will be given instruction and practice in the programming of complex parts which utilize the 3rd and 4th axis positioning capabilities of wire EDMs.

PREREQUISITES: Fundamentals of EDM Technology

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Explain principles of electrical discharge machining;
2. Practice safety in the EDM shop; and,
3. Set-up, program, and operate CNC wire EDM for 4-axis parts.

REQUIRED COURSE MATERIALS:

Textbook: None

Lab Manual: Instructor provided

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>Safety in the EDM shop</td>
<td></td>
</tr>
<tr>
<td>Review of EDM principles</td>
<td></td>
</tr>
<tr>
<td>Set-up and operation of the wire EDM</td>
<td></td>
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<tr>
<td>Programming the wire EDM (2-axis)</td>
<td></td>
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<tr>
<td>Using the CAM system for 2-axis parts</td>
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<tr>
<td>Simultaneous four-axis positioning</td>
<td></td>
</tr>
<tr>
<td>Independent four-axis positioning</td>
<td></td>
</tr>
<tr>
<td>Programming and machining 4-axis parts</td>
<td></td>
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<tr>
<td>Using the CA system for 4-axis parts</td>
<td></td>
</tr>
</tbody>
</table>

Total Lecture Hours 32

LAB OUTLINE:

<table>
<thead>
<tr>
<th>Lab Topics</th>
<th>Contact Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDM safety</td>
<td></td>
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<tr>
<td>Set-up and operation of CNC wire EDM</td>
<td></td>
</tr>
<tr>
<td>Project (Die block with holes, slots, and complex shapes)</td>
<td></td>
</tr>
<tr>
<td>Project (Complex shape using CAM system)</td>
<td></td>
</tr>
<tr>
<td>Simultaneous four-axis positioning</td>
<td></td>
</tr>
<tr>
<td>Project (Die block with slug clearance holes)</td>
<td></td>
</tr>
<tr>
<td>Independent four-axis positioning</td>
<td></td>
</tr>
<tr>
<td>Project (Number 1 - 2 transition using CAM system)</td>
<td></td>
</tr>
<tr>
<td>Project (Complex transition using CAM system)</td>
<td></td>
</tr>
<tr>
<td>Project (Complex transition using CAM system)</td>
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</tbody>
</table>

Total Lab Hours 32

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,

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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 oral 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 oral classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential oral 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:
   TLD-A1 through TLD-A6;
   TLD-B1 through TLD-B5;
   TLD-C1 through TLD-C3;
   TLD-D1 through TLD-D3;
   TLD-E1 through TLD-E6;
   TLD-F1;
   TLD-G1 through TLD-G4;
   TLD-H1;
   TLD-H4;
   TLD-H6;
   TLD-I1 through TLD-I2;
   TLD-J1; and,
   TLD-J3 through TLD-J4.

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

a consortium of educators and industry

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY

Tool & Die and EDM Series
INSTRUCTOR’S HANDBOOK

Supported by the National Science Foundation’s Advanced Technological Education Program
EDUCATIONAL RESOURCES FOR THE MACHINE TOOL INDUSTRY

Tool & Die and EDM Series INSTRUCTOR'S HANDBOOK

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 DD - 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 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. 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-Connelly 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 Mississippi

Evolving from a previously agrarian economy, the region served by Itawamba Community College now contains a significant industrial base. Approximately 45% of employed adults in the surrounding area work in manufacturing, with the predominant industries including metal-working, machinery, paper products, rubber/plastics, electrical components, furniture, apparel, and wood products. About 35-40% of all manufacturing employees work in the furniture industry. After World War II, several major metal-working companies established branch plants in the Tupelo area, a trend that has continued into the 1990's. Between 1975 and 1980, pressures of competition and technology caused a number of these companies to reconsider their continued presence in northern Mississippi, spurring action by regional economic development organizations to preserve an employment and tax base essential to the community. Many of their economic development initiatives involved the community college, leading directly to the establishment of its Tool and Die Making Technology program and introduction of training in CAD, CNC, robotics, and lasers.

Itawamba Community College

Itawamba Community College (ICC) provides university transfer programs, associate degree career programs, non-credit customized industry training, and continuing education to a rural five-county area in northeast Mississippi. Of the local population of approximately 170,000 persons, 79% are white and 19% black; the student profile at the College roughly mirrors the racial composition of the general population, and a high percentage of students are from low-income households. The mission of the College includes the mandate to provide “educational services which contribute to the needs of new, expanding, or existing businesses and industries and to the training needs of the people.” Accordingly, the College’s instructional programs are designed with national trends and the needs of business and industry in mind, and the objective of all courses and training is to provide both students and companies with what they need to succeed. The main campus is in Fulton and the vocational-technical campus in Tupelo.

Development Team

- **Project Director:** Don Benjamin, Associate Dean of Career Education, served as program manager and academic coordinator for the MASTER project.
- **Site Coordinator:** Barry Emison was responsible for industrial assessment and skills validation, as well as development of skill standards and course/program materials for the Tool and Die Technology component of the MASTER project.
- **Subject Matter Experts:** Several college academic and technology instructors served as advisors for basic academic competencies, sharing responsibility with Mr. Emison for compiling data from industry surveys and interviews during the skill standards development process. Donald Taylor and Terry Kitchens, Tool and Die Technology Instructors, served as technical advisors for workplace competencies and developed course curricula and program materials. They also served as co-instructors and coordinators for the MASTER pilot program in Tool and Die Technology.
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.
TOOL AND DIE MAKER ... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
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</thead>
<tbody>
<tr>
<td>A [Practice Safety]</td>
<td>A-1 Follow safety manuals and all safety regulations/requirements</td>
</tr>
<tr>
<td>B [Apply Mathematical Concepts]</td>
<td>B-1 Perform basic arithmetic functions</td>
</tr>
<tr>
<td>C [Interpret Engineering Drawings and Related Documents]</td>
<td>C-1 Interpret and understand basic layout/types of drawings</td>
</tr>
<tr>
<td>D [Demonstrate Knowledge of Manufacturing Materials]</td>
<td>D-1 Identify materials with desired properties</td>
</tr>
<tr>
<td>E [Measure/Inspect]</td>
<td>E-1 Understand metrology terms</td>
</tr>
<tr>
<td>F [Demonstrate Knowledge of Manufacturing Processes]</td>
<td>F-1 Discuss metal cutting and metal cutting tools</td>
</tr>
<tr>
<td>G [Use Computers]</td>
<td>G-1 Use computer operating systems</td>
</tr>
<tr>
<td>H [Perform CAD/CAM and CNC Programming Tasks]</td>
<td>H-1 Discuss fundamentals of CNC machines and controls</td>
</tr>
<tr>
<td>I [Perform Tool and Die Making Operations]</td>
<td>I-1 Discuss basic types and functions of jigs and fixtures</td>
</tr>
<tr>
<td>J [Operate Electrical Discharge Machine (EDM)]</td>
<td>J-1 Discuss fundamentals of EDM</td>
</tr>
<tr>
<td></td>
<td>A-2 Maintain equipment and machinery</td>
</tr>
<tr>
<td></td>
<td>B-2 Perform basic algebraic operations</td>
</tr>
<tr>
<td></td>
<td>C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances</td>
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<tr>
<td></td>
<td>D-2 Identify materials and processes to produce a part</td>
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<td>E-2 Select measurement tools</td>
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<td>E-3 Measure with handheld instruments</td>
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<td>E-4 Eliminate measurement variables</td>
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<td>E-5 Measure using surface plate and accessories</td>
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<td>E-6 Inspect using stationary equipment</td>
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<td></td>
<td>F-2 Operate metal saws</td>
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<td>F-3 Operate drill presses and tooling</td>
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<td></td>
<td>F-4 Operate engine and tooling</td>
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<td></td>
<td>F-5 Operate vertical and horizontal mills and tooling</td>
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<tr>
<td></td>
<td>F-6 Operate precision grinders</td>
</tr>
<tr>
<td></td>
<td>F-7 Operate heat treating equipment and processes</td>
</tr>
<tr>
<td></td>
<td>F-8 Operate sheet metal equipment</td>
</tr>
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<td>F-9 Operate welding equipment and processes</td>
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<tr>
<td></td>
<td>F-10 Estimate time required/cost to produce a part</td>
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<tr>
<td></td>
<td>G-2 Understand computer terminology</td>
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<tr>
<td></td>
<td>G-3 Use file management systems</td>
</tr>
<tr>
<td></td>
<td>G-4 Install and use software packages</td>
</tr>
<tr>
<td></td>
<td>H-2 Program and operate CNC milling machine and machining center</td>
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<tr>
<td></td>
<td>H-3 Program and operate CNCClathes</td>
</tr>
<tr>
<td></td>
<td>H-4 Use Computer-Aided Drafting (CAD) system</td>
</tr>
<tr>
<td></td>
<td>H-5 Create 3-D solid models</td>
</tr>
<tr>
<td></td>
<td>H-6 Use Computer-Aided Manufacturing (CAM) system</td>
</tr>
<tr>
<td></td>
<td>I-2 Utilize concept of jig and fixture design</td>
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<tr>
<td></td>
<td>I-3 Demonstrate understanding of different types of industrial dies</td>
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<tr>
<td></td>
<td>I-4 Utilize basic die theory</td>
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<td></td>
<td>I-5 Utilize principles of die design</td>
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<td></td>
<td>I-6 Perform tool and die repair</td>
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<td>I-7 Demonstrate tool and die making skills</td>
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<tr>
<td></td>
<td>J-2 Setup and operate conventional sinker EDM</td>
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<tr>
<td></td>
<td>J-3 Program, setup, and operate CNC sinker EDM and EDM drill</td>
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<tr>
<td></td>
<td>J-4 Program, setup, and operate CNC wire EDM</td>
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</table>
Tool and die maker are skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

### Duties

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<td>Operate Electrical Discharging Machine (EDM)</td>
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### Tasks

- **A-1** Follow safety manuals and all safety regulations/requirements
- **A-2** Maintain safe equipment and machinery
- **A-3** Use safe operating procedures for hand and machine tools
- **A-4** Maintain a clean and safe work environment
- **A-5** Use safe material handling practices
- **A-6** Consult and apply MSDS for hazards of various materials
- **B-1** Perform basic arithmetic functions
- **B-2** Perform basic algebraic operations
- **B-3** Use basic geometric principles
- **B-4** Perform basic trigonometric functions
- **B-5** Use and apply Cartesian Coordinate System
- **C-1** Interpret and understand basic layout and types of drawings
- **C-2** Interpret, review, and apply blue-prints, notes, dimensions, and tolerances
- **C-3** Use and apply geometric dimensioning and tolerancing (GD&T)
- **C-4** Demonstrate traditional mechanical drafting and sketching techniques
- **C-5** Understand and use quality systems
- **D-1** Identify materials with desired properties
- **D-2** Identify materials and processes to produce a part
- **D-3** Discuss classification systems for metal
- **D-4** Consult and apply MSDS for hazards of various materials
- **E-1** Understand metrology terms
- **E-2** Select measurement tools
- **E-3** Measure with hand-held instruments
- **E-4** Eliminate measurement variables
- **E-5** Measure and inspect using surface plate and accessories
- **E-6** Inspect using stationary equipment
- **F-1** Discuss metal cutting and metal cutting tools
- **F-2** Operate metal saws and metal cutting tools
- **F-3** Operate drill presses and tooling
- **F-4** Operate engine and turret lathes and tooling
- **F-5** Operate vertical and horizontal mills and tooling
- **F-6** Operate precision grinders
- **F-7** Operate heat treating equipment and processes
- **F-8** Operate sheet metal equipment
- **F-9** Operate welding equipment and processes
- **F-10** Estimate time required/cost to produce a part
- **G-1** Use computer operating systems
- **G-2** Understand computer terminology
- **G-3** Use file management systems
- **G-4** Install and use software packages
- **H-1** Discuss fundamentals of CNC machines and controls
- **H-2** Program and operate CNC milling machine and machining center
- **H-3** Program and operate CNC lathe
- **H-4** Use Computer-Aided Drafting (CAD) system
- **H-5** Create 3-D solid models
- **H-6** Use Computer-Aided Manufacturing (CAM) system
- **I-1** Discuss basic types and functions of jigs and fixtures
- **I-2** Utilize concepts of jig and fixture design
- **I-3** Demonstrate understanding of different types of industrial dies
- **I-4** Utilize basic die theory
- **I-5** Utilize principles of die design
- **I-6** Perform tool and die repair
- **I-7** Demonstrate tool and die making skills
- **J-1** Discuss fundamentals of EDM
- **J-2** Setup and operate conventional sinker EDM
- **J-3** Operate and use CNC sinker EDM and EDM drill
- **J-4** Operate a vertical and horizontal EDM and EDM mill

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227
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-A1

Subject: Tool & Die and EDM
Time: 2 Hrs.

Duty: Practice Safety
Task: Follow Safety Manuals and All Safety Regulations/Requirements

Objective(s):

Upon completion of this unit the student will be able to:
a. Assume responsibility for the personal safety of oneself and others;
b. Develop a personal attitude towards safety;
c. Interpret safety manual directives;
d. Identify and control common machine shop hazards; and,
e. Comply with established company safety practices.

Instructional Materials:

MASTER Handout (TLD-A1-HO)
MASTER Laboratory Exercise (TLD-A1-LE)
MASTER Laboratory Aid (TLD-A1-LA)
MASTER Self-Assessment

References:

Specific Company Safety Policy and Procedures Manual

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:

Safety on the job is not only the responsibility of the management of the company. While management must establish rules according to regulations that the government has set forth for your industry, and while they must enforce these rules, every employee must be taught what these rules are and how to obey them. However, the responsibility for safety is in your hands. You are the person closest to the work being performed. Learn and follow all rules. Never take short cuts or chances. Make safety your way of life.

Presentation Outline:

I. Assume Responsibility for the Personal Safety of Oneself and Others
   A. Safety is a way of life not an option
   B. Always operate with alertness and safety foremost in mind

II. Develop a Personal Attitude Towards Safety
   A. The key to safety is individual safety
   B. Everyone must develop a safe attitude
   C. Each step of the operation must be carefully planned

III. Interpret Safety Manual Directives
   A. Read and understand safety manual
   B. Read machine operation instructions

IV. Comply with Established Safety Practices
   A. Personal safety
      1. Body: keep body out of line of tool edge
      2. Proper lifting technique
         a. Personal lifting
            1) Lift with the legs, not the back
            2) Proper physical position while lifting
            3) Proper clearance for carrying
            4) “Buddy system” for heavy lifting
         b. Equipment lifting
            1) Checking ratings for lifting devices
            2) Checking lifting points on lifted item
            3) Overhead clearance requirements
            4) Static lifting devices (slings, jack stands) should be used instead of moving lifting devices (jacks or forklifts) for actually holding heavy items up while working on them
   B. Eyes: always wear safety glasses
   C. Head: keep long hair up; wear hard hat whenever required
   D. Ears: wear protection to prevent damage from noise
   E. Jewelry: no rings, watches, bracelets, necklaces (they can get caught in machinery and they are conductors of electricity)
F. Clothing: keep sleeves and pant legs rolled down; and ties, strings, and belts away from moving parts
G. No horse-play
H. Do not talk to someone while that person is operating a machine
I. Do not talk to someone while you are operating a machine

V. Identify and Control Common Machine Shop Hazards
A. Chip formation
B. Moving machine parts
C. Spills and other debris
D. Electrical lines
E. Hydraulic and pneumatic lines

VI. Cover specific safety policies of the company

Practical Application:

The students must demonstrate a practical and aware attitude toward safety in the workplace at all times. No careless or unsafe behavior is acceptable.

*NB:* The laboratory exercise for this module is to be completed before the instruction begins. Laboratory Exercise TLD-A1-LE ties directly to the final laboratory exercise in the TLD-A Safety series.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-A2) dealing with maintaining safe equipment and machinery.
Objective(s):

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

a. Assume responsibility for the personal safety of oneself and others;
b. Develop a personal attitude towards safety;
c. Interpret safety manual directives;
d. Identify and control common machine shop hazards; and,
e. Comply with established company safety practices.

Module Outline:

I. Assume Responsibility for the Personal Safety of Oneself and Others
   A. Safety is a way of life not an option
   B. Always operate with alertness and safety foremost in mind

II. Develop a Personal Attitude Towards Safety
   A. The key to safety is individual safety
   B. Everyone must develop a safe attitude
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            3) Overhead clearance requirements
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   B. Eyes: always wear safety glasses
   C. Head: keep long hair up; wear hard hat whenever required
D. Ears: wear protection to prevent damage from noise  
E. Jewelry: no rings, watches, bracelets, necklaces (they can get caught in machinery and they are conductors of electricity)  
F. Clothing: keep sleeves and pant legs rolled down; and ties, strings, and belts away from moving parts  
G. No horse-play  
H. Do not talk to someone while that person is operating a machine  
I. Do not talk to someone while you are operating a machine  

V. Identify and Control Common Machine Shop Hazards  
A. Chip formation  
B. Moving machine parts  
C. Spills and other debris  
D. Electrical lines  
E. Hydraulic and pneumatic lines  

VI. Cover specific safety policies of the company
The purpose of this exercise is to learn to recognize hazards in the workplace. Many of the hazards which you will find there are common practices by people who simply no longer see the danger.

The instructor will guide all students through part of the facility. Each student should write down, in the space provided below, as many safety hazards as are found.

Remember, anyone can cause a hazard merely by failing to see the mop bucket that sits in front of the fire exit every day. Such tunnel vision is the result of familiarity and demonstrates the importance of keeping a fresh perspective everyday.

Due to the nature of this laboratory exercise, no answer key is possible.

<table>
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<tr>
<th>Safety Hazards</th>
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</table>
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-A1
Follow Safety Manuals and All Safety Regulations/Requirements
Self-Assessment

Circle the letter preceding the correct answer.

1. A positive attitude towards safety:
   A. Is the responsibility of the individual.
   B. Is the responsibility of management.
   C. Can be developed by all workers, regardless of their work.
   D. All of the above
   E. None of the above answers is correct.

2. When is jewelry permitted to be worn?
   A. On slow moving machinery
   B. If all guards are in place
   C. Never
   D. If your supervisor knows
   E. None of the above answers is correct.

3. Most accidents occur because:
   A. Almost every tool is unsafe.
   B. There is an unsafe condition and an unsafe action.
   C. Workers lack motivation.
   D. There is a practical joker in every plant.
   E. None of the above answers is correct.

4. Who is responsible for safety on the job?
   A. Management and employees
   B. Employees
   C. Union
   D. Government
   E. None of the above answers is correct.

5. Your most important motivation for working safely is to:
   A. Get a raise.
   B. Avoid being suspended.
   C. Protect yourself.
   D. Avoid working too hard.
   E. None of the above answers is correct.
6. Your best protection against accidents is often:
   A. Alertness.
   B. Union policy.
   C. Close supervision.
   D. Buddy system.
   E. None of the above answers is correct.

7. Which of the following three things is more important than natural skill in doing a job well and safely?
   A. Training
   B. Attitude
   C. Alertness
   D. All of the above
   E. None of the above answers is correct.

8. When you spot something dangerous in your plant, the first thing you should do is:
   A. Notify OSHA.
   B. Report it to your supervisor.
   C. Note it in the company safety log.
   D. Walk off the job.
   E. None of the above answers is correct.

9. OSHA regulations state that machines or equipment are safe after they are:
   A. Locked or tagged out.
   B. Turned off.
   C. Assumed de-energized.
   D. Written in the maintenance log.
   E. None of the above answers is correct.

10. Before operating machines, the operators should:
    A. Ask a co-worker.
    B. Operate them until they learn how.
    C. Read all the operating manuals.
    D. Wear gloves.
    E. None of the above answers is correct.
TLD-A1
Follow Safety Manuals and All Safety Regulations/Requirements
Self-Assessment Answer Key

1. D
2. C
3. B
4. A
5. C
6. A
7. D
8. B
9. A
10. C
TLD-A2

TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-A2

Subject: Tool & Die and EDM
Time: 2 Hrs.

Duty: Practice Safety
Task: Maintain Safe Equipment and Machinery

Objective(s):

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

a. Wear protective safety clothing as required;
b. Maintain and use protective guards and equipment on machinery;
c. Locate and properly maintain safe equipment and machinery; and,
d. Use lifting aids when necessary.

Instructional Materials:

MASTER Handout (TLD-A2-HO)
MASTER Laboratory Exercise (TLD-A2-LE)
MASTER Laboratory Aid (TLD-A2-LA)
MASTER Self-Assessment

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
TLD-A1 “Follow Safety Manuals and All Safety Regulations/Requirements”

Introduction:

Safety is taught by schools and industries but it is up to the individual worker to put it into practice. Read the rules and regulations to know what clothing is safe for the job you are doing. Other manuals tell you how to safely operate and service machinery and equipment. There are also safety tips on how to lift or use lifting aids when moving or lifting is done. Being safe never takes as long as getting well.
Presentation Outline:

I. Wear Protective Safety Clothing as Required
   A. Different types of safety clothing
      1. Protective from debris, cuts, and blows
         a. Hard hat, safety glasses or goggles, work gloves when necessary
         b. Sturdy footwear
         c. Long sleeved shirt (sleeves rolled down and buttoned)
      2. Fire-retardant and fire-resistant clothing
         a. Long sleeved, 100% cotton shirt
         b. Long pants, 100% cotton
         c. Leather chest protector, sleeves
      3. Optical filters to protect vision from intense light
         a. Welding hood or goggles
         b. Safety glasses or goggles for grinding
         c. Tinted goggles for cutting torch work
      4. Breathing protection
         a. Mask for dust, lint, smoke
   B. Function and use of safety clothing
      1. Man made fiber clothing melts to worker's skin when ignited
      2. Prevents cuts and abrasions
      3. Keep shirt sleeves rolled down (hangs on equipment)
      4. Do not cuff pant legs (causes tripping)
      5. Do not wear jewelry
         a. Catches in moving parts
         b. Conducts electricity
      6. Do not wear neckties around moving parts of machinery
      7. Keep belts and apron strings tied and away from moving equipment

II. Maintain and Use Protective Guards and Equipment on Machinery
   A. Purposes of various guards
      1. Do not operate a machine until guards are in place
      2. Stop the machine to make adjustments or repairs
      3. Disconnect power before removing guards or panels
   B. Evaluation and maintenance of protective equipment
      1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
      2. Do not use defective equipment
      3. Report defective or unsafe equipment immediately
      4. Make sure equipment is properly grounded

III. Locate and Properly Maintain Safe Equipment and Machinery
   A. Install safety barriers
B. Use caution signs  
C. Install lock and tag devices  
D. Know where fire extinguishers are and how to use them  

IV. Use Lifting Aids When Necessary  
A. Discuss recommended limits on single-person lifting  
B. Discuss proper lifting methods (use of the legs)  
   1. Use your legs (bend your knees)  
   2. Keep the load close to your body  
   3. Don't twist your body while lifting  
   4. Make sure you can see where you are going  
   5. Wear support belts  
C. Discuss team-lifting  
   1. Keep load the same height while lifting  
   2. Move and lift on command  
   3. Use dolly, wheelbarrow, or forklift  
D. Determine lifting ratings of lifting equipment  
   1. Know how your forklift operates  
   2. Understand load characteristics (weight, size, shape)  
E. Determine holding ratings of static lifting devices  
F. Evaluate positions on the workpiece for placement of lifting and holding devices  

Practical Application:  

Evaluation and/or Verification:  

Students should successfully complete the Self-Assessment found at the end of this lesson.  

Summary:  

Review the main lesson points and answer student questions.  

Next Lesson Assignment:  

MASTER Technical Module (TLD-A3) dealing with the safe operating procedures for hand and machine tools.
TLD-A2-HO
Maintain Safe Equipment and Machinery
Attachment 1: MASTER Handout

Objective(s):

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

a. Wear protective safety clothing as required;
b. Maintain and use protective guards and equipment on machinery;
c. Locate and properly maintain safe equipment and machinery; and,
d. Use lifting aids when necessary.

Module Outline:

I. Wear Protective Safety Clothing as Required
   A. Different types of safety clothing
      1. Protective from debris, cuts, and blows
         a. Hard hat, safety glasses or goggles, work gloves when
            necessary
         b. Sturdy footwear
         c. Long sleeved shirt (sleeves rolled down and buttoned)
      2. Fire-retardant and fire-resistant clothing
         a. Long sleeved, 100% cotton shirt
         b. Long pants, 100% cotton
         c. Leather chest protector, sleeves
      3. Optical filters to protect vision from intense light
         a. Welding hood or goggles
         b. Safety glasses or goggles for grinding
         c. Tinted goggles for cutting torch work
      4. Breathing protection
         a. Mask for dust, lint, smoke
   B. Function and use of safety clothing
      1. Man made fiber clothing melts to worker's skin when ignited
      2. Prevents cuts and abrasions
      3. Keep shirt sleeves rolled down (hangs on equipment)
      4. Do not cuff pant legs (causes tripping)
      5. Do not wear jewelry
         a. Catches in moving parts
         b. Conducts electricity
      6. Do not wear neckties around moving parts of machinery
      7. Keep belts and apron strings tied and away from moving
         equipment

II. Maintain and Use Protective Guards and Equipment on Machinery
   A. Purposes of various guards
1. Do not operate a machine until guards are in place
2. Stop the machine to make adjustments or repairs
3. Disconnect power before removing guards or panels

B. Evaluation and maintenance of protective equipment
   1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
   2. Do not use defective equipment
   3. Report defective or unsafe equipment immediately
   4. Make sure equipment is properly grounded

III. Locate and Properly Maintain Safe Equipment and Machinery
   A. Install safety barriers
   B. Use caution signs
   C. Install lock and tag devices
   D. Know where fire extinguishers are and how to use them

IV. Use Lifting Aids When Necessary
   A. Discuss recommended limits on single-person lifting
   B. Discuss proper lifting methods (use of the legs)
      1. Use your legs (bend your knees)
      2. Keep the load close to your body
      3. Don't twist your body while lifting
      4. Make sure you can see where you are going
      5. Wear support belts
   C. Discuss team-lifting
      1. Keep load the same height while lifting
      2. Move and lift on command
      3. Use dolly, wheelbarrow, or forklift
   D. Determine lifting ratings of lifting equipment
      1. Know how your forklift operates
      2. Understand load characteristics (weight, size, shape)
   E. Determine holding ratings of static lifting devices
   F. Evaluate positions on the workpiece for placement of lifting and holding devices
The instructor will display as much protective equipment, such as welding masks, breathers, and hard hats as is practical and desirable. The instructor should demonstrate the proper use of this equipment.

Due to the nature of this exercise, no answer key is possible.
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-A2
Maintain Safe Equipment and Machinery
Self-Assessment

Circle the letter preceding the correct answer.

1. Back injuries, often from poor ______ are the most common type of serious occupational injury.
   A. Lifting techniques
   B. Muscle structure
   C. Attitude adjustment
   D. Warm-up

2. If a load is too heavy, get help or use a special:
   A. Lifting techniques.
   B. Mechanical device.
   C. Platforms.
   D. Friends.

3. When lifting or lowering from high places, stand on a:
   A. Ladder.
   B. Chair.
   C. Platform.
   D. Box.

4. Energy can be mechanical, __________, hydraulic, or pneumatic.
   A. Powerful
   B. Electrical
   C. Inactive
   D. All of the above

5. One step in the lockout procedure is to __________ to make sure the power is off.
   A. Test the operating controls
   B. Ask your supervisor
   C. Check with co-workers
   D. Turn switch off

6. Remember, __________ alone don't prevent equipment from starting up.
   A. Locks
   B. Verbal instructions
   C. Tags
   D. All of the above
7. Which of the following are unsafe in the industrial workplace?
   A. Jewelry
   B. Man-made fiber clothing
   C. Open-toe shoes
   D. All of the above

8. Proper protection equipment for a welder always includes all of the following except:
   A. Eye protection.
   B. Ear protection.
   C. Flame-resistant gloves.
   D. Gas mask.

9. Ultraviolet rays are harmful when welding because they produce:
   A. Intense heat.
   B. Skin cancer.
   C. Eye damage.
   D. Metal fatigue.

10. In double insulated tools, protection against electric shock is provided by the:
    A. Insulated case or liner.
    B. Two-wire supply cord.
    C. Three-wire supply cord.
    D. Lug.

11. It is good practice to connect the neutral conductor and the metallic conduit of an electrical circuit to a common ground, because doing so:
    A. Eliminates ground faults.
    B. Provides more protection against shock.
    C. Reduces fault current.
    D. Improves the voltage in the circuit.

12. Damaged or deteriorated conductors on machinery or equipment should be:
    A. Separated.
    B. Replaced.
    C. Taped.
    D. Reported.

13. All equipment should be inspected before use.
    A. True
    B. False
14. Guards may be left off equipment for frequent servicing while the equipment is running.
   A. True
   B. False

15. It is permissible to loan your lock out key to co-workers.
   A. True
   B. False
TLD-A2
Maintain Safe Equipment and Machinery
Self-Assessment Answer Key

1. A
2. B
3. C
4. B
5. A
6. C
7. D
8. D
9. C
10. A
11. B
12. B
13. A
14. B
15. B
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-A3

Subject: Tool & Die and EDM
Time: 2 Hrs.

Duty: Practice Safety
Task: Use Safe Operating Procedures for Hand and Machine Tools

Objective(s):

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

a. Identify and understand safe machine operating procedures; and,
b. Demonstrate safe machine operation.

Instructional Materials:

MASTER Handout (TLD-A3-HO)
MASTER Laboratory Exercise (TLD-A3-LE)
MASTER Laboratory Aid (TLD-A3-LA)
MASTER Self-Assessment
Operation manuals for all covered machines

References:


Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 "Follow Safety Manuals and All Safety Regulations/Requirements"
TLD-A2 "Maintain Safe Equipment and Machinery"

Introduction:

The reason that there are safety guards on machines is to prevent accidents. Read the operating manuals and train for the operation of the machine before attempting to use it. You cannot always tell whether a part is moving or energized by just looking at it. Before working on the machine, always bring the machine to a zero energy state. The more you learn about the machine, the safer and easier your work will be.
Presentation Outline:

I. Identify and Understand Safe Machine Operating Procedures
   A. Never make adjustments on a machine while it is running
      1. Keep guards in place at all times
      2. Discontinue power before servicing
      3. Keep body parts clear of moving machinery
      4. Beware of sharp edges and flying debris
      5. Secure work pieces to prevent slipping
      6. Never stand directly in line with blades or knives
      7. Avoid kickback
      8. Feed stack into machine correctly
   B. Electrical safety
      1. Use only those electrical devices which have been approved by UL (Underwriters’ Laboratories)
      2. Stand on dry surface when working on electrical equipment
      3. Replace defective cords or plugs on equipment
      4. Use only those tools that are in good condition
      5. Use only carbon dioxide or dry chemical fire extinguishers for control of electrical fires
      6. Obtain help when working on equipment that may become energized
   C. Avoid horseplay and practical jokes
   D. Keep work area clean.

II. Demonstrate Safe Machine Operation
   A. Good housekeeping
      1. Materials and equipment should be stacked straight and neat
      2. Keep aisles and walkways clear of tools, materials, and debris
      3. Dispose of scraps and rubbish daily
      4. Clean up spills
      5. Clean and store hand tools
   B. Good techniques
      1. Always walk - do not run
      2. Never talk to or interrupt anyone who is operating a machine
      3. Never leave tools or pieces of stock lying on table surface of a machine being used
      4. When finished with a machine, turn power OFF and wait until blades or cutters have come to a complete stop before leaving
      5. Check stock for defects before machining
         a. Do not use a machine until you understand it thoroughly
         b. Do not jam or rush stock into machinery
         c. Keep guards in place
         d. Make sure power is OFF before working on or servicing
6. Keep hands and fingers away from moving parts
7. Don't try to run too small a piece through the machine
8. Use a brush to clean the surface table
9. Keep your eyes focused on what you are working on
10. Never use an air hose to blow debris off yourself or other workers
11. Report faulty machinery to your supervisor
12. Make sure machinery is properly grounded
13. Never leave a piece of machinery that is running unattended
14. Make sure stack is solidly supported

C. Miscellaneous materials
1. Molten metal - can splash and cause serious burns
2. Chemicals - burn or irritate the skin or cause eye damage
3. Broken glass - causes cuts, can get in the eyes
4. Pointed objects - knives, screwdrivers, punches, staples can puncture the skin
5. Rough material - can scrape your skin and cause infections

D. Machinery
1. Understand the safety regulations that involve the guarding of moving parts
2. Know what parts of the equipment are energized
3. Use all safeguards that have been provided to protect people from machinery
4. See that all guards and protectors are in place before you start to work
5. If you must work nearer, turn the machine off and lock out the power
6. Never work in, around, or near dangerous, unguarded openings without wearing a safety belt and a lifeline that is properly seamed

E. One-fifth of all injuries on the job involve moving parts, machinery, or tools

Practical Application:

The students shall identify all major safeguards and protective devices on all covered machinery.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.
Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-A4) dealing with maintaining a clean and safe work environment
Objective(s):

Upon completion of this unit the student will be able to:
a. Identify and understand safe machine operating procedures; and,
b. Demonstrate safe machine operation.

Module Outline:

I. Identify and Understand Safe Machine Operating Procedures
   A. Never make adjustments on a machine while it is running
      1. Keep guards in place at all times
      2. Discontinue power before servicing
      3. Keep body parts clear of moving machinery
      4. Beware of sharp edges and flying debris
      5. Secure work pieces to prevent slipping
      6. Never stand directly in line with blades or knives
      7. Avoid kickback
      8. Feed stack into machine correctly
   B. Electrical safety
      1. Use only those electrical devices which have been approved by UL (Underwriters’ Laboratories)
      2. Stand on dry surface when working on electrical equipment
      3. Replace defective cords or plugs on equipment
      4. Use only those tools that are in good condition
      5. Use only carbon dioxide or dry chemical fire extinguishers for control of electrical fires
      6. Obtain help when working on equipment that may become energized
   C. Avoid horseplay and practical jokes
   D. Keep work area clean.

II. Demonstrate Safe Machine Operation
   A. Good housekeeping
      1. Materials and equipment should be stacked straight and neat
      2. Keep aisles and walkways clear of tools, materials, and debris
      3. Dispose of scraps and rubbish daily
      4. Clean up spills
      5. Clean and store hand tools
   B. Good techniques
      1. Always walk - do not run
      2. Never talk to or interrupt anyone who is operating a machine
3. Never leave tools or pieces of stock lying on table surface of a machine being used.
4. When finished with a machine, turn power OFF and wait until blades or cutters have come to a complete stop before leaving.
5. Check stock for defects before machining:
   a. Do not use a machine until you understand it thoroughly.
   b. Do not jam or rush stock into machinery.
   c. Keep guards in place.
   d. Make sure power is OFF before working on or servicing.
6. Keep hands and fingers away from moving parts.
7. Don't try to run too small a piece through the machine.
8. Use a brush to clean the surface table.
9. Keep your eyes focused on what you are working on.
10. Never use an air hose to blow debris off yourself or other workers.
11. Report faulty machinery to your supervisor.
12. Make sure machinery is properly grounded.
13. Never leave a piece of machinery that is running unattended.
14. Make sure stack is solidly supported.

C. Miscellaneous materials:
1. Molten metal - can splash and cause serious burns.
2. Chemicals - burn or irritate the skin or cause eye damage.
3. Broken glass - causes cuts, can get in the eyes.
4. Pointed objects - knives, screwdrivers, punches, staples can puncture the skin.
5. Rough material - can scrape your skin and cause infections.

D. Machinery:
1. Understand the safety regulations that involve the guarding of moving parts.
2. Know what parts of the equipment are energized.
3. Use all safeguards that have been provided to protect people from machinery.
4. See that all guards and protectors are in place before you start to work.
5. If you must work nearer, turn the machine off and lock out the power.
6. Never work in, around, or near dangerous, unguarded openings without wearing a safety belt and a lifeline that is properly seamed.

E. One-fifth of all injuries on the job involve moving parts, machinery, or tools.
For this exercise, the instructor should allow the students to observe other workers at their stations. The students should look for only practices related to safety. Upon returning to class, the students and instructor should discuss what they saw.

NOTE TO ALL STUDENTS: Unless your instructor tells you otherwise, all questions are to be directed to the instructor only. Do not disturb your fellow workers at their stations. Such distractions, in and of themselves, pose risks!

Due to the nature of this exercise, no answer key is possible.
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-A3
Use Safe Operating Procedures for Hand and Machine Tools
Self-Assessment

Circle the letter preceding the correct answer.

1. Barrier guards _________ the operator's access to the danger zone.
   A. Limit
   B. Prevent
   C. Stop the operator from entering maintenance area
   D. All of the above

2. Equipment grounding is accomplished by a separate wire which is colored:
   A. White.
   B. Black.
   C. Green.
   D. Red.

3. “Intrinsically safe” equipment is designed so that it cannot:
   A. Become damaged if dropped.
   B. Ignite materials nearby.
   C. Start its built-in alarm.
   D. Eliminate ground faults.

4. When making repairs on machinery the most important rule is to:
   A. Lock-out and tag-out.
   B. Report and document.
   C. Install barricades.
   D. Notify co-workers.

5. Safety guards would not be needed on machines if:
   A. Workers would be more careful.
   B. Machines had no moving parts.
   C. Safety rules were strictly enforced.
   D. Machines were better designed.
6. When you do maintenance work you are safer if you wear:
   A. A good-luck charm bracelet.
   B. Loose, comfortable clothing.
   C. Tight-fitting clothing.
   D. A narrow necktie.

7. Which of the following is not a pinch point?
   A. Where a belt meets a pulley
   B. Where a chain meets a sprocket
   C. Where a belt passes close to a fixed object
   D. Where a drill bit meets a work piece

8. After you have locked out the power to a machine, you should:
   A. Make sure all moving parts have stopped.
   B. Drain the hydraulic and pneumatic lines.
   C. Block any parts that might move.
   D. Do all of the above.

9. Debris should be cleared from machines using your:
   A. Bare hands.
   B. High pressure air hose.
   C. Brush.
   D. Neither, leave it for the next shift.

10. Which of the following statements is correct?
    A. Understand the safety regulations that involve the guarding of moving parts.
    B. Knowing what parts of the equipment are energized.
    C. Use all safeguards to protect people.
    D. All of the above.

11. You should begin work on a machine only after:
    A. The supervisor tells you to.
    B. You have read operating instructions and have been properly trained.
    C. Warned other people.
    D. All of the above.

12. Only authorized employees are permitted to install or remove locks or tags.
    A. True
    B. False
13. If a machine can't be locked or tagged a guard should be stationed at the controls.
   A. True
   B. False

14. It is permissible to talk to persons operating a piece of machinery.
   A. True
   B. False

15. Feed and extracting tools make it unnecessary for the operator to reach into the danger zone.
   A. True
   B. False
TLD-A3
Use Safe Operating Procedures for Hand and Machine Tools
Self-Assessment Answer Key

1. A
2. C
3. B
4. A
5. B
6. C
7. D
8. D
9. C
10. D
11. B
12. A
13. A
14. B
15. A
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-A4

Subject: Tool & Die and EDM  Time: 4 Hrs.
Duty: Practice Safety
Task: Maintain a Clean and Safe Work Environment

Objective(s):

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

a. Keep work areas clean;
b. Clean machine/hand tools when work is completed;
c. Put tools away when work is finished;
d. Keep isles clear of equipment and materials;
e. Perform preventive maintenance as required; and,
f. Understand chemical hazards and the use of Material Safety Data Sheets (MSDS).

Instructional Materials:

MASTER Handout (TLD-A4-HO)
MASTER Laboratory Exercise (TLD-A4-LE)
MASTER Laboratory Aid (TLD-A4-LA)
MASTER Self-Assessment

References:

Materials Safety Data Sheets

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 "Follow Safety Manuals and All Safety Regulations/Requirements"
TLD-A2 "Maintain Safe Equipment and Machinery"
TLD-A3 "Use Safe Operating Procedures for Hand and Machine Tools"
Introduction:

Cleanliness is the first rule of safety. A clean neat work area helps prevent accidents. A cluttered area invites slips, trips, or falls. Clean up around your machine or equipment. If you are unable to do so, ask your supervisor for a helper to clean or stack material. Clean and store tools when you are finished and keep cords and hoses rolled up. Most accidents are caused by workers who do unsafe things. Learn to do your part by helping to create a safe work environment.

Presentation Outline:

I. Keep Work Areas Clean
   A. Discuss the associated dangers of the most common hazards of the work place
      1. Tripping/falling hazards caused by spills, loose objects, etc.
         a. Wipe up spills immediately
         b. Dispose of scrap material
         c. Do not wear loose clothing
         d. Never roll sleeves or pants
         e. keep shoe strings tied
         f. Position electrical cords and air hoses in safe areas
      2. Chemical hazards
         a. Inhalants
         b. Chemical burns
         c. Flammable liquids
         d. Explosives and explosive combinations
         e. Toxins
      3. Electrical hazards
      4. High-pressure hazards
   B. Discuss methods of avoiding and correcting common hazards

II. Clean Machine/Hand Tools When Work Is Completed
III. Put Tools Away When Work Is Finished
IV. Keep Isles Clear of Equipment and Materials
V. Perform Preventive Maintenance as Required
   A. Discuss that certain machines require extra precautions
   B. Discuss how general maintenance enhances general safety
VI. Understand the Use of Material Safety Data Sheets (MSDS)
   A. What chemicals have MSDS?
   B. Where are the MSDS kept?
   C. What information is on the MSDS?
      1. Product identification
         a. Specific product name and common name
         b. Precautionary labeling
         c. Safety equipment
d. Precautionary label statements

2. Hazardous components

3. Physical data
   a. Boiling point
   b. Vapor pressure
   c. Melting point
   d. Vapor density
   e. Specific gravity
   f. Evaporation rate
   g. Solubility in water
   h. Percentage of volatile components by volume
   i. Appearance & odor

4. Fire and explosion hazard data
   a. Flash point
   b. NFPA 704M rating
   c. Flammable limits (upper and lower)
   d. Fire extinguishing media
   e. Special fire-fighting procedures
   f. Toxic gases produced

5. Health hazard data
   a. Threshold limit value
   b. Permissible exposure limit
   c. Toxicity
   d. Carcinogenicity
   e. Effects of over-exposure
   f. Target organs (those most affected by exposure)
   g. Medical conditions aggravated by exposure
   h. Routes of entry
   i. Emergency and first-aid procedures

6. Reactivity data
   a. Stability
   b. Hazardous polymerization
   c. Conditions to avoid
   d. Incompatible materials
   e. Decomposition products

7. Spill and disposal procedures
   a. Procedures: spill or discharge
   b. Procedures: disposal
   c. EPA hazardous waste number

8. Protective equipment
   a. Ventilation
   b. Respiratory protection
   c. Eye/skin protection

9. Storage and handling precautions
a. Storage color code  
b. Special precautions

10. Transportation data and additional information

a. Domestic transport  
   1) DOT shipping name  
   2) Hazard class  
   3) UN/NA  
   4) Labels  
   5) Reportable quantity

b. International  
   1) IMO shipping name  
   2) Hazard class  
   3) UN/NA  
   4) Labels

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Practical Application:

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Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

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Summary:

Review the main lesson points and answer student questions.

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Next Lesson Assignment:

MASTER Technical Module (TLD-A5) dealing with using safe material handling practices.
Objective(s):

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

a. Keep work areas clean;

b. Clean machine/hand tools when work is completed;

c. Put tools away when work is finished;

d. Keep isles clear of equipment and materials;

e. Perform preventive maintenance as required; and,

f. Understand chemical hazards and the use of Material Safety Data Sheets (MSDS).

Module Outline:

I. Keep Work Areas Clean
   A. Discuss the associated dangers of the most common hazards of the work place
      1. Tripping/falling hazards caused by spills, loose objects, etc.
         a. Wipe up spills immediately
         b. Dispose of scrap material
         c. Do not wear loose clothing
         d. Never roll sleeves or pants
         e. keep shoe strings tied
         f. Position electrical cords and air hoses in safe areas
      2. Chemical hazards
         a. Inhalants
         b. Chemical burns
         c. Flammable liquids
         d. Explosives and explosive combinations
         e. Toxins
      3. Electrical hazards
      4. High-pressure hazards
   B. Discuss methods of avoiding and correcting common hazards

II. Clean Machine/Hand Tools When Work Is Completed

III. Put Tools Away When Work Is Finished

IV. Keep Isles Clear of Equipment and Materials

V. Perform Preventive Maintenance as Required
   A. Discuss that certain machines require extra precautions
   B. Discuss how general maintenance enhances general safety

VI. Understand the Use of Material Safety Data Sheets (MSDS)
   A. What chemicals have MSDS?
B. Where are the MSDS kept?

C. What information is on the MSDS?
   1. Product identification
      a. Specific product name and common name
      b. Precautionary labeling
      c. Safety equipment
      d. Precautionary label statements
      e. Storage color code
   2. Hazardous components
   3. Physical data
      a. Boiling point
      b. Vapor pressure
      c. Melting point
      d. Vapor density
      e. Specific gravity
      f. Evaporation rate
      g. Solubility in water
      h. Percentage of volatile components by volume
      i. Appearance & odor
   4. Fire and explosion hazard data
      a. Flash point
      b. NFPA 704M rating
      c. Flammable limits (upper and lower)
      d. Fire extinguishing media
      e. Special fire-fighting procedures
      f. Toxic gases produced
   5. Health hazard data
      a. Threshold limit value
      b. Permissible exposure limit
      c. Toxicity
      d. Carcinogenicity
      e. Effects of over-exposure
      f. Target organs (those most affected by exposure)
      g. Medical conditions aggravated by exposure
      h. Routes of entry
      i. Emergency and first-aid procedures
   6. Reactivity data
      a. Stability
      b. Hazardous polymerization
      c. Conditions to avoid
      d. Incompatible materials
      e. Decomposition products
   7. Spill and disposal procedures
      a. Procedures: spill or discharge
      b. Procedures: disposal
c. EPA hazardous waste number

8. Protective equipment
   a. Ventilation
   b. Respiratory protection
   c. Eye/skin protection

9. Storage and handling precautions
   a. Storage color code
   b. Special precautions

10. Transportation data and additional information
    a. Domestic transport
       1) DOT shipping name
       2) Hazard class
       3) UN/NA
       4) Labels
       5) Reportable quantity
    b. International
       1) IMO shipping name
       2) Hazard class
       3) UN/NA
       4) Labels
TLD-A4-LE
Maintain a Clean and Safe Work Environment
Attachment 2: MASTER Laboratory Exercise

The instructor will guide all students through part of the facility. Each student should write down as many safety hazards as are found. While this may appear to be an exact duplicate of TLD-A1, the purpose of this exercise is to determine how much more aware of safety and hazards the students have become.

Upon returning to class, the students and the instructor should discuss what the students observed on this tour. Each student should compare his answers to those from TLD-A1, noting any differences and the reasons for those differences.

Due to the nature of this laboratory exercise, no answer key is possible.

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Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-A4
Maintain a Clean and Safe Work Environment
Self-Assessment:

Circle the letter preceding the correct answer.

1. A chemical label tells:
   A. The carrier where to send the container
   B. Only what the manufacture wants you to know
   C. Only the maximum hazard
   D. What a chemical's identity is

2. Labels are an important part of:
   A. Your company's Hazard Communication Program
   B. Right to know
   C. Both a and b
   D. Neither a nor b

3. On some labels, ___ represent the kind of hazards and ___ represent the degree of hazard.
   A. Colors ... numbers
   B. Caution ... danger
   C. OSHA ... MDS
   D. All of the above

4. Before you start any jobs with chemicals, check the detailed hazard and safety information on the:
   A. Supervisor's desk
   B. Material Safety Data Sheet
   C. Dock
   D. Poison control center

5. Chemicals can enter the body by:
   A. Swallowing
   B. Inhaling
   C. Skin contact
   D. All of the above

6. The Control Measures Section of the MSDS covers the:
   A. Protective equipment you might need
   B. Exposure limits
   C. Temperature limits
   D. Spill and leak
7. Which of the following is not a good housekeeping rule?  
A. Always put tools in their proper place  
B. Dispose of waste material properly  
C. Sweep debris from machine with hands  
D. Wipe up spills immediately

8. Which of the following is a fire risk?  
A. Disposing of oily rags in tightly covered containers  
B. Storing flammables in electrical closets  
C. Keeping motors and machines free of dust and grease  
D. Keeping passages and fire exits clear

9. Before performing maintenance on a machine you should:  
A. Shut off power  
B. Warn other people  
C. Bring the machine to a zero energy state  
D. Lock-out power and the valves

10. If you have to work on a suspended load you should:  
A. Make sure you have clearance  
B. Place barricades around the hoist  
C. Watch out for pedestrians  
D. Set the load down first

11. Flammable liquids should be stored in:  
A. Open metal containers  
B. Sealed metal containers  
C. Open glass containers  
D. Sealed glass containers

12. During maintenance, the controls of a power-driven conveyor should be locked in the OFF position to prevent:  
A. Start-up  
B. Theft  
C. Damage  
D. Fire

13. When working aloft, you need:  
A. Guard rail clamps  
B. Safety toed shoes  
C. A safety harness  
D. A helper posted below
14. Scrap material should be:
   A. Stacked around the machine
   B. Cleared from the area
   C. Swept out in aisles
   D. All of the above

15. Danger that is part of the job is a:
   A. Built-in hazard
   B. Walk-on hazard
   C. Accident chain
   D. Hazardous duty
   E. Problem for the insurance company, not me
TLD-A4
Maintain a Clean and Safe Work Environment
Self-Assessment Answer Key

1. D
2. C
3. A
4. B
5. D
6. A
7. C
8. B
9. C
10. D
11. B
12. A
13. C
14. B
15. A
Subject: Tool & Die and EDM
Time: 3 Hrs.

Duty: Practice Safety

Task: Use Safe Material Handling Practices

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; and,
d. Identify safety concerns to be addressed when lifting rough, sharp or fragile items.

Instructional Materials:

1. Large Empty Cardboard Box
2. Pencil
3. Paper
4. Gloves
5. Safety Glasses
6. Hand Truck
7. Conveyor
8. Chains
9. Sling
10. Face Shield
11. Side Shield
12. MASTER Handout (TLD-A5-HO)
13. MASTER Laboratory Exercise (TLD-A5-LE)
14. MASTER Laboratory Aid (TLD-A5-LA)
15. Copy of 29 CFR 1910 Regulations

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


*Lifting, Eye Protection and Hand Tool Safety*, - 20m - Video Tape - BBP, Latest Edition

*Rigging*, - Video Tape - ITS - Video Tape, Latest Edition

*Basic Injury Prevention*, - C.L.M. - Video Tape, Latest Edition

**Student Preparation:**

Students should have previously completed the following Technical Modules:

- **TLD-A1** "Follow Safety Manuals and All Safety Regulations/Requirements"
- **TLD-A2** "Maintain Safe Equipment and Machinery"
- **TLD-A3** "Use Safe Operating Procedures for Hand and Machine Tools"
- **TLD-A4** "Maintain a Clean and Safe Work Environment"
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.

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
   B. 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. 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
   IV. Discuss Equipment for Material Handling
      A. Hand Trucks
      B. Powered Trucks
      C. Conveyers
   V. 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

VI. Discuss and Demonstrate Use of Powered Hand Trucks
A. Watch out for people
B. Drive unit slowly
C. Use manual lifting rules

VII. 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

VIII. 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

IX. Discuss and Demonstrate Safe Use of Chains and Slings

Practical Application:

Students will practice correct lifting techniques. Each student will then complete the Laboratory exercise where he will be graded on demonstrating proper lifting techniques.
Evaluation and 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 (TLD-A5-HO) as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-A6) dealing with consulting and applying MSDS for hazards of various materials.
Standards of Performance:

Student shall demonstrate safety 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; and,
d. Identify safety concerns to be addressed when lifting rough, sharp or fragile items.

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. 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

IV. Discuss Equipment for Material Handling
A. Hand Trucks
B. Powered Trucks
C. Conveyers

V. 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

VI. Discuss and Demonstrate Use of Powered Hand Trucks
A. Watch out for people
B. Drive unit slowly
C. Use manual lifting rules

VII. 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

VIII. 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

IX. Discuss and Demonstrate Safe Use of Chains and Slings
EXERCISE

1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   - Hand truck
   - Conveyor
   - Chains
   - Sling
   - Face shield
   - Side shields

3. Exercises below must be taken in sequence. Instructor must confirm proficiency prior to student's progressing to next exercise.
   a. Practice manual lifting.
   b. Practice using hand truck to carry objects.
   c. Practice using powered truck to carry objects.
   d. Practice handling specific shapes.
   e. Practice lifting with slings.
   f. Practice lifting with chains.

4. Instructor will guide each exercise.

5. Instructor will grade each exercise.
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-A6

Subject: Tool & Die and EDM

Duty: Practice Safety

Task: Consult and Apply MSDS for Hazards of Various Materials

Objective(s):

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

a. Define hazardous material;
b. Identify hazardous material;c. Know the physical and chemical characteristics;d. Describe storage, transportation, disposal of hazardous waste; and,
e. Explain material safety data sheets.

Instructional Materials:

MASTER Handout (TLD-A6-HO)
MASTER Laboratory Aid (TLD-A6-LA)
MASTER Self-Assessment

References:

OSHA General Industry Requirements, U. S. Government Printing Office,
Latest Edition
Materials Safety Data Sheets for various chemicals

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 "Follow Safety Manuals and All Safety Regulations/Requirements"
TLD-A2 "Maintain Safe Equipment and Machinery"
TLD-A3 "Use Safe Operating Procedures for Hand and Machine Tools"
TLD-A4 "Maintain a Clean and Safe Work Environment"
TLD-A5 "Use Safe Material Handling Practices"
Introduction:

Hazardous materials can cause immediate or long-term health problems if not managed properly. It is the responsibility of all persons involved with hazard waste to know the rules, the material, and how to handle the material properly.

Presentation Outline:

I. Define Hazardous Materials According to the EPA
   A. What makes a material hazardous?
      1. It is hazardous if it causes harm to people or environment

II. Identify Hazardous Materials
    A. Material Safety Data Sheets (MSDS)
       1. Companies that make and distribute hazardous substances must provide your company with a MSDS on hazardous material
       2. MSDS developed by OSHA
       3. MSDS is part of the Hazard Communication Standard or Right to Know regulation
       4. MSDS is an easy reference for information on hazardous substances
    B. Information in MSDS
       1. What it is
       2. Who makes or sells it
       3. Where they are located
       4. Why it is hazardous
       5. How you can be exposed to the hazard
       6. Conditions that could increase the hazard
       7. How to handle the substance safely
       8. Protection to use while working with it
       9. What to do if exposed
      10. What to do if there is a spill or emergency

III. Know the Chemical and Physical Characteristics
    A. Corrosive
       1. Burns skin or eyes on contact
    B. Explosive
    C. Flammable
       1. Catches fire easily
    D. Radioactive
    E. Reactive
       1. Burns, explodes
       2. Releases toxic vapors
    F. Toxic
       1. Causes illness or possibly death
IV. Describe Storage, Transportation, Disposal

A. Resource Conservation and Recovery Act (RCRA)
   1. Designed to reduce hazards of waste by tracking and regulating the substance
   2. Method used is called from cradle (creation) to grave (disposal)
   3. Tells what hazards are and how to keep track of them
   4. Sets up rules for handling wastes
   5. Provides strict documentation system to track them

B. Your employer may have to report to the Environmental Protection Agency (EPA) on how the company is meeting the RCRA responsibilities

C. The law requires companies that treat, store, or dispose of hazardous wastes to:
   1. Must have a permit
   2. Identify and analyze new hazardous waste
   3. Provide a secure facility that keeps unauthorized people out
   4. Inspect the facility regularly
   5. Have a contingency plan for fire, explosion, and spills
   6. Practice emergency response for fire, explosion, spills
   7. Provide proper protective clothing and equipment
   8. Maintain EPA-required records

Practical Application:

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-B1) dealing with performing basic arithmetic functions.
Objective(s):

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

a. Define hazardous material;
b. Identify hazardous material;
c. Know the physical and chemical characteristics;
d. Describe storage, transportation, disposal of hazardous waste; and,
e. Explain material safety data sheets.

Module Outline:

I. Define Hazardous Materials According to the EPA
A. What makes a material hazardous?
   1. It is hazardous if it causes harm to people or environment

II. Identify Hazardous Materials
A. Material Safety Data Sheets (MSDS)
   1. Companies that make and distribute hazardous substances
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   1. What it is
   2. Who makes or sells it
   3. Where they are located
   4. Why it is hazardous
   5. How you can be exposed to the hazard
   6. Conditions that could increase the hazard
   7. How to handle the substance safely
   8. Protection to use while working with it
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   10. What to do if there is a spill or emergency

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A. Corrosive
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A. Resource Conservation and Recovery Act (RCRA)
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B. Your employer may have to report to the Environmental Protection Agency (EPA) on how the company is meeting the RCRA responsibilities

C. The law requires companies that treat, store, or dispose of hazardous wastes to:
   1. Must have a permit
   2. Identify and analyze new hazardous waste
   3. Provide a secure facility that keeps unauthorized people out
   4. Inspect the facility regularly
   5. Have a contingency plan for fire, explosion, and spills
   6. Practice emergency response for fire, explosion, spills
   7. Provide proper protective clothing and equipment
   8. Maintain EPA-required records
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Consult and Apply MSDS for Hazards of Various Materials
Self-Assessment

Circle the letter preceding the correct answer.

1. The law requires companies that treat, store, or dispose of hazardous wastes to ________.
   a. Have a permit
   b. Give notice before dumping
   c. Have OSHA personnel on site at all times
   d. All of the above

2. Your employer may have to report to the ________ on how the company is meeting the RCRA responsibility.
   a. OSHA
   b. EPA
   c. RCRA
   d. Local authorities

3. The EPA requires paperwork that tracks hazardous waste from ________ to ________.
   a. Company to company
   b. State to state
   c. Cradle to grave
   d. Manufacturer to company

4. The key pieces of information in the manifest are ________.
   a. Manifest document number
   b. Name, address, phone numbers, EPA ID number of generator
   c. Description of the hazardous waste
   d. All of the above

5. Who must sign the manifest and keep a copy?
   a. Only the manufacture
   b. Only the shipper
   c. Only those who dispose of the waste
   d. Everyone who handles the waste
6. A material safety data sheet tells you the chemical's _________.
   a. Market value
   b. Color
   c. Physical and chemical characteristics
   d. All of the above

7. If properly wrapped, hazardous waste _________________.
   a. May be disposed of at public dumps
   b. Must be disposed of according to the EPA guidelines
   c. Dumped on private property
   d. All of the above

8. MSDS stands for _____________.
   a. Material safety data sheet
   b. Military secret dumping site
   c. Mine safety division storage
   d. Material safe disposal site

9. OSHA developed the MSDS as part of _____________.
   a. Hazard communication standard
   b. Right-to-know regulations
   c. Both A & B
   d. Neither A nor B

10. The ____________ part of the label can either indicate a specific hazard or what personal protective equipment should be used.
    a. White
    b. Red
    c. Triangle
    d. Cross-hairs
TLD-A6
Consult and Apply MSDS for Hazards of Various Materials
Self-Assessment Answer Key

1. a
2. b
3. c
4. d
5. d
6. c
7. b
8. a
9. c
10. a
TOOL AND DIE MAKER ... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>Follow safety manuals and all safety regulations/reuirements</td>
</tr>
<tr>
<td>B</td>
<td>Perform basic arithmetic functions</td>
</tr>
<tr>
<td>C</td>
<td>Interpret engineering drawings and related documents</td>
</tr>
<tr>
<td>D</td>
<td>Identify materials with desired properties</td>
</tr>
<tr>
<td>E</td>
<td>Measure/inspect</td>
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<tr>
<td>F</td>
<td>Discuss metal cutting and metal cutting tools</td>
</tr>
<tr>
<td>G</td>
<td>Use computer operating systems</td>
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<tr>
<td>H</td>
<td>Discuss fundamentals of CNC machines and controls</td>
</tr>
<tr>
<td>I</td>
<td>Utilize concepts of jig and fixture design</td>
</tr>
<tr>
<td>J</td>
<td>Discuss fundamentals of EDM</td>
</tr>
</tbody>
</table>

TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-B1

Subject: Tool & Die and EDM

Time: 1 Hr.

Duty: Apply Mathematical Concepts

Task: Perform Basic Arithmetic Functions

Objective(s):

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

a. Add, subtract, multiply, and divide whole numbers;
b. Add, subtract, multiply, and divide fractions; and,
c. Add, subtract, multiply, and divide decimals.

Instructional Materials:

MASTER Handout (TLD-B1-HO)
MASTER Laboratory Aid (TLD-B1-LA)
MASTER Self-Assessment

References:


Student Preparation:

Introduction:

Mathematics is called the “Queen of Sciences” for a definite reason. In the modern world, almost nothing can be done without it. Fundamental to success in all mathematics is a thorough and complete understanding of the four basic functions of arithmetic: Addition, Subtraction, Multiplication, and Division. Technicians must perform all functions of arithmetic on a daily basis and with complete confidence. This lesson is designed to dust off all your old memories and to permit you to see that solid base of arithmetic which you must surely have to progress.
Presentation Outline:

I. Add, Subtract, Multiply, and Divide Whole Numbers
   A. Addition of whole numbers
   B. Subtraction of whole numbers
   C. Multiplication of whole numbers
   D. Division of whole numbers
   E. Hierarchy of operations

II. Add, Subtract, Multiply, and Divide Fractions
    A. Common operations
       1. Least common denominator
       2. Factoring for reduction
       3. Improper fractions
       4. Mixed numbers
    B. Addition
    C. Subtraction
    D. Multiplication
    E. Division

III. Add, Subtract, Multiply, and Divide Decimals
    A. Aligning the decimal (addition and subtraction)
    B. Moving the decimal
       1. In division, move the decimal to the right until it is eliminated in the divisor. Move the decimal the same number of places to the right in the dividend.
       2. In multiplication, count the total number of decimals places in the two numbers being multiplied. Beginning in the product at the right-most digit, count off the same number of places and place the decimal.

Practical Application:

The students shall demonstrate a working knowledge of the four basic operations of arithmetic and an ability to reduce fractions.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.
Next Lesson Assignment:

**MASTER Technical Module (TLD-B2)** dealing with performing basic algebraic operations.
Objective(s):

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

a. Add, subtract, multiply, and divide whole numbers;

b. Add, subtract, multiply, and divide fractions; and,

c. Add, subtract, multiply, and divide decimals.

Module Outline:

I. Add, Subtract, Multiply, and Divide Whole Numbers
   A. Addition of whole numbers
   B. Subtraction of whole numbers
   C. Multiplication of whole numbers
   D. Division of whole numbers
   E. Hierarchy of operations

II. Add, Subtract, Multiply, and Divide Fractions
   A. Common operations
      1. Least common denominator
      2. Factoring for reduction
      3. Improper fractions
      4. Mixed numbers
   B. Addition
   C. Subtraction
   D. Multiplication
   E. Division

III. Add, Subtract, Multiply, and Divide Decimals
   A. Aligning the decimal (addition and subtraction)
   B. Moving the decimal
      1. In division, move the decimal to the right until it is eliminated in the divisor. Move the decimal the same number of places to the right in the dividend.
      2. In multiplication, count the total number of decimals places in the two numbers being multiplied. Beginning in the product at the right-most digit, count off the same number of places and place the decimal.
Perform Basic Arithmetic Functions
Attachment 2: MASTER Laboratory Aid
TLD-B1
Perform Basic Arithmetic Functions
Self-Assessment

Show all work.

Reduce the following fractions:

1. \( \frac{4}{64} \)
2. \( \frac{6}{4} \)
3. \( \frac{6}{16} \)
4. \( \frac{12}{32} \)
5. \( \frac{9}{16} \)

Perform the indicated operations:

6. \( 3.25 + 2.375 = \)
7. \( \frac{15}{32} + \frac{1}{4} = \)
8. \( \frac{15}{32} - \frac{1}{4} = \)
9. \( \frac{9}{64} + \frac{9}{32} = \)
10. \( \frac{1}{4} \times \frac{3}{4} = \)
11. \( \frac{1}{4} \div \frac{3}{4} = \)
12. \( 0.625 \times \frac{1}{4} = \)
13. \( 0.625 + 1.125 = \)
14. \( 1.125 - 0.75 = \)
15. \( 1.25/1.5 = \)
For Questions 16 through 25, use the dimensional notations on the drawing.

16. What is the distance between Line A and Line B?  
17. What is the distance between Line B and Line C?  
18. What is the distance between Line B and Line D?  
19. What is the distance between Line C and Line E?  
20. What is the distance between Line C and Line D?  
21. What is the distance between Line E and Line F?  
22. What is the distance between Line F and Line G?  
23. What is the distance between Line F and Line I?  
24. What is the distance between Line G and Line H?  
25. What is the distance between Line I and Line E?
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<td>18.</td>
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<tr>
<td>4.</td>
<td>3/8</td>
<td>19.</td>
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<td>9/16</td>
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<tr>
<td>6.</td>
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<td>9.</td>
<td>27/64</td>
<td>24.</td>
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<td>12.</td>
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<td>14.</td>
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<td>15.</td>
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TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-B2

Subject: Tool & Die and EDM
Duty: Apply Mathematical Concepts
Task: Perform Basic Algebraic Operations

Time: 8 Hrs.

Objective(s):

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

a. Understand basic algebraic symbols and expressions; and,

b. Use equations to solve problems.

Instructional Materials:

Calculators for Students
MASTER Handout (TLD-B2-HO)
MASTER Self-Assessment

References:


Student Preparation:

Students should have previously completed the following Technical Modules:
TLD-B1 "Perform Basic Arithmetic Functions"

Introduction:

Algebra is critical in the workplace because technicians frequently encounter situations that include unknown quantities. The purpose of algebra is to provide a means of mathematically describing any situation so that those unknown quantities can be certainly deduced. In other words, algebra is not a set series of formulas; rather, it is a way of thinking about numbers. As a technician, you will daily take rods and bars of metal and form them into sometimes intricate parts on the lathe or the milling machine. Algebra is the lathe of mathematics—with its processes, you can manipulate numbers as easily as you work bronze or aluminum. Look past the fancy names that have been stuck on the processes and rules of algebra and look at what they say and do in common language. Many experienced technicians do algebra every day, in their heads, and never even realize what they are doing!
Presentation Outline:

I. Understand Basic Algebraic Symbols and Expressions
   A. Symbols
      1. Addition “+”
      2. Subtraction “-”
      3. Multiplication “·”, “x”, and parentheses
      4. Division “÷” and “/”
      5. Exponents are generally limited to the term “square” in linear measurements. This is the \( 2^{\text{nd}} \) notation.
   B. Expressions
      1. Sum: the total amount resulting from addition
      2. Difference: the remaining amount resulting from subtraction
      3. Product: the total amount resulting from multiplication
      4. Exponent: a superscript which indicates the number of times a quantity is multiplied by itself
      5. Quotient: the amount resulting from division

II. Use a Few Easy-to-Remember Rules to Solve Equations
   A. *Please Excuse My Dear Aunt Sue* indicates the order in which equations are solved. Each letter shows one of the algebraic notations or functions: Parentheses, Exponents, Multiply, Divide, Add, Subtract.
      1. In the expression \((x - y)^2 + 2x^2 - y^2\), the parentheses, which must be worked first, indicate that \(y\) must be subtracted from \(x\).
         Since we don’t know what \(x\) and \(y\) are, we can’t do that, and must move on.
      2. The next step is to square the term \((x - y)\), as indicated by the exponent. This gives us \(x^2 - 2xy + y^2 + 2x^2 - y^2\).
      3. There is no operable multiplication or division in this expression, so we move on.
      4. Grouping all the like terms to make seeing the answer easier, we have \(x^2 + 2x^2 + y^2 - y^2 - 2xy\).
      5. Adding, we now have \(3x^2 + y^2 - y^2 - 2xy\).
      6. Subtracting, which is the final step, renders \(3x^2 - 2xy\).
   B. *FOIL* gives the order in which you multiply the terms in expressions. Let us go back to squaring (multiplying by itself) \((x - y)\) from the expression above.
      1. *First* terms first, so, in \((x - y)(x - y)\), multiply the two \(x\)’s first. This gives us \(x^2\).
      2. *Outside* terms come next, so multiply the first \(x\) by the second \(y\). This gives us \(x^2 - xy\).
      3. *Inside* terms come next, so multiply the first \(y\) by the second \(x\). This gives us \(x^2 - xy - xy\).
4. Last terms are last, so multiply the two y’s. This gives us a complete (if complex) \( x^2 - xy - xy + y^2 \).
5. Simplifying gives us the expression \( x^2 - 2xy + y^2 \).

C. Thinking about algebra can be daunting to almost anybody, but once you see that algebra is just juggling done with numbers and with a lot of two-dollar words stuck all over it, algebra becomes rather simple. Remember, algebra is just taking the four basic mathematic operations (addition, subtraction, multiplication, and division) and using them to find out something that you didn’t know to start with.

D. Word problems are what you will encounter every day in the shop. Someone will tell you to get so much material and make so many parts from it. As you progress in skill, they will tell you to get such-and-such material and make so many parts from it. Your mastery of basic algebra will make these problems easy to solve.

**Practical Application:**

Students will be able to perform basic algebraic operations as needed to solve problems and to conduct operations encountered in the manufacturing industry. Taper calculations, thread calculations, and rpm calculations are all based on algebra.

**Evaluation and/or Verification:**

Students should successfully complete the Self-Assessment found at the end of this lesson.

**Summary:**

Review the main lesson points and answer student questions.

**Next Lesson Assignment:**

MASTER Technical Module (TLD-B3) dealing with basic geometric principles.
Objective(s):

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

a. Understand basic algebraic symbols and expressions; and,
b. Use equations to solve problems.

Module Outline:

I. Understand Basic Algebraic Symbols and Expressions
   A. Symbols
      1. Addition “+”
      2. Subtraction “−”
      3. Multiplication “·”, “x”, and parentheses
      4. Division “÷” and “/”
      5. Exponents are generally limited to the term “square” in linear measurements. This is the \( a^2 \) notation.
   B. Expressions
      1. Sum: the total amount resulting from addition
      2. Difference: the remaining amount resulting from subtraction
      3. Product: the total amount resulting from multiplication
      4. Exponent: a superscript which indicates the number of times a quantity is multiplied by itself
      5. Quotient: the amount resulting from division

II. Use a Few Easy-to-Remember Rules to Solve Equations
   A. Please Excuse My Dear Aunt Sue indicates the order in which equations are solved. Each letter shows one of the algebraic notations or functions: Parentheses, Exponents, Multiply, Divide, Add, Subtract.
      1. In the expression \( (x - y)^2 + 2x^2 - y^2 \), the parentheses, which must be worked first, indicate that \( y \) must be subtracted from \( x \). Since we don't know what \( x \) and \( y \) are, we can't do that, and must move on.
      2. The next step is to square the term \( (x - y) \), as indicated by the exponent. This gives us \( x^2 - 2xy + y^2 + 2x^2 - y^2 \).
      3. There is no operable multiplication or division in this expression, so we move on.
      4. Grouping all the like terms to make seeing the answer easier, we have \( x^2 + 2x^2 + y^2 - y^2 - 2xy \).
      5. Adding, we now have \( 3x^2 + y^2 - y^2 - 2xy \).
      6. Subtracting, which is the final step, renders \( 3x^2 - 2xy \).
B. **FOIL** gives the order in which you multiply the terms in expressions.
Let us go back to squaring (multiplying by itself) \((x - y)\) from the expression above.

1. *First terms first, so, in \((x - y)(x - y)\), multiply the two x's first.*
   This give us \(x^2\).

2. *Outside terms come next, so multiply the first x by the second y.*
   This gives us \(x^2 - xy\).

3. *Inside terms come next, so multiply the first y by the second x.*
   This gives us \(x^2 - xy - xy\).

4. *Last terms are last, so multiply the two y's. This gives us a complete (if complex) \(x^2 - xy - xy + y^2\).*

5. *Simplifying gives us the expression \(x^2 - 2xy + y^2\).*

C. Thinking about algebra can be daunting to almost anybody, but once you see that algebra is just juggling done with numbers and with a lot of two-dollar words stuck all over it, algebra becomes rather simple.
Remember, algebra is just taking the four basic mathematic operations (addition, subtraction, multiplication, and division) and using them to find out something that you didn’t know to start with.

D. Word problems are what you will encounter every day in the shop.
Someone will tell you to get so much material and make so many parts from it. As you progress in skill, they will tell you to get such-and-such material and make so many parts from it. Your mastery of basic algebra will make these problems easy to solve.
TLD-B2
Perform Basic Algebraic Operations
Self-Assessment

Answer the following questions by circling the most correct answer.

1. The technician is given an order for 100 six-inch bars of 1" CRS. If the company stores its 1" CRS in ten-foot lengths, how many lengths of 1" CRS must the technician obtain in order to complete the job? You may assume that there is no waste.
   A. Five
   B. Ten
   C. Twenty
   D. Twenty-five
   E. None of the above answers is correct.

2. The technician is now told to turn all those six-inch bars down from 1" to 7/8". How much must the technician take off each bar?
   A. 1/16"
   B. 2/16"
   C. 3/16"
   D. 4/16"
   E. None of the above answers is correct.

3. A technician must bore three holes in a 90° arc. The holes must be equally spaced along the arc, and Hole 1 is at the baseline (0°). What is the angle between Hole 1 and Hole 2?
   A. 15°
   B. 30°
   C. 45°
   D. 60°
   E. None of the above answers is correct.

4. A technician must bore three holes in a 90° arc. The holes must be equally spaced along the arc, and Hole 1 is at the baseline (0°). What is the angle between Hole 1 and Hole 3?
   A. 15°
   B. 30°
   C. 45°
   D. 60°
   E. None of the above answers is correct.
5. From a twelve-inch bar, the technician must cut two pieces such that one piece is twice as long as the other. What are the lengths of the resultant bars?
   A. 2" & 4"
   B. 3" & 6"
   C. 4" & 8"
   D. 5" & 10"
   E. None of the above answers is correct.

6. Whitworth threads require that the depth of the thread be .64 of the length of the pitch of the thread. If the thread pitch is 1/8 inch, what is the depth of the threads?
   A. .195 inch
   B. 5.12 inch
   C. .08 inch
   D. .765 inch
   E. None of the above answers is correct.

7. On spur gears, the tooth thickness equals 1.5708/P (the diametral pitch). If the diametral pitch of the gear is 24, what is the thickness of the teeth?
   A. .065"
   B. .377"
   C. .153"
   D. .655"
   E. None of the above answers is correct.

8. The finishing speed for low-carbon steels is 120 surface feet per minute (CS). The diameter of a given workpiece is 3" (D). Using the formula for determining machine speeds, \( \text{rpm} = \frac{4 \times \text{CS}}{D} \), what is the rpm?
   A. 10
   B. 160
   C. 1440
   D. Not enough information is given to solve the problem.
   E. None of the above answers is correct.

9. The technician must cut twenty-four plates, each 3" x 6". If the stock is one foot wide and three feet long, how many plates can the technician cut from one plate? Assume no waste or thickness of cut.
   A. 6
   B. 12
   C. 24
   D. 36
   E. None of the above answers is correct.
10. If the thickness of the saw blade is 1/8", how many bars, each exactly 6" long, can be cut from one three-foot piece of stock?
A. 3
B. 4
C. 5
D. 6
E. None of the above answers is correct.
TLD-B2
Perform Basic Algebraic Operations
Self-Assessment Answer Key

1. A
2. B
3. C
4. E
5. C
6. C
7. A
8. B
9. C
10. C
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-B3

Subject: Tool & Die and EDM
Duty: Apply Mathematical Concepts
Task: Use Basic Geometric Principles

Time: 20 Hrs.

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; and,
d. Understand the applications of planar geometry to solid forms.

Instructional Materials:

MASTER Handout (TLD-B3-H0);
MASTER Self-Assessment;
Paper
Pencil
Chalk Board
Overhead Projector
Various Geometric Objects

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


*Becoming a Mental Math Wizard*, Lucas, Jerry, Latest Edition
Introduction:

Geometry is used to calculate lengths, angles, arcs, areas, and volumes of various shapes and objects. These shapes and objects are the meat and bread of machining; they are machining’s sole purpose for existence. The technician takes a workpiece that may not bear any resemblance at all to the finished part, and turns it into that part. A basic understanding of these shapes and how they relate to each other is necessary to the survival of the technician. These shapes and relationships are also geometry.

Presentation Outline:

I. Some Rules of Angles
   A. Angles are usually expressed in degrees, minutes, and seconds
   B. No angle has more than 360°
   C. Angles have three points which determine them
   D. An angle having 90° is a right angle

II. Triangles
   A. Pythagorean Theorem: $a^2 + b^2 = c^2$
   B. All the angles in a triangle will add up to 180°, every day, every time, every triangle
   C. Have three corners. If one of them is 90°, then it is a right triangle.
   D. The absolute size of a triangle cannot be determined by its angles alone. At least one side must be known.

III. Circle
   A. 360°, every day, every time, every circle
   B. Pi ($\pi$) 3.1416 and its importance
   C. $2\pi r = d$, where $r$ is the circle's radius and $d$, its diameter

IV. Rectangles and Parallelograms
   A. Squares and rectangles
      1. Have four 90° corners
      2. Squares are rectangles all of whose sides are equal
   B. Parallelograms
      1. Have four corners not 90°
2. Have (at least) two parallel sides

V. Relating Planar Geometry to Solid Forms

In reality, planar geometry is an abstract way of looking at parts of solid things. Look at a piece of 1" CRS—at each end, it is a circle, so all the rules of circles apply to it, but only when looked at from the end. When you look at it from the sides, the rules for lines apply. So, that piece of 1" CRS, which is actually a cylinder, can be looked at as two circles joined by a line. Square workpieces have the same properties. No matter which way you look at them, each face is a rectangle or a parallelogram; and each face is subject to the rules of rectangles and parallelograms. Tapers are unequal circles joined by an incomplete triangle.

Practical Application:

Students will practice working math problems.

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 (TLD-B3-HO) as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-B4) dealing with performing basic trigonometric operations.
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; and,
d. Understand the applications of planar geometry to solid forms.

Module Outline:

I. Some Rules of Angles
   A. Angles are usually expressed in degrees, minutes, and seconds
   B. No angle has more than 360°
   C. Angles have three points which determine them
   D. An angle having 90° is a right angle

II. Triangles
   A. Pythagorean Theorem: $a^2 + b^2 = c^2$
   B. All the angles in a triangle will add up to 180°, every day, every time, every triangle
   C. Have three corners. If one of them is 90°, then it is a right triangle.
   D. The absolute size of a triangle cannot be determined by its angles alone. At least one side must be known.

III. Circle
   A. 360°, every day, every time, every circle
   B. Pi ($\pi$) 3.1416 and its importance
   C. $2\pi r = d$, where $r$ is the circle's radius and $d$, its diameter

IV. Rectangles and Parallelograms
   A. Squares and rectangles
      1. Have four 90° corners
      2. Squares are rectangles all of whose sides are equal
   B. - Parallelograms
      1. Have four corners not 90°
      2. Have (at least) two parallel sides

V. Relating Planar Geometry to Solid Forms
   In reality, planar geometry is an abstract way of looking at parts of solid things. Look at a piece of 1" CRS—at each end, it is a circle, so all the rules of circles apply to it, but only when looked at from the end. When you look at it from the sides, the rules for lines apply. So, that piece of 1" CRS, which is actually a cylinder, can be looked at as two circles joined by a line. Square workpieces have the same properties. No matter which way you look at them, each face is a
rectangle or a parallelogram; and each face is subject to the rules of rectangles and parallelograms. Tapers are unequal circles joined by an incomplete triangle.
Solve the following problems:

1. The technician is told to turn down a three-inch piece of 1" CRS to 3/4". What is the length of the new radius of the CRS?
   A. .750"
   B. .500"
   C. .375"
   D. .125"
   E. None of the above answers is correct.

2. The technician must bore six 1" holes in a plate. The holes must be bored in an eight-inch diameter circle and must be equally spaced. How many degrees apart are the holes?
   A. 30°
   B. 60°
   C. 90°
   D. 120°
   E. None of the above answers is correct.

3. The technician must cut triangular iron plates for a construction project. One angle is 80° and one of the others is 50°. What is the measure of the third angle?
   A. 230°
   B. 165°
   C. 50°
   D. Not enough information is given to solve the problem.
   E. None of the above answers is correct.

4. The technician is given six discs, each 3" in diameter. Each disc must be bored so that it produces an eccentricity of 1/2". How far off center does the technician drill the hole?
   A. 1/8"
   B. 1/4"
   C. 1/2"
   D. 1/4π"
   E. None of the above answers is correct.
The technician must cut a set of 1/2" square teeth along the top of a 6' rectangular rod. The top flat and the valley flat are equal and each end of the rod ends in a top flat. How many valley flats must be cut? (Note: There will be scrap.)
A. 36
B. 71
C. 70
D. 102
E. None of the above answers is correct.
TLD-B3
Use Basic Geometric Principles
Self-Assessment Answer Key

1. C
2. B
3. C
4. B
5. B
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-B4

Subject: Tool & Die and EDM

Time: 4 Hrs.

Duty: Apply Mathematical Concepts

Task: Perform Basic Trigonometric Operations

Objective(s):

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

a. Solve for unknown angles;
b. Solve for unknown sides; and,
c. Calculate bolt hole patterns.

Instructional Materials:

Scientific Calculator capable of trigonometric functions
MASTER Handout (TLD-B4-HO)
MASTER Laboratory Aid (TLD-B4-LA)
MASTER Self-Assessment

References:


Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-B1 “Perform Basic Arithmetic Functions”

Introduction:

Trigonometry for the technician is actually quite simple. There is nothing to memorize and the calculations are easy. It is important, however, to the operation of several measuring devices and tools.
Presentation Outline:

I. Solve for Unknown Angles
   A. Right triangles
      1. Sine Law: \( \sin \alpha = \text{side opposite divided by hypotenuse} \)
      2. Cosine Law: \( \cos \alpha = \text{side adjacent divided by hypotenuse} \)
      3. Tangent Law: \( \tan \alpha = \text{side opposite divided by side adjacent} \)
      4. *Oscar Has A Heap Of Apples* is a quick device to remember the above three runes.
         a. Sine \( \alpha = \text{Opposite/Hypoteneuse} \)
         b. Cosine \( \alpha = \text{Adjacent/Hypoteneuse} \)
         c. Tangent \( \alpha = \text{Opposite/Adjacent} \)
   B. Oblique Triangles
      1. Lengths of three sides (A, B, C) all known
         a. \( \cos \alpha = \frac{B^2 + C^2 - A^2}{2BC} \)
         b. \( \sin b = \frac{B \times \sin \alpha}{A} \)
         c. \( c = 180^\circ - (a + b) \)
      2. Two angles (\( \alpha \) and \( \beta \)) known
         c = 180° - (\( a + b \))
      3. Two sides and interior angle (\( A, c, B \)) known
         a. \( \tan a = \frac{A \times \sin c}{B-(A \times \cos c)} \)
         b. \( b = 180^\circ - (a + c) \)
         c. \( C = \frac{A \times \sin c}{\sin a} \)
      4. Two sides and an opposite angle (\( A, B, \) known
         a. \( \sin b = \frac{B \times \sin \alpha}{A} \)
         b. \( c = 180^\circ - (a + b) \)
         c. \( C = \frac{A \times \sin c}{\sin a} \)

II. Solve for Unknown Sides
   A. Right triangles, any two sides known, where C is the hypotenuse \( A^2 + B^2 = C^2 \)
   B. One side and two angles (\( a, b, A \)) known
      1. \( c = 180^\circ - (a + b) \)
      2. \( B = \frac{A \times \sin b}{\sin a} \)
      3. \( C = \frac{A \times \sin c}{\sin a} \)
   C. Two sides and the interior angle (\( A, B, \)) known
      \( C = \sqrt{[A^2 + B^2 - (2AB \times \cos c)]} \)
   D. Three angles known
      It is impossible to determine the actual length of any side when only the sizes of the three angles are known. The length of at least one side must be known in order to calculate the lengths of the other sides.

III. Calculate Bolt Hole Patterns
   A. Discuss the construction of reference triangles to solve bolt-hole patterns
   B. Discuss circles and their uses in figuring bolt-hole patterns.

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Practical Application:

Students will display the ability to correctly lay out bolt hole patterns and to compute angular distances using trigonometry. This module also prepares students for the use of sine bars and sine plates.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-B5) dealing with using and applying Cartesian coordinate system.
TLD-B4-HO
Perform Basic Trigonometric Operations
Attachment 1: MASTER Handout

Objective(s):

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

a. Solve for unknown angles;
b. Solve for unknown sides; and,
c. Calculate bolt hole patterns.

Module Outline:

I. Solve for Unknown Angles
   A. Right triangles
      1. Sine Law: \( \sin a = \frac{\text{side opposite}}{\text{hypotenuse}} \)
      2. Cosine Law: \( \cos a = \frac{\text{side adjacent}}{\text{hypotenuse}} \)
      3. Tangent Law: \( \tan a = \frac{\text{side opposite}}{\text{side adjacent}} \)
      4. Oscar Has A Heap Of Apples is a quick device to remember the above three runes.
         a. Sine \( \angle = \frac{\text{Opposite}}{\text{Hypoteneuse}} \)
         b. Cosine \( \angle = \frac{\text{Adjacent}}{\text{Hypoteneuse}} \)
         c. Tangent \( \angle = \frac{\text{Opposite}}{\text{Adjacent}} \)
   B. Oblique Triangles
      1. Lengths of three sides (A, B, C) all known
         a. \( \cos a = \frac{B^2 + C^2 - A^2}{2BC} \)
         b. \( \sin b = \frac{B \times \sin a}{A} \)
         c. \( c = 180^\circ - (a + b) \)
      2. Two angles (a and b) known
         c = 180\(^\circ\) - (a + b)
      3. Two sides and interior angle (A, c, B) known
         a. \( \tan a = \frac{A \times \sin c}{B - (A \times \cos c)} \)
         b. \( b = 180^\circ - (a + c) \)
         c. \( C = \frac{(A \times \sin c)}{\sin a} \)
      4. Two sides and an opposite angle (a, A, B) known
         a. \( \sin b = \frac{B \times \sin a}{A} \)
         b. \( c = 180^\circ - (a + b) \)
         c. \( C = \frac{(A \times \sin c)}{\sin a} \)

II. Solve for Unknown Sides
   A. Right triangles, any two sides known, where C is the hypotenuse
      \( A^2 + B^2 = C^2 \)
   B. One side and two angles (a, b, A) known
      1. \( c = 180^\circ - (a + b) \)
      2. \( B = (A \times \sin b)/\sin a \)
3. \[ C = \frac{(A \times \sin c)}{\sin \alpha} \]

C. Two sides and the interior angle (A, B, c) known
\[ C = \sqrt{A^2 + B^2 - (2AB \times \cos c)} \]

D. Three angles known
It is impossible to determine the actual length of any side when only the sizes of the three angles are known. The length of at least one side must be known in order to calculate the lengths of the other sides.

III. Calculate Bolt Hole Patterns
A. Discuss the construction of reference triangles to solve bolt-hole patterns
B. Discuss circles and their uses in figuring bolt-hole patterns.
Basic Triangle - TLD-B4

- Side B
- Side C
- Side A

- Angle a
- Angle b
- Angle c
Using the reference triangle on the accompanying page, solve the following triangles from the information given. Show all work.

1. Side A = 9"; Side B = 8"; Side C = 12"; solve for all angles. The triangle is oblique.

2. Side A = 6 cm; Angle c = 60°; Side B = 12 cm; solve for Angle a.

3. Angle a = 35°; Angle b = 57° 30'; solve for Angle c.

4. Angle a = 40°; Side A = 18"; Side B = 12"; solve for Angles b & c.

5. Side A = cm; Angle c = 90°; Side B = 12 cm; solve for Side C.

6. Angle a = 22° 30'; Angle b = Angle a; Side A = 9"; solve for Sides B & C.

7. Side A = 12 cm; Side B = 12 cm; Angle c = 60°; solve for Side C.

8. The triangle is a right triangle. Side A = 3'; Side B = 4'; Side C = 5'; solve for all angles.

9. A right triangle has two 45° angles. Solve for the sides, in inches.
Angle a
Side B

Angle b
Side C

Angle c

Side A
Basic Triangle - TLD-B4
Using the two bolt-hole patterns shown in the illustrations on the accompanying page, solve the following questions. Remember that the answers should be in the form of $x,y$.

10. Four holes are spaced around a 2" semi-circle. If Hole One is at 1,0; where are the other three holes?

11. Three equally-spaced holes around a 6" diameter reference circle. If Hole One is at 0,3; where are the other two holes?
TLD-B4
Perform Basic Trigonometric Operations
Self-Assessment Answer Key

1. \( a = 48.59^\circ \) \hspace{1cm} \( b = 41.81^\circ \) \hspace{1cm} \( c = 89.6^\circ \)

2. \( a = 86.11^\circ \)

3. \( c = 87^\circ \ 30' \)

4. \( b = 25.37^\circ \) \hspace{1cm} \( c = 114.63^\circ \)

5. Side C = 13.41 cm

6. Side B = 9" \hspace{0.5cm} Side C = 16.63"

7. Side C = 12 cm

8. Angle a = 36.87°  \hspace{0.5cm} Angle b = 53.13°  \hspace{0.5cm} Angle c = 90°

9. The problem is impossible to solve.

10. Hole 1: 1.0  \hspace{0.5cm} Hole 2: 0.7071, -0.7071  
    Hole 3: -1.0  \hspace{0.5cm} Hole 4: -0.7071, 0.7071

11. Hole 1: 0, 3  \hspace{0.5cm} Hole 2: 0.866, -0.500  \hspace{0.5cm} Hole 3: -0.500, -0.866
Subject: Tool & Die and EDM  
Duty: Apply Mathematical Concepts  
Task: Use and Apply Cartesian Coordinate System

Objective(s):

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

a. Identify points using the Cartesian coordinate system;
b. Identify points using the absolute dimensioning system;
c. Identify points using the incremental dimensioning system; and,
d. Identify points using the polar coordinate system.

Instructional Materials:

Scientific calculator  
MASTER Handout (TLD-B5-HO)  
MASTER Self-Assessment

References:


Student Preparation:

Students should have previously completed the following Technical Modules:

MLD-B1 “Perform Basic Arithmetic Functions”

Introduction:

Many operations which the technician must perform require the location of holes or other machining locations from a datum or origin point. Many drawings are dimensioned such that part features must be located in reference to another point or part feature. Many of today’s machine tools have been fitted with digital read-out equipment which allow the technician to quickly set and move to the required machining locations. Virtually all of the CNC machines in use today require that the technician be able to locate and program machining locations using the Cartesian coordinate or the polar coordinate systems. It is, therefore, imperative that the technician understand and be able to use these coordinate systems.
Presentation Outline:

I. Identify Points Using the Cartesian Coordinate System
   A. Describe the Cartesian (rectangular) coordinate system - the basis for all machine movement
      1. Define \textit{axis} - any direction of movement on a machine tool. The spindle is always defined as the Z axis on 3 axis systems.
      2. Discuss the plus and minus aspects of an axis
      3. Discuss the quadrants I, II, III, and IV. Note that the signs for the X- and Y-axes change for the different quadrants.
      4. Discuss the concept of three dimensional locations
      5. Discuss how points are described in both 2- and 3-axis systems
      6. Describe how a part fits into the axis system

II. Identify Points Using the Polar Coordinate System
   A. Describe the polar coordinate system - a system by which all points are located around a known location (or pole).
      1. Points are usually identified by a known distance from the pole and a given angle from the horizontal (3:00 o'clock position equals zero degrees)
      2. Positive angles are measured from angle zero in a counterclockwise direction
      3. Negative angles are measured from angle zero in a clockwise direction
   B. Student practice

III. Locate Points Using the Absolute Dimensioning System
   A. Define \textit{absolute positioning} - in absolute positioning, all machine locations are taken from one fixed zero (origin) point. This origin point does not change.
   B. This corresponds to the datum dimensioning method used by drafters.
      In datum dimensioning, all dimensions on a drawing are placed in reference to one fixed zero point.
   C. Student practice

IV. Locate Points Using the Incremental Dimensioning System
   A. Define \textit{incremental positioning} - in incremental positioning, the X0/Y0 moves with each position change. The current position, in fact, becomes the X0/Y0 for the next positioning move.
   B. This corresponds to the delta dimensioning method used by drafters.
      In delta dimensioning, all dimensions on a drawing are “chain-linked.” Each location is dimensioned from the previous one.
   C. Student practice
Practical Application:

Students will be able to calculate boring and cutting patterns for those machines which use datum-point controls.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (MLD-C1) dealing with interpreting and understanding basic layout/types of drawings.
Upon completion of this unit the student will be able to:

a. Identify points using the Cartesian coordinate system;
b. Identify points using the absolute dimensioning system;
c. Identify points using the incremental dimensioning system; and,
d. Identify points using the polar coordinate system.

Module Outline:

I. Identify Points Using the Cartesian Coordinate System
   A. Describe the Cartesian (rectangular) coordinate system - the basis for all machine movement
      1. Define axis - any direction of movement on a machine tool. The spindle is always defined as the Z axis on 3 axis systems.
      2. Discuss the plus and minus aspects of an axis
      3. Discuss the quadrants I, II, III, and IV. Note that the signs for the X- and Y-axes change for the different quadrants.
      4. Discuss the concept of three dimensional locations
      5. Discuss how points are described in both 2- and 3-axis systems
      6. Describe how a part fits into the axis system

II. Identify Points Using the Polar Coordinate System
   A. Describe the polar coordinate system - a system by which all points are located around a known location (or pole).
      1. Points are usually identified by a known distance from the pole and a given angle from the horizontal (3:00 o'clock position equals zero degrees)
      2. Positive angles are measured from angle zero in a counterclockwise direction
      3. Negative angles are measured from angle zero in a clockwise direction
   B. Student practice

III. Locate Points Using the Absolute Dimensioning System
   A. Define absolute positioning- in absolute positioning, all machine locations are taken from one fixed zero (origin) point. This origin point does not change.
   B. This corresponds to the datum dimensioning method used by drafters. In datum dimensioning, all dimensions on a drawing are placed in reference to one fixed zero point.
   C. Student practice
IV. Locate Points Using the Incremental Dimensioning System

A. Define *incremental positioning*- in incremental positioning, the X0/Y0 moves with each position change. The current position, in fact, becomes the X0/Y0 for the next positioning move.

B. This corresponds to the delta dimensioning method used by drafters. In delta dimensioning, all dimensions on a drawing are "chain-linked." Each location is dimensioned from the previous one.

C. Student practice
TLD-B5
Use and Apply Cartesian Coordinate System
Self-Assessment

Circle the letter preceding the correct answer.

1. Using the Cartesian plane shown (Diagram 1), what can be said of point 1, regardless of the values of the actual coordinates?
   A. X is positive and Y is positive.
   B. X is positive and Y is negative.
   C. X is negative and Y is positive.
   D. X is negative and Y is negative.
   E. None of the above answers is correct.

2. Using Diagram 1, what can be said of point 2, regardless of the actual values of the coordinates?
   A. X is positive and Y is positive.
   B. X is positive and Y is negative.
   C. X is negative and Y is positive.
   D. X is negative and Y is negative.
   E. None of the above answers is correct.

3. Which of the following statements is not true?
   A. In absolute dimensioning, all machine locations are taken from a point called the origin or zero point.
   B. The origin point is fixed.
   C. Absolute dimensioning corresponds the drafting method known as datum dimensioning.
   D. In datum dimensioning, all dimensions are determined from a single, fixed point.
   E. All of the above statements are true.

4. Incremental positioning:
   A. Corresponds to the drafting method known as delta dimensioning.
   B. Moves the X0/Y0 point after each operation.
   C. Has "chain-linked" dimensions on the blueprints.
   D. All of the above answers are applicable to the question.
   E. None of the above answers is correct.
5. In a three-axis system, the spindle always corresponds to the:
   A. X-axis.
   B. Y-axis.
   C. Z-axis.
   D. The correspondence of the spindle is not standard.
   E. None of the above answers is correct.

6. In the polar coordinate system, points are identified by a known distance from the pole and a known ___ from the horizon.
   A. Angle
   B. 3:00 o'clock position
   C. Horizon
   D. Pole
   E. None of the above answers is correct.

For questions 7 through 9, all holes are 3/8 inch diameter and the workpiece setup point corresponds to a point of 6,4 from the table origin.

7. Using Diagram 2 and the absolute dimensioning system, dimension program the part. Show all work. All measurements are in inches.

<table>
<thead>
<tr>
<th>Hole</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
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<tr>
<td>C</td>
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</table>

8. Using Diagram 2 and the incremental dimensioning system, dimension program the part. Show all work. All measurements are in inches.

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<tr>
<th>Hole</th>
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<td>C</td>
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</tbody>
</table>
9. Using Diagram 3 and the absolute dimensioning system, dimension program the part. Show all work; all linear measurements are in inches.

<table>
<thead>
<tr>
<th>Hole</th>
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<td>E</td>
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</table>

10. Using Diagram 3 and the incremental dimensioning system, dimension program the part. Show all work; all linear measurements are in inches.

<table>
<thead>
<tr>
<th>Hole</th>
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</tbody>
</table>
Diagram 1 - TLD-B5
**TLD-B5**

*Use and Apply Cartesian Coordinate System*

*Self-Assessment Answer Key*

1. C
2. D
3. E
4. D
5. C
6. A
7. A
8. B
9. C

<table>
<thead>
<tr>
<th>Hole</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6 13/16</td>
<td>3</td>
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<tr>
<td>B</td>
<td>8 7/16</td>
<td>1 3/16</td>
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<tr>
<td>C</td>
<td>9 7/8</td>
<td>-3/4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hole</th>
<th>X</th>
<th>Y</th>
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<tr>
<td>A</td>
<td>6 13/16</td>
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<tr>
<td>B</td>
<td>1 5/8</td>
<td>-1 13/16</td>
</tr>
<tr>
<td>C</td>
<td>1 7/16</td>
<td>-1 15/16</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Hole</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7 1/2</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>11 1/2</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>9 1/2</td>
<td>1/4</td>
</tr>
<tr>
<td>D</td>
<td>10 23/64</td>
<td>-1 1/4</td>
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<tr>
<td>E</td>
<td>8 37/64</td>
<td>-1 1/4</td>
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<td>Hole</td>
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<td>Y</td>
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<tr>
<td>A</td>
<td>7 ½</td>
<td>2</td>
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<td>B</td>
<td>4</td>
<td>0</td>
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<tr>
<td>C</td>
<td>-2</td>
<td>-1 3/4</td>
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<tr>
<td>D</td>
<td>55/64</td>
<td>-1 ½</td>
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<tr>
<td>E</td>
<td>-1 23/32</td>
<td>0</td>
</tr>
</tbody>
</table>
TOOL AND DIE MAKER ... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

### Duties

<table>
<thead>
<tr>
<th>A</th>
<th>Practice Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Apply Mathematical Concepts</td>
</tr>
<tr>
<td>C</td>
<td>Interpret Engineering Drawings and Related Documents</td>
</tr>
<tr>
<td>D</td>
<td>Demonstrate Knowledge of Manufacturing Materials</td>
</tr>
<tr>
<td>E</td>
<td>Measure/Inspect</td>
</tr>
<tr>
<td>F</td>
<td>Demonstrate Knowledge of Manufacturing Processes</td>
</tr>
<tr>
<td>G</td>
<td>Use Computers</td>
</tr>
<tr>
<td>H</td>
<td>Perform CAD, CAM and CNC Programming Tasks</td>
</tr>
<tr>
<td>I</td>
<td>Perform Tool and Die Making Operations</td>
</tr>
<tr>
<td>J</td>
<td>Operate Electrical Discharge Machines (EDM)</td>
</tr>
</tbody>
</table>

### Tasks

<table>
<thead>
<tr>
<th>A-1</th>
<th>Follow safety manuals and all safety regulations/requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-2</td>
<td>Maintain safe equipment and machinery</td>
</tr>
<tr>
<td>A-3</td>
<td>Use safe operating procedures for hand and machine tools</td>
</tr>
<tr>
<td>A-4</td>
<td>Maintain a clean and safe work environment</td>
</tr>
<tr>
<td>A-5</td>
<td>Use safe material handling practices</td>
</tr>
<tr>
<td>A-6</td>
<td>Consult and apply MSDS for hazards of various materials</td>
</tr>
<tr>
<td>B-1</td>
<td>Perform basic arithmetic functions</td>
</tr>
<tr>
<td>B-2</td>
<td>Perform basic algebraic operations</td>
</tr>
<tr>
<td>B-3</td>
<td>Use basic geometric principles</td>
</tr>
<tr>
<td>B-4</td>
<td>Perform basic trigonometric functions</td>
</tr>
<tr>
<td>B-5</td>
<td>Use and apply Cartesian Coordinate System</td>
</tr>
<tr>
<td>C-1</td>
<td>Interpret and understand layout/types of drawings</td>
</tr>
<tr>
<td>C-2</td>
<td>Interpret, review, and apply blueprint notes, dimensions, and tolerances</td>
</tr>
<tr>
<td>C-3</td>
<td>Demonstrate understanding of geometric dimensioning and tolerancing (GD&amp;T)</td>
</tr>
<tr>
<td>C-4</td>
<td>Demonstrate traditional mechanical drafting and sketching techniques</td>
</tr>
<tr>
<td>C-5</td>
<td>Use and apply quality systems</td>
</tr>
<tr>
<td>D-1</td>
<td>Identify materials with desired properties</td>
</tr>
<tr>
<td>D-2</td>
<td>Identify materials and processes to produce a part</td>
</tr>
<tr>
<td>D-3</td>
<td>Discuss classification systems for metal</td>
</tr>
<tr>
<td>D-4</td>
<td>Use and apply quality systems</td>
</tr>
<tr>
<td>E-1</td>
<td>Understand measurement terms</td>
</tr>
<tr>
<td>E-2</td>
<td>Select measurement tools</td>
</tr>
<tr>
<td>E-3</td>
<td>Measure with hand held instruments</td>
</tr>
<tr>
<td>E-4</td>
<td>Eliminate measurement variables</td>
</tr>
<tr>
<td>E-5</td>
<td>Measure/inspect using surface plate and accessories</td>
</tr>
<tr>
<td>E-6</td>
<td>Inspect using stationary equipment</td>
</tr>
<tr>
<td>E-7</td>
<td>Use computer operating systems</td>
</tr>
<tr>
<td>E-8</td>
<td>Understand computer terminology</td>
</tr>
<tr>
<td>F-1</td>
<td>Discuss metal cutting and metal cutting tools</td>
</tr>
<tr>
<td>F-2</td>
<td>Operate metal saws</td>
</tr>
<tr>
<td>F-3</td>
<td>Operate drill presses and tooling</td>
</tr>
<tr>
<td>F-4</td>
<td>Operate engine and turret lathes and tooling</td>
</tr>
<tr>
<td>F-5</td>
<td>Operate vertical and horizontal mills and tooling</td>
</tr>
<tr>
<td>F-6</td>
<td>Operate precision grinders</td>
</tr>
<tr>
<td>F-7</td>
<td>Operate heat treating equipment and processes</td>
</tr>
<tr>
<td>F-8</td>
<td>Operate sheet metal equipment and processes</td>
</tr>
<tr>
<td>F-9</td>
<td>Operate welding equipment and processes</td>
</tr>
<tr>
<td>F-10</td>
<td>Estimate time required/cost to produce a part</td>
</tr>
<tr>
<td>G-1</td>
<td>Use computer operating systems</td>
</tr>
<tr>
<td>G-2</td>
<td>Understand computer terminology</td>
</tr>
<tr>
<td>G-3</td>
<td>Use file management system</td>
</tr>
<tr>
<td>G-4</td>
<td>Install and use software packages</td>
</tr>
<tr>
<td>H-1</td>
<td>Discuss fundamentals of CNC machines and controls</td>
</tr>
<tr>
<td>H-2</td>
<td>Program and operate CNC milling machine and machining center</td>
</tr>
<tr>
<td>H-3</td>
<td>Program and operate CNC lathe</td>
</tr>
<tr>
<td>H-4</td>
<td>Use Computer-Aided Drafting (CAD) system</td>
</tr>
<tr>
<td>H-5</td>
<td>Create 3-D solid models</td>
</tr>
<tr>
<td>H-6</td>
<td>Use Computer-Aided Manufacturing (CAM) system</td>
</tr>
<tr>
<td>I-1</td>
<td>Discuss basic types and functions of jigs and fixtures</td>
</tr>
<tr>
<td>I-2</td>
<td>Utilize concepts of jig and fixture design</td>
</tr>
<tr>
<td>I-3</td>
<td>Demonstrate understanding of different types of industrial dies</td>
</tr>
<tr>
<td>I-4</td>
<td>Utilize basic die theory</td>
</tr>
<tr>
<td>I-5</td>
<td>Utilize principles of die design</td>
</tr>
<tr>
<td>I-6</td>
<td>Perform tool and die repair</td>
</tr>
<tr>
<td>I-7</td>
<td>Demonstrate tool and die making skills</td>
</tr>
<tr>
<td>J-1</td>
<td>Discuss fundamentals of EDM</td>
</tr>
<tr>
<td>J-2</td>
<td>Setup and operate conventional sinker EDM</td>
</tr>
<tr>
<td>J-3</td>
<td>Program, setup, and operate CNC sinker EDM and EDM drill</td>
</tr>
<tr>
<td>J-4</td>
<td>Program, setup, and operate CNC wire EDM</td>
</tr>
</tbody>
</table>
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-C1

Subject: Tool & Die and EDM

Time: 6 Hrs.

Duty: Interpret Engineering Drawings and Related Documents

Task: Interpret and Understand Basic Layout/Types of Drawings

Objective(s):

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

a. Identify types of drawings;
b. Identify parts of a drawing and list components of each;
c. Identify types of lines on a drawing;
d. List and describe the different views found on a drawing;
e. List and apply the three primary planes of projection;
f. List and apply the six principle views;
g. Apply auxiliary views; and,
h. Apply sectional views.

Instructional Materials:

MASTER Handout (TLD-C1-HO)
MASTER Self-Assessment

References:


*Basic Blueprint Reading*, Pamela Smith, Developed by Industrial Services Staff, Research and Curriculum Unit, Mississippi State University for Division of Vocational - Technical Education, Mississippi State Department of Education, Latest Edition


Student Preparation:

Introduction:

In industrial work the blueprint is the guidepost and the primary means of communication. The blueprint represents communication between engineering and process manufacturing. Tool and die makers need to know how to read and interpret a blueprint accurately and then build the products as cost effectively as possible. The process of building a better understanding of basic layouts and types of drawings will facilitate each stage of production until the product is completed.

Presentation Outline:

I. Interpret and Understand Basic Layout of Drawings
   A. ANSI & ISO sheet size layout
   B. ANSI & ISO forms of lettering arrangements

II. Interpret and Understand Types of Drawings
   A. Orthographic and multi-view projection
   B. Perspective or central projection
   C. Oblique projection
   D. Axonometric projection

III. Identify Parts of a Blue Print/Drawing and List Components of Each
   A. Body
   B. Title block
      1. Drawing number
      2. Drawing title
      3. Scale
      4. Signatures
      5. Job number
      6. Material list number
      7. Reference drawings
      8. Distribution section
      9. Revision
     10. Work order number
   C. Bill of Materials
      1. Piece mark number
      2. Number of pieces required for each piece mark
      3. Description of materials
      4. Traceability requirements
5. Material specifications
6. Length
7. Gross weight
8. Total weight

IV. Identify Types of Lines on a Drawing
A. Visible line
B. Hidden line
C. Center line
D. Section line
E. Dimension line
F. Extension line
G. Leaders line
H. Cutting plane/viewing plane line
I. Short-break line
J. Long-break line
K. Phantom line
L. Stitch line
M. Chain line
N. Cylindrical break/conventional break lines

V. List and Describe the Different Views Found on a Drawing
A. One view
   1. Sphere
   2. Plate
B. Two view
   1. Cylinder
   2. Rectangle
C. Three view
   1. Pyramids
   2. Multi-view projection

VI. List and Apply the Three Primary Planes of Projection
A. Frontal projection plane
B. Profile projection plane
   1. Right side
   2. Left side
C. Horizontal projection plane

VII. List and Apply the Six Principal Views
A. Front view
B. Rear view
C. Right side view
D. Left side view
E. Top view
F. Bottom view

VIII. List and Apply Auxiliary Views
A. Surfaces needing auxiliary views
   1. Inclined surfaces
2. Oblique surfaces
B. Primary auxiliary views
C. Secondary auxiliary views
D. To generate an auxiliary view
   1. Folding-line method
   2. Reference-plane method
E. Classifications of auxiliary views
   1. Depth auxiliary views
   2. Height auxiliary views
   3. Width auxiliary views
F. Dihedral angles
G. Partial auxiliary views
H. Half auxiliary views
I. Auxiliary sections
J. Basic four uses of auxiliary views
   1. True length of line
   2. Point view of line
   3. Edge view of plane
   4. True size of plane

IX. List and Apply Sectional Views
A. Need for sectional views
B. Cutting plane
   1. Direction
   2. Labels
   3. Alternate styles
C. Section lining
   1. Techniques
   2. Symbols
D. Types of sectional views
   1. Full section
   2. Half/partial section
   3. Broken-out section
   4. Revolved section
   5. Removed section
   6. Offset section
   7. Aligned section
   8. Auxiliary section
   9. Partial section

Practical Application:

Students should be given several drawings of various types with varying degrees of complexity to read and answer questions about.
Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson, along with successful completion of blueprint reading exercises.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-C2) dealing with interpreting, reviewing, and applying blueprint notes, dimensions, and tolerances.
Objective(s):

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

a. Identify types of drawings;
b. Identify parts of a drawing and list components of each;
c. Identify types of lines on a drawing;
d. List and describe the different views found on a drawing;
e. List and apply the three primary planes of projection;
f. List and apply the six principle views;
g. Apply auxiliary views; and,
h. Apply sectional views.

Module Outline:

I. Interpret and Understand Basic Layout of Drawings
   A. ANSI & ISO sheet size layout
   B. ANSI & ISO forms of lettering arrangements

II. Interpret and Understand Types of Drawings
    A. Orthographic and multi-view projection
    B. Perspective or central projection
    C. Oblique projection
    D. Axonometric projection

III. Identify Parts of a Blue Print/Drawing and List Components of Each
    A. Body
    B. Title block
       1. Drawing number
       2. Drawing title
       3. Scale
       4. Signatures
       5. Job number
       6. Material list number
       7. Reference drawings
       8. Distribution section
       9. Revision
       10. Work order number
    C. Bill of Materials
       1. Piece mark number
       2. Number of pieces required for each piece mark
       3. Description of materials
       4. Traceability requirements
5. Material specifications
6. Length
7. Gross weight
8. Total weight

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J. Long-break line
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   2. Plate
B. Two view
   1. Cylinder
   2. Rectangle
C. Three view
   1. Pyramids
   2. Multi-view projection

VI. List and Apply the Three Primary Planes of Projection
A. Frontal projection plane
B. Profile projection plane
   1. Right side
   2. Left side
C. Horizontal projection plane

VII. List and Apply the Six Principal Views
A. Front view
B. Rear view
C. Right side view
D. Left side view
E. Top view
F. Bottom view

VIII. List and Apply Auxiliary Views
A. Surfaces needing auxiliary views
   1. Inclined surfaces
2. Oblique surfaces
B. Primary auxiliary views
C. Secondary auxiliary views
D. To generate an auxiliary view
   1. Folding-line method
   2. Reference-plane method
E. Classifications of auxiliary views
   1. Depth auxiliary views
   2. Height auxiliary views
   3. Width auxiliary views
F. Dihedral angles
G. Partial auxiliary views
H. Half auxiliary views
I. Auxiliary sections
J. Basic four uses of auxiliary views
   1. True length of line
   2. Point view of line
   3. Edge view of plane
   4. True size of plane

IX. List and Apply Sectional Views
A. Need for sectional views
B. Cutting plane
   1. Direction
   2. Labels
   3. Alternate styles
C. Section lining
   1. Techniques
   2. Symbols
D. Types of sectional views
   1. Full section
   2. Half/partial section
   3. Broken-out section
   4. Revolved section
   5. Removed section
   6. Offset section
   7. Aligned section
   8. Auxiliary section
   9. Partial section
TLD-C1
Interpret and Understand Basic Layout/Types of Drawings
Self-Assessment

1. Who is the ANSI?

2. Who is the ISO?

3. Identify three sheet size layouts.

4. Identify four forms of lettering arrangements.

5. What is multi-view projection?

6. What is perspective or central projection?

7. What is oblique projection?

8. What is axonometric projection?
9. What is the main part of a drawing?

10. Name five components in a title block.

11. Name four components in a bill of materials.

12. Identify and illustrate six types of lines that can be found on a drawing.

13. What is a one view drawing?

14. What is a two view drawing?

15. What is a three view drawing?

16. Identify and describe the three primary planes of projection.

17. Name the six principle views.
18. What are auxiliary views?

19. What surfaces need auxiliary views?

20. What is a primary auxiliary view?

21. What is a secondary auxiliary view?

22. Name two methods for generating auxiliary views.

23. Name three classifications for auxiliary views.

24. What is a dihedral angle?

25. What are partial auxiliary views?

26. What are half auxiliary views?
27. What is an auxiliary section?

28. Name four uses for auxiliary views.

29. What are sectional views?

30. What are cutting planes?

31. Identify two section lining techniques.

32. Identify and illustrate five section lining symbols.

33. What is a full section?

34. What is a half / partial section?

35. What are broken-out sections?
36. How are revolved sections used on drawings?

37. How are removed sections used on drawings?

38. What are off-set sections?

39. What are aligned sections?

40. What is the purpose of an auxiliary section?
## Subject: Tool & Die and EDM

**Time:** 8 Hrs.

### Duty:
Interpret Engineering Drawings and Related Documents

### Task:
Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances

### Objective(s):

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

- **a.** Distinguish between general and specific notes;
- **b.** Interpret and apply general and specific notes;
- **c.** Determine and apply dimensions on a drawing;
- **d.** Identify basic symbols and abbreviations found on a drawing;
- **e.** Identify tolerances or limits on a drawing; and,
- **f.** Identify ANSI limits and fits.

### Instructional Materials:

- MASTER Handout (TLD-C2-HO)
- MASTER Self-Assessment

### References:

- *Basic Blueprint Reading*, Pamela Smith, Developed by Industrial Services Staff, Research and Curriculum Unit, Mississippi State University for Division of Vocational - Technical Education, Mississippi State Department of Education, Latest Edition
Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-C1 "Interpret and Understand Basic Layout/Types of Drawings"

Introduction:

The blueprint is the universal language of industry in all countries. While systems of measurements and drafting techniques vary between different countries, we are still striving for global standardization. The tool maker, by interpreting, reviewing, and applying the notes, dimensions, and tolerances properly, could produce identical parts and mechanisms, even though they worked in different countries and spoke different languages. The blueprint forms a foundation for the manufacturing and production of interchangeable parts, as well as, interchangeable workforces in a variety of countries.

Presentation Outline:

I. Distinguish Between General and Specific Notes
   A. General notes
   B. Specific notes/local notes

II. Interpret and Apply General and Specific Notes
   A. General notes applied
      1. Title strip/title block
      2. Parts list/bill of material
   B. Interpret general notes
      1. Including material
      2. General tolerances
      3. Heat treatment
      4. Pattern information
      5. Processes of manufacture
      6. Requirements of the product
   C. Interpret specific notes
      1. Apply to specific operations
      2. Apply to specific processes of manufacture
      3. Apply to the requirements of the product

III. Determine and Apply Dimensions on a Drawing
   A. Identify organizations that determine dimension standards
      1. American National Standards Institutes (ANSI)
      2. International Standards Organization (ISO)
   B. Determine dimensions on a drawing
      1. Size dimensions
2. Location dimensions

C. Applying dimensions on a drawing
   1. Scale of drawing
   2. Techniques of dimensioning
   3. Placement of dimensions
   4. Choice of dimensions
   5. Types of lines used in the dimensioning process
   6. Arrowheads used on drawings
   7. Leaders used on drawings
   8. Dimensioning systems
      a. Fractional
      b. Decimal
      c. Metric
      d. Combination dimensioning
   9. Dimension figures
   10. Direction of dimension figures
       a. Unidirectional system
       b. Aligned system
   11. Dimensioning angles
   12. Dimensioning arcs
   13. Dimensioning fillets and rounds
   14. Identify surfaces to be machined
   15. Contour dimensioning
   16. Dimensioning of curves
   17. Dimensioning of rounded-end shapes
   18. Dimensioning of threads
   19. Dimensioning of tapers
   20. Dimensioning of chamfers
   21. Dimensioning shaft centers
   22. Dimensioning keyways
   23. Dimensioning knurls
      a. Diamond
      b. Straight
   24. Dimensioning along curved surfaces
   25. Tabular dimensions
   26. Dimensioning standards
   27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
   A. Traditional terms used to describe various shapes, processes, and size
   B. Identify abbreviations used to describe various shapes, processes, and size
   C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
   A. Identify tolerances or limits
1. Nominal size
2. Basic size or dimension
3. Actual size
4. Tolerance
5. Limits
6. Allowance

B. Methods of expressing tolerances
1. General tolerances
2. Limit dimensioning
3. Plus and minus dimensioning
   a. Unilateral system
   b. Bilateral system
4. Single-limit dimensioning
5. Angular tolerances

VI. Identify ANSI Limits and Fits
A. Fits between mating parts
1. Clearance fit
2. Interference fit
3. Transition fit
4. Line fit

B. Limits and fits for cylindrical parts
1. Running or sliding clearance fits
2. Locational clearance fits
3. Transition clearance interference fits
4. Locational interference fits
5. Force or shrink fits

Practical Application:

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (TLD-C3) dealing with using and applying Geometric Dimensioning and Tolerancing (GD&T).
TLD-C2-HO
Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
Attachment 1: MASTER Handout

Objective(s):

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

a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

Module Outline:

I. Distinguish Between General and Specific Notes
   A. General notes
   B. Specific notes/local notes

II. Interpret and Apply General and Specific Notes
   A. General notes applied
      1. Title strip/title block
      2. Parts list/bill of material
   B. Interpret general notes
      1. Including material
      2. General tolerances
      3. Heat treatment
      4. Pattern information
      5. Processes of manufacture
      6. Requirements of the product
   C. Interpret specific notes
      1. Apply to specific operations
      2. Apply to specific processes of manufacture
      3. Apply to the requirements of the product

III. Determine and Apply Dimensions on a Drawing
   A. Identify organizations that determine dimension standards
      1. American National Standards Institutes (ANSI)
      2. International Standards Organization (ISO)
   B. Determine dimensions on a drawing
      1. Size dimensions
      2. Location dimensions
   C. Applying dimensions on a drawing
      1. Scale of drawing
      2. Techniques of dimensioning
3. Placement of dimensions
4. Choice of dimensions
5. Types of lines used in the dimensioning process
6. Arrowheads used on drawings
7. Leaders used on drawings
8. Dimensioning systems
   a. Fractional
   b. Decimal
   c. Metric
   d. Combination dimensioning
9. Dimension figures
10. Direction of dimension figures
    a. Unidirectional system
    b. Aligned system
11. Dimensioning angles
12. Dimensioning arcs
13. Dimensioning fillets and rounds
14. Identify surfaces to be machined
15. Contour dimensioning
16. Dimensioning of curves
17. Dimensioning of rounded-end shapes
18. Dimensioning of threads
19. Dimensioning of tapers
20. Dimensioning of chamfers
21. Dimensioning shaft centers
22. Dimensioning keyways
23. Dimensioning knurls
   a. Diamond
   b. Straight
24. Dimensioning along curved surfaces
25. Tabular dimensions
26. Dimensioning standards
27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
   A. Traditional terms used to describe various shapes, processes, and size
   B. Identify abbreviations used to describe various shapes, processes, and size
   C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
   A. Identify tolerances or limits
      1. Nominal size
      2. Basic size or dimension
      3. Actual size
      4. Tolerance
5. Limits
6. Allowance

B. Methods of expressing tolerances
   1. General tolerances
   2. Limit dimensioning
   3. Plus and minus dimensioning
      a. Unilateral system
      b. Bilateral system
   4. Single-limit dimensioning
   5. Angular tolerances

VI. Identify ANSI Limits and Fits
A. Fits between mating parts
   1. Clearance fit
   2. Interference fit
   3. Transition fit
   4. Line fit

B. Limits and fits for cylindrical parts
   1. Running or sliding clearance fits
   2. Locational clearance fits
   3. Transition clearance interference fits
   4. Locational interference fits
   5. Force or shrink fits
1. What are general notes?

2. What are specific or local notes?

3. Name two places where general notes will appear on a drawing.

4. Name four categories that general notes supply information.

5. Name two specific or local notes.

6. Identify two organizations that determine dimension standards.

7. Name two important functions that dimensions serve on a drawing.

8. Name three considerations to dimension.
9. Identify three types of lines that can be used to dimension.

10. What is the length and width of an arrowhead?

11. Identify the parts of a leader.

12. Name three types of dimensioning systems.

13. Identify three specifications for dimensioning figures.

14. Name two systems of reading direction for dimensions.

15. Name two specifications for dimensioning angles.

16. Identify two specifications for dimensioning arcs.

17. Name two specifications for dimensioning fillets and rounds.
18. What is used to represent surfaces to be machined?

19. What is contour dimensioning?

20. Name two specifications for dimensioning curves.

21. Name two methods for dimensioning round-end shapes.

22. What information would be contained in a thread dimension.

23. What information would be needed to dimension a taper?

24. What information would be necessary to dimension a chamfer?

25. What information would be needed to dimension a shaft center?

27. Name two specifications for dimensioning knurls.

28. Name two specifications for dimensioning along curved surfaces.

29. What is tabular dimensions?

30. Where could one go to get dimensioning standards?

31. What is coordinate dimensioning?

32. Name five terms used to describe various shapes, processes, and size.

33. Name five abbreviations used to describe various shapes, processes, and size.

34. Illustrate five symbols used to replace traditional terms and abbreviations.

35. What is nominal size?
36. What is basic size or dimension?

37. What does actual size refer to?

38. What specifically does tolerance mean?

39. What are limits?

40. What does allowance mean?

41. Name three methods of expressing tolerances.

42. Name three general types of fit between parts.

43. Name three types of fits for cylindrical parts.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-C3

Subject: Tool & Die and EDM
Time: 10 Hrs.

Duty: Interpret Engineering Drawings and Related Documents
Task: Use and Apply Geometric Dimensioning and Tolerancing (GD&T)

Objective(s):

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

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

Instructional Materials:

MASTER Handout (TLD-C3-HO)
MASTER Self-Assessment

References:


Design Dimensioning and Tolerancing, Bruce A. Wilson, Goodheart-Willcox Co. Inc., Latest Edition


Geometric Dimensioning and Tolerancing: A Self-Study Workbook, Alex Krucikowski, Effective Training Inc., Latest Edition


Student Preparation:

Students should have previously completed the following Technical Modules:
- TLD-C1 “Interpret and Understand Basic Layout/Types of Drawings”
- TLD-C2 “Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances”

Introduction:

In this highly competitive, industrial world in which we live, every possible method should be taken to improve efficiency and reduce product cost. By understanding and applying geometric dimensioning and tolerancing to current designs and products this goal can be achieved. Geometric dimensioning and tolerancing is an aid to better communication of dimensioning standards and design philosophy to provide liberal tolerances that can gain substantial savings in a company’s tool and die making operation expenses.

Presentation Outline:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
   A. General/conventional tolerancing
      1. Definitions of general/conventional tolerancing
         a. Dimension
         b. Reference dimension
         c. Feature
         d. Feature of size
         e. Actual size
         f. Stock size
      2. Maximum material condition
      3. Least material condition
      4. Basic fits
      5. Clearance fit
      6. Allowance
      7. Clearance
      8. Force fit
   B. Geometric dimensioning and tolerancing
      1. Definition of geometric dimensioning and tolerancing
      2. Dimensioning rules
      3. Dimensioning units

II. Explain and Use Geometric Positional Tolerancing and Symbols
A. Explain positional / location tolerances
B. Identify and use geometric position tolerancing symbols
   1. Position
   2. Concentricity
   3. Symmetry

III. Explain and Use Tolerances of Form Symbols
A. Explain form tolerances
B. Identify and use tolerances of form symbols
   1. Straightness
   2. Flatness
   3. Circularity
   4. Cylindrical

IV. Explain and Use Profile Tolerances
A. Explain profile tolerance
B. Identify and use profile tolerance symbols
   1. Profile of a line
   2. Profile of a surface
   3. Profile of an arc
   4. Profile of irregular curves
   5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
A. Explain orientation tolerances
B. Identify and use orientation tolerance symbols
   1. Parallelism
   2. Perpendicularity
   3. Angularity

VI. Explain and Use Runout Tolerances
A. Explain runouts
   1. Circular
   2. Total
B. Identify and use runout tolerances symbols
   1. Circular
   2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
A. Maximum material condition (MMC)
B. Regardless of feature size (RFS)
C. Least material condition (LMC)
D. Datum feature symbol
E. Datum reference frame concept
   1. Primary datum plane
   2. Secondary datum plane
   3. Tertiary datum plane
F. Datum target symbol
   1. Target point
   2. Target line
3. Target area

VIII. Explain and Use the Feature Control Frame
   A. Explain feature control frame
   B. Explain the compartments of a feature control frame
      1. Geometric characteristic symbol
      2. Geometric tolerance
      3. Zone descriptor
      4. Material condition symbol
      5. Primary datum reference
      6. Secondary datum reference
      7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
   A. Explain and use additional modifying symbols.
      1. Diameter
      2. Radius R
      3. Reference ()
      4. Counterbore/spotface L/
      5. Square □
      6. Dimension origin O
      7. Slope
      8. Projected tolerance zone
      9. Spherical diameter
      10. Spherical radius
      11. Arc length
      12. Counter sink
      13. Depth
      14. Conical taper
      15. Place, times, or by
      16. Basic dimension

Practical Application:

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (TLD-C4) dealing with demonstrating traditional mechanical drafting and sketching techniques.
TLD-C3-HO
Use and Apply Geometric Dimensioning and Tolerancing (GD&T)
Attachment 1: MASTER Handout

Objective(s):

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

a. Distinguish between conventional and geometric dimensioning and tolerancing;
b. Explain and use geometric positional tolerancing and symbols;
c. Explain and use tolerances of form and symbols;
d. Explain and use the feature control symbol; and,
e. Explain and use modifiers in geometric dimensioning and tolerancing.

Module Outline:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
   A. General/conventional tolerancing
      1. Definitions of general/conventional tolerancing
         a. Dimension
         b. Reference dimension
         c. Feature
         d. Feature of size
         e. Actual size
         f. Stock size
      2. Maximum material condition
      3. Least material condition
      4. Basic fits
      5. Clearance fit
      6. Allowance
      7. Clearance
      8. Force fit
   B. Geometric dimensioning and tolerancing
      1. Definition of geometric dimensioning and tolerancing
      2. Dimensioning rules
      3. Dimensioning units

II. Explain and Use Geometric Positional Tolerancing and Symbols
   A. Explain positional / location tolerances
   B. Identify and use geometric position tolerancing symbols
      1. Position
      2. Concentricity
      3. Symmetry

III. Explain and Use Tolerances of Form Symbols
   A. Explain form tolerances
B. Identify and use tolerances of form symbols
   1. Straightness
   2. Flatness
   3. Circularity
   4. Cylindrical

IV. Explain and Use Profile Tolerances
A. Explain profile tolerance
B. Identify and use profile tolerance symbols
   1. Profile of a line
   2. Profile of a surface
   3. Profile of an arc
   4. Profile of irregular curves
   5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
A. Explain orientation tolerances
B. Identify and use orientation tolerance symbols
   1. Parallelism
   2. Perpendicularity
   3. Angularity

VI. Explain and Use Runout Tolerances
A. Explain runouts
   1. Circular
   2. Total
B. Identify and use runout tolerances symbols
   1. Circular
   2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
A. Maximum material condition (MMC)
B. Regardless of feature size (RFS)
C. Least material condition (LMC)
D. Datum feature symbol
E. Datum reference frame concept
   1. Primary datum plane
   2. Secondary datum plane
   3. Tertiary datum plane
F. Datum target symbol
   1. Target point
   2. Target line
   3. Target area

VIII. Explain and Use the Feature Control Frame
A. Explain feature control frame
B. Explain the compartments of a feature control frame
   1. Geometric characteristic symbol
   2. Geometric tolerance
   3. Zone descriptor
4. Material condition symbol
5. Primary datum reference
6. Secondary datum reference
7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
A. Explain and use additional modifying symbols.
   1. Diameter
   2. Radius R
   3. Reference ( )
   4. Counterbore/spotface L/
   5. Square □
   6. Dimension origin O
   7. Slope
   8. Projected tolerance zone
   9. Spherical diameter
   10. Spherical radius
   11. Arc length
   12. Counter sink
   13. Depth
   14. Conical taper
   15. Place, times, or by
   16. Basic dimension
TLD-C3
Use and Apply Geometric Dimensioning and Tolerancing (GD&T)
Self-Assessment

1. What is conventional tolerancing?

2. Name three terms associated with conventional tolerancing.

3. Describe the term maximum material condition.

4. Define the term least material condition.

5. Identify basic fits of mating parts.

6. Describe clearance fit.

7. What is allowance?

8. Define clearance.
9. What is force fit?

10. Define geometric dimensioning and tolerance.

11. List three general rules for dimensioning and tolerancing.

12. List two general units used for dimensioning and tolerancing.

13. What is positional tolerancing?


15. Represent two position/location tolerancing symbols.


17. Represent three form tolerancing symbols.
18. What is profile tolerancing?

19. Represent three profile tolerancing symbols.

20. Define orientation tolerances.

21. Represent two orientation tolerancing symbols.

22. What are runout tolerances?

23. Define circular runouts.

24. Define total runouts.

25. Represent two runout tolerancing symbols.

26. What are modifiers in geometric dimensioning and tolerancing.
27. Represent two modifiers in geometric dimensioning and tolerancing.

28. Define datums as used in geometric dimensioning and tolerancing.

29. Describe the datum reference frame concept.

30. Name three datum planes.

31. What are datum target?

32. Represent three datum target symbols.

33. Define feature control frame.

34. Describe the various compartments of a feature control frame.

35. Represent a feature control frame with symbols for each compartment.
36. List other additional modifiers used in geometric dimensioning and tolerancing.

37. Represent five additional modifying symbols used in geometric dimensioning and tolerancing.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-C4

Subject: Tool & Die and EDM
Time: 24 Hrs.

Duty: Interpret Engineering Drawings and Related Documents
Task: Demonstrate Traditional Mechanical Drafting and Sketching Techniques

Objective(s):

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

a. Demonstrate use of drafting machine;
b. Demonstrate use of drafting instruments;
c. Demonstrate drafting techniques used to create basic geometric elements;
d. Demonstrate sketching techniques;
e. Demonstrate isometric sketching;
f. Demonstrate oblique sketching; and,
g. Demonstrate perspective sketching.

Instructional Materials:

MASTER Handout (TLD-C4-HO)
MASTER Laboratory Exercise (TLD-C4-LE)
MASTER Self-Assessment

References:


Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-G1  “Interpret and Understand Basic Layout/Types of Drawings”
TLD-G2  “Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances”
TLD-G3  “Use and Apply Geometric Dimensioning and Tolerancing (GD&T)”

Introduction:

The graphic representation of real thing and ideas can be developed along two lines of thought and purpose, artistic and technical. The earlier technical drawings go back to the Romans but it was not until the fifteenth and sixteenth century that mechanical drawings were generated. This brought about the development of the scribe-type compass which gave way to the compass with graphite lead shortly after graphite pencils were developed. The tool and die maker of today must use many technical devices to accomplish their goals. One such technical device is the drafting board and machine, another is the drafting instruments and equipment.

Presentation Outline:

I. Demonstrate Use of Drafting Machine
   A. Types of drafting machines
      1. Elbow drafting machines
         a. Controlling head
         b. Vernier
      2. Track drafting machines
         a. Controlling head
         b. Vernier
   II. Demonstrate Use of Drafting Instruments
       A. Drawing pencil types
          1. Drawing pencil
             a. Grade
             b. Sharpening
          2. Mechanical pencil
             a. Grade
             b. Sharpening
          3. Thin-lead mechanical pencil
             a. Grade
             b. Lead diameter
       B. Types of erasers
          1. Pink pearl
2. Mars - plastiz
3. Artgum
4. Electric erasing machine

C. Erasing shield
D. Dusting brush

E. Types of triangles
1. 45° triangle
2. 30° x 60° triangle
3. Adjustable triangle

F. Protractor

G. Types of scales
1. Metric scale
2. Engineers' scale
3. Mechanical engineers' scale
4. Decimal scale
5. Architects' scale
6. Combination scale

H. Drawing instruments
1. Compass
   a. Giant bow compass
   b. Beam attachment
2. Beam compass/trammel
3. Dividers

I. Irregular/french curve

J. Templets
1. Circle
2. Ellipse
3. Chemical
4. Electrical
5. Architectural
6. Mechanical

K. Lettering guide

L. Calculator

M. Drafting tape

N. Pencil lead sharpening devices
1. Lead pointer
2. Sandpaper pad

O. Drafting board table

P. Drafting paper/detail paper

Q. Tracing papers kinds
1. Treated with oils, waxes, and similar substances (vellums)
2. Non-treated papers

R. Tracing cloth

S. Polyester film

III. Demonstrate Drafting Techniques to Create Basic Geometric Elements
A. Perform drafting techniques necessary to bisect a line or a circular arc
B. Perform drafting techniques necessary to bisect an angle and to transfer an angle
C. Perform drafting techniques necessary to construct a line parallel to a given line at a given distance
D. Perform drafting techniques necessary to divide a line into equal or proportional parts
E. Perform drafting techniques necessary to construct a triangle with the length of the sides given
F. Perform drafting techniques necessary to inscribe a circle in a triangle
G. Perform drafting techniques necessary to construct a right triangle with hypotenuse and one side given
H. Perform drafting techniques necessary to construct a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line
I. Perform drafting techniques necessary to construct a square with a side given
J. Perform drafting techniques necessary to inscribe a regular pentagon in a given circle
K. Perform drafting techniques necessary to inscribe and circumscribe a hexagon on a given circle
L. Perform drafting techniques necessary to inscribe an octagon in a given square
M. Perform drafting techniques necessary to construct a circle through three given points not in a straight line
N. Perform drafting techniques necessary to construct a circle of a given size tangent to a given line and passing through a given point
O. Perform drafting techniques necessary to construct a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line
P. Perform drafting techniques necessary to construct a circle of a given size tangent to a given circle and passing through a given point
Q. Perform drafting techniques necessary to construct an arc of a given size tangent to two given intersecting lines at acute or obtuse angles
R. Perform drafting techniques necessary to construct a given size circle tangent to two given circles
S. Perform drafting techniques necessary to construct an ellipse using the concentric circle method with major and minor diameters given
T. Perform drafting techniques necessary to construct an approximate ellipse with major and minor diameters given

IV. Demonstrate Sketching Techniques
A. Horizontal lines
B. Vertical lines
C. Inclined lines
D. Circles
E. Arcs  
F. Ellipses  

V. Demonstrate Isometric Sketching  
A. Box construction technique  
B. Blocking recesses and projections  
C. Dim all construction lines  
D. Heavy in all final lines  

VI. Demonstrate Oblique Sketching  
A. Block in front view  
B. Sketch receding lines  
C. Dim all construction lines  
D. Heavy in all final lines  

VII. Demonstrate Perspective Sketching  
A. One-point perspective  
1. Sketch the true front view and select vanishing point  
2. Sketch receding lines to vanishing point  
3. Estimate the depth  
4. Dim all construction lines  
5. Heavy in all final lines  

B. Two-point perspective  
1. Sketch the front corner of view in true height and locate two vanishing points on a horizontal line  
2. Estimate depth and width and sketch enclosing box  
3. Block in all details  
4. Dim all construction lines  
5. Heavy in all final lines  
6. Make contour lines thicker and inside lines thinner  

Practical Application:  

Student should be assigned several drawing projects with various drafting machines, instruments, techniques. Geometry and various sketching skills are required at various degrees of accuracy to generate and complete the assigned task.  

Evaluation and/or Verification:  

Students should successfully complete the Self-Assessment found at the end of this lesson along with successful completion of traditional mechanical drafting skills to complete assigned exercises.  

Summary:  

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (TLD-C5) dealing with understanding and using quality systems.
TLD-C4-HO
Demonstrate Traditional Mechanical Drafting and Sketching Techniques
Attachment 1: MASTER Handout

Objective(s):

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

a. Demonstrate use of drafting machine;
b. Demonstrate use of drafting instruments;
c. Demonstrate drafting techniques used to create basic geometric elements;
d. Demonstrate sketching techniques;
e. Demonstrate isometric sketching;
f. Demonstrate oblique sketching; and,
g. Demonstrate perspective sketching.

Module Outline:

I. Demonstrate Use of Drafting Machine
   A. Types of drafting machines
      1. Elbow drafting machines
         a. Controlling head
         b. Vernier
      2. Track drafting machines
         a. Controlling head
         b. Vernier

II. Demonstrate Use of Drafting Instruments
    A. Drawing pencil types
       1. Drawing pencil
          a. Grade
          b. Sharpening
       2. Mechanical pencil
          a. Grade
          b. Sharpening
       3. Thin-lead mechanical pencil
          a. Grade
          b. Lead diameter
    B. Types of erasers
       1. Pink pearl
       2. Mars - plastiz
       3. Artgum
       4. Electric erasing machine
    C. Erasing shield
    D. Dusting brush
E. Types of triangles
1. 45° triangle
2. 30° x 60° triangle
3. Adjustable triangle

F. Protractor

G. Types of scales
1. Metric scale
2. Engineers’ scale
3. Mechanical engineers’ scale
4. Decimal scale
5. Architects’ scale
6. Combination scale

H. Drawing instruments
1. Compass
   a. Giant bow compass
   b. Beam attachment
2. Beam compass/trammel
3. Dividers

I. Irregular/french curve

J. Templet
1. Circle
2. Ellipse
3. Chemical
4. Electrical
5. Architectural
6. Mechanical

K. Lettering guide

L. Calculator

M. Drafting tape

N. Pencil lead sharpening devices
1. Lead pointer
2. Sandpaper pad

O. Drafting board table

P. Drafting paper/detail paper

Q. Tracing papers kinds
1. Treated with oils, waxes, and similar substances (vellums)
2. Non-treated papers

R. Tracing cloth

S. Polyester film

III. Demonstrate Drafting Techniques to Create Basic Geometric Elements
A. Perform drafting techniques necessary to bisect a line or a circular arc
B. Perform drafting techniques necessary to bisect an angle and to transfer an angle
C. Perform drafting techniques necessary to construct a line parallel to a given line at a given distance
D. Perform drafting techniques necessary to divide a line into equal or proportional parts
E. Perform drafting techniques necessary to construct a triangle with the length of the sides given
F. Perform drafting techniques necessary to inscribe a circle in a triangle
G. Perform drafting techniques necessary to construct a right triangle with hypotenuse and one side given
H. Perform drafting techniques necessary to construct a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line
I. Perform drafting techniques necessary to construct a square with a side given
J. Perform drafting techniques necessary to inscribe a regular pentagon in a given circle
K. Perform drafting techniques necessary to inscribe and circumscribe a hexagon on a given circle
L. Perform drafting techniques necessary to inscribe an octagon in a given square
M. Perform drafting techniques necessary to construct a circle through three given points not in a straight line
N. Perform drafting techniques necessary to construct a circle of a given size tangent to a given line and passing through a given point
O. Perform drafting techniques necessary to construct a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line
P. Perform drafting techniques necessary to construct a circle of a given size tangent to a given circle and passing through a given point
Q. Perform drafting techniques necessary to construct an arc of a given size tangent to two given intersecting lines at acute or obtuse angles
R. Perform drafting techniques necessary to construct a given size circle tangent to two given circles
S. Perform drafting techniques necessary to construct an ellipse using the concentric circle method with major and minor diameters given
T. Perform drafting techniques necessary to construct an approximate ellipse with major and minor diameters given

IV. Demonstrate Sketching Techniques
A. Horizontal lines
B. Vertical lines
C. Inclined lines
D. Circles
E. Arcs
F. Ellipses

V. Demonstrate Isometric Sketching
A. Box construction technique
B. Blocking recesses and projections

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C. Dim all construction lines
D. Heavy in all final lines

VI. Demonstrate Oblique Sketching
A. Block in front view
B. Sketch receding lines
C. Dim all construction lines
D. Heavy in all final lines

VII. Demonstrate Perspective Sketching
A. One-point perspective
   1. Sketch the true front view and select vanishing point
   2. Sketch receding lines to vanishing point
   3. Estimate the depth
   4. Dim all construction lines
   5. Heavy in all final lines
B. Two-point perspective
   1. Sketch the front corner of view in true height and locate two vanishing points on a horizontal line
   2. Estimate depth and width and sketch enclosing box
   3. Block in all details
   4. Dim all construction lines
   5. Heavy in all final lines
   6. Make contour lines thicker and inside lines thinner
TLD-C4-LE
Demonstrate Traditional Mechanical Drafting and Sketching Techniques
Attachment 2: MASTER Laboratory Exercise

1. The instructor will:
   a. Demonstrate use of drafting machine;
   b. Demonstrate use of drafting instruments;
   c. Demonstrate drafting techniques to create basic geometric elements;
   d. Demonstrate sketching techniques, including:
      (1) Isometric sketching;
      (2) Oblique sketching; and,
      (3) One-point and two-point perspective sketching.

2. The student will:
   a. Demonstrate use of drafting machine;
   b. Demonstrate use of drafting instruments;
   c. Demonstrate drafting techniques to create basic geometric elements, which include:
      (1) Bisecting a line or a circular arc;
      (2) Bisecting an angle and to transfer an angle;
      (3) Constructing a line parallel to a given line at a given distance;
      (4) Dividing a line into equal or proportional parts;
      (5) Constructing a triangle with the length of the sides given;
      (6) Inscribing a circle in a triangle;
      (7) Constructing a right triangle with hypotenuse and one side given;
      (8) Constructing a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line;
      (9) Constructing a square with a side given;
      (10) Inscribing a regular pentagon in a given circle;
      (11) Inscribing and circumscribing a hexagon on a given circle;
      (12) Inscribing an octagon in a given square;
      (13) Constructing a circle through three given points not in a straight line;
      (14) Constructing a circle of a given size tangent to a given line and passing through a given point;
      (15) Constructing a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line;
      (16) Constructing a circle of a given size tangent to a given circle and passing through a given point;
(17) Constructing an arc of a given size tangent to two given intersecting lines at acute or obtuse angles;
(18) Constructing a given size circle tangent to two given circles;
(19) Constructing an ellipse using the concentric circle method with major and minor diameters given;
(20) Construct an approximate ellipse with major and minor diameters given;

d. Demonstrate sketching techniques, including:
   (1) Isometric sketching;
   (2) Oblique sketching; and,
   (3) One-point and two-point perspective sketching.

3. The instructor will grade the student's performance on the student's ability to:
   a. Demonstrate use of drafting machine;
   b. Demonstrate use of drafting instruments;
   c. Demonstrate drafting techniques to create basic geometric elements, which include:
      (1) Bisecting a line or a circular arc;
      (2) Bisecting an angle and to transfer an angle;
      (3) Constructing a line parallel to a given line at a given distance;
      (4) Dividing a line into equal or proportional parts;
      (5) Constructing a triangle with the length of the sides given;
      (6) Inscribing a circle in a triangle;
      (7) Constructing a right triangle with hypotenuse and one side given;
      (8) Constructing a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line;
      (9) Constructing a square with a side given;
      (10) Inscribing a regular pentagon in a given circle;
      (11) Inscribing and circumscribing a hexagon on a given circle;
      (12) Inscribing an octagon in a given square;
      (13) Constructing a circle through three given points not in a straight line;
      (14) Constructing a circle of a given size tangent to a given line and passing through a given point;
      (15) Constructing a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line;
      (16) Constructing a circle of a given size tangent to a given circle and passing through a given point;
      (17) Constructing an arc of a given size tangent to two given intersecting lines at acute or obtuse angles;
      (18) Constructing a given size circle tangent to two given circles;
(19) Constructing an ellipse using the concentric circle method with major and minor diameters given;

(20) Construct an approximate ellipse with major and minor diameters given;

d. Demonstrate sketching techniques, including:

(1) Isometric sketching;

(2) Oblique sketching; and,

(3) One-point and two-point perspective sketching.
TLD-C4
Demonstrate Traditional Mechanical Drafting and Sketching Techniques
Self-Assessment

1. Name two types of drafting machines.

2. What is a control head?

3. What is a vernier?

4. How does one read a vernier?

5. Name three types of pencils used in technical drawing.

6. List three grades of drafting pencils.

7. Describe two methods of sharpening drafting pencils.

8. Name two types of erasers used in technical drafting.
9. What is the primary function of an erasing shield?

10. How is the dusting brush used in technical drafting?

11. Name three types of triangles used in technical drafting.

12. Describe the use of a protractor in technical drafting.

13. Identify four types of scales used in technical drafting.

14. What is contained in a set of drawing instruments?

15. Define french/irregular curve and explain its' use.

16. Name four types of templets used in technical drafting?

17. Describe the use of a lettering guide in technical drafting.
18. Name the modern day device used in technical drafting which aids in mathematical computations.

19. Identify and explain the use of the material used to hold technical drawings in place.

20. What type of surface should one try to generate technical drawings on?

21. Name the type of paper used to generate technical drawings.

22. Identify two types of tracing paper used in technical drafting.

23. Name the thin transparent muslin fabric sized with a starch compound or plastic to provide a good working surface for pencil or ink.

24. Name the transparent film that is a superior drafting material. It is made by bonding a mat surface to one or both sides of a sheet or roll.

25. Name four solid geometric shapes used in technical drafting.
26. Describe a point as used in technical drafting.

28. Define what a line is in technical drafting.

29. What is a parallel line?

30. Define and explain perpendicular lines.

31. What does bisect mean in geometric construction?

32. Define a circle as used in technical drafting.

33. Describe a right angle as used in technical drafting.

34. What is an acute angle as used in geometric construction?

35. Define an obtuse angle as used in geometric construction.
36. Describe a complimentary angle as used in geometric construction.

37. What is a supplementary angle as used in geometric construction.

38. Define an equilateral triangle.

39. Describe an isosceles triangle.

40. What is a scalene triangle?

41. Define a right angle.

42. Name four quadrilaterals.

43. Identify four regular polygons.

44. Describe and explain concentric and eccentric circles.
45. What is circumference?

46. Define diameter of a circle.

47. Describe radius of a circle.

48. What does the term tangent mean as used in geometric construction?

49. Name two methods used to generate ellipse.

50. Describe sketching techniques for horizontal lines.

51. Describe sketching techniques for vertical lines.

52. Describe sketching techniques for inclined lines.

53. Describe sketching techniques for generating circles.
54. Describe sketching techniques for generating arcs.

55. Describe sketching techniques for generating ellipses.

56. List and define isometric sketching techniques.

57. Name and define oblique sketching techniques.

58. Identify one-point perspective sketching and explain this technique.

59. Identify two-point perspective sketching and explain this technique.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-C5

Subject: Tool & Die and EDM
Time: 6 Hrs.

Duty: Interpret Engineering Drawings and Related Documents
Task: Understand and Use Quality Systems

Objective(s): Upon completion of this unit the student will be able to:

a. Understand and apply quality principles, including continuous improvement; and,
b. Document paper trails for part revisions.

Instructional Materials:

MASTER Handout (TLD-C5-H0)

References:

Student Preparation:

Introduction:
The ultimate goal of all technicians is to fabricate perfect parts and make absolute repairs. Unfortunately, we just can’t get there from here. However, with the consistent application of quality controls at every level, we can get close.

Presentation Outline:

I. Understand and Apply Quality Principles, Including Continuous Improvement
   A. Tolerances as basic quality control
   B. The technician as the first line of excellence
   C. Specific systems
      These systems are diverse. You, as the instructor, must tailor this portion of the lecture to the system used in your circumstances.
   D. The inspector as guarantor
   E. The consumer: the ultimate judge of top quality
II. ISO 9000
   A. Purpose
   B. What is ISO 9000?
   C. How does it work?
   D. Where do the standards come from?
   E. Who uses this stuff, anyway?

III. Document Paper Trails for Part Revisions

---

Practical Application:

Due to the large number of quality assurance systems, the instructor must tailor the Self-Assessment to his own company.

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Evaluation and/or Verification:

Students should successfully complete the Self-Assessment.

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Summary:

Review the main lesson points and answer student questions.

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Next Lesson Assignment:

MASTER Technical Module (TLD-D1) dealing with physical properties of manufacturing materials.
TLD-C5-HO
Understand and Use Quality Systems
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
a. Understand and apply quality principles, including continuous improvement; and,
b. Document paper trails for part revisions.

Module Outline:

I. Understand and Apply Quality Principles, Including Continuous Improvement
   A. Tolerances as basic quality control
   B. The technician as the first line of excellence
   C. Specific systems
      These systems are diverse. You, as the instructor, must tailor this portion of the lecture to the system used in your circumstances.
   D. The inspector as guarantor
   E. The consumer: the ultimate judge of top quality

II. ISO 9000
   A. Purpose
   B. What is ISO 9000?
   C. How does is work?
   D. Where do the standards come from?
   E. Who uses this stuff, anyway?

III. Document Paper Trails for Part Revisions
TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

**Duties**

<table>
<thead>
<tr>
<th>Practice Safety</th>
<th>Tasks</th>
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</thead>
<tbody>
<tr>
<td>A-1 Follow safety manuals and all safety regulations/requirements</td>
<td></td>
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<tr>
<td>A-2 Maintain safe equipment and machinery</td>
<td></td>
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<tr>
<td>A-3 Use safe operating procedures for hand and machine tools</td>
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<td>A-4 Maintain a clean and safe work environment</td>
<td></td>
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<tr>
<td>A-5 Use safe material handling practices</td>
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<tr>
<td>A-6 Consult and apply MSDS for hazards of various materials</td>
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<thead>
<tr>
<th>Apply Mathematical Concepts</th>
<th>Tasks</th>
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<td>B-1 Perform basic arithmetic functions</td>
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<td>B-2 Perform basic algebraic operations</td>
<td></td>
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<tr>
<td>B-3 Use basic geometric principles</td>
<td></td>
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<tr>
<td>B-4 Perform basic trigonometric functions</td>
<td></td>
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<tr>
<td>B-5 Use and apply Cartesian Coordinate System</td>
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<table>
<thead>
<tr>
<th>Interpret Engineering Drawings and Related Documents</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-1 Interpret and understand basic layout/types of drawings</td>
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<tr>
<td>C-2 Interpret, review, and apply blue-print notes, dimensions, and tolerances</td>
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<tr>
<td>C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&amp;T)</td>
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<tr>
<td>C-4 Demonstrate traditional mechanical drafting and sketching techniques</td>
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<tr>
<td>C-5 Understand and use quality systems</td>
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<thead>
<tr>
<th>Demonstrate Knowledge of Manufacturing Materials</th>
<th>Tasks</th>
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</thead>
<tbody>
<tr>
<td>D-1 Identify materials with desired properties</td>
<td></td>
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<tr>
<td>D-2 Identify materials and processes to produce a part</td>
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<tr>
<td>D-3 Discuss classification systems for metal</td>
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<tr>
<th>Measure/Inspect</th>
<th>Tasks</th>
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</thead>
<tbody>
<tr>
<td>E-1 Understand metrology terms</td>
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<tr>
<td>E-2 Select measurement tools</td>
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<tr>
<td>E-3 Measure with hand held instruments</td>
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<td>E-4 Eliminate measurement variables</td>
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<tr>
<td>E-5 Measure/inspect using surface plate and accessories</td>
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<tr>
<td>E-6 Inspect using stationary equipment</td>
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<thead>
<tr>
<th>Demonstrate Knowledge of Manufacturing Processes</th>
<th>Tasks</th>
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</thead>
<tbody>
<tr>
<td>F-1 Discuss metal cutting and metal cutting tools</td>
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<tr>
<td>F-2 Operate metal saws</td>
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<td>F-3 Operate drill presses and tooling</td>
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<td>F-4 Operate engine and turret lathes and tooling</td>
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<tr>
<td>F-5 Operate vertical and horizontal mills and tooling</td>
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<td>F-6 Operate precision grinders</td>
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<td>F-7 Operate heat treating equipment and processes</td>
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<td>F-8 Operate sheet metal equipment and processes</td>
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<tr>
<td>F-9 Operate welding equipment and processes</td>
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<tr>
<td>F-10 Estimate time required/cost to produce a part</td>
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<tr>
<th>Use Computers</th>
<th>Tasks</th>
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<tbody>
<tr>
<td>G-1 Use computer operating systems</td>
<td></td>
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<tr>
<td>G-2 Understand computer terminology</td>
<td></td>
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<tr>
<td>G-3 Use file management systems</td>
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<tr>
<td>G-4 Install and use software packages</td>
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<tr>
<th>Perform CAD, CAM and CNC Programming Tasks</th>
<th>Tasks</th>
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</thead>
<tbody>
<tr>
<td>H-1 Discuss fundamentals of CNC machines and controls</td>
<td></td>
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<tr>
<td>H-2 Program and operate CNC milling machine and machining center</td>
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<tr>
<td>H-3 Program and operate CNC lathe</td>
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<tr>
<td>H-4 Use Computer-Aided Drafting (CAD) system</td>
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<tr>
<td>H-5 Create 3-D solid models</td>
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<tr>
<td>H-6 Use Computer-Aided Manufacturing (CAM) system</td>
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<thead>
<tr>
<th>Perform Tool and Die Making Operations</th>
<th>Tasks</th>
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<tbody>
<tr>
<td>I-1 Discuss basic types and functions of jigs and fixtures</td>
<td></td>
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<tr>
<td>I-2 Utilize concept of jigs and fixture design</td>
<td></td>
</tr>
<tr>
<td>I-3 Demonstrate understanding of different types of industrial dies</td>
<td></td>
</tr>
<tr>
<td>I-4 Utilize basic die theory</td>
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<tr>
<td>I-5 Utilize principles of die design</td>
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</tr>
<tr>
<td>I-6 Perform tool and die repair</td>
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<tr>
<td>I-7 Demonstrate tool and die making skills</td>
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<tr>
<th>Operate Electrical Discharge Machine (EDM)</th>
<th>Tasks</th>
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</thead>
<tbody>
<tr>
<td>J-1 Discuss fundamentals of EDM</td>
<td></td>
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<tr>
<td>J-2 Setup and operate conventional and conventional EDM and EDM drill</td>
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<tr>
<td>J-3 Program, setup, and operate EDM sinker EDM and EDM drill</td>
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<tr>
<td>J-4 Program, setup, and operate EDM wire EDM</td>
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</tbody>
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**BEST COPY AVAILABLE**
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-D1

Subject: Tool & Die and EDM
Time: 2 Hrs.

Duty: Demonstrate Knowledge of Manufacturing Materials
Task: Identify Materials With Desired Properties

Objective(s):

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

a. Discuss classification system for metals; and,
b. Describe general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals.

Instructional Materials:

MASTER Handout (TLD-D1-HO1)
The following tables are included in this module for reference or reproduction as needed.
Table 1.1 “Effects of Alloying Elements on Steel” (TLD-D1-HO2)
Table 1.2 “SAE-ANSI Numerical Designation of Alloy Steels” (TLD-D1-HO3)
MASTER Self-Assessment

References:


NTMA Modules:
MA-II-46 “Physical Metallurgy”
MA-II-77 “Cast Irons”
MA-II-48 “Property of Metals”
MA-II-79 “Powder Metallurgy”
MA-II-50 “Iron Carbon Constitutional Diagram”
MA-II-57 “Steel Classification & Basic Tests for Identifying the Content of an Unknown Metal”
MA-II-59 “Plain Carbon Steel”
MA-II-67 “Alloy Steels and Stainless Steels”
MA-II-69 “Aluminum & Aluminum Alloys”
MA-II-71 “Magnesium & Magnesium Alloys”
Introduction:

It has become increasingly important for the technician to understand the properties of metals during the last few years. With more and more emphasis on weight reduction and increased strength in products such as automobiles and aircraft, the technician will be expected to work with many different types of carbon and alloy steels. So it is imperative that the technician understand the properties and identification system for metals commonly found in the machine shop.

Presentation Outline:

I. Discuss the Physical Properties of Metal
   A. Brittleness - the property of a metal which permits no permanent distortion before breaking
   B. Ductility - the ability of the metal to be permanently deformed without breaking
   C. Elasticity - the ability of a metal to return to its original shape after any force acting upon it has been removed
   D. Hardness - the resistance to forcible penetration
   E. Malleability - the property of a metal which permits it to be hammered or rolled into other sizes and shapes
   F. Tensile strength - the maximum amount of pull that a material will withstand before breaking
   G. Toughness - the property of a metal to withstand shock or impact

II. Discuss the Classification System for Steel
   A. Carbon steels
      1. Low carbon steel - contains from 0.02 to 0.20 percent of carbon
      2. Medium carbon steel - contains from 0.30 to 0.60 percent of carbon
      3. High carbon steel (tool steel) - contains over 0.60 percent of carbon
   B. Alloy steels - alloying elements allow steels to possess special characteristics
      Discuss Table 1.1 “Effects of Alloying Elements on Steel”
      Discuss Table 1.2 “SAE-ANSI Numerical Designation of Alloy Steels”

III. Describe General Characteristics For:
A. Carbon Steels
B. Tool Steels
C. Stainless Steels
D. Structural Steels
E. Cast Irons
F. Non-Ferrous Metals
   1. Aluminum and Its Alloys
   2. Copper and Its Alloys
   3. Nickel Alloys
   4. Precious Metals
   5. Others

Practical Application:

Students will be able to select metals based on their properties through understanding their physical characteristics and the standard coding system.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions

Next Lesson Assignment:

MASTER Technical Module (TLD-D2) dealing with the identification of materials and processes used to produce a part.
Objective(s):

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

a. Discuss classification system for metals; and,

b. Describe general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals.

Module Outline:

I. Discuss the Physical Properties of Metal
   A. Brittlement - the property of a metal which permits no permanent distortion before breaking
   B. Ductility - the ability of the metal to be permanently deformed without breaking
   C. Elasticity - the ability of a metal to return to its original shape after any force acting upon it has been removed
   D. Hardness - the resistance to forcible penetration
   E. Malleability - the property of a metal which permits it to be hammered or rolled into other sizes and shapes
   F. Tensile strength - the maximum amount of pull that a material will withstand before breaking
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   B. Alloy steels - alloying elements allow steels to possess special characteristics
      Discuss Table 1.1 “Effects of Alloying Elements on Steel”
      Discuss Table 1.2 “SAE-ANSI Numerical Designation of Alloy Steels”

III. Describe General Characteristics For:
   A. Carbon Steels
   B. Tool Steels
   C. Stainless Steels
   D. Structural Steels
   E. Cast Irons
F. Non-Ferrous Metals
1. Aluminum and Its Alloys
2. Copper and Its Alloys
3. Nickel Alloys
4. Precious Metals
5. Others
### TABLE 1.1

#### THE EFFECT OF ALLOYING ELEMENTS ON STEEL

<table>
<thead>
<tr>
<th>EFFECT</th>
<th>Carbon</th>
<th>Chromium</th>
<th>Cobalt</th>
<th>Lead</th>
<th>Manganese</th>
<th>Molybdenum</th>
<th>Nickel</th>
<th>Phosphorus</th>
<th>Silicon</th>
<th>Sulfur</th>
<th>Tungsten</th>
<th>Vanadium</th>
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<tbody>
<tr>
<td>Increases tensile strength</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Increases hardness</td>
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<tr>
<td>Increases wear resistance</td>
<td>X</td>
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<tr>
<td>Increases hardenability</td>
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<td>Increases ductility</td>
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<td>Increases elastic limit</td>
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<td>Increases rust resistance</td>
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<td>Increases abrasion resistance</td>
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<td>Increases toughness</td>
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<td>Increases shock resistance</td>
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<td>Increases fatigue resistance</td>
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<td>Decreases ductility</td>
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<tr>
<td>Raises critical temperature</td>
<td>X</td>
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<td>Lowers critical temperature</td>
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<td>Causes hot shortness</td>
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<td>X</td>
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<td>Causes cold shortness</td>
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<tr>
<td>Imparts red hardness</td>
<td>X</td>
<td>X</td>
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<td>Imparts fine grain structure</td>
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<tr>
<td>Reduces deformation</td>
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<tr>
<td>Acts as deoxidizer</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Acts as desulphurizer</td>
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<td></td>
<td>X</td>
</tr>
<tr>
<td>Imparts oil hardening properties</td>
<td>X</td>
<td>X</td>
<td></td>
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<td></td>
<td>X</td>
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<tr>
<td>Imparts air hardening properties</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Eliminates blow holes</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Creates soundness in casting</td>
<td></td>
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<td></td>
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<tr>
<td>Facilitates rolling and forging</td>
<td>X</td>
<td>X</td>
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<td></td>
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<td></td>
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<tr>
<td>Improves machinability</td>
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<td>X</td>
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</table>
TABLE 1.2

SAE-AISI NUMERICAL DESIGNATION OF ALLOY STEELS
(X Represents Percent of Carbon in Hundredths)

<table>
<thead>
<tr>
<th>Carbon Steels</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain carbon</td>
<td>10xx</td>
</tr>
<tr>
<td>Free-cutting, resulfurized</td>
<td>11xx</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Manganese Steels</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>13xx</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nickel Steels</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>.50% nickel</td>
<td>20xx</td>
</tr>
<tr>
<td>1.50% nickel</td>
<td>21xx</td>
</tr>
<tr>
<td>3.50% nickel</td>
<td>23xx</td>
</tr>
<tr>
<td>5.00% nickel</td>
<td>25xx</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nickel-Chromium Steels</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.25% nickel, .65% chromium</td>
<td>31xx</td>
</tr>
<tr>
<td>1.75% nickel, 1.00% chromium</td>
<td>32xx</td>
</tr>
<tr>
<td>3.50% nickel, 1.57% chromium</td>
<td>33xx</td>
</tr>
<tr>
<td>3.00% nickel, .80% chromium</td>
<td>34xx</td>
</tr>
<tr>
<td>Corrosion and heat-resisting steels</td>
<td>303xx</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Molybdenum Steels</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromium</td>
<td>41xx</td>
</tr>
<tr>
<td>Chromium-nickel</td>
<td>43xx</td>
</tr>
<tr>
<td>Nickel</td>
<td>46xx and 48xx</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chromium Steels</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-chromium</td>
<td>50xx</td>
</tr>
<tr>
<td>Medium-chromium</td>
<td>511xx</td>
</tr>
<tr>
<td>High-chromium</td>
<td>521xx</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chromium-Vanadium Steels</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6xxx</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Tungsten Steels</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7xxx and 7xxxx</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tungsten Steels</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>8xxx</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Triple-Alloy Steels</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>9xxx</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Silicon-Manganese Steels</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11Lxx (example)</td>
<td></td>
</tr>
</tbody>
</table>
TLD-D1
Identify Materials With Desired Properties
Self-Assessment

Circle the letter preceding the correct answer.

1. Using the SAE system, 1008 indicates:
   A. Plain carbon steel, 8% carbon.
   B. Plain carbon steel, 0.8% carbon
   C. Plain carbon steel, 0.08% carbon.
   D. Low-chromium steel, 0.08% carbon.
   E. None of the above answers is correct.

2. In the SAE system, triple-alloy steels are designated by the numeral:
   A. 6
   B. 7
   C. 8
   D. 9
   E. None of the above answers is correct.

3. The AISI system uses ___ to indicate the process used to manufacture the steel.
   A. Numerical prefixes
   B. Numerical suffixes
   C. Capital-letter prefixes
   D. Capital-letter suffixes
   E. None of the above answers is correct.

4. Which of the following does not increase the tensile strength of steel?
   A. Carbon
   B. Molybdenum
   C. Nickel
   D. All of the above elements increase the tensile strength of steel.
   E. None of the above answers is correct.

5. Which of the following elements decreases the toughness of steel?
   A. Cobalt
   B. Phosphorus
   C. Vanadium
   D. All of the above elements increase the toughness of steel.
   E. None of the above answers is correct.
6. Which of the following elements imparts fine grain structure to steel?
   A. Chromium
   B. Manganese
   C. Silicon
   D. Tungsten
   E. None of the above answers is correct.

7. The AISI prefix B designates that the steel is:
   A. Acid Bessemer carbon steel.
   B. Basic open hearth carbon steel.
   C. Acid open hearth carbon steel.
   D. Brass.
   E. None of the above answers is correct.

8. ____ steels have their own alphabetic classification system.
   A. Stainless
   B. Low-carbon
   C. Tool
   D. Austenitic
   E. None of the above answers is correct.

9. ____ stainless steel cannot be hardened by quenching.
   A. Austenitic
   B. Ferritic
   C. Martensitic
   D. All of the above stainless steels can be hardened by quenching.
   E. None of the above answers is correct.

10. Which of the following metals is magnetic?
    A. Phosphorus
    B. Silicon
    C. Sulfur
    D. All of the above metals are magnetic.
    E. None of the above answers is correct.
TLD-D1
Identify Materials With Desired Properties
Self-Assessment Answer Key

1. C  
2. C  
3. C  
4. D  
5. A  
6. B  
7. A  
8. C  
9. A  
10. E
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-D2

Subject: Tool & Die and EDM
Time: 6 Hrs.

Duty: Demonstrate Knowledge of Manufacturing Materials
Task: Identify Materials and Processes to Produce a Part

Objective(s):

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

a. Briefly describe and list the advantages and disadvantages for each of the following: casting processes, hot working processes, and cold working processes;

b. Discuss service requirements (strength, hardness, etc.);

c. Discuss fastening processes (fasteners, welding, bonding, etc.); and,

d. Discuss corrosion resistance methods.

Instructional Materials:

MASTER Handout (TLD-D2-HO)
MASTER Self Assessment
Several samples of parts treated to resist corrosion by different methods
Several fasteners and samples of different bonding agents
Samples of metals showing exemplary welds
Samples of parts made by each process covered by the instructor

References:


Student Preparation:

Students should have previously completed the following Technical Module:
TLD-D1 “Identify Materials with Desired Properties”

Introduction:

As in all other crafts, the materials of machining determine the properties of the part. While two pieces may appear the same to the naked eye, different metals have different strengths; and the two pieces may differ markedly in their performance.
Therefore, the technician must be capable of identifying not only the material itself, but also its working properties.

Presentation Outline:

I. Describe Casting Processes
   A. Discuss the following casting processes: sand, evaporative, shell molding, permanent mold, centrifugal, investment, and die casting
   B. Discuss pattern and mold design factors for each of the above casting processes
   C. List the advantages and disadvantages of the casting processes

II. Describe Hot Working Processes
   A. Discuss the following hot working processes: rolling, strand casting, forging, drawing, extrusion, spinning, and roll forming
   B. List the advantages and disadvantages of the hot working processes

III. Describe Cold Working Processes
   A. Discuss the following cold working processes: rolling, blanking, pressing, drawing, extruding, wire and bar drawing, bending, shearing, and roll forming
   B. List the advantages and disadvantages of the cold working process

IV. Evaluate Alternative Manufacturing Processes
   A. Discuss the powder metallurgy process (PM)
   B. Discuss the following nontraditional machining processes: EDM, laser machining, ultrasonic machining, hydrojet machining, electron beam machining, and plasma beam machining

Practical Application:

Students will be able to recognize fasteners forms, casting processes, and novel machining methods and to readily identify the uses and advantages of each.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (TLD-D3) dealing with classification systems for metal.
Objective(s):

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

a. Briefly describe and list the advantages and disadvantages for each of the following: casting processes, hot working processes, and cold working processes;
b. Discuss service requirements (strength, hardness, etc.);
c. Discuss fastening processes (fasteners, welding, bonding, etc.); and,
d. Discuss corrosion resistance methods.

Module Outline:

I. Describe Casting Processes
   A. Discuss the following casting processes: sand, evaporative, shell molding, permanent mold, centrifugal, investment, and die casting
   B. Discuss pattern and mold design factors for each of the above casting processes
   C. List the advantages and disadvantages of the casting processes

II. Describe Hot Working Processes
    A. Discuss the following hot working processes: rolling, strand casting, forging, drawing, extrusion, spinning, and roll forming
    B. List the advantages and disadvantages of the hot working processes

III. Describe Cold Working Processes
     A. Discuss the following cold working processes: rolling, blanking, pressing, drawing, extruding, wire and bar drawing, bending, shearing, and roll forming
     B. List the advantages and disadvantages of the cold working process

IV. Evaluate Alternative Manufacturing Processes
    A. Discuss the powder metallurgy process (PM)
    B. Discuss the following nontraditional machining processes: EDM, laser machining, ultrasonic machining, hydrojet machining, electron beam machining, and plasma beam machining
TLD-D2
Identify Materials and Processes to Produce a Part
Self-Assessment

Circle the letter preceding the correct answer.

1. In ___ casting, the mold is composed of sand and resin.
   A. Green-sand
   B. Shell
   C. V-process
   D. Squeeze
   E. None of the above answers is correct.

2. Which of the following is not a method of injecting material into a mold?
   A. Gravitic flow
   B. Pressure
   C. Centrifugal force
   D. All of the above are methods of injecting material into a mold.
   E. None of the above answers is correct.

3. What is the skin effect?
   A. The vacuoles created when the surface of a casting cools faster than its interior
   B. The thin, weak, exterior layer on castings caused by improper mixing of alloys
   C. The layers of metal formed in die casting
   D. Abrasions caused by excessive polishing of the casting
   E. Goose bumps

4. Die castings should be designed with ___ to relieve cooling stresses.
   A. Cores of simple shapes
   B. Heavy sections
   C. Small cores
   D. Uniform wall thicknesses
   E. None of the above answers is correct.

5. Which of the following is a major problem of the hot extrusion process?
   A. Cost of glass-powder lubricants
   B. Graphite lubricants contaminating the billet
   C. Construction of the equipment
   D. Scarcity of metals that can be successfully extruded
   E. None of the above answers is correct.
6. Extrusion generates ___ force, but not ___ force.
   A. Tensile...compressive
   B. Tensile...shear
   C. Compressive...shear
   D. Compressive...tensile
   E. None of the above answers is correct.

7. Plasma cutters can generate heat in excess of:
   A. 20,000°F.
   B. 30,000°F.
   C. 40,000°F.
   D. 80,000°F.
   E. 120,000°F.

8. Which of the following is not an advantage of EDM?
   A. Localized heat treating
   B. Extremely fine detail is possible.
   C. Can be used on very hard metals.
   D. All of the above answers are valid.
   E. None of the above answers is correct.

9. Which of the following processes would be most advantageous for internal deburring operations?
   A. ECDB
   B. Hydrojet machining
   C. Plasma machining
   D. Laser machining
   E. None of the above answers is correct.

10. What is meant by ELG?
    A. Extremely Large Gauge
    B. Electrolytic Grinding
    C. Emerald Laser Grinding
    D. Electron-Lathe Guide
    E. None of the above answers is correct.
TLD-D2
Identify Materials and Processes to Produce a Part
Self-Assessment Answer Key

1. B  
2. D  
3. C  
4. D  
5. C  
6. D  
7. C  
8. A  
9. A  
10. B
### Subject: Tool & Die and EDM

### Time: 8 Hrs.

### Duty: Demonstrate Knowledge of Manufacturing Materials

### Task: Discuss Classification Systems for Metal

### Objective(s):

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

a. Identify organizations that classify metals;

b. Distinguish between types of metal by manufacturing method and/or shape;

c. Identify designation of each digit of a metal classification;

d. Identify carbon and alloy content of a metal using classification system;

e. Identify content of an unknown metal using shop tests; and,

f. Identify conformity of a metal to a specification system.

### Instructional Materials:

- MASTER Handout (TLD-D3-H01)
- MASTER Handout (TLD-D3-H02)
- MASTER Handout (TLD-D3-H03)
- MASTER Handout (TLD-D3-H04)
- MASTER Laboratory Aid (TLD-D3-LA)
- MASTER Worksheet (TLD-D3-LW)
- MASTER Self-Assessment

Random collection of objects for student practice (shop tests) and observation

### References:

The following NTMA Machinist Training Modules are recommended as reference material:

- **MA-II-57** “Metallurgy: Steel Classifications & Basic Tests for Identifying the Content of an Unknown Metal”
- **MA-II-59** “Metallurgy: Plain Carbon Steel”
- **MA-II-67** “Metallurgy: Alloy Steels and Stainless Steels”
- **MA-II-69** “Metallurgy: Aluminum and Aluminum Alloys”
- **MA-II-71** “Metallurgy: Magnesium and Magnesium Alloys”
- **MA-II-73** “Metallurgy: Copper and Copper Alloys”
- **MA-II-75** “Metallurgy: Other Nonferrous Metals and Cast Alloys”
MA-II-77 "Metallurgy: Cast Irons"

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-D1 "Identify Materials With Desired Properties"
TLD-D2 "Identify Materials and Processes to Produce a Part"

Introduction:

When there was only wrought iron and plain carbon steel available, separating and identifying metals was relatively simple. Now, however, with the hundreds of different compositions in use, identification would be confusing without some means of reference or classification. Several different numbering systems have been developed by various organizations to classify metals and alloys according to content, properties, manufacturing process, or intended use. A Tool and Die Maker must be capable of distinguishing between materials by understanding these systems and their designations.

Presentation Outline:

I. Identify the Organizations That Classify Metals and Discuss the Significance of Each
   A. American Iron and Steel Institute (AISI)
   B. Society of Automotive Engineers (SAE)
   C. American Society for Testing and Materials (ASTM)
   D. American National Standards Institute (ANSI)
   E. Aluminum Association

II. Identify Classifications by Manufacturing Methods or Processes
    A. Hot rolled
    B. Cold rolled
    C. Turned and polished (sometimes referred to as ground and polished)
    D. Castings
    E. Forgings
    F. Galvanized

III. Identify Classifications by Shape
     A. Sheet and plate
     B. Bar stock
     C. Pipe and tubing
     D. Rod and wire
     E. Coil or strip
     F. Structural steel

IV. Discuss the AISI-SAE Numbering Systems for Carbon Steels
    A. Plain carbon steels (AISI-SAE 10xx and 15xx)
B. Free-cutting steels (AISI-SAE 11xx and 12xx)

V. Discuss the AISI-SAE Classification Systems for Alloy Steels
A. Manganese steels (AISI-SAE 13xx)
B. Nickel steels (AISI-SAE 2xxx)
C. Nickel-chromium steels (AISI-SAE 3xxx)
D. Molybdenum steels (AISI-SAE 4xxx)
E. Low chromium steels (AISI-SAE 5xxx)
F. Other alloy steels (AISI-SAE 61xx, 8xxx, and 9xxx)

VI. Discuss the AISI-SAE Classification of Stainless Steels
A. Chromium-nickel austenitic steels (SAE 30xxx or AISI 20x and 3xx)
B. Ferritic chromium steels (SAE 51xxx or AISI 4xx and 50x)
C. Martensitic chromium steels (SAE 51xxx or AISI 4xx and 50x)

VII. Discuss the AISI Classification of Tool Steels
A. High speed tool steels (AISI type M and T)
B. Hot work tool steels (AISI type H)
C. Cold work tool steels (AISI type D, A, and O)
D. Shock resisting tool steels (AISI type S)
E. Mold steels (AISI type P)
F. Special purpose tool steels (AISI type L and F)
G. Water hardening tool steels (AISI type W)

VIII. Discuss the Classification of Nonferrous Alloys
A. Aluminum and aluminum alloys (Aluminum Association four digit system)
B. Magnesium alloys (SAE type 5x and 5xx)
C. Nickel and nickel alloys (by name)
D. Titanium and titanium alloys (titanium and chief alloying element)
E. Copper and copper alloys (by name and SAE standard number)

IX. Discuss the Classification of Castings
A. Brass and bronze castings (SAE standard number)
B. Aluminum casting alloys (Aluminum Association four digit system)
C. Cast Iron (ASTM grade)
D. Steel Castings (ASTM grade)

X. Discuss the Unified Numbering System (UNS) for Metals and Alloys

XI. Discuss the Basic Identification of an Unmarked Piece of Steel Using Shop Tests
A. Observation
B. Magnet test
C. Hardness test
D. Scratch test
E. File test
F. Chemical test
G. Spark test

XII. Identify Specification Systems for Metals and Alloys
A. American Society for Testing and Materials (ASTM)
B. American National Standards Institute (ANSI)
C. U.S. Department of Defense (military specifications)
D. General Accounting Office (federal specifications)

Practical Application:

Students will practice identifying materials by their nomenclature and by shop tests. Each student will then complete the Laboratory Worksheet and turn 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 following components:

a. Identify organizations that classify metals;
b. Identify metal type given a classification;
c. Identify content of a metal given a classification;
d. Identify content of an unknown metal using shop tests;
e. Identify conformity of a metal given an ASTM specification; and,
f. Self-Assessment.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-E1) dealing with understanding metrology terms.
Discuss Classification Systems for Metal
Attachment 1: MASTER Handout No. 1

Objective(s):

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

a. Identify organizations that classify metals;
b. Distinguish between types of metal by manufacturing method and/or shape;
c. Identify designation of each digit of a metal classification;
d. Identify carbon and alloy content of a metal using classification system;
e. Identify content of an unknown metal using shop tests; and,
f. Identify conformity of a metal to a specification system.

Module Outline:

I. Identify the Organizations That Classify Metals and Discuss the Significance of Each
   A. American Iron and Steel Institute (AISI)
   B. Society of Automotive Engineers (SAE)
   C. American Society for Testing and Materials (ASTM)
   D. American National Standards Institute (ANSI)
   E. Aluminum Association

II. Identify Classifications by Manufacturing Methods or Processes
   A. Hot rolled
   B. Cold rolled
   C. Turned and polished (sometimes referred to as ground and polished)
   D. Castings
   E. Forgings
   F. Galvanized

III. Identify Classifications by Shape
   A. Sheet and plate
   B. Bar stock
   C. Pipe and tubing
   D. Rod and wire
   E. Coil or strip
   F. Structural steel

IV. Discuss the AISI-SAE Numbering Systems for Carbon Steels
   A. Plain carbon steels (AISI-SAE 10xx and 15xx)
   B. Free-cutting steels (AISI-SAE 11xx and 12xx)

V. Discuss the AISI-SAE Classification Systems for Alloy Steels
   A. Manganese steels (AISI-SAE 13xx)
B. Nickel steels (AISI-SAE 2xxx)
C. Nickel-chromium steels (AISI-SAE 3xxx)
D. Molybdenum steels (AISI-SAE 4xxx)
E. Low chromium steels (AISI-SAE 5xxx)
F. Other alloy steels (AISI-SAE 61xx, 8xxx, and 9xxx)

VI. Discuss the AISI-SAE Classification of Stainless Steels
A. Chromium-nickel austenitic steels (SAE 30xxx or AISI 20x and 3xx)
B. Ferritic chromium steels (SAE 51xxx or AISI 4xx and 50x)
C. Martensitic chromium steels (SAE 51xxx or AISI 4xx and 50x)

VII. Discuss the AISI Classification of Tool Steels
A. High speed tool steels (AISI type M and T)
B. Hot work tool steels (AISI type H)
C. Cold work tool steels (AISI type D, A, and O)
D. Shock resisting tool steels (AISI type S)
E. Mold steels (AISI type P)
F. Special purpose tool steels (AISI type L and F)
G. Water hardening tool steels (AISI type W)

VIII. Discuss the Classification of Nonferrous Alloys
A. Aluminum and aluminum alloys (Aluminum Association four digit system)
B. Magnesium alloys (SAE type 5x and 5xx)
C. Nickel and nickel alloys (by name)
D. Titanium and titanium alloys (titanium and chief alloying element)
E. Copper and copper alloys (by name and SAE standard number)

IX. Discuss the Classification of Castings
A. Brass and bronze castings (SAE standard number)
B. Aluminum casting alloys (Aluminum Association four digit system)
C. Cast Iron (ASTM grade)
D. Steel Castings (ASTM grade)

X. Discuss the Unified Numbering System (UNS) for Metals and Alloys

XI. Discuss the Basic Identification of an Unmarked Piece of Steel Using Shop Tests
A. Observation
B. Magnet test
C. Hardness test
D. Scratch test
E. File test
F. Chemical test
G. Spark test

XII. Identify Specification Systems for Metals and Alloys
A. American Society for Testing and Materials (ASTM)
B. American National Standards Institute (ANSI)
C. U.S. Department of Defense (military specifications)
D. General Accounting Office (federal specifications)
### AISI-SAE STANDARD STEELS CLASSIFICATION

<table>
<thead>
<tr>
<th>AISI-SAE</th>
<th>Type of Steel and Nominal Alloy Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>10xx</td>
<td>Plain Carbon (Max 1% Mn.)</td>
</tr>
<tr>
<td>15xx</td>
<td>Plain Carbon (Max 1% - 1.65% Mn.)</td>
</tr>
<tr>
<td>11xx</td>
<td>Free Cutting, Resulfurized</td>
</tr>
<tr>
<td>12xx</td>
<td>Free Cutting, Resulfurized and Rephosphorized</td>
</tr>
<tr>
<td>13xx</td>
<td>1.75% Manganese</td>
</tr>
<tr>
<td>23xx</td>
<td>3.50% Nickel</td>
</tr>
<tr>
<td>25xx</td>
<td>5.00% Nickel</td>
</tr>
<tr>
<td>31xx</td>
<td>1.25% Nickel; 0.65% and 0.80% Chromium</td>
</tr>
<tr>
<td>32xx</td>
<td>1.75% Nickel; 1.07% Chromium</td>
</tr>
<tr>
<td>33xx</td>
<td>3.50% Nickel; 1.50% and 1.57% Chromium</td>
</tr>
<tr>
<td>34xx</td>
<td>3.00% Nickel; 0.77% Chromium</td>
</tr>
<tr>
<td>40xx</td>
<td>0.20% and 0.25% Molybdenum</td>
</tr>
<tr>
<td>44xx</td>
<td>0.40% and 0.52% Molybdenum</td>
</tr>
<tr>
<td>41xx</td>
<td>0.50% - 0.95% Chromium; 0.12% - 0.30% Molybdenum</td>
</tr>
<tr>
<td>46xx</td>
<td>0.65% and 1.62% Nickel; 0.20% and 0.25% Molybdenum</td>
</tr>
<tr>
<td>48xx</td>
<td>3.50% Nickel; 0.25% Molybdenum</td>
</tr>
<tr>
<td>50xx</td>
<td>0.27% - 0.65% Chromium</td>
</tr>
<tr>
<td>51xx</td>
<td>0.80% - 1.05% Chromium</td>
</tr>
<tr>
<td>50xx</td>
<td>0.50% Chromium; Min. 1.00% Carbon</td>
</tr>
<tr>
<td>51xx</td>
<td>1.02% Chromium; Min. 1.00% Carbon</td>
</tr>
<tr>
<td>52xx</td>
<td>1.45% Chromium; Min. 1.00% Carbon</td>
</tr>
<tr>
<td>61xx</td>
<td>0.60% - 0.95% Chromium; 0.10% and 0.15% Vanadium</td>
</tr>
<tr>
<td>72xx</td>
<td>1.75% Tungsten; 0.75% Chromium</td>
</tr>
<tr>
<td>43xx</td>
<td>1.82% Nickel; 0.50% and 0.80% Chromium; 0.25% Molybdenum</td>
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<td>47xx</td>
<td>1.05% Nickel; 0.45% Chromium; 0.20% and 0.35% Molybdenum</td>
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<td>80xx</td>
<td>0.30% - 0.55% Nickel; 0.40% - 0.50% Chromium; 0.12% - 0.35% Molybdenum</td>
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<tr>
<td>92xx</td>
<td>1.40% and 2.00% Silicon; 0.00% and 0.65% Chromium; 0.65% - 0.85% Manganese</td>
</tr>
<tr>
<td>93xx</td>
<td>3.25% Nickel; 1.20% Chromium; 0.12% Molybdenum</td>
</tr>
<tr>
<td>94xx</td>
<td>0.45% Nickel; 0.40% Chromium; 0.12% Molybdenum</td>
</tr>
<tr>
<td>98xx</td>
<td>1.00% Nickel; 0.80% Chromium; 0.25% Molybdenum</td>
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</table>

<table>
<thead>
<tr>
<th>AISI</th>
<th>SAE</th>
<th>Stainless Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>2xx</td>
<td>302xx</td>
<td>Austentic Steels; 16% - 19% Chromium; 1% - 5.5% Nickel</td>
</tr>
<tr>
<td>3xx</td>
<td>303xx</td>
<td>Austentic Steels; 16% - 24% Chromium; 6% - 15% Nickel</td>
</tr>
<tr>
<td>4xx</td>
<td>514xx</td>
<td>Ferritic or Martensitic Steels; 10.5% - 18% Chromium</td>
</tr>
<tr>
<td>5xx</td>
<td>515xx</td>
<td>Ferritic or Martensitic Steels; 4% - 6% Chromium</td>
</tr>
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</table>
### Discuss Classification Systems for Metal
Attachment 3: MASTER Handout No. 3

#### AISI TOOL STEELS CLASSIFICATION

<table>
<thead>
<tr>
<th>CATEGORY DESIGNATION</th>
<th>AISI</th>
<th>GROUP DESIGNATION</th>
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<tr>
<td>High Speed Tool Steels</td>
<td>M</td>
<td>Molybdenum Types</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>Tungsten Types</td>
</tr>
<tr>
<td>Hot Work Tool Steels</td>
<td>H1 - H19</td>
<td>Chromium Types</td>
</tr>
<tr>
<td></td>
<td>H20 - H39</td>
<td>Tungsten Types</td>
</tr>
<tr>
<td></td>
<td>H40 - H59</td>
<td>Molybdenum Types</td>
</tr>
<tr>
<td>Cold Work Tool Steels</td>
<td>D</td>
<td>High Carbon, High Chromium Types</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>Medium Alloy, Air Hardening Types</td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>Oil Hardening Types</td>
</tr>
<tr>
<td>Shock Resisting Tool Steels</td>
<td>S</td>
<td>-----</td>
</tr>
<tr>
<td>Mold Steels</td>
<td>P</td>
<td>-----</td>
</tr>
<tr>
<td>Special Purpose Tool Steels</td>
<td>L</td>
<td>Low Alloy Types</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>Carbon Tungsten Types</td>
</tr>
<tr>
<td>Water Hardening Tool Steels</td>
<td>W</td>
<td>-----</td>
</tr>
</tbody>
</table>

#### UNIFIED NUMBERING SYSTEM (UNS) FOR METALS & ALLOYS

<table>
<thead>
<tr>
<th>UNS SERIES</th>
<th>METAL</th>
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<tbody>
<tr>
<td>A00001 to A99999</td>
<td>Aluminum and Aluminum Alloys</td>
</tr>
<tr>
<td>C00001 to C99999</td>
<td>Copper and Copper Alloys</td>
</tr>
<tr>
<td>E00001 to E99999</td>
<td>Rare Earth and Rare Earth-Like Metals and Alloys</td>
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<tr>
<td>L00001 to L99999</td>
<td>Low Melting Metals and Alloys</td>
</tr>
<tr>
<td>M00001 to M99999</td>
<td>Miscellaneous Nonferrous Metals and Alloys</td>
</tr>
<tr>
<td>P00001 to P99999</td>
<td>Precious Metals and Alloys</td>
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<tr>
<td>R00001 to R99999</td>
<td>Reactive and Refractory Metals and Alloys</td>
</tr>
<tr>
<td>Z00001 to Z99999</td>
<td>Zinc and Zinc Alloys</td>
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<tr>
<td>D00001 to D99999</td>
<td>Specified Mechanical Property Steels</td>
</tr>
<tr>
<td>F00001 to F99999</td>
<td>Cast Irons</td>
</tr>
<tr>
<td>G00001 to G99999</td>
<td>AISI and SAE Carbon and Alloy Steels (Except Tool Steels)</td>
</tr>
<tr>
<td>H00001 to H99999</td>
<td>AISI H-Steels</td>
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<tr>
<td>J00001 to J99999</td>
<td>Cast Steels (Except Tool Steels)</td>
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<tr>
<td>K00001 to K99999</td>
<td>Miscellaneous Steels and Ferrous Alloys</td>
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<tr>
<td>S00001 to S99999</td>
<td>Heat and Corrosion Resistant (Stainless Steels)</td>
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<tr>
<td>T00001 to T99999</td>
<td>Tool Steels</td>
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## HOT ROLLED CARBON STEEL BARS

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<tr>
<th>Size</th>
<th>Tolerance</th>
<th>Out-of-Section</th>
<th>Size</th>
<th>Tolerance</th>
<th>Out-of-Section</th>
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<tbody>
<tr>
<td>Rounds, Squares and Round-Cornered Squares</td>
<td></td>
<td></td>
<td>Rounds, Squares and Round-Cornered Squares</td>
<td></td>
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</tr>
<tr>
<td>To 5/16</td>
<td>.005</td>
<td>.005</td>
<td>.008</td>
<td>Over 1-1/2 to 2</td>
<td>1/64</td>
</tr>
<tr>
<td>Over 5/16 to 7/16</td>
<td>.006</td>
<td>.006</td>
<td>.009</td>
<td>Over 2 to 2-1/2</td>
<td>1/32</td>
</tr>
<tr>
<td>Over 7/16 to 5/8</td>
<td>.007</td>
<td>.007</td>
<td>.010</td>
<td>Over 2-1/2 to 3-1/2</td>
<td>3/64</td>
</tr>
<tr>
<td>Over 5/8 to 7/8</td>
<td>.008</td>
<td>.008</td>
<td>.012</td>
<td>Over 3-1/2 to 4-1/2</td>
<td>1/16</td>
</tr>
<tr>
<td>Over 7/8 to 1</td>
<td>.009</td>
<td>.009</td>
<td>.013</td>
<td>Over 4-1/2 to 5-1/2</td>
<td>5/64</td>
</tr>
<tr>
<td>Over 1 to 1-1/8</td>
<td>.010</td>
<td>.010</td>
<td>.015</td>
<td>Over 5-1/2 to 6-1/2</td>
<td>1/8</td>
</tr>
<tr>
<td>Over 1-1/2 to 1-1/4</td>
<td>.011</td>
<td>.011</td>
<td>.016</td>
<td>Over 6-1/2 to 8-1/4</td>
<td>5/32</td>
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<tr>
<td>Over 1-1/4 to 1-3/8</td>
<td>.012</td>
<td>.012</td>
<td>.018</td>
<td>Over 8-1/4 to 9-1/2</td>
<td>3/16</td>
</tr>
<tr>
<td>Over 1-3/8 to 1-1/2</td>
<td>.014</td>
<td>.014</td>
<td>.021</td>
<td>Over 9-1/2 to 10</td>
<td>1/4</td>
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## COLD FINISHED CARBON STEELS

<table>
<thead>
<tr>
<th>Size</th>
<th>Max. % Carbon</th>
<th>Minus Tolerance</th>
<th>Size</th>
<th>Max. % Carbon</th>
<th>Minus Tolerance</th>
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<tbody>
<tr>
<td></td>
<td>Up to .28</td>
<td>Over .28 to .55</td>
<td>Over .55</td>
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<tr>
<td>Cold Drawn Rounds</td>
<td></td>
<td></td>
<td>Cold Drawn Flats</td>
<td></td>
<td></td>
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<tr>
<td>To 1-1/2</td>
<td>.002</td>
<td>.003</td>
<td>.005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 1-1/2 to 2-1/2</td>
<td>.003</td>
<td>.004</td>
<td>.006</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 2-1/2 to 4</td>
<td>.004</td>
<td>.005</td>
<td>.007</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 4 to 6</td>
<td>.005</td>
<td>.006</td>
<td>.008</td>
<td></td>
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</tr>
<tr>
<td>Cold Drawn Hexagons</td>
<td></td>
<td></td>
<td>Cold Drawn Squares</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To 3/4</td>
<td>.002</td>
<td>.003</td>
<td>.006</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 3/4 to 1-1/2</td>
<td>.003</td>
<td>.004</td>
<td>.007</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 1-1/2 to 2-1/2</td>
<td>.004</td>
<td>.005</td>
<td>.008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 2-1/2 to 3-1/8</td>
<td>.005</td>
<td>.006</td>
<td>.009</td>
<td></td>
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<tr>
<td>Cold Drawn Squares</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To 3/4</td>
<td>.002</td>
<td>.003</td>
<td>.006</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 3/4 to 1-1/2</td>
<td>.003</td>
<td>.004</td>
<td>.007</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 1-1/2 to 2-1/2</td>
<td>.004</td>
<td>.005</td>
<td>.008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over 2-1/2 to 3-1/8</td>
<td>.005</td>
<td>.006</td>
<td>.009</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Turned and Polished Rounds |               |                 |                 |               |                 |
| To 1-1/2         | .002          | .003            | .005             |               |                 |
| Over 1-1/2 to 2-1/2 | .003       | .004            | .006             |               |                 |
| Over 2-1/2 to 4   | .004          | .005            | .007             |               |                 |
1. **Observation Test**  
Sample of round bars with various surface finishes (cold finished, hot rolled, ground and polished)

2. **Magnet Test**  
Sample of carbon steel, ferritic or martensitic stainless steel, austenitic stainless steel, aluminum, and nickel steel

3. **Hardness Test**  
Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

4. **Scratch Test**  
Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

5. **File Test**  
Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

6. **Chemical Test**  
Sample of carbon steel, type 302 or 304 stainless steel, type 316 or 317 stainless steel

7. **Spark Test**  
Sample of low carbon steel, high carbon steel, cast iron, high speed steel, tool steel, and manganese steel

8. **Observation Test**  
Samples of bar stock (round and square), hot rolled sheet, cold finished coil strip, galvanized sheet, small diameter pipe, small diameter tubing, small gauge wire, hot rolled rod, and cold finished rod
TLD-D3-LW
Discuss Classification Systems for Metal
Attachment 6: MASTER Laboratory Worksheet

I. Identify the following:
   a. AISI
   b. SAE
   c. ASTM
   d. ANSI
   e. UNS

II. Complete the following charts:

A. Standard Steels and Alloy Steels

<table>
<thead>
<tr>
<th></th>
<th>AISI-SAE</th>
<th>APP. % CARBON</th>
<th>MAJOR ALLOYING ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex.</td>
<td>1020</td>
<td>.20</td>
<td>Only Carbon</td>
</tr>
<tr>
<td>Ex.</td>
<td>6118</td>
<td>.18</td>
<td>Chromium &amp; Vanadium</td>
</tr>
<tr>
<td>Ex.</td>
<td>4340</td>
<td>.40</td>
<td>Nickel, Chromium, Molybdenum</td>
</tr>
<tr>
<td>1.</td>
<td>1040</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>1095</td>
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<td></td>
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<td>3.</td>
<td>1212</td>
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<td>4.</td>
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<td>10.</td>
<td>4140</td>
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<td>11.</td>
<td>4320</td>
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<td>12.</td>
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<td>13.</td>
<td>5135</td>
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<td>14.</td>
<td>52100</td>
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<tr>
<td>15.</td>
<td>6150</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
B. **AISI-SAE-UNS Classification System**

<table>
<thead>
<tr>
<th>AISI-SAE</th>
<th>UNS</th>
<th>TYPE METAL OR STEEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex. 1212</td>
<td>G12120</td>
<td>Free Cutting Carbon Steel</td>
</tr>
<tr>
<td>Ex. 48xx</td>
<td>G48xx0</td>
<td>Nickel-Molybdenum Steel</td>
</tr>
<tr>
<td>Ex. A6</td>
<td>T30106</td>
<td>Air Harden Cold Work Tool Steel</td>
</tr>
<tr>
<td>1.</td>
<td>1527</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>1151</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>G10290</td>
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<tr>
<td>4.</td>
<td>G41xx0</td>
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<td>5.</td>
<td>G61500</td>
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</tr>
<tr>
<td>6.</td>
<td></td>
<td>Tungsten-Chromium Steels</td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td>Austenitic Stainless Steels</td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td>Nickel Steels</td>
</tr>
<tr>
<td>9.</td>
<td>H21</td>
<td>T20821</td>
</tr>
<tr>
<td>10.</td>
<td>T12002</td>
<td>Tungsten High Speed Tool Steels</td>
</tr>
<tr>
<td>11.</td>
<td>Sx</td>
<td>T4190x</td>
</tr>
<tr>
<td>12.</td>
<td>D2</td>
<td>T30402</td>
</tr>
<tr>
<td>13.</td>
<td>T41906</td>
<td>Shock Resisting Tool Steels</td>
</tr>
<tr>
<td>14.</td>
<td>......</td>
<td>Axxxxx</td>
</tr>
<tr>
<td>15.</td>
<td></td>
<td>Copper and Copper Alloy</td>
</tr>
</tbody>
</table>

III. Answer the following questions:

A. What is the out-of-round tolerance for 2-1/2" diameter hot rolled bar?

B. What is the size tolerance for 1-3/4" cold finished hexagon bar made from 1045?
C. If the only requirements given you were 1" 1018 square bar with a size tolerance of -.006, would you choose hot rolled (much cheaper) or cold finished stock?

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Test Used</th>
<th>Kind of Metal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
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<td>2.</td>
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<td>4.</td>
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<td>5.</td>
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</tbody>
</table>
TLD-D3
Discuss Classification Systems for Metal
Self-Assessment

1. Who is the AISI?

2. Who is the SAE?

3. What organization's classification system of aluminum and aluminum alloys is accepted by industry and used by commercial producers?

4. What organization has published a specification system for metals and alloys?

5. Name three classes of metals by manufacturing method, process, or material finish.

6. Identify four basic shapes that metals are produced in.

7. What do the first two digits of a steel name designate?
8. What do the last two digits (in a four-digit name) designate?

9. What is the approximate percent of carbon in 1045 carbon steel?

10. What is the approximate percent of carbon in 52100 chromium steel?

11. What type steel is 4147?

12. What is the alloying element in 2517 steel? What percent of that element is present?

13. If the element chromium makes steel stainless, why are the 5xxx and 5xxxx steels not included in the stainless steel group?

14. Name three types of stainless steel.

15. Which types are magnetic?
16. What element is added to austenitic stainless steels to improve ductility and other properties?

17. What type steel is indicated by the symbol W1 or A6?

18. What type tool steel is designated by the symbol D (category and group designations)?

19. What three groups of cold work tool steels are available?

20. What is the designation for water hardening tool steel?

21. Identify three categories of nonferrous alloys.

22. What category of nonferrous metals does brass and bronze belong to?

23. What does the first digit of an aluminum designation identify?
24. What are the basic temper designations and subdivisions for aluminum alloys?

25. Name 5 basic types of cast iron.

26. Name 2 basic types of steel castings.

27. What is the UNS designation for 1212 free cutting carbon steel?

28. What type metal are the T series numbers reserved for in the UNS numbering system?

29. What does a G as the first digit of a UNS classification designate?

30. What is the AISI-SAE classification for a G13300 steel?

31. When checking the hardness of a piece of steel with the file test, the file slides over the surface without cutting. What type steel is it most likely to be?
32. What can you determine about a metal by observation?

33. If an unknown sample cannot be scratched by a piece of mild steel keystock but the keystock can be scratched by the sample, what conclusion can you draw about the sample?

34. If a hardness tester is not available, how can you determine relative hardness of a sample?

35. When spark testing a sample to determine carbon content, what does orange carrier lines ending in pear-shaped globules and very little branching indicate?

36. What is the out-of-round tolerance for 2-1/2" diameter hot rolled bar?

37. What is the maximum width of 1-1/4" key made from 1045 cold finished square bar? What is the minimum width?

38. What is the maximum diameter of a shaft made from 5" hot rolled 1018 bar? What is the minimum?
39. Name two other specification systems in use.

40. Define color coding and explain what it is used for.
TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Practice Safety</td>
<td>A-1 Follow safety manuals and all safety regulations/requirements</td>
</tr>
<tr>
<td>B. Apply Mathematical Concepts</td>
<td>B-1 Perform basic arithmetic functions</td>
</tr>
<tr>
<td>C. Interpret Engineering Drawings and Related Documents</td>
<td>C-1 Interpret and understand basic layout and type of drawings</td>
</tr>
<tr>
<td>D. Demonstrate Knowledge of Manufacturing Materials</td>
<td>D-1 Identify materials with desired properties</td>
</tr>
<tr>
<td>E. Measure/Inspect</td>
<td>E-1 Understand measurement systems</td>
</tr>
<tr>
<td>F. Demonstrate Knowledge of Manufacturing Processes</td>
<td>F-1 Discuss metal cutting and metal cutting tools</td>
</tr>
<tr>
<td>G. Use Computers</td>
<td>G-1 Use computer operating systems</td>
</tr>
<tr>
<td>H. Perform CAD/CAM and CNC Programming Tasks</td>
<td>H-1 Discuss fundamentals of CNC machines and controls</td>
</tr>
<tr>
<td>I. Perform Tool and Die Making Operations</td>
<td>I-1 Discuss basic types and functions of jigs and fixtures</td>
</tr>
<tr>
<td>J. Operate Electrical Discharge Machines (EDM)</td>
<td>J-1 Discuss fundamentals of EDM</td>
</tr>
</tbody>
</table>

- A-2 Maintain safe equipment and machinery
- A-3 Use safe operating procedures for hand and machine tools
- A-4 Maintain a clean and safe work environment
- A-5 Use and apply manufacturing materials
- A-6 Use and apply manufacturing processes
- A-7 Use and apply computer-aided manufacturing (CAD) system
- A-8 Consult and apply MSDS for hazards of various materials
- A-9 Use tool and die making skills

- B-2 Perform basic algebraic operations
- B-3 Use basic geometric principles
- B-4 Perform trigonometric functions
- B-5 Use and apply manufacturing materials
- B-6 Use and apply manufacturing processes

- C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances
- C-3 Understand machine and use quality systems

- D-2 Determine materials and processes to produce a part
- D-3 Discuss classification systems for metal

- E-2 Select measurement tools
- E-3 Measure with hand held instruments
- E-4 Measure using surface plate and accessories

- F-2 Operate metal saws
- F-3 Operate drill presses and tooling
- F-4 Operate horizontal and vertical lathes and tooling

- G-2 Understand computer terminology
- G-3 Use file management systems
- G-4 Install and use software packages

- H-2 Program and operate CNC milling machines and machining centers
- H-3 Program and operate CNC lathes

- I-2 Utilize concepts of jigs and fixture design
- I-3 Demonstrate understanding of different types of industrial dies
- I-4 Utilize basic die theory
- I-5 Utilize principles of die design

- J-2 Setup and operate conventional sinker EDM
- J-3 Program, setup, and operate CNC sinker EDM and EDM drill
- J-4 Program, setup, and operate CNC wire EDM

- F-5 Operate precision grinding
- F-6 Operate vertical and horizontal mills and tooling

- G-5 Create 3-D solid models
- G-8 Operate sheet metal equipment and processes
- G-9 Operate welding equipment and processes

- H-4 Use Computer-Aided Drafting (CAD) system
- H-5 Use Computer-Aided Manufacturing (CAM) system
- H-8 Use Computer-Aided Manufacturing (CAM) system

- I-6 Perform tool and die repair
- I-7 Demonstrate tool and die making skills
- I-8 Demonstrate tool and die making skills

- J-5 Use EDM for cutting and drilling
- J-6 Use EDM for cutting and drilling
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-E1

Subject: Tool & Die and EDM
Time: 2 Hrs.

Duty: Measure/Inspect
Task: Understand Metrology Terms

Objective(s):

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

a. Discuss the use of metrology in manufacturing;
b. Discuss the Inch system of measurement;
c. Discuss the Metric system of measurement;
d. Discuss semi-precision and precision measurement; and,
e. Discuss the following: precision, reliability, discrimination, and accuracy.

Instructional Materials:

MASTER Handout (TLD-E1-H0)
MASTER Self-Assessment
As many different measurement instruments in both English and metric as is practical

References:


NTMA Modules:
MA-I-35 “Fractions”
MA-II-05 “Metric Measurement”

Student Preparation:

Students should have previously completed the following Technical Modules:
TLD-B1 “Perform Basic Arithmetic Functions”

Introduction:

The world has depended on some form of measurement system since the beginning of civilization. Measurement has progressed through many forms down through the years. Measurement is now referred to as metrology and has, by necessity, become an
exact science because of the high degrees of precision required by manufactures and consumers today. Interchangeable manufacture, world trade, and the need for high precision have all contributed to the need for a highly accurate international system of measurement.

Presentation Outline:

I. Discuss the Use of Metrology in Manufacturing
   A. Discuss the function and reason for measurements in manufacturing
   B. Discuss the changes (metrology related) in manufacturing today
      1. Interchangeable manufacture
      2. World trade
      3. High precision

II. Discuss the Inch System of Measurement
    A. Discuss fractional (scale) dimensions for linear measurement
    B. Discuss decimal dimensions for linear measurement
    C. Convert fractional to decimal
       1. Review mathematical conversion method
       2. Fractional/decimal conversion charts
    D. Practice and demonstration of skills listed above

III. Discuss the Metric System of Measurement
     A. Discuss the units of measure commonly used in the metric system
     B. Convert inch to metric
        1. Review mathematical method (1 inch = 25.4 mm)
        2. Conversion charts
     C. Practice and demonstration of skills listed above

IV. Discuss Semi-Precision and Precision Measurement
    A. Discuss the difference between semi-precision and precision measurement
       1. Semi-precision measurements are 1/64" (.5mm) or greater
       2. Precision measurements are less than 1/64" (.5mm)
    B. Discuss the five categories of precision measurement
       1. Outside measurement
       2. Inside measurement
       3. Depth measurement
       4. Thread measurement
       5. Height measurement

V. Discuss the Following Measurement Terms: Accuracy, Precision, Reliability, and Discrimination
   A. Accuracy - whether or not something is made according to standard. (The standard for manufacturing is the blueprint.)
   B. Precision - the degree of exactness required for an application or design requirement
   C. Reliability - the ability to consistently obtain the desired result
D. *Discrimination* - the degree that a measuring instrument divides its basic unit of length

**Practical Application:**

Students will understand the differences in metric and English measurements, will recognize different measuring tools, and will understand the principles of precision measurement.

**Evaluation and/or Verification:**

Students should successfully complete the Self-Assessment found at the end of this lesson.

**Summary:**

Review the main lesson points and answer student questions.

**Next Lesson Assignment:**

MASTER Technical Module (TLD-E2) dealing with the selection of the correct measuring tool based on tool characteristics and measurement requirements.
Objective(s):

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

a. Discuss the use of metrology in manufacturing;
b. Discuss the Inch system of measurement;
c. Discuss the Metric system of measurement;
d. Discuss semi-precision and precision measurement; and,
e. Discuss the following: precision, reliability, discrimination, and accuracy.

Module Outline:

I. Discuss the Use of Metrology in Manufacturing
   A. Discuss the function and reason for measurements in manufacturing
   B. Discuss the changes (metrology related) in manufacturing today
      1. Interchangeable manufacture
      2. World trade
      3. High precision

II. Discuss the Inch System of Measurement
    A. Discuss fractional (scale) dimensions for linear measurement
    B. Discuss decimal dimensions for linear measurement
    C. Convert fractional to decimal
       1. Review mathematical conversion method
       2. Fractional/decimal conversion charts
    D. Practice and demonstration of skills listed above

III. Discuss the Metric System of Measurement
     A. Discuss the units of measure commonly used in the metric system
     B. Convert inch to metric
        1. Review mathematical method (1 inch = 25.4 mm)
        2. Conversion charts
     C. Practice and demonstration of skills listed above

IV. Discuss Semi-Precision and Precision Measurement
     A. Discuss the difference between semi-precision and precision measurement
        1. Semi-precision measurements are 1/64" (.5mm) or greater
        2. Precision measurements are less than 1/64" (.5mm)
     B. Discuss the five categories of precision measurement
        1. Outside measurement
        2. Inside measurement
        3. Depth measurement
V. Discuss the Following Measurement Terms: Accuracy, Precision, Reliability, and Discrimination

A. Accuracy - whether or not something is made according to standard. (The standard for manufacturing is the blueprint.)

B. Precision - the degree of exactness required for an application or design requirement

C. Reliability - the ability to consistently obtain the desired result

D. Discrimination - the degree that a measuring instrument divides its basic unit of length
TLD-E1
Understand Metrology Terms
Self-Assessment

Circle the letter preceding the correct answer.

1. Which of the following is not a term for the science of measuring?
   A. Calibration
   B. Comparison
   C. Measuology
   D. Metrology

2. Name two systems of measurement presently used in the United States.
   A. Fractions and decimals
   B. Metric and inch
   C. Precision and non-precision
   D. Inside and outside

3. What is the most common inch to metric conversion factor in use today?
   A. 1" = 25.4mm
   B. 1mm = .25.4"
   C. 1' = 12mm
   D. 1/16" = 64mm

4. Precision measurement can be defined as any measurement made to a degree finer than:
   A. 1/8".
   B. 1/16".
   C. 1/32".
   D. 1/64".

5. Precision measurement can also be defined as any measurement made to a degree finer than:
   A. .25mm.
   B. .5mm.
   C. .10mm.
   D. 3.24mm.
6. ___________ in metrology refers to whether or not a specific measurement is actually within its stated size.
   A. Precision
   B. Reliability
   C. Discrimination
   D. Accuracy

7. ___________ in metrology is relative to the specific measurement being made, with regard to the degree of exactness required.
   A. Precision
   B. Reliability
   C. Discrimination
   D. Accuracy

8. ___________ in metrology refers to the degree to which a measuring instrument divides the basic unit of length it is using for measurement.
   A. Precision
   B. Reliability
   C. Discrimination
   D. Accuracy

9. ___________ in metrology refers to the ability to obtain the desired result to the degree of precision required.
   A. Precision
   B. Reliability
   C. Discrimination
   D. Accuracy

10. The five categories of precision measurement are outside, inside, length, depth, and:
    A. Taper
    B. Rpm
    C. Thread
    D. Rms
TLD-E1
Understand Metrology Terms
Self-Assessment Answer Key

1. B
2. B
3. A
4. D
5. B
6. D
7. A
8. C
9. B
10. C
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-E2

Subject: Tool & Die and EDM  Time: 4 Hrs.
Duty: Measure/Inspect
Task: Select Measurement Tools

Objective(s):

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

a. Identify basic semi-precision measuring tools;
b. Identify precision measuring tools;
c. Justify use of particular measurement tools based on tool characteristics;
d. Identify error possibilities in measurement tool selection; and,
e. Demonstrate proper care of precision measuring tools.

Instructional Materials:

MASTER Handout (TLD-E2-HO)
MASTER Laboratory Aid (TLD-E2-LA)
MASTER Self-Assessment
Steel Rules (metric and fractional)
0-1" micrometer
Assortment of outside (larger than 1") micrometers
1 set inside micrometers
1 depth micrometer set
1 ea. - outside spring caliper and inside spring caliper
6" dial calipers
1 ea. - Digital micrometer and digital vernier caliper
1 ea. - Set of telescoping gages and set of small hole gages
Examples of “go/no-go” gages

References:


NTMA Modules:

MA-I-05  “Steel Rules”
MA-I-09  “Steel Rules and Transfer Tools”
MA-I-13  “Micrometers”
MA-I-17  “Vernier Instruments”
Student Preparation:

Students should have previously completed the following MASTER Technical Modules:

TLD-E1  "Understand Metrology Terms"

Introduction:

A person choosing to enter the technician trade is often surprised at the number of measuring tools available to such workers. With hundreds of these tools to choose from, the technician has a tool to cover almost any conceivable measuring situation. Often these tools are used alone or in combination with other measuring tools. As you begin your technician career, it is important that you learn to properly identify, use and care for these precision instruments.

Presentation Outline:

I. Describe and Discuss the Following Semi-Precision Measuring Tools
   A. Steel rules
   B. Calipers
   C. Squares

II. Describe and Discuss the Following Precision Measuring Tools
    A. Micrometers (outside, inside and depth)
    B. Verniers (calipers and height gage)
    C. Gages (small hole, telescope, fixed, and dial bore)

III. Justify Use of Particular Measurement Tools Based on Tool Characteristics
     A. What tolerance is required by the print?
     B. What physical characteristics of the part influence tool selection?
     C. What is the discrimination of the tool?
     D. How much time is available for part measurement/inspection?
     E. Will the tool be used by itself or in conjunction with some other tool?
     F. What is the most reliable tool for this application?

IV. Identify Error Possibilities in Measurement Tool Selection
    A. Part not being produced to specifications
    B. Too much time spent trying to measure correctly by not having the right tool

V. Demonstrate Proper Care of Precision Measuring Tools
   A. Storage
   B. Handling
   C. Cleaning
Practical Application:

Complete the Self-Assessment at the end of the chapters in the text.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-E3) dealing with measuring with hand held technician measuring instruments.
Objective(s):

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

a. Identify basic semi-precision measuring tools;
b. Identify precision measuring tools;
c. Justify use of particular measurement tools based on tool characteristics;
d. Identify error possibilities in measurement tool selection; and,
e. Demonstrate proper care of precision measuring tools.

Module Outline:

I. Describe and Discuss the Following Semi-Precision Measuring Tools
   A. Steel rules
   B. Calipers
   C. Squares

II. Describe and Discuss the Following Precision Measuring Tools
    A. Micrometers (outside, inside and depth)
    B. Verniers (calipers and height gage)
    C. Gages (small hole, telescope, fixed, and dial bore)

III. Justify Use of Particular Measurement Tools Based on Tool Characteristics
     A. What tolerance is required by the print?
     B. What physical characteristics of the part influence tool selection?
     C. What is the discrimination of the tool?
     D. How much time is available for part measurement/inspection?
     E. Will the tool be used by itself or in conjunction with some other tool?
     F. What is the most reliable tool for this application?

IV. Identify Error Possibilities in Measurement Tool Selection
    A. Part not being produced to specifications
    B. Too much time spent trying to measure correctly by not having the right tool

V. Demonstrate Proper Care of Precision Measuring Tools
   A. Storage
   B. Handling
   C. Cleaning
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-E2
Select Measurement Tools
Self-Assessment

Circle the letter preceding the best answer.

1. A ___________ is a linear measuring instrument whose graduations represent real units of length.
   A. Steel tape
   B. Scale
   C. Rule
   D. Yardstick

2. A vernier caliper has two scales: the vernier scale and the ____________.
   A. Top scale
   B. Main scale
   C. Principle scale
   D. Inside scale

3. What is the discrimination for vernier instruments used for linear measurement?
   A. .001"
   B. .02mm
   C. 1/64"
   D. A and B above

4. How are metric scales usually graduated?
   A. Meters
   B. Feet and inches
   C. Milliliters
   D. MM and .5mm

5. The technician combination set includes 4 components: the steel rule, the protractor head, the square head, and ____________.
   A. Magnetic base
   B. Protective cover
   C. Center head
   D. Adjustable depth gage
6. The vernier caliper may be used for inside measurement, outside measurement and ____________.
   A. Diameter measurement
   B. Length measurement
   C. Depth measurement
   D. All of the above

7. Which of the following is **not** a valid type of micrometer?
   A. Outside micrometer
   B. Universal micrometer
   C. Thread micrometer
   D. Digital micrometer

8. Which of the following does the most harm to precision measuring tools?
   A. Heat
   B. Dirt
   C. Moisture
   D. Oil

9. A **standard** micrometer has a discrimination of what part of an inch?
   A. .0001"
   B. .001"
   C. .010"
   D. .100"

10. In order to be certain of the dimension when measuring with a micrometer:
    A. Take at least one reading
    B. Take at least two readings
    C. Take at least three readings
    D. Take at least four readings
TLD-E2
Select Measurement Tools
Self-Assessment Answer Key

1. C
2. B
3. D
4. D
5. C
6. D
7. B
8. C
9. B
10. B
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-E3

Subject: Tool & Die and EDM
Duty: Measure/Inspect
Task: Measure with Hand Held Instruments

Time: 4 Hrs.

Objective(s):

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

a. Measure with steel rules (metric and inch);
b. Measure with micrometers;
c. Measure with comparison measuring instruments (e.g., calipers, telescope gages);
d. Measure with direct measuring instruments (e.g., vernier, dial and digital instruments); and,
e. Measure with fixed gages (go and no-go gages).

Instructional Materials:

MASTER Handout (TLD-E3-HO)
MASTER Laboratory Exercise (TLD-E3-LE1)
MASTER Laboratory Exercise (TLD-E3-LE2)
MASTER Laboratory Aid (TLD-E3-LA)
Steel Rules (metric and fractional) for each student or group of students
0-1” micrometers for each student or group of students
Assortment of outside (larger than 1”) micrometers
1 set inside micrometers
1 depth micrometer set
1 ea. - outside spring caliper and inside spring caliper
6” dial calipers for each student or group of students
Random collection of objects for student practice
1 ea. - Digital micrometer and digital vernier caliper
1 ea. - Set of telescoping gages and set of small hole gages
Examples of “go/no-go” gages

References:

NTMA Modules:
   MA-I-05 “Steel Rules”
Student Preparation:

Students should have previously completed the following MASTER Technical Modules:

- **TLD-E1**  "Understand Metrology Terms"
- **TLD-E2**  "Select Measurement Tools"

Introduction:

Every aspect of our lives, from the clothes we wear to the cars we drive, is greatly influenced by measurement. For the technician, measurement is especially important since it is the technician who is responsible for crafting the tools, fixtures, and components which make up or support virtually every part of our lives. Therefore, it is essential for the technician to be a master in the use of not only the machine tools, but also the instruments which are used to measure the precision components demanded by consumers today. One of the most valuable assets you can possess is the expert use of the technician measuring tools and a desire to practice quality consciousness in every aspect of your job performance.

Presentation Outline:

I. Discuss the Importance of Learning and Practicing Proper Measurement Techniques
   A. Show the video "Measuring Tools"
   B. Give each student a copy of the handout "Proper Measuring Techniques"

II. Discuss and Demonstrate Proper Measurement Techniques Using the Steel Rule

III. Discuss and Demonstrate the Use of Micrometer Type Measuring Instruments
   A. Outside micrometers
   B. Inside micrometers
   C. Depth micrometers
   D. Practice and demonstration of skills listed above

IV. Discuss and Demonstrate the Use of Transfer Type Measuring Instruments
   A. Spring calipers (inside and outside)
   B. Telescope gages
   C. Small hole gages
   D. Practice and demonstration of skills listed above

V. Discuss and Demonstrate the Use of Direct Measuring Instruments
A. Vernier calipers  
B. Dial calipers  
C. Digital calipers  
D. Practice and demonstration of skills listed above

VI. Discuss the Purpose of Fixed Gages and Demonstrate Their Use
A. Cylindrical plug and ring gages  
B. Taper plug and ring gages  
C. Snap gages  
D. Thread plug gages  
E. Practice and demonstration of skills listed above

VII. Complete Practical Exercises (TLD-E3-LE1) and (TLD-E3-LE2) On All the Above Material

Practical Application:

Students will practice in the lab with each measuring instrument and complete the Laboratory Worksheet (TLD-E3-LW) and turn it in to the instructor for evaluation.

Evaluation and/or Verification:

Given: All the measuring instruments listed in the “Instructional Materials” and appropriate sample workpieces to measure;

The student will: Study the material as presented by the instructor, evaluate his/her skills through the Self-Assessment, and demonstrate those skills through the Laboratory Worksheet.

The standards of skill performance are that the student will:

1. Score 90% on the Self-Assessment;
2. Measure with the steel rule to an accuracy of ±1/64 inch;
3. Measure with the micrometer to an accuracy of ±0.001 inch;
4. Measure with the dial and digital caliper to an accuracy of ±0.001 inch; and,
5. Determine whether the holes, tapers, and threads are within acceptable limits by use of the appropriate go/no-go gages.

Summary:

Review the main lesson points. Hold class discussion and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (TLD-E4) dealing with eliminating variables which affect accurate measurement.
Objective(s):

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

a. Measure with steel rules (metric and inch);

b. Measure with micrometers;

c. Measure with comparison measuring instruments (e.g., calipers, telescope gages);

d. Measure with direct measuring instruments (e.g., vernier, dial and digital instruments); and,

e. Measure with fixed gages (go and no-go gages).

Module Outline:

I. Discuss the Importance of Learning and Practicing Proper Measurement Techniques
   A. Show the video "Measuring Tools"
   B. Give each student a copy of the handout "Proper Measuring Techniques"

II. Discuss and Demonstrate Proper Measurement Techniques Using the Steel Rule

III. Discuss and Demonstrate the Use of Micrometer Type Measuring Instruments
   A. Outside micrometers
   B. Inside micrometers
   C. Depth micrometers
   D. Practice and demonstration of skills listed above

IV. Discuss and Demonstrate the Use of Transfer Type Measuring Instruments
   A. Spring calipers (inside and outside)
   B. Telescope gages
   C. Small hole gages
   D. Practice and demonstration of skills listed above

V. Discuss and Demonstrate the Use of Direct Measuring Instruments
   A. Vernier calipers
   B. Dial calipers
   C. Digital calipers
   D. Practice and demonstration of skills listed above

VI. Discuss the Purpose of Fixed Gages and Demonstrate Their Use
   A. Cylindrical plug and ring gages
   B. Taper plug and ring gages
   C. Snap gages
   D. Thread plug gages
   E. Practice and demonstration of skills listed above
VII. Complete Practical Exercise (TLD-E3-LE1) and (TLD-E3-LE2) On All the Above Material
1. What is the reading on the vernier caliper below?
   a. .642
   b. 1.642
   c. 1.645
   d. 1.64

   [Diagram of vernier caliper with main and vernier scales]

2. What is the reading on the vernier caliper below?
   a. .415
   b. 3.125
   c. 3.405
   d. 3.412

   [Diagram of vernier caliper with main and vernier scales]
3. What is the reading on the vernier caliper below?
   a. 4.575
   b. 4.250
   c. 4.570
   d. 4.275

4. What is the reading on this vernier caliper?
   a. 3.785
   b. 3.800
   c. 3.473
   d. 3.793
Using the measuring instruments provided for you and the measuring specimens, measure for the following dimensions and record your answers in the space provided. Be sure to provide metric and inch answers for each dimension. Turn this sheet in to your instructor for evaluation.

<table>
<thead>
<tr>
<th>Specimen Number</th>
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<tr>
<td>Dimension</td>
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Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-E4

Subject: Tool & Die and EDM
Duty: Measure/Inspect
Task: Eliminate Measurement Variables

Time: 4 Hrs.

Objective(s):

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

a. Discuss factors affecting accurate measurement (dirt, temperature, improper measuring tool calibration);
b. Explain calibration requirements of various precision instruments;
c. Illustrate measurement differences when taken with calibrated and non-calibrated instruments; and,
d. Calibrate a micrometer type measuring tool.

Instructional Materials:

MASTER Handout (TLD-E4-HO)
MASTER Laboratory Exercise (TLD-E4-LE)
MASTER Laboratory Aid (TLD-E4-LA)
MASTER Self-Assessment
Assortment of outside micrometers with standards and adjusting wrench
Dial calipers with adjustment tool
Set of gage blocks

References:


Student Preparation:

Students should have previously completed the following MASTER Technical Modules:

TLD-E1 “Understand Metrology Terms”
TLD-E2 “Select Measurement Tools”
TLD-E3 “Measure With Hand Held Instruments”
Introduction:

Simply possessing the finest measuring tools that money can buy does not insure precision measurement. Many other factors affect accurate measurement. The technician must learn how to prepare the surface for measurement, how to manipulate the measuring tools correctly, and how to check the calibration of those measuring tools. All of these things are important if the technician is to consistently make accurate measurements.

Presentation Outline:

I. Discuss Factors Affecting Accurate Measurement
   A. Tool selection
   B. Cleanliness
   C. Temperature
   D. Calibration
   E. "Feel"

II. Explain Calibration Requirements of Various Precision Instruments
   A. Individual responsibility vs. company responsibility
   B. Calibration standards

III. Illustrate Measurement Differences When Taken With Calibrated and Non-Calibrated Instruments

IV. Calibrate a Micrometer Type Measuring Tool
   A. 5 steps adjusting an outside micrometer which needs adjustment
      1. Clean the measuring faces of the micrometer
      2. Close the measuring faces carefully against the standard by turning the ratchet stop or friction thimble
      3. Insert the C-spanner into the hole or slot provided in the sleeve
      4. Carefully turn the sleeve until the index line on the sleeve coincides with the zero line on the thimble
      5. Recheck the accuracy of the micrometer by opening and then closing the micrometer faces by turning the ratchet stop or friction thimble
   B. Student practice of the above procedure

Practical Application:

Students will clean, check and calibrate an outside micrometer.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.
Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-E5) on the subject of performing measurements and inspections using a surface plate and accessories
Objective(s):

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

a. Discuss factors affecting accurate measurement (dirt, temperature, improper measuring tool calibration);
b. Explain calibration requirements of various precision instruments;
c. Illustrate measurement differences when taken with calibrated and non-calibrated instruments; and,
d. Calibrate a micrometer type measuring tool.

Module Outline:

I. Discuss Factors Affecting Accurate Measurement
   A. Tool selection
   B. Cleanliness
   C. Temperature
   D. Calibration
   E. “Feel”

II. Explain Calibration Requirements of Various Precision Instruments
   A. Individual responsibility vs. company responsibility
   B. Calibration standards

III. Illustrate Measurement Differences When Taken With Calibrated and Non-Calibrated Instruments

IV. Calibrate a Micrometer Type Measuring Tool
   A. 5 steps adjusting an outside micrometer which needs adjustment
      1. Clean the measuring faces of the micrometer
      2. Close the measuring faces carefully against the standard by turning the ratchet stop or friction thimble
      3. Insert the C-spanner into the hole or slot provided in the sleeve
      4. Carefully turn the sleeve until the index line on the sleeve coincides with the zero line on the thimble
      5. Recheck the accuracy of the micrometer by opening and then closing the micrometer faces by turning the ratchet stop or friction thimble
   B. Student practice of the above procedure
The student will perform the following:

1. Calibrate a micrometer by:
   a. Adjusting micrometer;
   b. Cleaning the measuring faces of the micrometer;
   c. Closing the measuring faces carefully against the standard by turning the ratchet stop or friction thimble;
   d. Inserting the C-spanner into the hole or slot provided in the sleeve;
   e. Carefully turning the sleeve until the index line on the sleeve coincides with the zero line on the thimble; and,
   f. Rechecking the accuracy of the micrometer by opening and then closing the micrometer faces by turning the ratchet stop or friction thimble.
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Write the answers to the following questions in the space provided.

1. List 5 factors which may affect accurate measurement.

2. Briefly explain why some companies place the burden of calibration on the technician while other companies employ persons to calibrate the tools and instruments of the technician.

3. Even though standards are furnished with many outside micrometers, what is generally considered to the best standard to use for calibration of technician measuring instruments?
4. Why are many inspection/quality control stations located in climate controlled areas?

5. List the steps (in order) to follow should the accuracy of a micrometer require adjustment.

1. 

2. 

3. 

4. 

5. 

TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-E5

Subject: Tool & Die and EDM
Time: 8 Hrs.

Duty: Measure/Inspect
Task: Measure/Inspect Using Surface Plate and Accessories

Objective(s):

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

a. Describe care of surface plate;
b. Use surface plate accessories correctly (sine bar, gage blocks, etc.);
c. Check for part squareness;
d. Check part dimensions for accuracy; and,
e. Align workpieces using height gage and dial indicators.

Instructional Materials:

MASTER Handout (TLD-E5-HO)
MASTER Laboratory Exercise (TLD-E5-LE)
MASTER Laboratory Aid (TLD-E5-LA)
MASTER Self-Assessment
Surface plate and accessories
Parts to check

References:


Student Preparation:

Students should have previously completed the following MASTER Technical Modules:

- TLD-E1 “Understand Metrology Terms”
- TLD-E2 “Select Measurement Tools”
- TLD-E3 “Measure With Hand Held Instruments”
- TLD-E4 “Eliminate Measurement Variables”
Introduction:

Much of the measuring that a technician performs is done at various points during the processing of the workpiece. Whenever a higher degree of precision is required or whenever the work has been removed from the machine, the work is often subjected to inspection. This inspection process is frequently accomplished on a surface plate using a set of accessories which are specifically for use with the surface plate. This lesson will cover the use of the surface plate and the accessories which are used for layout and inspection purposes.

Presentation Outline:

I. Describe Types of Surface Plate and Surface Tables
   A. Cast iron and semi-steel surface plates
   B. Granite surface plate

II. Discuss the Different Surface Plate Accessories and Their Use
   A. Sine bar
   B. Gage blocks
   C. Vernier height gage
   D. Precision height gage
   E. Dial test indicator
   F. Squares
   G. Angle plate and clamps
   H. 1,2,3 blocks

III. Demonstrate Checking For Part Squareness

IV. Demonstrate Checking Part Dimensions For Accuracy

V. Demonstrate Aligning Workpieces Using Height Gage and Dial Indicators

Practical Application:

Students will complete assignments using a surface plate, gage blocks, sine bar, and other accessories normally used in conjunction with the surface plate.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson

Summary:

Review the main lesson points and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (TLD-E6) dealing with the use of stationary equipment for inspection purposes.
TLD-E5-HO
Measure/Inspect Using Surface Plate and Accessories
Attachment 1: MASTER Handout

Objective(s):

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

a. Describe care of surface plate;
b. Use surface plate accessories correctly (sine bar, gage blocks, etc.);
c. Check for part squareness;
d. Check part dimensions for accuracy; and,
e. Align workpieces using height gage and dial indicators.

Module Outline:

I. Describe Types of Surface Plate and Surface Tables
   A. Cast iron and semi-steel surface plates
   B. Granite surface plate

II. Discuss the Different Surface Plate Accessories and Their Use
   A. Sine bar
   B. Gage blocks
   C. Vernier height gage
   D. Precision height gage
   E. Dial test indicator
   F. Squares
   G. Angle plate and clamps
   H. 1,2,3 blocks

III. Demonstrate Checking For Part Squareness

IV. Demonstrate Checking Part Dimensions For Accuracy

V. Demonstrate Aligning Workpieces Using Height Gage and Dial Indicators
TLD-E5-LE
Measure/Inspect Using Surface Plate and Accessories
Attachment 2: MASTER Laboratory Exercise

1. Instructor will provide sample mechanical parts for students to:
   a. Demonstrate checking for part squareness;
   b. Demonstrate checking part dimensions for accuracy; and,
   c. Demonstrate aligning workpieces using height gage and dial indicators.

2. Students will practice:
   a. Checking for part squareness;
   b. Checking part dimensions for accuracy; and,
   c. Aligning workpieces using height gage and dial indicators.
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-E5
Measure/Inspect Using Surface Plate and Accessories
Self-Assessment

Using the measuring instruments provided for you and the measuring specimens, measure for the following dimensions and record your answers in the space provided. Be sure to provide metric and inch answers for each dimension. Turn this sheet in to your instructor for evaluation.

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Subject: Tool & Die and EDM

Duty: Measure/Inspect

Task: Inspect Using Stationary Equipment

Objective(s):

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

a. Set up and use an Optical Comparator; and,
b. Set up and use a Coordinate Measuring Machine (CMM).

Instructional Materials:

MASTER Handout (TLD-E6-HO)
MASTER Laboratory Exercise (TLD-E6-LE)
MASTER Laboratory Aid (TLD-E6-LA)
MASTER Self-Assessment
Optical Comparator
Coordinate Measuring Machine
Samples for Measurement

References:


Student Preparation:

Students should have previously completed the following Technical Modules:

- **TLD-E1** “Understand Metrology Terms”
- **TLD-E2** “Select Measurement Tools”
- **TLD-E3** “Measure With Hand Held Instruments”
- **TLD-E4** “Eliminate Measurement Variables”
- **TLD-E5** “Measure/Inspect Using Surface Plate and Accessories”
Introduction:

Today's manufacturing processes require much higher degrees of precision. Many components are also manufactured at one location then shipped to another for assembly. These factors have caused the technician to rely more and more on measuring and inspecting instruments with higher degrees of precision. Free standing inspection devices such as the optical comparator and the coordinate measuring machine (CMM) are being used to help the technician maintain the high levels of precision required by manufacturers and consumers alike.

Presentation Outline:

I. Define the Term “Comparison Measurement”
   A. Describe the following comparison instruments:
      1. Dial indicator
      2. Mechanical comparator
      3. Optical comparator
      4. Mechanical-optical comparator
      5. Air gages
      6. Electronic comparator
   B. Demonstrate the setup and operation of the optical comparator
   C. Allow students to practice setup and operation of the optical comparator

II. Discuss the Advantages of Measuring with the Coordinate Measuring Machine (CMM)
   A. Demonstrate the setup and operation of the CMM
   B. Allow students to practice setup and operation of the CMM

Practical Application:

Students will complete assignments using the optical comparator and the coordinate measuring machine.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (TLD-F1) dealing with metal cutting and metal cutting tools.
Objective(s):

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

a. Set up and use an Optical Comparator; and,

b. Set up and use a Coordinate Measuring Machine (CMM).

Module Outline:

I. Define the Term “Comparison Measurement”
   A. Describe the following comparison instruments:
      1. Dial indicator
      2. Mechanical comparator
      3. Optical comparator
      4. Mechanical-optical comparator
      5. Air gages
      6. Electronic comparator
   B. Demonstrate the setup and operation of the optical comparator
   C. Allow students to practice setup and operation of the optical comparator

II. Discuss the Advantages of Measuring with the Coordinate Measuring Machine (CMM)
   A. Demonstrate the setup and operation of the CMM
   B. Allow students to practice setup and operation of the CMM
1. The instructor will:
   a. Demonstrate the setup and operation of the optical comparator; and,
   b. Demonstrate the setup and operation of the Coordinate Measuring Machine (CMM).

2. The students will:
   a. Practice the setup and operation of the optical comparator; and,
   b. Practice the setup and operation of the Coordinate Measuring Machine (CMM).
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-E6
Inspect Using Stationary Equipment
Self-Assessment

Circle the letter preceding the best answer.

1. The CMM measures workpieces in ___ dimensions.
   A. One
   B. Two
   C. Three
   D. Four
   E. None of the above answers is correct.

2. Optical comparators project a ___ shadow of the object.
   A. Magnified
   B. True size
   C. Miniaturized
   D. Any of the above answers could be correct, depending on how the technician sets up the comparator.
   E. None of the above answers is correct.

3. Which of the following cannot be checked using the optical comparator?
   A. Screw threads
   B. Gears
   C. Cutting tools
   D. All of the above are normally checked with optical comparators.
   E. None of the above answers is correct.

4. The optical comparator often uses ___ to check the workpiece.
   A. Ideal models
   B. Templates
   C. Photographs
   D. All of the above are used with the comparator.
   E. None of the above answers is correct.

5. The CMM is useful for checking ___ among parts.
   A. Relative locations
   B. Relative sizes
   C. Relative weights
   D. All of the above answers are correct.
   E. None of the above answers is correct.
TLD-E6
Inspect Using Stationary Equipment
Self-Assessment Answer Key

1. C
2. A
3. D
4. B
5. A
TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
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| A.1 Follow safety manuals and all safety regulations/requirements | Demonstrate Knowledge of Manufacturing Materials
| A.2 Maintain safe equipment and machinery | Demonstrate Knowledge of Manufacturing Processes
| A.3 Use safe operating procedures for hand and machine tools | Demonstrate Knowledge of Manufacturing Processes
| A.4 Maintain a clean and safe work environment | Demonstrate Knowledge of Manufacturing Processes
| A.5 Use safe material handling practices | Demonstrate Knowledge of Manufacturing Processes
| A.6 Consult and apply MSDS for hazards of various materials | Demonstrate Knowledge of Manufacturing Processes

**Duties**

A. Practice Safety
B. Apply Mathematical Concepts
C. Interpret Engineering Drawings and Related Documents
D. Demonstrate Knowledge of Manufacturing Materials
E. Measure/Inspect
F. Demonstrate Knowledge of Manufacturing Processes
G. Use Computers
H. Perform CAD/CAM and CNC Programming Tasks
I. Perform Tool and Die Making Operations
J. Operate Electrical Discharge Machine (EDM)

**Tasks**

A.1 Demonstrate Knowledge of Manufacturing Materials
B.1 Perform basic arithmetic operations
C.1 Interpret and understand basic layout types of drawings
D.1 Identify materials and processes to produce a part
E.1 Understand measurement terms
F.1 Discuss metal cutting and metal cutting tools
G.1 Use computer operating systems
H.1 Discuss fundamentals of CNC machines and controls
I.1 Discuss basic types and functions of jigs and fixtures
J.1 Discuss fundamentals of EDM

A.2 Demonstrate Knowledge of Manufacturing Materials
B.2 Perform basic geometric principles
C.2 Interpret, review, and apply blueprints, notes, dimensions, and tolerances
D.2 Identify materials and processes to produce a part
E.2 Select measurement tools
F.2 Operate metal saws
G.2 Understand computer terminology
H.2 Program and operate CNC milling machine and machining center
I.2 Utilize concepts of jig and fixture design
J.2 Setup and operate conventional sinker EDM

A.3 Demonstrate Knowledge of Manufacturing Materials
B.3 Perform basic trigonometric functions
C.3 Use and apply geometric dimensioning and tolerancing (GD&T)
D.3 Discuss classification systems for metal
E.3 Measure with hand held instruments
F.3 Operate drill presses and tooling
G.3 Use file management systems
H.3 Program and operate CNC lathe
I.3 Demonstrate understanding of different types of industrial dies
J.3 Program, setup, and operate CNC sinker EDM and EDM drill

A.4 Demonstrate Knowledge of Manufacturing Materials
B.4 Use and apply Cartesian Coordinate System
C.4 Demonstrate traditional mechanical drafting and sketching techniques
D.4 Discuss classification systems for metal
E.4 Eliminate measurement variables
F.4 Operate engine and turret lathes and tooling
G.4 Install and use software packages
H.4 Use Computer-Aided Drafting (CAD) system
I.4 Utilize basic die theory
J.4 Program, setup, and operate CNC wire EDM

A.5 Demonstrate Knowledge of Manufacturing Materials
B.5 Use and apply MSDS for hazards of various materials
C.5 Understand and use quality systems
D.5 Use safe material handling practices
E.5 Measure/inspect using surface plate and accessories
F.5 Operate precision grinders
G.5 Use and apply O.D. and Tolerance (O.D.T) systems
H.5 Create 3-D solid models
I.5 Utilize principles of die design
J.5 Perform tool and die repair

A.6 Demonstrate Knowledge of Manufacturing Materials
B.6 Use and apply Cartesian Coordinate System
C.6 Understand and use quality systems
D.6 Consult and apply MSDS for hazards of various materials
E.6 Inspect using stationary equipment
F.6 Operate precision grinders
G.6 Use and apply O.D. and Tolerance (O.D.T) systems
H.6 Use Computer-Aided Manufacturing (CAM) system
I.6 Demonstrate tool and die making skills
J.6 Operate precision grinders

H.7 Operate heat treating equipment and processes
I.7 Demonstrate tool and die making skills
J.7 Demonstrate tool and die making skills
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-F1

Subject: Tool & Die and EDM
Time: 10 Hrs.

Duty: Demonstrate Knowledge of Manufacturing Processes
Task: Discuss Metal Cutting and Metal Cutting Tools

Objective(s):

Upon completion of this unit the student will be able to:
a. Discuss physics of metal cutting
b. Discuss cutting tools
c. Discuss cutting fluids and coolants
d. Select appropriate tooling for application

Instructional Materials:

MASTER Handout (TLD-F1-HO)
MASTER Self-Assessment

References:

NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition
Machining Fundamentals, John R. Walker, Goodheart-Willcox, Latest Edition
Student Preparation:

Students should have previously completed the following Technical Modules:

- TLD-A1 through TLD-A6 “Practice Safety”
- TLD-B1 through TLD-B5 “Apply Mathematical Concepts”
- TLD-D1 through TLD-D3 “Demonstrate Knowledge of Manufacturing Materials”

Introduction:

Many times students of metal trades learn to simply operate machines, rather than to cut metal.

Before a student becomes proficient as a machinist or tool maker, it is imperative that he/she have an understanding of what takes place when the cutting tool contacts the workpiece. Although many successful technicians have had no formal training in the physics of metal cutting, they apply empirical knowledge with each setup. It is important that students be taught the fundamentals about metal cutting and metal cutting tools in order to make knowledgeable decisions regarding the machining process. This module is not intended to replace helpful charts and manuals that technicians use to aid in setup, cutting speeds and feeds, tool geometry, etc., but will give students the foundation to build upon as they again experience in the machine shop.

Presentation Outline:

I. Discuss Physics of Metal Cutting
   A. Explain the metal cutting process
   B. Define metal cutting terms
      1. Built-up edge
      2. Chip-tool interface
      3. Crystal elongation
      4. Deformed zone
      5. Plastic deformation
      6. Plastic flow
      7. Rupture
      8. Shear angle (plane)
9. Shear zone
10. Cutting force
11. Feed force
12. Cutting Speed
   a. Surface feet per minute (SFM)
   b. Revolutions per minute (RPM)
13. Feed

C. Discuss machinability of metals
1. Low-carbon steel
2. High-carbon steel
3. Tool steel
4. Alloys
5. Cast iron

D. Discuss chip formation
1. Discontinuous
2. Continuous
3. Continuous with built-up edge

II. Discuss Cutting Tools
A. Geometry
   1. Front, or end, relief (clearance)
   2. Side relief
   3. Side cutting edge angle
   4. Nose radius
   5. Side rake angle
   6. Back rake angle

B. Materials
   1. High-speed tool steel
   2. Cemented carbide
      a. Brazed-tip
      b. Indexable disposable inserts
      c. Coated
   3. Ceramic
   4. Diamond

C. ANSI insert identification system

D. Discuss factors that affect tool life
   1. Type material being cut
   2. Microstructure of the material
   3. Hardness of the material
   4. Surface condition of the material
   5. Cutting tool material
   6. Profile of the cutting tool
   7. Type machining operation being performed
   8. Speed, feed, and depth of cut
   9. Effectiveness of cutting fluid

E. Discuss grinding single-point tools
III. Discuss Cutting Fluids and Coolants
   A. Function
      1. Coolant
      2. Lubricant
      3. Prolong tool life
      4. Control rust
   B. Types
      1. Cutting oils
      2. Soluble oils
      3. Chemical fluids
   C. Desirable characteristics
      1. Good cooling capacity
      2. Good lubricating qualities
      3. Rust resistance
      4. Stability (long life)
      5. Resistance to rancidity
      6. Nontoxic
      7. Transparent
      8. Relatively low viscosity
      9. Nonflammable
   D. Application
      1. Flood method
      2. Mist method
      3. Coolant-fed tooling

IV. Discuss the Selection of Appropriate Tooling for an Application
   A. Tool geometry
   B. Tool material
   C. Cutting fluids

Practical Application:

Students should be given demonstrations of metal cutting operations to emphasize
points introduced in lecture. Students should also be given projects to grind single-
point tool bits for turning and threading.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this
lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class
discussion and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (TLD-F2) dealing with operation of metal saws.
Objective(s):

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

a. Discuss physics of metal cutting
b. Discuss cutting tools
c. Discuss cutting fluids and coolants
d. Select appropriate tooling for application

Module Outline:

I. Discuss Physics of Metal Cutting
   A. Explain the metal cutting process
   B. Define metal cutting terms
      1. Built-up edge
      2. Chip-tool interface
      3. Crystal elongation
      4. Deformed zone
      5. Plastic deformation
      6. Plastic flow
      7. Rupture
      8. Shear angle (plane)
      9. Shear zone
      10. Cutting force
      11. Feed force
      12. Cutting Speed
         a. Surface feet per minute (SFM)
         b. Revolutions per minute (RPM)
      13. Feed
   C. Discuss machinability of metals
      1. Low-carbon steel
      2. High-carbon steel
      3. Tool steel
      4. Alloys
      5. Cast iron
   D. Discuss chip formation
      1. Discontinuous
      2. Continuous
      3. Continuous with built-up edge

II. Discuss Cutting Tools
    A. Geometry
1. Front, or end, relief (clearance)
2. Side relief
3. Side cutting edge angle
4. Nose radius
5. Side rake angle
6. Back rake angle

B. Materials
1. High-speed tool steel
2. Cemented carbide
   a. Brazed-tip
   b. Indexable disposable inserts
   c. Coated
3. Ceramic
4. Diamond

C. ANSI insert identification system

D. Discuss factors that affect tool life
1. Type material being cut
2. Microstructure of the material
3. Hardness of the material
4. Surface condition of the material
5. Cutting tool material
6. Profile of the cutting tool
7. Type machining operation being performed
8. Speed, feed, and depth of cut
9. Effectiveness of cutting fluid

E. Discuss grinding single-point tools

III. Discuss Cutting Fluids and Coolants

A. Function
1. Coolant
2. Lubricant
3. Prolong tool life
4. Control rust

B. Types
1. Cutting oils
2. Soluble oils
3. Chemical fluids

C. Desirable characteristics
1. Good cooling capacity
2. Good lubricating qualities
3. Rust resistance
4. Stability (long life)
5. Resistance to rancidity
6. Nontoxic
7. Transparent
8. Relatively low viscosity
9. Nonflammable

D. Application
   1. Flood method
   2. Mist method
   3. Coolant-fed tooling

IV. Discuss the Selection of Appropriate Tooling for an Application
   A. Tool geometry
   B. Tool material
   C. Cutting fluids
TLD-F1
Discuss Metal Cutting and Metal Cutting Tools
Self-Assessment

1. The layer of compressed metal from the material being cut which adheres to and piles up on the cutting tool edge during a machining operation is the:
   a. Compression
   b. Built-up edge
   c. Rupture
   d. Rake angle

2. That portion of the face of the cutting tool upon which the chip slides as it is cut from the metal is the:
   a. Chip-tool interface
   b. Tool face
   c. Side rake
   d. Chip face

3. *Crystal elongation* is:
   a. The ability of the metal to crystallize during machining
   b. The distortion of the crystal structure of the material during a machining operation
   c. The elongation of the crystal structure of the cutting tool
   d. The desired effect of machining crystal

4. The area in which the work material is being deformed during a cutting action is the:
   a. Shear zone
   b. Deformed zone
   c. Distortion zone
   d. Error zone

5. The area where plastic deformation of metal occurs is called the:
   a. Shear plane
   b. Shear zone
   c. Rupture area
   d. Plastic flow
6. In a turning operation, the vertical force is in the direction of the cutting speed and is referred to the:
   a. Feed force
   b. Cutting force
   c. Turning force
   d. Cutting feed

7. The relationship between the velocity of the cutting tool and the work piece is called the:
   a. Velocity ration
   b. Tool velocity
   c. Cutting speed
   d. Cutting feed

8. Calculate the RPM for a 1/2" diameter drill in tool steel (CS=60 SFM) with a high-speed steel drill.

9. List and explain two ways of specifying feed rate.

10. Define machinability.

11. List and define the three basic types of chip formations.

12. What is rake angle?

13. What is the purpose of a nose radius?
14. What is the purpose of end relief?

15. Name 3 materials that cutting tools are made of and characterize each.

16. In an ANSI insert designation, what information does the first digit identify?

17. List 4 functions of a cutting fluid.

18. List 3 types of cutting fluids.

19. List and explain 3 application methods for cutting fluids.

20. Determine the appropriate tool geometry for a carbide insert taking 1/4" depth of cut at .020 IPR feed in tool steel.
Subject: Tool & Die and EDM  
Time: 10 Hrs.

Duty: Demonstrate Knowledge of Manufacturing Processes

Task: Operate Metal Saws

Objective(s):

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

a. Define bandsaw, horizontal and vertical;
b. Discuss bandsaw safety;
c. Explain machine components and accessories of bandsaws;
d. Discuss application of the various tooth forms, pitch sets, and gages of bandsaw blades;
e. Weld and maintain bandsaw blade;
f. Calculate proper length of bandsaw blade;
g. Use recommended cutting speed and feed rate for specific materials and tooling;
h. Define circular type metal saws, abrasive cutoff and cold circular;
i. Discuss circular saw safety;
j. Explain tooling (blades and wheels) on circular saws; and,
k. Setup and operate bandsaw and circular saw.

Instructional Materials:

MASTER Handout (TLD-F2-HO)
MASTER Laboratory Aid (TLD-F2-LA)
MASTER Self-Assessment

References:

NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition

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Machining Fundamentals, John R. Walker, Goodheart-Willcox, Latest Edition


Application of Metal Cutting Theory, Fryderyk E. Gorczyca, Industrial Press, Latest Edition


Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6 "Practice Safety"
TLD-B1 through TLD-B5 "Apply Mathematical Concepts"
TLD-C1 "Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2 "Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3 "Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4 "Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-D1 through TLD-D3 "Demonstrate Knowledge of Manufacturing Materials"
TLD-E1 through TLD-E6 "Measure/Inspect"
TLD-F1 "Discuss Metal Cutting and Metal Cutting Tools"

Introduction:

A necessary component of all machine shops is some form of metal cutting saw. The saw is the most efficient and economical way to remove unwanted material from the stock piece. The tool and die maker must be familiar with saw operations and techniques to perform tasks such as cutoff of piece blank from stock material or rough cutting a profile. Without the knowledge of metal saws, machinist would find many tasks almost impossible and much more expensive to perform.
Presentation Outline:

I. Define Bandsaw and Identify Types
   A. Horizontal
   B. Vertical

II. Discuss Bandsaw Safety

III. Explain Machine Components and Accessories of Bandsaws
   A. Horizontal
      1. Saw frame
      2. Vise
      3. Stop gage
      4. Pulleys
      5. Blade tension handle
      6. Roller guide brackets
      7. Saw blade
      8. Power stock feed
      9. Coolant
   B. Vertical (contour)
      1. Column
      2. Head
      3. Base
      4. Pulleys
      5. Table
      6. Saw guides
      7. Table tilt handwheel
      8. Butt welder
      9. Blade grinder
     10. Coolant
     11. Power feed

IV. Discuss Bandsaw Blades
   A. Tooth forms
      1. Precision or regular tooth
      2. Claw or hook tooth
      3. Buttress or skip tooth
   B. Pitch
   C. Set
      1. Raker
      2. Wave
      3. Straight
   D. Width
   E. Gage
   F. Material
   G. Specialty blades

V. Explain How to Calculate Proper Length of Bandsaw Blade
VI. Explain How to Weld and Maintain Bandsaw Blade
VII. Explain How to Determine Cutting Speed and Feed Rate for Specific Materials and Tooling Using Charts And/or Selector Dial
VIII. Define Circular Type Metal Saws and Identify Types and Uses
   A. Cold circular
   B. Abrasive cutoff
IX. Discuss Circular Metal Saw Safety
X. Discuss Tooling (Blades and Wheels) on Circular Saws
   A. Cold circular blades (reiterate tooth forms, pitch, set, gage, and material)
   B. Abrasive cut-off wheels
      1. Grade
      2. Material
XI. Setup and Operate Bandsaw and Circular Saw
   A. Safety
   B. Horizontal
   C. Vertical
   D. Cold circular
   E. Abrasive cutoff

Practical Application:

Students should be given a demonstration of the operation of each of the types of metal saws. They should then complete several sawing projects utilizing each type of saw.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson as well as demonstrate the operation of metal saws.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-F3) dealing with operation of drilling presses and tooling.
 objetivo(s):

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

a. Define bandsaw, horizontal and vertical;
b. Discuss bandsaw safety;
c. Explain machine components and accessories of bandsaws;
d. Discuss application of the various tooth forms, pitch sets, and gages of bandsaw blades;
e. Weld and maintain bandsaw blade;
f. Calculate proper length of bandsaw blade;
g. Use recommended cutting speed and feed rate for specific materials and tooling;
h. Define circular type metal saws, abrasive cutoff and cold circular;
i. Discuss circular saw safety;
j. Explain tooling (blades and wheels) on circular saws; and,
k. Setup and operate bandsaw and circular saw.

module outline:

i. Define Bandsaw and Identify Types
   a. Horizontal
   b. Vertical

ii. Discuss Bandsaw Safety

iii. Explain Machine Components and Accessories of Bandsaws
   a. Horizontal
      1. Saw frame
      2. Vise
      3. Stop gage
      4. Pulleys
      5. Blade tension handle
      6. Roller guide brackets
      7. Saw blade
      8. Power stock feed
      9. Coolant
   b. Vertical (contour)
      1. Column
      2. Head
      3. Base
      4. Pulleys
      5. Table
6. Saw guides
7. Table tilt handwheel
8. Butt welder
9. Blade grinder
10. Coolant
11. Power feed

IV. Discuss Bandsaw Blades
A. Tooth forms
   1. Precision or regular tooth
   2. Claw or hook tooth
   3. Buttress or skip tooth
B. Pitch
C. Set
   1. Raker
   2. Wave
   3. Straight
D. Width
E. Gage
F. Material
G. Specialty blades

V. Explain How to Calculate Proper Length of Bandsaw Blade

VI. Explain How to Weld and Maintain Bandsaw Blade

VII. Explain How to Determine Cutting Speed and Feed Rate for Specific Materials and Tooling Using Charts And/or Selector Dial

VIII. Define Circular Type Metal Saws and Identify Types and Uses
A. Cold circular
B. Abrasive cutoff

IX. Discuss Circular Metal Saw Safety

X. Discuss Tooling (Blades and Wheels) on Circular Saws
A. Cold circular blades (reiterate tooth forms, pitch, set, gage, and material)
B. Abrasive cut-off wheels
   1. Grade
   2. Material

XI. Setup and Operate Bandsaw and Circular Saw
A. Safety
B. Horizontal
C. Vertical
D. Cold circular
E. Abrasive cutoff
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-F2
Operate Metal Saws
Self-Assessment

1. List 5 components or accessories of a horizontal bandsaw and give function of each.

2. List 5 components or accessories of a vertical bandsaw and give function of each.

3. List the types of tooth forms for bandsaw blades and give application of each.

4. Define pitch.

5. List and distinguish between the different types of set patterns.

6. What is a band file?
7. Calculate the length of saw band required for a contour bandsaw with two 30" diameter pulleys with a center-to-center distance of 50".

8. List the primary steps to weld and grind a saw blade.

9. What method is used to determine the proper cutting speed for a bandsaw operation?

10. What is a contour bandsaw

11. Define a cold circular saw.

12. Define an abrasive cut-off machine

13. What type metal would an aluminum oxide wheel be used for?

14. Discuss the relationship between the diameter and the thickness of the wheel.
15. Discuss saw safety.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-F3

Subject: Tool & Die and EDM  Time: 15 Hrs.

Duty: Demonstrate Knowledge of Manufacturing Processes
Task: Operate Drill Presses and Tooling

Objective(s):

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

a. Identify types of drilling machines;
b. Discuss drilling machine safety;
c. Explain machine components and accessories of drilling machines;
d. Describe and give function of various types of tooling used on drilling machines;
e. Explain processes performed on drilling machines;
f. Calculate speeds and feeds based on materials and tooling; and,
g. Set-up and operate drilling machines.

Instructional Materials:

MASTER Handout (TLD-F3-HO)
MASTER Laboratory Aid (TLD-F3-LA)
MASTER Self-Assessment

References:

NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition
Introduction:

One of the most common and useful machines in a tool and die shop is the drill press. Although modern drilling machines come in several types, sizes, and complexity, they share a common purpose: to produce holes. It is imperative that tool and die makers become proficient at the operation of these machines since a large part of his/her job will be hole production in tools and dies. By studying drilling machines, tooling, setups, and drilling processes, students can learn the proper methods and procedures to produce accurate holes at precise locations.

Presentation Outline:

I. Identify Types of Drilling Machines
   A. Bench-type sensitive drill press
   B. Upright drilling machine
   C. Radial drilling machine
D. Numerical controlled drilling machine

II. Discuss Drill Safety

III. Explain Machine Components and Accessories of Drilling Machines
   A. Major components
      1. Base
      2. Column
      3. Table
      4. Drilling head
      5. Radial Arm
   B. Accessories
      1. Tool-holding devices
         a. Chucks
         b. Sleeves and sockets
      2. Work-holding devices
         a. Vise (drill, angle, contour)
         b. V-blocks
         c. Clamps, straps, and step blocks
         d. Angle plate
         e. Drill jig

IV. Describe and Give Function and Maintenance of Various Types of Tooling Used on Drilling Machines
   A. Drills
      1. Twist
         a. Geometry and parts
         b. Sizes
         c. Grinding
      2. Center
      3. Core
      4. Spade
      5. Step
   B. Reamers
      1. Rose-type
      2. Shell-type
      3. Expansion-type
      4. Adjustable-type
   C. Counterbore
   D. Countersink
   E. Tap

V. Explain Processes Performed on Drilling Machines
   A. Layout for drilling operations
   B. Drilling
   C. Reaming
   D. Counterboring
   E. Spotfacing
   F. Countersinking
G. Tapping

VI. Calculate Speeds and Feeds Based on Materials and Tooling
   A. Drilling
   B. Reaming
   C. Counterboring/spotfacing
   D. Countersinking
   E. Tapping

VII. Set-Up and Operate Drilling Machines

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Practical Application:

Students should be given demonstration of drill press operation performing each of the above processes. They should then be given projects to perform each process on the drilling machine.

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Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

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Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

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Next Lesson Assignment:

MASTER Technical Module (TLD-F4) dealing with operating engine and turret lathes and tooling.
Objective(s):

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

a. Identify types of drilling machines;
b. Discuss drilling machine safety;
c. Explain machine components and accessories of drilling machines;
d. Describe and give function of various types of tooling used on drilling machines;
e. Explain processes performed on drilling machines;
f. Calculate speeds and feeds based on materials and tooling; and,
g. Set-up and operate drilling machines.

Module Outline:

I. Identify Types of Drilling Machines
   A. Bench-type sensitive drill press
   B. Upright drilling machine
   C. Radial drilling machine
   D. Numerical controlled drilling machine

II. Discuss Drill Safety

III. Explain Machine Components and Accessories of Drilling Machines
   A. Major components
      1. Base
      2. Column
      3. Table
      4. Drilling head
      5. Radial Arm
   B. Accessories
      1. Tool-holding devices
         a. Chucks
         b. Sleeves and sockets
      2. Work-holding devices
         a. Vise (drill, angle, contour)
         b. V-blocks
         c. Clamps, straps, and step blocks
         d. Angle plate
         e. Drill jig

IV. Describe and Give Function and Maintenance of Various Types of Tooling Used on Drilling Machines
   A. Drills
1. Twist  
   a. Geometry and parts  
   b. Sizes  
   c. Grinding  
2. Center  
3. Core  
4. Spade  
5. Step  

B. Reamers  
   1. Rose-type  
   2. Shell-type  
   3. Expansion-type  
   4. Adjustable-type  

C. Counterbore  
D. Countersink  
E. Tap  

V. Explain Processes Performed on Drilling Machines  
   A. Layout for drilling operations  
   B. Drilling  
   C. Reaming  
   D. Counterboring  
   E. Spotfacing  
   F. Countersinking  
   G. Tapping  

VI. Calculate Speeds and Feeds Based on Materials and Tooling  
   A. Drilling  
   B. Reaming  
   C. Counterboring/spotfacing  
   D. Countersinking  
   E. Tapping  

VII. Set-Up and Operate Drilling Machines
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
1. List and discuss three types of drilling machines.

2. List five safety precautions for a drill press.

3. Describe and state the purpose of each component of a drilling machine.

4. Name the two types of tool-holding devices used on drilling machines and describe each.

5. Name three ways that work may be held for drilling operations.

6. Name four types of drills and discuss the application of each.
7. List seven of the most important hints for drilling.

8. Name and describe three types of reamers.


10. How is a tap used on a drilling machine?

11. Why is it good practice to start each hole with a center drill?

12. List the procedure for laying out a hole before drilling.

13. List the procedure for drilling large holes.

14. What is the general rule for the amount of material left in a hole for machine reaming?
15. List seven of the most important reaming hints.

16. Why should holes that are to be tapped be countersunk?

17. Describe the procedure for tapping a hole by hand in a drill press.

18. Name three methods of transferring the location of holes from one part to another.

19. What are transfer punches and how are they used?

20. Calculate the RPM and feed rate for a 3/8" diameter drill in tool steel.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-F4

Subject: Tool & Die and EDM
Tune: 30 Hrs.

Duty: Demonstrate Knowledge of Manufacturing Processes
Task: Operate Engine and Turret Lathes and Tooling

Objective(s):

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

a. Define lathes, engine and turret;
b. Discuss lathe safety;
c. Explain machine components and accessories of lathes;
d. Describe and give function and maintenance of various types of tooling used on lathes;
e. Explain turning processes, inside and outside;
f. Calculate speeds and feeds based on materials, tooling and setup; and,
g. Set-up and operate engine and turret lathes.

Instructional Materials:

MASTER Handout (TLD-F4-HO)
MASTER Laboratory Aid (TLD-F4-LA)
MASTER Self-Assessment

References:

NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition
**Student Preparation:**

Students should have previously completed the following Technical Modules:

- **TLD-A1 through TLD-A6**  
  “Practice Safety”
- **TLD-B1 through TLD-B5**  
  “Apply Mathematical Concepts”
- **TLD-C1**  
  “Interpret and Understand Basic Layout/Types of Drawings”
- **TLD-C2**  
  “Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances”
- **TLD-C3**  
  “Use and Apply Geometric Dimensioning and Tolerancing (GD&T)”
- **TLD-C4**  
  “Demonstrate Traditional Mechanical Drafting and Sketching Techniques”
- **TLD-D1 through TLD-D3**  
  “Demonstrate Knowledge of Manufacturing Materials”
- **TLD-E1 through TLD-E6**  
  “Measure/Inspect”
- **TLD-F1**  
  “Discuss Metal Cutting and Metal Cutting Tools”
- **TLD-F2**  
  “Operate Metal Saws”
- **TLD-F3**  
  “Operate Drill Presses and Tooling”

**Introduction:**

An essential part of any machine shop is the lathe. It is one of the most versatile machine tools used in industry. Modern lathes incorporate the same basic principle of the potter’s wheel forming clay into a cylindrical shape. Because many parts can only be produced with a lathe, it is imperative that tool and die makers become proficient at its operation and processes.

**Presentation Outline:**

I. Define Lathes and Identify Types
   A. Engine
   B. Turret
   C. Computer Numerical Control (CNC)
II. Discuss Lathe Safety
III. Explain Machine Components and Accessories of Lathes
A. Major components
   1. Bed
   2. Headstock
   3. Gearbox
   4. Carriage
      a. Saddle
      b. Cross-slide
      c. Compound rest
   5. Tailstock

B. Accessories
   1. Centers
   2. Chucks
      a. Three-jaw universal
      b. Four-jaw independent
      c. Collet-type
      d. Magnetic
   3. Faceplate
   4. Steadyrest
   5. Follower rest
   6. Lathe dogs
   7. Toolposts
   8. Tool holders

IV. Describe and Give Function and Maintenance of Various Types of Tooling Used on Lathes
   A. Types
      1. O.D. turning tools
      2. I.D. turning tools
      3. Face turning tools
      4. Threading tools
      5. Grooving tools
      6. Knurling tools
      7. Form tools
   B. Maintenance and grinding

V. Explain Turning Processes
   A. Inside operations
      1. Drilling, tapping, reaming
      2. Boring
      3. Threading
      4. Chamfering
      5. Grooving
      6. Taper boring
   B. Outside operations
      1. Turning
         a. Chuck turning
         b. Between centers
c. Form turning
d. Taper turning

2. Facing
3. Threading
4. Grooving
5. Knurling
6. Chamfering
7. Cut-off

C. Explain depth of cut

VI. Calculate Speeds and Feeds Based on Materials, Tooling, and Setup
VII. Set-Up and Operate Engine and Turret Lathes

Practical Application:

Student's first project should be to grind tool bit for turning and threading. Students should then be given several lathe projects involving the processes identified above.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-F5) dealing with operating vertical and horizontal mills and tooling.
Objective(s):

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

a. Define lathes, engine and turret;
b. Discuss lathe safety;
c. Explain machine components and accessories of lathes;
d. Describe and give function and maintenance of various types of tooling used on lathes;
e. Explain turning processes, inside and outside;
f. Calculate speeds and feeds based on materials, tooling and setup; and,
g. Set-up and operate engine and turret lathes.

Module Outline:

I. Define Lathes and Identify Types
   A. Engine
   B. Turret
   C. Computer Numerical Control (CNC)

II. Discuss Lathe Safety

III. Explain Machine Components and Accessories of Lathes
   A. Major components
      1. Bed
      2. Headstock
      3. Gearbox
      4. Carriage
         a. Saddle
         b. Cross-slide
         c. Compound rest
      5. Tailstock
   B. Accessories
      1. Centers
      2. Chucks
         a. Three-jaw universal
         b. Four-jaw independent
         c. Collet-type
         d. Magnetic
      3. Faceplate
      4. Steadyrest
      5. Follower rest
      6. Lathe dogs
IV. Describe and Give Function and Maintenance of Various Types of Tooling Used on Lathes
   A. Types
      1. O.D. turning tools
      2. I.D. turning tools
      3. Face turning tools
      4. Threading tools
      5. Grooving tools
      6. Knurling tools
      7. Form tools
   B. Maintenance and grinding

V. Explain Turning Processes
   A. Inside operations
      1. Drilling, tapping, reaming
      2. Boring
      3. Threading
      4. Chamfering
      5. Grooving
      6. Taper boring
   B. Outside operations
      1. Turning
         a. Chuck turning
         b. Between centers
         c. Form turning
         d. Taper turning
      2. Facing
      3. Threading
      4. Grooving
      5. Knurling
      6. Chamfering
      7. Cut-off
   C. Explain depth of cut

VI. Calculate Speeds and Feeds Based on Materials, Tooling, and Setup

VII. Set-Up and Operate Engine and Turret Lathes
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-F4
Operate Engine and Turret Lathes and Tooling
Self-Assessment

1. Identify types of lathes and discuss differences.

2. List five safety rules or precautions for lathe operation.

3. Name the five main units of a lathe.

4. What is the purpose of the cross-slide?

5. What is the purpose of the compound rest?

6. Name the three types of lathe centers and state the purpose of each.

7. Distinguish between a steadyrest and a follower rest.
8. Define and state the purpose of lathe dogs.

9. Name and state the purpose of four types of toolposts.

10. Describe three types of standard toolholders and state the purpose of each.

11. Make a sketch of a single-point cutting tool and label the face, cutting edge, nose, point, flank, and shank.

12. Describe the process for grinding a general-purpose toolbit.

13. Define a form tool and give an example of one.

14. Describe the process of using a twist drill bit in the tailstock to drill holes.

15. Describe knurling tools.
16. Describe threading tools, I.D. and O.D.

17. Explain how to machine an O.D. journal.

18. Describe a boring bar.

19. Explain a grooving process.

20. Explain the difference in techniques between turning material held in a chuck and material held between centers.

21. Calculate the TPF and tailstock offset for a taper with the following dimensions: \( D=1.625\), \( d=1.425\), \( TL=3\), \( OL=10\).

22. Calculate the RPM to rough-turn a 3.75" dia. piece of machine steel using a high-speed steel toolbit.

23. Define lathe feed.
24. What would the depth of the finishing cut be for a 2-1/2" dia. workpiece to be machined to 2.375" dia.?

25. Explain the knurling procedure, including the proper cutting speed and feed.

26. List the steps required to cut a 1-1/4 - 7 UNC thread on a 1-1/2" dia. shaft.

27. Explain how to true work in a four-jaw independent chuck.

28. List the steps to cut-off work in a chuck.

29. Explain the steps to bore a hole using the cross-slide and compound rest.

30. Explain the three-wire method of measuring 60° threads. Include the calculations required.
Subject: Tool & Die and EDM

Time: 30 Hrs.

Duty: Demonstrate Knowledge of Manufacturing Processes

Task: Operate Vertical and Horizontal Mills and Tooling

Objective(s):

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

a. Define milling machines, horizontal and vertical;
b. Discuss mill safety;
c. Explain machine components and accessories of milling machines;
d. Describe and give function of different types of tooling used on milling machines;
e. Explain milling processes;
f. Explain boring processes on milling machine;
g. Explain precision set-ups on the milling machine;
h. Calculate speeds, feeds, and depth of cut based on materials, tooling and setup; and,
i. Set-up and operate horizontal and vertical milling machine for milling and boring operations.

Instructional Materials:

MASTER Handout (TLD-F5-H0)
MASTER Laboratory Aid (TLD-F5-LA)
MASTER Self-Assessment

References:

NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition
Student Preparation:

Students should have previously completed the following Technical Modules:

- TLD-A1 through TLD-A6  “Practice Safety”
- TLD-B1 through TLD-B5  “Apply Mathematical Concepts”
- TLD-C1  “Interpret and Understand Basic Layout/Types of Drawings”
- TLD-C2  “Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances”
- TLD-C3  “Use and Apply Geometric Dimensioning and Tolerancing (GD&T)”
- TLD-C4  “Demonstrate Traditional Mechanical Drafting and Sketching Techniques”
- TLD-D1 through TLD-D3  “Demonstrate Knowledge of Manufacturing Materials”
- TLD-E1 through TLD-E6  “Measure/Inspect”
- TLD-F1  “Discuss Metal Cutting and Metal Cutting Tools”
- TLD-F2  “Operate Metal Saws”
- TLD-F3  “Operate Drill Presses and Tooling”
- TLD-F4  “Operate Engine and Turret Lathes and Tooling”

Introduction:

The milling machine is a versatile machine tool which can accurately utilize at least three axes to machine an unlimited variety of shapes. It can also handle many tasks normally performed by other machine tools such as drilling, reaming, thread cutting, boring, facing, and more. Because of its flexibility and usefulness, machinist and tool makers will spend countless hours operating a milling machine. Similarly, machine shop and tool and die students should be given instruction and experience in milling operations and processes.
Presentation Outline:

I. Define Milling Machines
   A. Horizontal
      1. Manufacturing type
      2. Knee-and-column type
   B. Vertical
      1. Standard
      2. Ram type
   C. CNC Machining Centers

II. Discuss Mill Safety

III. Explain Machine Components and Accessories of Milling Machines
   A. Major components
      1. Base
      2. Column
      3. Overarm
      4. Table
      5. Saddle
      6. Knee
   B. Accessories
      1. Fixtures
      2. Vises
      3. Parallel bars
      4. Arbors, collets, and adapters
      5. Milling attachment
      6. Slotting attachment
      7. Indexing or dividing head
      8. Rotary table
      9. Backlash eliminator

IV. Describe and Give Function of Different Types of Tooling Used on Milling Machines
   A. Arbor type cutters
      1. Plain
      2. Side-milling
      3. Face-milling
      4. Angular
      5. Formed
   B. End mills
      1. Standard
      2. Ball
      3. Bull
      4. Formed
      5. Shell
   C. Specialty cutters
1. T-slot
2. Dovetail
3. Woodruff keyseat
4. Flycutter

D. Tooling materials
1. High speed steel
2. Carbide brazed
3. Carbide inserted

V. Explain Milling Processes
A. Face milling
B. Side milling
C. Straddle milling
D. Slot or keyseat milling
E. Gang milling
F. Sawing or slitting
G. Specialty milling (T-slot, dovetail, woodruff keyseat, etc.)

VI. Explain Boring Processes on Milling Machine

VII. Explain Precision Set-Ups on the Milling Machine
A. Using the dial indicator
B. Digital readout devices
C. Aligning the head and table
D. Aligning the vise or fixture
E. Finding edge, center, or face locations

VIII. Calculate Speeds, Feeds, and Depth of Cut Based on Materials, Tooling and Setup

IX. Set-Up and Operate Horizontal and Vertical Milling Machine for Milling and Boring Operations

Practical Application:

Students should be given assigned projects involving the above setups and processes.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (TLD-F6) dealing with operating precision grinders.
Objective(s):

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

a. Define milling machines, horizontal and vertical;
b. Discuss mill safety;
c. Explain machine components and accessories of milling machines;
d. Describe and give function of different types of tooling used on milling machines;
e. Explain milling processes;
f. Explain boring processes on milling machine;
g. Explain precision set-ups on the milling machine;
h. Calculate speeds, feeds, and depth of cut based on materials, tooling and setup; and,
i. Set-up and operate horizontal and vertical milling machine for milling and boring operations.

Module Outline:

I. Define Milling Machines
   A. Horizontal
      1. Manufacturing type
      2. Knee-and-column type
   B. Vertical
      1. Standard
      2. Ram type
   C. CNC Machining Centers

II. Discuss Mill Safety

III. Explain Machine Components and Accessories of Milling Machines
   A. Major components
      1. Base
      2. Column
      3. Overarm
      4. Table
      5. Saddle
      6. Knee
   B. Accessories
      1. Fixtures
      2. Vises
      3. Parallel bars
      4. Arbors, collets, and adapters
5. Milling attachment
6. Slotting attachment
7. Indexing or dividing head
8. Rotary table
9. Backlash eliminator

IV. Describe and Give Function of Different Types of Tooling Used on Milling Machines
A. Arbor type cutters
   1. Plain
   2. Side-milling
   3. Face-milling
   4. Angular
   5. Formed
B. End mills
   1. Standard
   2. Ball
   3. Bull
   4. Formed
   5. Shell
C. Specialty cutters
   1. T-slot
   2. Dovetail
   3. Woodruff keyseat
   4. Flycutter
D. Tooling materials
   1. High speed steel
   2. Carbide brazed
   3. Carbide inserted

V. Explain Milling Processes
A. Face milling
B. Side milling
C. Straddle milling
D. Slot or keyseat milling
E. Gang milling
F. Sawing or slitting
G. Specialty milling (T-slot, dovetail, woodruff keyseat, etc.)

VI. Explain Boring Processes on Milling Machine

VII. Explain Precision Set-Ups on the Milling Machine
A. Using the dial indicator
B. Digital readout devices
C. Aligning the head and table
D. Aligning the vise or fixture
E. Finding edge, center, or face locations

VIII. Calculate Speeds, Feeds, and Depth of Cut Based on Materials, Tooling and Setup
IX. Set-Up and Operate Horizontal and Vertical Milling Machine for Milling and Boring Operations
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-F5
Operate Vertical and Horizontal Mills and Tooling
Self-Assessment

1. List types of horizontal milling machines and distinguish between each.

2. List types of vertical milling machines and distinguish between each.

3. List five safety rules or precautions for milling machine operation.

4. Name the six main units of a milling machine.

5. What is the purpose of a fixture?

6. Explain how parallel bars can be used in conjunction with a vise to machine parallel surfaces.
7. Name three methods of holding cutters on a milling machine.

8. Name three materials used in milling cutters.

9. List three types of arbor type cutters and discuss differences and applications of each.

10. List three types of end mills and discuss each.

11. Discuss what is meant by “center-cutting” end mills?

12. Explain face milling.

13. Explain straddle milling.


15. Distinguish between climb and conventional milling.
16. Explain the purpose of the backlash eliminator.

17. Explain a boring operation on a milling machine.

18. Explain how to use a dial indicator to align the head and table of a milling machine.

19. Explain how to "indicate in" or align a fixture or vise with the milling machine.

20. Explain how to set the cutter to the work surface using a long, thin piece of paper.

21. Determine the cutter speed, feed, and depth of cut for a 1/2" dia. 2-flute standard end mill cutting low-carbon steel held in a vise.

22. List the steps to set-up a die block and bore a close-tolerance hole to a precise location.

23. List the steps to set-up and machine a block square and parallel and to a specific size.
24. List the steps to accurately cut a 1/4" X 3" keyseat 1" from the end of a 2" dia. shaft. Include the calculations required and the measurement techniques.

25. Explain how to use a rotary table to mill a circular slot or surface.
Subject: Tool & Die and EDM

Time: 25 Hrs.

Duty: Demonstrate Knowledge of Manufacturing Processes

Task: Operate Precision Grinders

Objective(s):

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

a. Define types of precision grinders;
b. Discuss grinding safety;
c. Identify major components and accessories of grinding machines;
d. Identify types, nomenclature, and uses of grinding wheels;
e. Discuss care and maintenance of grinding wheels;
f. Identify the factors involved in electing grinding wheel specifications;
g. Explain grinding processes; and,
h. Setup and operate precision grinding machines.

Instructional Materials:

MASTER Handout (TLD-F6-HO)
MASTER Laboratory Aid (TLD-F6-LA)
MASTER Self-Assessment

References:


*NTMA Machinist Training Program Module(s)*, National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition


Introduction:

One of the most important processes to a tool maker is precision grinding. Initially used only for hardened parts, grinding was once considered impractical and more expensive than other machining methods. Today, however, modern grinding machines allow intricate parts to be produced faster and more accurately than even conventional machining. Toolmakers, therefore, are turning to grinding operations to manufacture parts where high accuracy and surface finish are required.

Presentation Outline:

I. Define Types and Uses of Precision Grinders
   A. Surface
      1. Horizontal with reciprocating or rotary motion table
2. Vertical with reciprocating or rotary motion table

B. Cylindrical
   1. Center type (universal)
   2. Centerless

C. Universal tool and cutter

II. Discuss Grinding Safety

III. Identify Major Components and Accessories of Grinding Machines

A. Hydraulic surface grinder
   1. Major Components
      a. Base
      b. Saddle
      c. Table
      d. Column
   2. Accessories
      a. Magnetic chuck
      b. Chuck blocks
      c. Sine chuck
      d. Adapter plate
      e. Angle plate
      f. Diamond dresser

B. Cylindrical grinder
   1. Major Components
      a. Base
      b. Wheelhead
      c. Table
      d. Headstock
      e. Footstock
      f. Work rest blade (centerless)
      g. Regulating wheel (centerless)
   2. Accessories
      a. Backrest or steadyrest
      b. Center rest
      c. Internal grinding attachment

C. Tool and cutter grinder
   1. Major components
      a. Base
      b. Wheelhead
      c. Saddle
      d. Table
   2. Accessories and attachments
      a. Headstock
      b. Footstock
      c. Centering gage
      d. Tooth rest
      e. Tooth rest blade
Mandrel

IV. Identify Types, Nomenclature, and Uses of Grinding Wheels
A. Abrasive Types
   1. Aluminum Oxide
   2. Silicon Carbide
B. Grain Size
C. Grade
D. Structure
E. Bond Type
F. Shapes

V. Discuss the Procedures to Care and Maintain Grinding Wheels
A. Inspecting
B. Mounting
C. Balancing
D. Truing and dressing

VI. Identify the Factors Involved in Selecting Grinding Wheel Specifications
A. Type of grinding operation
B. Material to be ground
C. Amount of stock to be removed
D. Area of contact
E. Finish required
F. Wheel speed
G. Method of cooling

VII. Explain Grinding Processes
A. Surface grinding operations
   1. Squaring blocks (flat and edge grinding)
   2. Vertical surfaces
   3. Angular surfaces
   4. Form grinding
   5. Cutoff operations
B. Cylindrical grinding operations
   1. Outside diameters
   2. Tapers
   3. Internal diameters
   4. Centerless grinding
C. Tool and cutter grinder operations
   1. Cylindrical grinding
   2. Plain helical milling cutter
   3. End mill
   4. Side and face milling cutters
   5. Form-relieved cutter

VIII. Setup and Operate Grinding Machines (Surface, Cylindrical, and Tool and Cutter)
Practical Application:

Students should be given projects involving the above processes.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-F7) dealing with operating heat treating equipment and processes.
Objective(s):

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

a. Define types of precision grinders;
b. Discuss grinding safety;
c. Identify major components and accessories of grinding machines;
d. Identify types, nomenclature, and uses of grinding wheels;
e. Discuss care and maintenance of grinding wheels;
f. Identify the factors involved in electing grinding wheel specifications;
g. Explain grinding processes; and,
h. Setup and operate precision grinding machines.

Module Outline:

I. Define Types and Uses of Precision Grinders
   A. Surface
      1. Horizontal with reciprocating or rotary motion table
      2. Vertical with reciprocating or rotary motion table
   B. Cylindrical
      1. Center type (universal)
      2. Centerless
   C. Universal tool and cutter

II. Discuss Grinding Safety

III. Identify Major Components and Accessories of Grinding Machines
   A. Hydraulic surface grinder
      1. Major Components
         a. Base
         b. Saddle
         c. Table
         d. Column
      2. Accessories
         a. Magnetic chuck
         b. Chuck blocks
         c. Sine chuck
         d. Adapter plate
         e. Angle plate
         f. Diamond dresser
   B. Cylindrical grinder
      1. Major Components
         a. Base
b. Wheelhead
c. Table
d. Headstock
e. Footstock
f. Work rest blade (centerless)
g. Regulating wheel (centerless)

2. Accessories
   a. Backrest or steadyrest
   b. Center rest
   c. Internal grinding attachment

C. Tool and cutter grinder
   1. Major components
      a. Base
      b. Wheelhead
      c. Saddle
      d. Table
   2. Accessories and attachments
      a. Headstock
      b. Footstock
      c. Centering gage
      d. Tooth rest
      e. Tooth rest blade
      f. Mandrel

IV. Identify Types, Nomenclature, and Uses of Grinding Wheels
   A. Abrasive Types
      1. Aluminum Oxide
      2. Silicon Carbide
   B. Grain Size
   C. Grade
   D. Structure
   E. Bond Type
   F. Shapes

V. Discuss the Procedures to Care and Maintain Grinding Wheels
   A. Inspecting
   B. Mounting
   C. Balancing
   D. Truing and dressing

VI. Identify the Factors Involved in Selecting Grinding Wheel Specifications
   A. Type of grinding operation
   B. Material to be ground
   C. Amount of stock to be removed
   D. Area of contact
   E. Finish required
   F. Wheel speed
   G. Method of cooling
VII. Explain Grinding Processes
   A. Surface grinding operations
      1. Squaring blocks (flat and edge grinding)
      2. Vertical surfaces
      3. Angular surfaces
      4. Form grinding
      5. Cutoff operations
   B. Cylindrical grinding operations
      1. Outside diameters
      2. Tapers
      3. Internal diameters
      4. Centerless grinding
   C. Tool and cutter grinder operations
      1. Cylindrical grinding
      2. Plain helical milling cutter
      3. End mill
      4. Side and face milling cutters
      5. Form-relieved cutter

VIII. Setup and Operate Grinding Machines (Surface, Cylindrical, and Tool and Cutter)
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-F6
Operate Precision Grinders
Self-Assessment

1. List and discuss the types of precision grinders.

2. Discuss grinding safety.

3. List the major components of the three types of grinding machines.

4. List some accessories of the three types of grinding machines.

5. Name two materials used to make grinding wheels.

6. Why is grain size important?

7. What bond type is most common in grinding wheels?

8. What factors are involved in selecting a grinding wheel for an application?
9. Select the proper grinding wheel to square grind a piece of SAE 1045 to a 63 finish using a straight wheel with coolant.

10. Explain how to inspect a grinding wheel for cracks before mounting.

11. Explain how to true and dress a grinding wheel using a diamond dresser.

12. Explain the steps to square grind a block to a specific size.

13. Explain the steps to grind a part at a precise angle.

14. Explain the steps to grind a shaft to a specific diameter.

15. Explain centerless grinding.

16. Explain how to sharpen an end mill on a tool and cutter grinder.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-F7

Subject: Tool & Die and EDM
Time: 10 Hrs.

Duty: Demonstrate Knowledge of Manufacturing Processes
Task: Operate Heat Treating Equipment and Processes

Objective(s):

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

a. Define heat treatment;
b. Identify types of heat treating equipment;
c. Identify the three major steps for all heat-treatment processes;
d. Explain heat treating processes and procedures;
e. Explain the terms relevant to heat treatment processes; and,
f. Set-up and operate heat treating equipment.

Instructional Materials:

MASTER Handout (TLD-F7-HO)
MASTER Laboratory Aid (TLD-F7-LA)
MASTER Self-Assessment

References:

NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition
Machining Fundamentals, John R. Walker, Goodheart-Willcox, Latest Edition
Student Preparation:

Students should have previously completed the following Technical Modules:

- TLD-A1 through TLD-A6  “Practice Safety”
- TLD-B1 through TLD-B5  “Apply Mathematical Concepts”
- TLD-C1  “Interpret and Understand Basic Layout/Types of Drawings”
- TLD-C2  “Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances”
- TLD-C3  “Use and Apply Geometric Dimensioning and Tolerancing (GD&T)”
- TLD-C4  “Demonstrate Traditional Mechanical Drafting and Sketching Techniques”
- TLD-D1 through TLD-D3  “Demonstrate Knowledge of Manufacturing Materials”
- TLD-E1 through TLD-E6  “Measure/Inspect”
- TLD-F1  “Discuss Metal Cutting an Metal Cutting Tools”
- TLD-F2  “Operate Metal Saws”
- TLD-F3  “Operate Drill Presses and Tooling”
- TLD-F4  “Operate Engine and Turret Lathes and Tooling”
- TLD-F5  “Operate Vertical and Horizontal Mills and Tooling”
- TLD-F6  “Operate Precision Grinders”

Introduction:

One of the most important mechanical properties of steel is its ability to be heat treated to improve certain characteristics and, therefore, its usefulness. Tools, die components, gages, and etc. must be hardened to resist wear and abrasion. Sometimes, toolmakers heat treat steel to soften it in order to improve ductility and machinability. In either case, a tool and die shop must have a thorough understanding of the heat treatment process. While this level of understanding requires years of experience to develop, students should become familiar with the basics and have the foundation to build upon.

Presentation Outline:

I. Define Heat Treatment
II. Identify Types of Heat Treating Equipment
III. Identify the Three Major Steps for All Heat-treatment Processes
   A. Heating
   B. Soaking
   C. Cooling
IV. Explain Heat Treating Processes and Procedures
A. Hardening
   1. Hardening temperature
   2. Quenching and quenching solutions
   3. Factors affecting hardness
B. Tempering, or drawing
   1. Need for tempering
   2. Tempering temperatures (and factors)
   3. Procedure
C. Annealing
   1. Need for annealing
   2. Types of annealing (and procedures)
      a. Full annealing
      b. Process annealing
      c. Spheroidizing annealing
D. Normalizing
   1. Normalizing temperature
   2. Procedure
E. Other methods of heat treatment
   1. Case-hardening
      a. Methods
      b. Hardening
   2. Flame Hardening
   3. Induction Hardening
   4. Laser and electron beam hardening

V. Explain the Terms Relevant to Heat Treatment Processes
A. Pearlite
B. Cementite
C. Austenite
D. Martensite
E. Troosite, sorbite, or tempered martensite
F. Eutectoid Steel
G. Hypereutectoid steel
H. Hypoeutectoid steel
I. Decalescence point
J. Recalcescence point
K. Lower critical temperature point
L. Upper critical temperature point
M. Critical range
N. Body-centered cube
O. Face-centered cube

VI. Set-Up and Operate Heat Treating Equipment
Practical Application:
If feasible, students should be given projects involving the above processes. If not, as many examples as possible will be very helpful.

Evaluation and/or Verification:
Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:
Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:
MASTER Technical Module (TLD-F8) dealing with operating sheet metal equipment.
Objective(s):

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

a. Define heat treatment;
b. Identify types of heat treating equipment;
c. Identify the three major steps for all heat-treatment processes;
d. Explain heat treating processes and procedures;
e. Explain the terms relevant to heat treatment processes; and,
f. Set-up and operate heat treating equipment.

Module Outline:

I. Define Heat Treatment
II. Identify Types of Heat Treating Equipment
III. Identify the Three Major Steps for All Heat-treatment Processes
   A. Heating
   B. Soaking
   C. Cooling
IV. Explain Heat Treating Processes and Procedures
   A. Hardening
      1. Hardening temperature
      2. Quenching and quenching solutions
      3. Factors affecting hardness
   B. Tempering, or drawing
      1. Need for tempering
      2. Tempering temperatures (and factors)
      3. Procedure
   C. Annealing
      1. Need for annealing
      2. Types of annealing (and procedures)
         a. Full annealing
         b. Process annealing
         c. Spheroidizing annealing
   D. Normalizing
      1. Normalizing temperature
      2. Procedure
   E. Other methods of heat treatment
      1. Case-hardening
         a. Methods
         b. Hardening
2. Flame Hardening
3. Induction Hardening
4. Laser and electron beam hardening

V. Explain the Terms Relevant to Heat Treatment Processes
A. Pearlite
B. Cementite
C. Austenite
D. Martensite
E. Troosite, sorbite, or tempered martensite
F. Eutectoid Steel
G. Hypereutectoid steel
H. Hypoeutectoid steel
I. Decalescence point
J. Recalescence point
K. Lower critical temperature point
L. Upper critical temperature point
M. Critical range
N. Body-centered cube
O. Face-centered cube

VI. Set-Up and Operate Heat Treating Equipment
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.

2. Explain the use of the thermocouple and pyrometer.

3. Define soaking.


5. Explain how medium- or high-carbon tool steel is hardened.

6. Name three ways the hardening temperature of steel can be determined.

7. List four factors that affect the hardness.
8. List four kinds of quenching solutions and identify which cools most rapidly and which cools most slowly.

9. What is the purpose of tempering?

10. What factors must be considered in deciding what tempering temperature to use?

11. When should hardened steel be tempered?

12. List three kinds of annealing processes and explain the purpose of each kind.

13. Explain how full annealing is done.

14. Define normalizing and explain how it is done.

15. Define case-hardening and list the two steps.
16. List three kinds of case-hardening methods.

17. Briefly explain flame hardening and induction hardening.

18. Define pearlite, cementite, austenite, and martensite.

19. What is the difference between the decaescence point and the recaescence point of a piece of steel?

20. Define lower critical point and upper critical point.

21. At what point in relation to the upper and lower critical temperatures is hardening performed?

22. At what point in relation to the upper and lower critical temperatures is tempering performed?

23. Define critical range.
24. Explain the difference between eutectoid, hypereutectoid, and hypoeutectoid steel.

25. Describe the arrangement of atoms in a body- and a face-centered cube.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-F8

Subject: Tool & Die and EDM

Time: 4 Hrs.

Duty: Demonstrate Knowledge of Manufacturing Processes

Task: Operate Sheet Metal Equipment

Objective(s):

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

a. Discuss fabrication of sheet metal parts;
b. Discuss gas/plasma cutting equipment and processes;
c. Discuss shearing operation and equipment;
d. Discuss pressworking processes;
e. Demonstrate sheet metal layout; and,
f. Apply conservation-of-material concepts.

Instructional Materials:

MASTER Handout (TLD-F8-HO)
MASTER Laboratory Aid (TLD-F8-LA)
MASTER Self-Assessment

References:

NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition
Machining Fundamentals, John R. Walker, Goodheart-Willcox, Latest Edition
**Introduction:**

An important part of manufacturing can be classified as sheet metal operations. Many tools and all dies are for use in sheet metal processes. In addition, toolmakers will certainly find, from time to time, that they need to utilize certain sheet metal processes in building tools and dies. This necessitates an understanding of sheet metal fundamentals by tool and die makers. The intent of this module is simply to introduce sheet metal operations to tool and die students and give them working definitions of these processes.

**Presentation Outline:**

I. Discuss Fabrication of Sheet Metal Parts  
   A. Sheet metal definition  
   B. Sheet metal sizes  
   C. Pattern development  
   D. Hems, edges, and seams  

II. Discuss Gas Cutting Equipment
A. Oxygen-acetylene gas torch
B. Plasma torch (nitrogen and oxygen)
C. Single and gantry types
D. Control methods
   1. Tracer and “Electric Eye”
   2. CNC

III. Discuss Shearing Operations and Equipment

IV. Discuss Pressworking Processes
   A. Punch press
   B. CNC turret punch press
   C. Press brake
   D. Roll forming machine

V. Discuss Sheet Metal Layout
   A. Templates
   B. Layout-on-metal

VI. Discuss Conservation-of-Material Concepts

---

Practical Application:

If feasible, students should be given simple projects involving the above processes. If not, as many examples as possible will be very helpful.

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Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

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Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

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Next Lesson Assignment:

MASTER Technical Module (TLD-F9) dealing with operating welding equipment and processes.
TLD-F8-HO
Operate Sheet Metal Equipment
Attachment 1: MASTER Handout

Objective(s):
Upon completion of this module the student will be able to:
a. Discuss fabrication of sheet metal parts;
b. Discuss gas/plasma cutting equipment and processes;
c. Discuss shearing operation and equipment;
d. Discuss pressworking processes;
e. Demonstrate sheet metal layout; and,
f. Apply conservation-of-material concepts.

Module Outline:
I. Discuss Fabrication of Sheet Metal Parts
   A. Sheet metal definition
   B. Sheet metal sizes
   C. Pattern development
   D. Hems, edges, and seams
II. Discuss Gas Cutting Equipment
    A. Oxygen-acetylene gas torch
    B. Plasma torch (nitrogen and oxygen)
    C. Single and gantry types
    D. Control methods
       1. Tracer and "Electric Eye"
       2. CNC
III. Discuss Shearing Operations and Equipment
IV. Discuss Pressworking Processes
    A. Punch press
    B. CNC turret punch press
    C. Press brake
    D. Roll forming machine
V. Discuss Sheet Metal Layout
    A. Templates
    B. Layout-on-metal
VI. Discuss Conservation-of-Material Concepts
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-F8
Operate Sheet Metal Equipment
Self-Assessment

1. Define sheet metal

2. Discuss how sheet metal is sized.

3. How thick is 10 ga. material?

4. Explain the pattern layout for a cylinder.

5. What is a hem?

6. What is a bend allowance and how is it used?

7. What is the difference between a plasma torch and an oxy-acetylene torch?

8. Explain what is meant by a gantry system.
9. What must you have to use a tracer or "electric eye" burner?

10. Explain the use of CNC controls on a CNC burner.

11. Explain how you could use a plate shear to cut a square plate.

12. What is the difference between a punch press and a brake press?

13. Which would you use to form large cone from a sheet metal pattern?

14. What is a hand brake?

15. Explain the term "die" as it relates to a press brake and a punch press.

16. Explain the purpose of the turret on a CNC turret punch press.

17. Explain the use of templates in sheet metal work.
18. Explain the term "nesting."

19. Why is layout-on-metal often necessary?

20. Explain the steps necessary to cut and make a rectangular box (in one piece) from a 12 ga. sheet.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-F9

Subject: Tool & Die and EDM
Time: 4 Hrs.

Duty: Demonstrate Knowledge of Manufacturing Processes
Task: Operate Sheet Metal Equipment

Objectives:

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

a. Discuss welding safety;
b. Identify and discuss types of welds;
c. Identify and discuss weld joints;
d. Identify and interpret weld symbols;
e. Identify and discuss welding processes;
f. Discuss weld characteristics; and,
g. Discuss edge preparation and fit-up.

Instructional Materials:

MASTER Handout (TLD-F9-HO)
MASTER Laboratory Aid (TLD-F9-LA)
MASTER Self-Assessment

References:

Modern Welding, Althouse, Turnquist, Bowditch, and Bowditch, Goodheart-Willcox, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

- TLD-A1 through TLD-A6 “Practice Safety”
- TLD-B1 through TLD-B5 “Apply Mathematical Concepts”
- TLD-C1 “Interpret and Understand Basic Layout/Types of Drawings”
- TLD-C2 “Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances”
- TLD-C3 “Use and Apply Geometric Dimensioning and Tolerancing (GD&T)”
- TLD-C4 “Demonstrate Traditional Mechanical Drafting and Sketching Techniques”
- TLD-D1 through TLD-D3 “Demonstrate Knowledge of Manufacturing Materials”
- TLD-E1 through TLD-E6 “Measure/Inspect”
- TLD-F1 “Discuss Metal Cutting and Metal Cutting Tools”
- TLD-F2 “Operate Metal Saws”
- TLD-F3 “Operate Drill Presses and Tooling”
- TLD-F4 “Operate Engine and Turret Lathes and Tooling”
- TLD-F5 “Operate Vertical and Horizontal Mills and Tooling”
- TLD-F6 “Operate Precision Grinders”
- TLD-F7 “Operate Heat Treating Equipment and Processes”
- TLD-F8 “Operate Sheet Metal Equipment”

Introduction:

Welding is an important manufacturing process used in manufacturing today. It is one of the principle means of fabricating and repairing metal products. Many times, welding is used on tooling either as the fastener of choice or in repair. Although tool and die makers are typically recognized for their machining skills, it is important that they know the basics of welding technology.

Presentation Outline:

I. Discuss Welding Safety
   II. Identify and Discuss Types of Welds
       A. Surfacing weld
       B. Fillet weld
       C. Groove weld
       D. Plug and slot weld
   III. Identify and Discuss Weld Joints
IV. Identify and Interpret Weld Symbols

V. Identify and Discuss Welding Processes
   A. Oxyacetylene welding (OAW)
   B. Arc Welding
      1. Shielded Metal-Arc Welding (SMAW)
      2. Gas Shielded-Arc Welding (GTAW and GMAW)
   C. Other Welding Processes
      1. Brazing
      2. Surfacing
      3. Pipe Welding
      4. Cutting Operations
      5. Resistance

VI. Discuss Weld Characteristics
   A. Penetration
   B. Defects
   C. Residual Stresses
   D. Distortion

VII. Discuss Edge Preparation and Fit-up

---

Practical Application:

Students should be shown examples of as many of the above welds, joints, and processes as feasible. Students should then demonstrate basic OAW, SMAW, and GMAW.

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Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

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Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (TLD-F10) dealing with estimating time required and cost to produce a part.
Objectives:

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

a. Discuss welding safety;
b. Identify and discuss types of welds;
c. Identify and discuss weld joints;
d. Identify and interpret weld symbols;
e. Identify and discuss welding processes;
f. Discuss weld characteristics; and,
g. Discuss edge preparation and fit-up.

Module Outline:

I. Discuss Welding Safety
II. Identify and Discuss Types of Welds
   A. Surfacing weld
   B. Fillet weld
   C. Groove weld
   D. Plug and slot weld
III. Identify and Discuss Weld Joints
    A. Butt joint
    B. Tee joint
    C. Lap joint
    D. Corner joint
    E. Edge joint
IV. Identify and Interpret Weld Symbols
V. Identify and Discuss Welding Processes
   A. Oxyacetylene welding (OAW)
   B. Arc Welding
      1. Shielded Metal-Arc Welding (SMAW)
      2. Gas Shielded-Arc Welding (GTAW and GMAW)
   C. Other Welding Processes
      1. Brazing
      2. Surfacing
      3. Pipe Welding
      4. Cutting Operations
      5. Resistance
VI. Discuss Weld Characteristics
    A. Penetration
    B. Defects
C. Residual Stresses
D. Distortion

VII. Discuss Edge Preparation and Fit-up
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-F9
Operate Welding Equipment and Processes
Self-Assessment

1. What precautions must be taken before cutting or welding a container?

2. List eight safety precautions for cutting.

3. List three basic safety rules for oxyacetylene equipment.

4. List eight safety precautions or warnings for arc welding and arc welding equipment.

5. List and explain four types of welds.
6. List and describe the five basic types of weld joints.

7. Draw the weld symbol for a 1/4" fillet weld opposite side 1" long 4" pitch.

8. What are the principle components of oxyacetylene welding?

9. Briefly explain the basic procedure for OAW.

10. What is unique about the acetylene hose connector and how can you distinguish it from the oxygen connector?

11. What are the principle components of a SMAW welding process?

12. What basic principles can be used to sustain a stable arc?

13. How does the appearance of the molten puddle and weld bead indicate a good or poor weld?
14. What is an undercut? What is an overlap?

15. Briefly explain the GTAW process.

16. What is the purpose of the tungsten electrode in a TIG process?

17. What are the principle components of the GMAW process?

18. Describe the characteristics of a good weld.

19. Discuss residual stress and distortion from the welding process.

20. Very briefly explain the basics of the following welding processes: brazing, surfacing, and pipe welding.
Subject: Tool & Die and EDM
Time: 4 Hrs.

Duty: Demonstrate Knowledge of Manufacturing Processes

Task: Estimate Time Required/Cost to Produce a Part

Objective(s):

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

a. Determine component parts and requirements for assembly;
b. Determine processes required to produce piece parts;
c. Determine the material requirements and costs;
d. Determine tooling required;
e. Estimate time required to manufacture and assemble parts; and,
f. Estimate manufacturing costs.

Instructional Materials:

MASTER Handout (TLD-F10-HO)
MASTER Laboratory Aid (TLD-F10-LA)
MASTER Self-Assessment

References:

NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744, Latest Edition
Machining Fundamentals, John R. Walker, Goodheart-Willcox, Latest Edition
Introduction:

Many times tool and die makers are asked to make time, cost, or material estimates for the manufacture of a particular part. These estimates are sometimes used to make price quotations, schedule production, order stock material, or predetermine tooling or personnel requirements.

Presentation Outline:

I. Determine Component Parts and Requirements for Assembly
II. Determine Processes Required to Produce Piece Parts
   A. Considerations
1. Shape and size
2. Fit and form tolerances and specifications
3. Safety factors

B. Order of operations
C. Buy vs. make
   1. Capabilities
   2. Workload

III. Determine the Material Requirements and Costs
A. Stock material
   1. Types and sizes
   2. Quantity required
      a. Finished quantity
      b. Machining excess
      c. Scrap factor
      d. Material conservation techniques
   3. Calculating material costs
      a. Cost per unit
      b. Total amount required
      c. Freight costs
      d. Overhead

B. Purchased components

IV. Determine Tooling Required
A. Fixtures, jigs, vices, etc.
B. Cutting tools
C. Lubrication/coolant requirements
D. Additional resources required

V. Estimate Manufacturing Time
A. Setup
   1. Lot size
   2. Tooling
   3. Rigidity
B. Cycle time
   1. Speeds and feeds
   2. Depth of cut
C. Tool life
D. Handling time
   1. Transport
   2. Load/unload
E. Personal allowance time

VI. Estimate Manufacturing Costs (MLO)
A. Material
B. Labor
C. Overhead
Practical Application:

Students should be given problems and exercises to calculate time, material, and manufacturing costs.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-G1) dealing with using computer operating systems.
Objective(s):

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

a. Determine component parts and requirements for assembly;
b. Determine processes required to produce piece parts;
c. Determine the material requirements and costs;
d. Determine tooling required;
e. Estimate time required to manufacture and assemble parts; and,
f. Estimate manufacturing costs.

Module Outline:

I. Determine Component Parts and Requirements for Assembly
II. Determine Processes Required to Produce Piece Parts
   A. Considerations
      1. Shape and size
      2. Fit and form tolerances and specifications
      3. Safety factors
   B. Order of operations
   C. Buy vs. make
      1. Capabilities
      2. Workload
III. Determine the Material Requirements and Costs
   A. Stock material
      1. Types and sizes
      2. Quantity required
         a. Finished quantity
         b. Machining excess
         c. Scrap factor
         d. Material conservation techniques
      3. Calculating material costs
         a. Cost per unit
         b. Total amount required
         c. Freight costs
         d. Overhead
   B. Purchased components
IV. Determine Tooling Required
   A. Fixtures, jigs, vices, etc.
   B. Cutting tools
   C. Lubrication/coolant requirements
D. Additional resources required

V. Estimate Manufacturing Time
A. Setup
   1. Lot size
   2. Tooling
   3. Rigidity
B. Cycle time
   1. Speeds and feeds
   2. Depth of cut
C. Tool life
D. Handling time
   1. Transport
   2. Load/unload
E. Personal allowance time

VI. Estimate Manufacturing Costs (MLO)
A. Material
B. Labor
C. Overhead
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-F10
Estimate Time Required/Cost to Produce a Part
Self-Assessment

1. Using Project #8 in the student workbook, list the component parts that make up the Drilling and Tapping Fixture assembly.

2. List in order the processes required to manufacture Part #5. Assume there are no restrictions because of workload or capabilities and that out-sourcing is unfeasible.

3. If the material for part #5 cost $1.00/lb (freight included), what is the total material cost, including machining excess and scrap quantity?

4. What tooling will be required to manufacture part #5?

5. In determining whether to buy or make in-house, what factors are to be considered?

6. In determining manufacturing time, what factors are to be considered?

7. In determining setup time per piece, what factors are to be considered?
8. In determining cycle time, what factors are to be considered?

9. In determining manufacturing costs, what factors are to be considered?

10. Estimate the MLO for the part below, using the following guidelines:

<table>
<thead>
<tr>
<th>Material</th>
<th>Machine Steel</th>
<th>Shop Rate</th>
<th>$50/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock Size</td>
<td>1.000&quot; Dia.</td>
<td>Overhead</td>
<td>5%</td>
</tr>
<tr>
<td>Mat. Cost:</td>
<td>$1.00/lb.</td>
<td>Lot size</td>
<td>100</td>
</tr>
</tbody>
</table>

![Diagram of part dimensions]
DUTIES

TOOL AND DIE MAKER ... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

**A** Practice Safety
- A-1 Follow safety manuals and all safety regulations/restrictions

**B** Apply Mathematical Concepts
- B-1 Perform basic arithmetic functions

**C** Interpret Engineering Drawings and Related Documents
- C-1 Interpret and understand basic layout/typologies of drawings
- C-2 Interpret, review, and apply blueprints, notes, dimensions, and tolerances

**D** Demonstrate Knowledge of Manufacturing Materials
- D-1 Identify materials with desired properties
- D-2 Identify materials and processes to produce a part

**E** Measure/Inspect
- E-1 Understand metrology terms
- E-2 Select measurement tools
- E-3 Measure with hand-held instruments
- E-4 Eliminate measurement variables

**F** Demonstrate Knowledge of Manufacturing Processes
- F-1 Discuss metal cutting and metalworking tools
- F-2 Operate metal saws
- F-3 Operate drill presses and tooling
- F-4 Operate engine and turret lathes and tooling

**G** Use Computers
- G-1 Use computer operating systems
- G-2 Understand computer terminology
- G-3 Use file management systems

**H** Perform CAD/CAM and CNC Programming Tasks
- H-1 Discuss fundamentals of CNC machines and controls
- H-2 Program and operate CNC milling machines and machining centers
- H-3 Program and operate CNC lathes
- H-4 Use Computer-Aided Drafting (CAD) System
- H-5 Create 3-D solid models

**I** Perform Tool and Die Making Operations
- I-1 Discuss basic types and functions of jigs and fixtures
- I-2 Utilize concepts of jig and fixture design
- I-3 Demonstrate understanding of different types of industrial dies

**J** Operate Electrical Discharge Machine (EDM)
- J-1 Discuss fundamentals of EDM
- J-2 Setup and operate conventional sinker EDM
- J-3 Setup and operate CNC sinker EDM and EDM drills
- J-4 Program, setup, and operate CNC wire EDM

**Tasks**

- A-2 Maintain safe equipment and machinery
- A-3 Use safe operating procedures for hand and machine tools
- A-4 Maintain a clean and safe work environment
- A-5 Use safe material handling practices
- A-6 Consult and apply MSDS for hazards of various materials

- B-2 Perform basic geometric operations
- B-3 Use basic trigonometric functions
- B-4 Perform basic geometric operations
- B-5 Use and apply Cartesian Coordinate System

- C-3 Use and apply geometric dimensioning and tolerancing (GD&T)
- C-4 Demonstrate traditional drafting and sketching techniques
- C-5 Understand and use quality systems

- D-3 Discuss classification systems for metal
- D-4 Demonstrate traditional mechanical drafting and sketching techniques

- E-5 Measure/inspect using surface plate and accessories
- E-6 Inspect using stationary equipment

- F-5 Operate vertical and horizontal mills and tooling
- F-6 Operate precision grinders
- F-7 Operate heat treating equipment and processes
- F-8 Operate sheet metal equipment and processes
- F-9 Operate welding equipment and processes
- F-10 Estimate time required/cost to produce a part

- G-4 Install and use software packages

- H-6 Use Computer-Aided Manufacturing (CAM) system

- I-4 Utilize basic die theory
- I-5 Utilize principles of die design
- I-6 Perform tool and die repair
- I-7 Demonstrate tool and die-making skills

- J-5 Program and operate CNC sinker EDM, EDM drills
- J-6 Program, setup, and operate CNC wire EDM
Subject: Tool & Die and EDM

Time: 10 Hrs.

Duty: Use Computers

Task: Use Computer Operating Systems

Objective(s):

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

a. Distinguish between a directory/file folder and a file;
b. Understand data organization and terminology;
c. Explain the function of an operating system;
d. Explain what the term “IBM compatible” means;
e. Use a mouse;
f. Utilize file manager in Windows 3.1 to view directories and files;
g. Utilize explorer in Windows 95 to view folders and files; and,
h. Explain and use basic network concepts.

Instructional Materials:

Data Disks with files
MASTER Handout (TLD-G1-HO)
MASTER Laboratory Worksheets (TLD-G1-LW1; TLD-G1-LW2; TLD-G1-LW3)
MASTER Self-Assessment

References:

Windows 3.1 and/or Windows 95 Computer Lab, Latest Edition
Introduction to Using Windows 3.1, Latest Edition
Introduction to Using Windows 95, Latest Edition
Introduction to Using Networks, Latest Edition

Student Preparation:

None

Introduction:

Technicians are like all other people in today's workplace. They must be able to use the computer as a tool to get their work done. In order to use computers effectively, it is
important that one understands components and operating systems as they relate to the use of a computer. This module will introduce the student to these concepts and provide a foundation for developing good basic skills in the use of a computer.

Presentation Outline:

I. Introduction to Computers
   A. Discuss hardware components
   B. Explain disk drive configurations
   C. Discuss software
      1. Application programs
      2. Operating systems
         a. DOS
         b. Windows
         c. Windows 95
         d. Network operating systems
   D. Discuss brands of computers
      1. Apple & MacIntosh
      2. IBM & compatibles
   E. Explain data organization
      1. Files
      2. Filenames and extensions
      3. Root directory & backward slash (\)
      4. Directory and subdirectory structure
   F. Explain the terms directory path and file specification

II. Introduction to the Windows Operating System
   A. Discuss how to start Windows
   B. Discuss basic mouse operations
      1. Pointing
      2. Clicking
      3. Double clicking
      4. Dragging
   C. Discuss Windows elements
      1. Window borders
      2. Title bar
      3. Control-menu box
      4. Mouse pointer
      5. Sizing buttons
      6. Scroll bar and arrows
      7. Menu bar
      8. Pull-down menus
      9. Work area
      10. Icons
   D. Use File Manager
1. Explain the file manager screen
2. Change drives
3. Expand directories
4. Collapse directories
5. Change file information displayed
6. Run an application

E. Run an application from an icon in Program Manager

III. Introduction to Windows 95 Operating System
   A. Discuss Windows 95 desktop components
      1. My Computer icon
      2. Recycle Bin icon
      3. Network Neighborhood icon
      4. Start button
      5. Taskbar
   B. Use Windows 95
      1. Open a window from an icon
      2. Use sizing buttons and close button
      3. Discuss Start menu
      4. Open an application using the Start button
      5. Explain shut down menu under Start
      6. Use Windows Explorer
         a. Explain Windows Explorer toolbar buttons
         b. Explain folders and subfolders
         c. Select folders
         d. Open and close folders
         e. Change drives
         f. Change file list display

IV. Introduction to Computer Network Systems
   A. Explain what a network is
   B. Discuss basic network components
      1. File server
      2. Network operating system (NOS)
      3. Local area network (LAN) cable
      4. Network devices
   C. Explain types of networks
      1. Campus
      2. National
      3. International
   D. Explain and use basic network concepts
      1. File server login/logout
      2. Application sharing
      3. Document sharing
      4. Electronic mail
Practical Application:

Students will use Windows 3.1, Windows 95, and a NOS by completing the Laboratory Worksheets labeled TLD-G1-LW1, TLD-G1-LW2, and TLD-G1-LW3.

Evaluation and/or Verification:

Successful completion of this technical module will be determined by the student’s ability to successfully demonstrate the following competencies:

1. Explain the function of an operating system;
2. Define terminology associated with data organization;
3. Explain the term “IBM compatible;”
4. Define terminology associated with basic network concepts;
5. Use File Manager in Windows to view the directory structure of a disk, to view the contents of a directory, and to change the display of a file list; and,
6. Use Windows Explorer in Windows 95 to view the directory structure of a disk, to view the contents of a directory, and to change the display of a file list.

Summary:

Review the concepts covered in this module in preparation for the self-assessment.

Next Lesson Assignment:

MASTER Technical Module (TLD-G2) dealing with understanding computer terminology.
Objective(s):

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

a. Distinguish between a directory/file folder and a file;
b. Understand data organization and terminology;
c. Explain the function of an operating system;
d. Explain what the term “IBM compatible” means;
e. Use a mouse;
f. Utilize file manager in Windows 3.1 to view directories and files;
g. Utilize explorer in Windows 95 to view folders and files; and,
h. Explain and use basic network concepts.

Module Outline:

I. Introduction to Computers
   A. Discuss hardware components
   B. Explain disk drive configurations
   C. Discuss software
      1. Application programs
      2. Operating systems
         a. DOS
         b. Windows
         c. Windows 95
         d. Network operating systems
   D. Discuss brands of computers
      1. Apple & MacIntosh
      2. IBM & compatibles
   E. Explain data organization
      1. Files
      2. Filenames and extensions
      3. Root directory & backward slash (\)
      4. Directory and subdirectory structure
   F. Explain the terms directory path and file specification

II. Introduction to the Windows Operating System
   A. Discuss how to start Windows
   B. Discuss basic mouse operations
      1. Pointing
      2. Clicking
      3. Double clicking
      4. Dragging
C. Discuss Windows elements
   1. Window borders
   2. Title bar
   3. Control-menu box
   4. Mouse pointer
   5. Sizing buttons
   6. Scroll bar and arrows
   7. Menu bar
   8. Pull-down menus
   9. Work area
  10. Icons

D. Use File Manager
   1. Explain the file manager screen
   2. Change drives
   3. Expand directories
   4. Collapse directories
   5. Change file information displayed
   6. Run an application

E. Run an application from an icon in Program Manager

III. Introduction to Windows 95 Operating System
A. Discuss Windows 95 desktop components
   1. My Computer icon
   2. Recycle Bin icon
   3. Network Neighborhood icon
   4. Start button
   5. Taskbar

B. Use Windows 95
   1. Open a window from an icon
   2. Use sizing buttons and close button
   3. Discuss Start menu
   4. Open an application using the Start button
   5. Explain shut down menu under Start
   6. Use Windows Explorer
      a. Explain Windows Explorer toolbar buttons
      b. Explain folders and subfolders
      c. Select folders
      d. Open and close folders
      e. Change drives
      f. Change file list display

IV. Introduction to Computer Network Systems
A. Explain what a network is
B. Discuss basic network components
   1. File server
   2. Network operating system (NOS)
   3. Local area network (LAN) cable
4. Network devices

C. Explain types of networks
   1. Campus
   2. National
   3. International

D. Explain and use basic network concepts
   1. File server login/logout
   2. Application sharing
   3. Document sharing
   4. Electronic mail
TLD-G1-LW1
Use Computer Operating Systems
Attachment 2: MASTER Laboratory Worksheet No. 1

Introduction to Using Windows 3.1

1. Double-click the Main Group and open the File Manager. Click Tree and choose Indicate Expandable Branches, if it has not been selected. What lets you know this selection has been made? What does this selection do?

2. Select the root of drive C. Choose Tree from the command bar. Then clock Collapse Branch. What does this selection do?

3. Choose Tree again and click Expand One Level. How many directories/folders are on drive C?

4. In the command bar, select Tree and choose Expand All. What happened?

5. Find the folder WPWIN. How many subdirectories/subfolders are listed under the directory/folder name TEMPLATE?

6. Double-click a directory/folder that contains a subdirectory/subfolder. What happened?

7. What happens if you double-click the folder again?

8. Place a disk in drive A. How can you view the contents of the file in drive A?

9. Select drive C again. Under View, choose All File Details. What happened?

10. Select the MACROS subdirectory/subfolder under WPWIN. Go to View and choose Sort by Name. What is the first file listed? Sort by Type. The first file listed is ____________________________
Sort by Size. The first file listed is ________________________________

Sort by Date. The first file listed is ________________________________

11. How can the list of files in a particular folder be viewed?

12. Exit File Manager and close the Main Group. How did you do this?

13. How could an application package, such as WordPerfect for Windows, be loaded and run from Windows 3.1?
Introduction to Using Windows 95

1. Click Start, go to Programs, and click Windows Explorer.

2. Maximize the window, if necessary.

3. Click in the square to the left of the My Computer icon.

4. What does a + in the square mean? What happens when you click the +?

5. What does a - in the square mean? What happens when you click the -?

6. Click on C:. How many directories/folders are at the root of drive C? How many files are at the root of drive C?

7. Expand drive C. How many directories under drive C are expandable?

8. How do you expand and collapse directories/folders?

9. Click View and select Details, what happened?

10. Put a disk in drive A and select drive A. How many directories/folders and files are at the root of drive A?

11. Select drive C again and open the DOS folder. How can you sort the file list by name, type, size, or date?

12. Exit Explorer. How did you do this?
13. How do you run an application package, such as WordPerfect, from Windows 95?
**Introduction to Using Networks**

1. Locate the file server? Where is it?

2. What type of NOS is being used in this lab?

3. How do you login to the file server? What is the purpose of this?

4. Can you send an e-mail message in this lab? If so, what steps must be taken to do this?

5. What type of “sharing” can be done?

6. How can the directory structure of the file server be viewed?

7. Logout of the network. What is the purpose of this?
TLD-G1
Use Computer Operating Systems
Self-Assessment

1. Explain the function of an operating system?

2. What does the term “IBM compatible” mean?

3. Create your own names for directories/folders and files to design a directory structure containing three directories at the root. The first directory is to hold two files and one subdirectory. The second directory is to hold two subdirectories with one file in each subdirectory. The third directory should contain five files.

4. What is a directory/folder?

5. What does the term “path” mean?

6. What is a file specification?

7. What does the backward slash (\) represent?

8. What is a network and what are the basic network components?

9. What do the acronyms NOS and LAN stand for?
10. What is the purpose of logging into a network?

11. What is the purpose of logging out of a network?

12. What is meant by application sharing?

13. What is meant by document sharing?

14. What is electronic mail?

THE FOLLOWING QUESTIONS CONCERN WINDOWS 3.1.

15. When using Windows 3.1, how can the directory structure of a disk be viewed?

16. Using Windows 3.1, write how to do each of the following:
   a. View the directory contents of a different drive
   b. Expand and collapse a directory
   c. Change the file information displayed

17. How do you run an application such as Lotus 123 or WordPerfect from Windows 3.1?
18. What are the rules for naming files in Windows 3.1?

THE FOLLOWING QUESTIONS CONCERN WINDOWS 95.

19. When using Windows 95 how can the directory structure of a disk be viewed?

20. Using Windows 95, write how to do each of the following:
   a. Open and close a folder
   b. View directory contents of a different drive
   c. Change the file list display

21. How can directories/folders be distinguished from files?

22. How do you run an application, such as Lotus 123, from Windows 95?
Subject: Tool & Die and EDM

Duty: Use Computers

Task: Understand Computer Terminology

Objective(s):

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

a. Explain what RAM is;
b. Explain what ROM is;
c. Explain memory caching;
d. Define and convert bytes, kilobytes, and megabytes;
e. Discuss the function of a central processing unit;
f. Discuss processor speed; and,
g. Understand RS-232 protocol.

Instructional Materials:

MASTER Handout (TLD-G2-HO)
MASTER Self-Assessment

References:

Student Preparation:

Students should have previously completed the following technical modules:

TLD-G1 “Use Computer Operating Systems”

Introduction:

In order for the technicians to maximize the use of the computer and its related software, it is important that they have a conceptual understanding of how information and data are managed and processed within the computer. This module will introduce the student to the computer’s brain, memory, and basic design for getting things done that are of value to the user.
Presentation Outline:

I. Explain What Memory Is
   A. RAM
   B. ROM
   C. Cache memory
   D. Measuring memory
      1. Byte
      2. Kilobyte
      3. Megabyte

II. Discuss Purpose and Function Of:
    A. Central Processing Units (CPUs)
    B. Processor performance
       1. Speed
       2. Generation
       3. Type
    C. RS-232 serial port

III. Determine the Amount of Available Memory on a System
    A. Choose About from the Help menu in Program Manager for Windows 3.1
    B. Choose About from the Help menu in Windows Explorer for Windows 95

Evaluation and/or Verification:

Successful completion of this technical module will be determined by the student's ability to successfully demonstrate the following competencies:
1. Define RAM and explain its function;
2. Define ROM and explain its function;
3. Explain the value of memory caching;
4. Explain the function of the CPU;
5. Determine the faster processor speed and explain what determines the speed;
6. Convert between bytes, kilobytes, and megabytes; and,
7. Explain the significance of a RS-232 serial port.

Summary:

Review the concepts covered in this module in preparation for the self-assessment.
Next Lesson Assignment:

MASTER Technical Module (TLD-G3) dealing with the use of file management systems.
Objective(s):

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

a. Explain what RAM is;
b. Explain what ROM is;
c. Explain memory caching;
d. Define and convert bytes, kilobytes, and megabytes;
e. Discuss the function of a central processing unit;
f. Discuss processor speed; and,
g. Understand RS-232 protocol.

Module Outline:

I. Explain What Memory Is
   A. RAM
   B. ROM
   C. Cache memory
   D. Measuring memory
      1. Byte
      2. Kilobyte
      3. Megabyte

II. Discuss Purpose and Function Of:
   A. Central Processing Units (CPUs)
   B. Processor performance
      1. Speed
      2. Generation
      3. Type
   C. RS-232 serial port

III. Determine the Amount of Available Memory on a System
   A. Choose About from the Help menu in Program Manager for Windows 3.1
   B. Choose About from the Help menu in Windows Explorer for Windows 95
TLD-G2
Understand Computer Terminology
Self-Assessment

1. What is RAM and explain its function.

2. What is ROM and explain its function.

3. What does the term "memory caching" mean?

4. What is the function of the CPU?

5. Circle the faster processor speed and explain why it is faster.
   a. 33-MHz 80486 or 20-MHz 80486
   b. 20-MHz 80486 or 33-MHz 80386
6. Fill in the blanks below.

1800 bytes = ______ KB

2 KB = ______ bytes

4 megabytes = ______ bytes

500 MB = ______ kilobytes

1,000,000 bytes = ______ megabytes

3300 kilobytes = ______ MB

7. What is the significance of a RS-232 serial port?
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-G3

Subject: Tool & Die and EDM

Duty: Use Computers

Task: Use File Management Systems

Time: 10 Hrs.

Objectives:

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

a. Explain file management concepts;
b. Create and delete directories/folders;
c. Copy a file(s) from one directory to another;
d. Copy a file(s) between a floppy disk and a hard drive;
e. Rename, move, and delete a file(s); and,
f. Format disks and make system disks.

Instructional Materials:

Data Disks
MASTER Handout (TLD-G3-HO)
MASTER Laboratory Worksheets (TLD-G3-LW1; TLD-G3-LW2)
MASTER Self-Assessment

References:

Windows 3.1 and/or Windows 95 Computer Lab, Latest Edition
Using Windows 3.1 to Perform File Management Operations, Latest Edition
Using Windows 95 to Perform File Management Operations, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-G1 "Use Computer Operating Systems"
TLD-G2 "Understand Computer Terminology"

Introduction:

The understanding of files, file management systems, and the storage of files becomes important when one has entered information into the computer for processing. Since
this is often a time consuming process in manufacturing, it becomes even more important that one understand the concepts. This module focuses on the development of competencies related to file management systems.

Presentation Outline:

I. Explain and Discuss File Management Concepts
   A. Copying a file(s)
   B. Deleting a file(s)
   C. Moving a file(s)
   D. Renaming a file(s)
   E. Creating a directory
   F. Deleting a directory
   G. Copying a disk
   H. Formatting a disk
   I. Making a system disk

II. Use File Manager in Windows 3.1 to Perform File Management Operations
   A. Use the file menu to:
      1. Create a directory
         a. On the hard drive
         b. On a floppy disk
      2. Copy a file(s)
         a. From one directory to another
         b. From a floppy disk to the hard drive
         c. From the hard drive to a floppy disk
      3. Move a file(s)
      4. Rename a file(s)
      5. Delete a file(s)
      6. Delete a directory
   B. Use the disk menu to:
      1. Copy a disk
      2. Format a disk
      3. Make a system disk

III. Use Windows 95 to Perform File Management Operations
   A. Use the file menu in Windows Explorer to:
      1. Create a new folder on the hard drive
      2. Create a new folder on the floppy drive
   B. Use the edit menu in Windows Explorer to:
      1. Copy a file(s) from one directory to another
      2. Copy a file(s) from a floppy disk to the hard drive
      3. Copy a file(s) from the hard drive to a floppy disk
      3. Cut a file(s)
      4. Paste a file(s)
   C. Use the file menu in Windows Explorer to:
1. Rename a file(s)
2. Delete a file(s)
3. Delete a folder

D. Use My Computer on the Windows 95 desktop to:
   1. Format a disk
   2. Make a system disk

Practical Application:

Students will use Windows 3.1 and Windows 95 to complete the Laboratory Worksheets TLD-G3-LW1 and TLD-G3-LW2.

Evaluation and/or Verification:

Successful completion of this technical module will be determined by the student’s ability to successfully demonstrate the following competencies in Windows 3.1 and/or Windows 95:

1. Create a directory/folder on a hard drive and a floppy disk;
2. Copy files from the hard drive to a floppy disk and from a floppy disk to a hard drive;
3. Rename a file;
4. Move a file;
5. Delete a file;
6. Delete a directory; and,
7. Format a system disk.

Summary:

Review the concepts covered in this module in preparation for the self-assessment.

Next Lesson Assignment:

MASTER Technical Module (TLD-G4) which deals with installing and using software packages.
Use File Management Systems
Attachment 1: MASTER Handout

Objectives:

Upon completion of this unit the student will be able to:
a. Explain file management concepts;
b. Create and delete directories/folders;
c. Copy a file(s) from one directory to another;
d. Copy a file(s) between a floppy disk and a hard drive;
e. Rename, move, and delete a file(s); and,
f. Format disks and make system disks.

Module Outline:

I. Explain and Discuss File Management Concepts
   A. Copying a file(s)
   B. Deleting a file(s)
   C. Moving a file(s)
   D. Renaming a file(s)
   E. Creating a directory
   F. Deleting a directory
   G. Copying a disk
   H. Formatting a disk
   I. Making a system disk

II. Use File Manager in Windows 3.1 to Perform File Management Operations
   A. Use the file menu to:
      1. Create a directory
         a. On the hard drive
         b. On a floppy disk
      2. Copy a file(s)
         a. From one directory to another
         b. From a floppy disk to the hard drive
         c. From the hard drive to a floppy disk
      3. Move a file(s)
      4. Rename a file(s)
      5. Delete a file(s)
      6. Delete a directory
   B. Use the disk menu to:
      1. Copy a disk
      2. Format a disk
      3. Make a system disk

III. Use Windows 95 to Perform File Management Operations
A. Use the file menu in Windows Explorer to:
   1. Create a new folder on the hard drive
   2. Create a new folder on the floppy drive

B. Use the edit menu in Windows Explorer to:
   1. Copy a file(s) from one directory to another
   2. Copy a file(s) from a floppy disk to the hard drive
   3. Copy a file(s) from the hard drive to a floppy disk
   4. Cut a file(s)
   5. Paste a file(s)

C. Use the file menu in Windows Explorer to:
   1. Rename a file(s)
   2. Delete a file(s)
   3. Delete a folder

D. Use My Computer on the Windows 95 desktop to:
   1. Format a disk
   2. Make a system disk
Using Windows 3.1 to Perform File Management Operations

*** A DATA DISK WILL BE NEEDED TO COMPLETE THESE EXERCISES. ***

1. Open the Main window and start File Manager.
2. Maximize the directory tree window.
3. View the contents of drive A and create a directory called RAINBOW.
4. View the contents of the hard drive by selecting the root icon for drive C.
5. Expand the directory named WINDOWS and view the files in the SYSTEM subdirectory.
6. Sort the files in SYSTEM by size and select the four smallest files.
7. Copy these files to the RAINBOW directory on drive A.
8. Check to see that these four files are still in the SYSTEM subdirectory. Now, view the contents of the RAINBOW directory on drive A to make sure the files were copied.
9. Rename each of the files under RAINBOW on drive A as Red, Blue, Green, and Yellow.
10. Create another directory on drive A named COLORS.
11. Move the files Red and Green from RAINBOW to COLORS.
12. Check to see that RAINBOW now contains only the files named Blue and Yellow.
13. Check to see that COLORS contains two files named Red and Green.
14. Delete the Yellow file in the RAINBOW directory.
15. Delete the RAINBOW directory.
16. Create a directory on the hard drive named your first name.

17. Copy the files on the disk in drive A to the directory on the hard drive with your name.

18. Format your data disk and then view its contents.

19. Make a system disk with your data disk. Use this system disk to restart the computer.
TLD-G3-LW2
Use File Management Systems
Attachment 3: MASTER Laboratory Worksheet No. 2

Using Windows 95 to Perform File Management Operations

*** A DATA DISK WILL BE NEEDED TO COMPLETE THESE EXERCISES. ***

1. Click START and choose Windows Explorer under Programs.
2. Maximize this window.
3. View the contents of your data disk in drive A and create a folder named SAMPLE on your data disk.
4. View the contents of the hard drive by selecting the root icon for drive C.
5. Expand the WINDOWS folder and view the files in the HELP subdirectory.
6. View the details of the files and arrange the files by size.
7. Select the four smallest files and copy them to the SAMPLE folder on drive A.
8. Check to see that these four files are still in the HELP folder on the hard drive. Now, view the contents of the SAMPLE folder on drive A to make sure the files were copied.
10. Create another folder on drive A named EXERCISE.
11. Move the files File1 and File3 under SAMPLE to the folder named EXERCISE.
12. Check to see that SAMPLE now contains the files named File2 and File4.
13. Check to see that EXERCISE contains File1 and File3.
14. Delete File2 in SAMPLE.
15. Delete the folder SAMPLE.
16. Create a folder on the hard drive named PRACTICE.

17. Copy the files on the disk in drive A to the PRACTICE folder on the hard drive.

18. Format your data disk. Does it still contain your files?

19. Make your data disk a system disk. Explain the value of having a system disk.
TLD-G3
Use File Management Systems
Self-Assessment

Use Windows 3.1 or Windows 95 to perform the following operations. You will need two data disks. Please turn in both disks to the instructor when you have completed the following tasks.

1. Create a directory/folder on the hard drive using TEST as the directory/folder name.
2. Copy any three files from the hard drive into TEST.
3. Create a directory/folder on one of your data disks using MINE as the directory/folder name.
4. Move the three files in TEST on the hard drive to MINE on the floppy disk.
5. In the MINE directory/folder, rename each of the files as File1, File2, and File3.
6. Copy File1, File2, and File3 to the TEST directory/folder on the hard drive.
7. Delete File1 in the MINE directory/folder on the data disk.

*** ASK THE INSTRUCTOR TO WATCH AS YOU PERFORM TASK #8. ***
8. Delete the TEST directory/folder on the hard drive.
9. Use a second data disk to make a system disk.
10. What is a system disk?
Subject: Tool & Die and EDM  
Time: 40 Hrs.

Duty: Use Computers

Task: Install and Use Software Packages

Objectives:

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

a. Install a software package to a hard disk;
b. Configure the system parameters upon installation;
c. Create a word processing document;
d. Create a spreadsheet; and,
e. Open, edit, enhance, save, and print word processing and spreadsheet files.

Instructional Materials:

Data Disks
Creating a Word Processing Document
Creating a Spreadsheet
MASTER Laboratory Worksheets (TLD-G4-LW1; TLD-G4-LW2)
MASTER Self-Assessment

References:

Windows 3.1 and/or Windows 95 Computer Lab, Latest Edition
Software package to install from CD
Software package to install from diskettes
Word processing software
Spreadsheet software

Student Preparation:

Students should have previously completed the following Technical Modules:

MLD-G1 “Use Computer Operating Systems”
MLD-G2 “Understand Computer Terminology”
MLD-G3 “Use File Management Systems”
Introduction:

In order to process data, computers need a set of instructions to tell it what to do. These instructions are called programs. Since technicians will want to use programs that perform certain tasks, it is important that they understand how to install, configure, and use software. That is the purpose of this module.

Presentation Outline:

I. Explain How to Install Software Packages Using Windows 3.1
   A. Install from a CD-ROM
   B. Install from diskettes
II. Explain How to Install Software Packages Using Windows 95
    A. Install from a CD-ROM
    B. Install from diskettes
III. Explain How to Configure System Parameters for a Software Package
     A. Modification to AUTOEXEC.BAT and CONFIG.SYS
     B. Modification of INI files (e.g. WIN.INI, SYSTEM.INI)
     C. Plotter/printer driver configurations
     D. Digitizer pad/mouse driver configurations
IV. Use a Word Processor Software Package (e.g. WordPerfect, MS Word)
    A. Typing a document
    B. Using cursor movement keys
    C. Editing a document with backspace and delete
    D. Using the spelling checker
    E. Saving a file
    F. Printing a file
    G. Closing a file
    H. Opening a file
    I. Changing the margins
    J. Using bold, italics, and underline
    K. Changing alignment
V. Use a Spreadsheet Software Package (e.g. Lotus 123, MS Excel)
   A. Entering values and labels
   B. Editing the spreadsheet
   C. Using formulas and functions
   D. Changing column widths
   E. Changing number format
   F. Changing alignment
   G. Copying formulas and functions
   H. Printing the spreadsheet
   I. Saving the spreadsheet and chart
Practical Application:

Students can perform practical applications by installing software packages to a hard disk and answering system parameter prompts during the installation. Students will create word processing and spreadsheet documents by completing the Laboratory Worksheets TLD-G4-LW1 and TLD-G4-LW2.

Evaluation and/or Verification:

Successful completion of this technical module will be determined by the student's ability to successfully demonstrate the following competencies:

1. Install a software package and give proper system parameters;
2. Create, save, and print a word processing document; and,
3. Create, save, and print a spreadsheet.

Summary:

Review the concepts covered in this module in preparation for the self-assessment.

Next Lesson Assignment:

MASTER Technical Module (TLD-H1) dealing with fundamentals of CNC machines and controls.
TLD-G4-HO
Install and Use Software Packages
Attachment 1: MASTER Handout

Objectives:

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

a. Install a software package to a hard disk;
b. Configure the system parameters upon installation;
c. Create a word processing document;
d. Create a spreadsheet; and,
e. Open, edit, enhance, save, and print word processing and spreadsheet files.

Module Outline:

I. Explain How to Install Software Packages Using Windows 3.1
   A. Install from a CD-ROM
   B. Install from diskettes

II. Explain How to Install Software Packages Using Windows 95
   A. Install from a CD-ROM
   B. Install from diskettes

III. Explain How to Configure System Parameters for a Software Package
    A. Modification to AUTOEXEC.BAT and CONFIG.SYS
    B. Modification of INI files (e.g. WIN.INI, SYSTEM.INI)
    C. Plotter/printer driver configurations
    D. Digitizer pad/mouse driver configurations

IV. Use a Word Processor Software Package (e.g. WordPerfect, MS Word)
    A. Typing a document
    B. Using cursor movement keys
    C. Editing a document with backspace and delete
    D. Using the spelling checker
    E. Saving a file
    F. Printing a file
    G. Closing a file
    H. Opening a file
    I. Changing the margins
    J. Using bold, italics, and underline
    K. Changing alignment

V. Use a Spreadsheet Software Package (e.g. Lotus 123, MS Excel)
   A. Entering values and labels
   B. Editing the spreadsheet
   C. Using formulas and functions
   D. Changing column widths
E. Changing number format
F. Changing alignment
G. Copying formulas and functions
H. Printing the spreadsheet
I. Saving the spreadsheet and chart
I. Creating Documents

A. Key the following document in a word processing software package.

The Vernier Caliper
The basic parts of a vernier caliper are a main scale which is similar to a steel rule with a fixed jaw and a sliding jaw with a vernier scale. They are available in a wide range of lengths with different types of jaws and scale graduations.

B. Check your spelling.

C. Save the document on your data disk as CALIPERS and print.

D. Close the document.

E. Create another new document and enter the text below.

Micrometers
Micrometers are basic measuring instruments used by technicians in the processing and checking of parts. They are available in a wide range of sizes and types.

Outside micrometers are used to measure dimensions between parallel surfaces of parts and outside diameters of cylinders. Other types, such as depth micrometers, screw thread micrometers, disc and blade micrometers, and inside micrometers, also have wide application in the machine shop.

F. Boldface and italicize the title.

G. Change the top margin to 2.8 inches and check the spelling.

H. Save the document on your data disk under the name MICS and print.

I. Close the document.
II. Opening Documents and Editing

A. Open the document CALIPERS.

B. Insert Decimal-Inch in the title between “The” and “Vernier”, so the title will read The Decimal-Inch Vernier Caliper. Also, boldface the title.

C. Insert the following text as the second sentence.

The vernier scale slides parallel to the main scale and provides a degree of precision to 0.001".

D. In the last sentence, change “They” to “Calipers”.

E. Change the top margin to 2.7 inches and check your spelling.

F. Save under the same name and print.

G. Open the document MICS.

H. Make the two paragraphs one.

I. Save the document under the same name and print.
Creating a Spreadsheet

I. Create a Spreadsheet, Change Column Widths, and Alignment

A. Enter the following labels as shown below to create a spreadsheet. Change the column width as necessary.

<table>
<thead>
<tr>
<th>Diametral Pitch</th>
<th>Number of Teeth</th>
<th>Pitch Diameter</th>
<th>Addendum (inches)</th>
<th>Dedendum (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. Center the labels in the cells.

C. In the Diametral Pitch column enter the following values: 4, 6, 8, and 3.

D. In the Number of Teeth column enter the following values: 45, 75, 44, and 54.

E. Save the spreadsheet to your data disk as BEVEL and print.

F. Open a new document and enter the following information below. Change the column widths as necessary.

<table>
<thead>
<tr>
<th>Name</th>
<th>Rate</th>
<th>Hours</th>
<th>Gross Pay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natalie Nicholson</td>
<td>6.80</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Dave Miller</td>
<td>8.60</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Karen Lark</td>
<td>8.60</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Taylor Smithsonian</td>
<td>5.50</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

G. Center the values in the Hours column.

H. Set the number format in the Rate column to show two decimal places and the number format in the Hours column to show zero decimal places.

I. Save the spreadsheet to your data disk as PAYROLL and print.

II. Create and Copy Formulas/functions and Edit the Spreadsheet
A. Place BEVEL back on your desktop.

B. Enter the following formulas in the appropriate cell and copy to other cells where the formula is needed.

Pitch Diameter = Number of Teeth / Diametral Pitch
Dedendum = 1.157 / Diametral Pitch
Addendum = 1 / Diametral Pitch

C. Save under the same name and print.

D. Change the Diametral Pitch in the first cell from 4 to 5.

E. Change the Number of Teeth in the last cell from 54 to 50

F. Add a Diametral Pitch of 10 with the Number of Teeth given as 80.

G. Copy the formulas to the new row.

H. Save and print.

I. Place PAYROLL back on the desktop and enter the formula to compute the Gross Pay. (Gross Pay = Rate * Hours)

J. Format the Gross Pay as currency.

K. Add the Hours column.

L. Change Dave Miller's rate of pay to $9.00.

M. Save and print.
1. Install the software package assigned to you by your instructor and give the proper system parameters.

2. Create the following word processing document.

   (date)

Mr. Eric Brown
Director of Personnel
Mason Manufacturing Company
Crestview Drive
Franklin, MS 38801

Dear Mr. Brown:

I read your advertisement seeking a manufacturing technician for your company. Please consider this letter as my application for the position.

I received my Associate of Applied Science degree in Manufacturing Technology from Texas State Technical College in Waco, Texas. Presently I am a manufacturing technician. I have held this position for four years with Acme Tool and Die in Waco, Texas.

As a manufacturing technician I have had experience in conventional machine operations, CNC mill and CNC wire EDM operations, and CAM programming. I have just received my certification as a journeyman, but presently there are no positions available in my present place of employment.

Sincerely,

(your name)

Enclosure

3. Save the document on your data disk under the name MASON and print.

5. Add the following as the fourth paragraph:

I have enclosed my resume which will supply you with more specific information about my background and present employment. I would very much appreciate an interview with you.

6. Save the document again and print.

7. Create the following spreadsheet. Right align the labels.

<table>
<thead>
<tr>
<th>Circular Pitch (inches)</th>
<th>Working Depth (inches)</th>
<th>Clearance (inches)</th>
<th>Tooth Thickness (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3925</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.1582</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.8069</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2378</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5931</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. Enter the following formulas into the appropriate cell and use copy to place the formula in the other cells.

- Working depth = 0.6366 * Circular Pitch
- Clearance = 0.05 * Circular Pitch
- Tooth thickness = 0.5 * Circular Pitch

9. Save the spreadsheet as SPUR and print.

10. Change the last measurement in the Circular Pitch column to 1.1359.

11. Save the spreadsheet again and print.
TOOL AND DIE MAKER ... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice Safety</td>
<td>A-1 Follow safety manuals and all safety regulations/requirements</td>
</tr>
<tr>
<td>Apply Mathematical Concepts</td>
<td>B-1 Perform basic arithmetic functions</td>
</tr>
<tr>
<td>Interpret Engineering Drawings and Related Documents</td>
<td>C-1 Interpret and understand basic layout of drawings</td>
</tr>
<tr>
<td>Demonstrate Knowledge of Manufacturing Materials</td>
<td>D-1 Identify materials with desired properties</td>
</tr>
<tr>
<td>Measure/Inspect</td>
<td>E-1 Demonstrate knowledge of manufacturing materials</td>
</tr>
<tr>
<td>Demonstrate Knowledge of Manufacturing Processes</td>
<td>F-1 Discuss metal cutting and metal finishing tools</td>
</tr>
<tr>
<td>Use Computers</td>
<td>G-1 Use computer operating systems</td>
</tr>
<tr>
<td>Perform CAD/CAM and CNC Programming Tasks</td>
<td>H-1 Discuss fundamentals of CNC machining machines and controls</td>
</tr>
<tr>
<td>Perform Tool and Die Making Operations</td>
<td>I-1 Discuss basic types and functions of jigs and fixtures</td>
</tr>
<tr>
<td>Operate Electrical Discharge Machines (EDM)</td>
<td>J-1 Discuss fundamentals of EDM</td>
</tr>
</tbody>
</table>

| A-2 Maintain safe equipment and machinery | B-2 Perform basic geometric operations |
| A-3 Use safe operating procedures for hand and machine tools | B-3 Use basic trigonometric functions |
| A-4 Maintain a clean and safe work environment | B-4 Perform basic trigonometric functions |

| A-5 Use safe material handling practices | B-5 Use and apply Cartesian Coordinate System |
| A-6 Consult and apply MSDS for hazards of various materials | |

| E-2 Select measurement tools | F-2 Operate metal cutting and metal finishing tools |
| E-3 Measure with hand held instruments | F-3 Operate drill press and tooling |
| E-4 Eliminate measurement variables | F-4 Operate lathes and tooling |
| E-5 Measure and inspect using surface plate and accessories | F-5 Operate vertical and horizontal mills and tooling |
| E-6 Inspect using stationary equipment | F-6 Operate precision grinders and other equipment |
| F-7 Operate sheet metal equipment and processes | F-8 Operate welding equipment and processes |
| F-9 Operate equipment and processes | F-10 Estimate time required to produce a part |
| F-10 Estimate time required to produce a part | |
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-H1

Subject: Tool & Die and EDM
Time: 15 Hrs.

Duty: Perform CAD/CAM and CNC Programming Tasks
Task: Discuss Fundamentals of CNC Machines and Controls

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

a. Identify and describe essentials and safety of CNC systems;
b. Identify and describe types of CNC hardware and software;
c. Identify and describe machine axes and coordinate systems; and,
d. Identify and describe coordinate systems.

Instructional Materials:
MASTER Handout (TLD-H1-HO)
MASTER Self-Assessment

References:


Student Preparation:
Students should have previously completed the following Technical Modules:

TLD-A1 through TLD-A6  “Practice Safety”
TLD-B1 through TLD-B5  “Apply Mathematical Concepts”
TLD-C1 through TLD-C5  “Interpret Engineering Drawings and Related Documents”
TLD-D1 through TLD-D3  “Demonstrate Knowledge of Manufacturing Materials”
TLD-E1 through TLD-E6  “Measure/Inspect”
TLD-F1 through TLD-F10  “Demonstrate Knowledge of Manufacturing Processes”
TLD-G1 through TLD-G4  “Use Computers”
Introduction:

In the modern world of machining more and more companies are relying heavily on CNC machinery. This is a trend that is expected to continue into the future of machine technology. Many students are highly motivated to learn how to program and operate this type of equipment. It is wise to have a basic understanding of how the equipment functions so we can have a better understanding of how to program the machine tool operations. Many of the procedures can be compared directly to their conventional machine counterparts. Most people will progress further along if they establish a solid foundation in the basic principles.

Presentation Outline:

I. Identify and Describe Essentials and Safety of CNC Systems
   A. Identify and explain essentials
      1. Define numerical control
      2. Explain history and future of CNC technology
      3. Identify basic elements of CNC system
      4. Define Computer Numerical Control (CNC)
      5. Explain advantages and limitations of CNC
      6. Identify applications of CNC technology
   B. Compare types of CNC systems
      1. Identify and describe modes on numerical control systems
      2. Explain difference between the following:
         a. Point-to-point
         b. Axial path
         c. 45° line type
         d. Linear path
         e. Continuous path
      3. Describe CNC interpolation
      4. Identify types of CNC interpolations
      5. Explain difference between open loop and closed loop systems
      6. List benefits and problems of open and closed loop systems
   C. Demonstrate safety practices related to CNC systems
      1. Demonstrate safety practices, including:
         a. Safety guard/door interlocks
         b. Power box interlocks
         c. Tool loading and unloading
         d. Loading and unloading work holding devices
         e. Machine coolant disposal
      2. Describe/identify personal safety equipment

II. Identify and Describe Types of CNC Hardware and Software
   A. Identify and describe CNC hardware
      1. Compare NC and CNC systems
2. Identify components of CNC machine control unit (MCU)
3. Define applications of operator control panel
4. Explain functions of operator control panel
5. Define utilities found on typical control panel
6. Select appropriate CNC controls

B. Describe CNC software
1. Describe software related to machine tool
2. Describe applications of operation, interface and application software
3. Describe interface of software and hardware

C. Explain feedback drive system
1. Describe feedback drive system
2. Explain feedback mechanisms
3. Compare direct and indirect measurement systems

III. Identify and Describe Machine Axes and Coordinate Systems

A. Identify and describe machine axes
1. Define and identify machine axes X, Y and Z
2. Identify and describe linear axes using right hand rule
3. Identify and define primary rotary axes A, B and C

B. Describe coordinate systems
1. Describe Cartesian coordinate system as used in NC program
2. Define relationship of Cartesian coordinate system with machine axes

C. Define characteristics of positioning systems
1. Define application of absolute positioning systems
2. Define application of incremental positioning systems

D. Define reference systems
1. Describe characteristics of:
   a. Machine reference coordinates
   b. Work reference coordinates
   c. Program reference coordinates
   d. Fixtures offset coordinates

IV. Describe and Interpret CNC Coding Systems

A. Interpret number bases
   1. Interpret decimal and binary bases
   2. Interpret octal and hexadecimal bases

B. Describe NC program storage media
   1. Describe the media
   2. Describe advantages and disadvantages of each media

C. Describe EIA and ASCII formatted tapes
   1. Describe EIA format on tapes
   2. Describe ASCII format on tapes
   3. Describe differences in EIA and ASCII formats
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 and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-H2) dealing with programming and operating CNC milling machine and machining center.
Objectives:

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

a. Identify and describe essentials and safety of CNC systems;

b. Identify and describe types of CNC hardware and software;

c. Identify and describe machine axes and coordinate systems; and,

d. Identify and describe coordinate systems.

Module Outline:

I. Identify and Describe Essentials and Safety of CNC Systems
A. Identify and explain essentials
   1. Define numerical control
   2. Explain history and future of CNC technology
   3. Identify basic elements of CNC system
   4. Define Computer Numerical Control (CNC)
   5. Explain advantages and limitations of CNC
   6. Identify applications of CNC technology

B. Compare types of CNC systems
   1. Identify and describe modes on numerical control systems
   2. Explain difference between the following:
      a. Point-to-point
      b. Axial path
      c. 45° line type
      d. Linear path
      e. Continuous path
   3. Describe CNC interpolation
   4. Identify types of CNC interpolations
   5. Explain difference between open loop and closed loop systems
   6. List benefits and problems of open and closed loop systems

C. Demonstrate safety practices related to CNC systems
   1. Demonstrate safety practices, including:
      a. Safety guard/door interlocks
      b. Power box interlocks
      c. Tool loading and unloading
      d. Loading and unloading work holding devices
      e. Machine coolant disposal
   2. Describe/identify personal safety equipment

II. Identify and Describe Types of CNC Hardware and Software
A. Identify and describe CNC hardware
1. Compare NC and CNC systems
2. Identify components of CNC machine control unit (MCU)
3. Define applications of operator control panel
4. Explain functions of operator control panel
5. Define utilities found on typical control panel
6. Select appropriate CNC controls

B. Describe CNC software
   1. Describe software related to machine tool
   2. Describe applications of operation, interface and application software
   3. Describe interface of software and hardware

C. Explain feed back drive system
   1. Describe feed drive system
   2. Explain feed back mechanisms
   3. Compare direct and indirect measurement systems

III. Identify and Describe Machine Axes and Coordinate Systems
A. Identify and describe machine axes
   1. Define and identify machine axes X, Y and Z
   2. Identify and describe linear axes using right hand rule
   3. Identify and define primary rotary axes A, B and C

B. Describe coordinate systems
   1. Describe Cartesian coordinate system as used in NC program
   2. Define relationship of Cartesian coordinate system with machine axes

C. Define characteristics of positioning systems
   1. Define application of absolute positioning systems
   2. Define application of incremental positioning systems

D. Define reference systems
   1. Describe characteristics of:
      a. Machine reference coordinates
      b. Work reference coordinates
      c. Program reference coordinates
      d. Fixtures offset coordinates

IV. Describe and Interpret CNC Coding Systems
A. Interpret number bases
   1. Interpret decimal and binary bases
   2. Interpret octal and hexadecimal bases

B. Describe NC program storage media
   1. Describe the media
   2. Describe advantages and disadvantages of each media

C. Describe EIA and ASCII formatted tapes
   1. Describe EIA format on tapes
   2. Describe ASCII format on tapes
   3. Describe differences in EIA and ASCII formats
TLD-H1
Discuss Fundamentals of CNC Machines and Controls
Self-Assessment

Circle the letter preceding the correct answer.

1. The definition “a system in which actions are controlled by the insertion of numerical data at some point” refers to?
   A. Direct Numerical Control
   B. Distributive Numerical Control
   C. Numerical Control
   D. Computerized Numerical Control

2. Which company is given credit for creating the first numerical control milling machine?
   A. Rohr Industries
   B. Massachusetts Institute of Technology
   C. Parsons Corporations
   D. General Electric

3. The term CNC stands for?
   A. Continuous Numerical Control
   B. Centerline Numerical Control
   C. Computerized Numerical Control
   D. Computerized Numerical Counter

4. The term DNC has multiple definitions one is:
   A. Distinct numerical control
   B. Desired numerical control
   C. Direct numerical control
   D. Destination numerical control

5. The term DNC has multiple definitions another one is:
   A. District numerical control
   B. Distributive numerical control
   C. Distinctive numerical control
   D. Desired numerical control

6. Examples of basic elements of a CNC system would include:
   A. Center drill
   B. Milling cutters
   C. Mouse
   D. Part program
7. Examples of basic elements of a CNC system would include:
   A. Anilam
   B. Program input device
   C. Pocket calculator
   D. Coolant

8. Examples of basic elements of a CNC system would include:
   A. Machine control unit
   B. Outside micrometer
   C. Pencil and paper
   D. Basic understanding of mathematics

9. Examples of basic elements of a CNC system would include:
   A. Barcoding system
   B. Inside micrometer
   C. Drive systems
   D. Basic understanding of engineering drawings

10. Examples of basic elements of a CNC system would include:
    A. Machine tool
    B. Basic theory of metal removal
    C. Dial calipers
    D. Windows operating system

11. Examples of basic elements of a CNC system would include:
    A. Clamping devices
    B. Depth micrometers
    C. Feedback systems
    D. Fine surface finishes

12. NC systems are often referred to as:
    A. Primary memory
    B. Softwired
    C. Hardwired
    D. Secondary memory

13. CNC systems are often referred to as:
    A. Primary memory
    B. Softwired
    C. Hardwired
    D. Secondary memory
14. Examples of advantages of CNC would include:
   A. High cost of cutting tools
   B. Increased productivity
   C. Highly attractive machines
   D. More interesting for maintenance workers

15. Examples of advantages of CNC would include:
   A. Lower number of pallets needed
   B. Increased electronics
   C. Inch and metric calibrations
   D. High accuracy and repeatability

16. Examples of advantages of CNC would include:
   A. Reduced production costs
   B. Systems require less attention
   C. Cost effective for small production runs
   D. Lower maintenance requirements

17. Examples of advantages of CNC would include:
   A. Reduced initial investment
   B. Reduced indirect operating costs
   C. Cost effective for small production runs
   D. Lower maintenance requirements

18. CNC operators have to have a higher skill level than a precision tool maker
   A. True
   B. False

19. Examples of disadvantages (limitations) of CNC would include:
   A. High cost of cutting tools
   B. Higher productivity
   C. High initial investment
   D. High probability of human error

20. Examples of disadvantages (limitations) of CNC would include:
   A. Higher scrap rates
   B. Higher Maintenance requirements
   C. Higher machine utilization
   D. High probability of human error

21. Examples of disadvantages (limitations) of CNC would include:
   A. Not cost effective for precision parts
   B. Not cost effective for alloys
   C. Not cost effective for low production levels
   D. Not cost effective for non ferrous metals
22. CNC can only be applied to applications of chip removal.
   A. True
   B. False

23. The addition of CNC machines guarantees increased productivity.
   A. True
   B. False

24. CNC programming has been dramatically changed by the advent of:
   A. Fiber optics
   B. CAD/CAM
   C. Space age coolants
   D. Special applications

25. The Point to Point control system is most often used in ________ operations.
   A. Rough machining
   B. Pocket machining
   C. Drilling
   D. Contouring

26. The Continuous-Path control system is often called __________ system.
   A. Rough machining
   B. Pocket machining
   C. Drilling
   D. Contouring

27. The Continuous-Path control system is limited since it can only move one axis at a time.
   A. True
   B. False

28. An example of a function of the CNC interpolator would include:
   A. Generates spindle speed calculations for efficient material removal
   B. Generates intermediate coordinate positions along the program path
   C. Generates the proper feed rate in program
   D. Generates a complete list of “G” codes as needed by the machine

29. An example of a function of the CNC interpolator would include:
   A. Computes coolant selections for machine tool as needed
   B. Computes separate tool changes as needed
   C. Computes individual axis velocities as needed
   D. Computes material finish requirements as needed
30. One example of a common interpolation would be:
   A. Metabolic
   B. Bicubic approximation
   C. Linear
   D. Helical cubic NURB

31. One example of a common interpolation would be:
   A. Eliptoidal
   B. Bi nurdic eliptoidal
   C. Radius
   D. Circular

32. One significant feature of the ______________ control system is that there is no feedback signal for checking whether the programmed position has been reached.
   A. Closed loop
   B. Open loop
   C. NC
   D. CNC

33. One significant feature of the ______________ control system is that there are feedback signals that check whether the programmed position has been reached.
   A. Closed loop
   B. Open loop
   C. NC
   D. CNC

34. The ______________ control system is usually used with the Point to Point systems.
   A. Closed loop
   B. Open loop
   C. NC
   D. CNC

35. The ______________ control system is usually used with Continuous Path systems.
   A. Closed loop
   B. Open loop
   C. NC
   D. CNC
36. The acronym MCU stands for:
A. Machine Companies Unification
B. Machine control unit
C. Machine control university
D. Machine control union

37. Examples of primary memory would include:
A. Floppy disks
B. Hard drives
C. RAM
D. Paper tape

38. Examples of primary memory would include:
A. Greco system
B. DNC
C. ROM
D. Punch cards

39. Examples of secondary memory would include:
A. Greco system
B. DNC
C. ROM
D. Hard drives

40. Examples of secondary memory would include:
A. Floppy disks
B. Greco system
C. RAM
D. Paper tape

41. Machine ____________ is what allows us to reach a exact desired point coordinate.
A. Controller
B. Repeatability
C. Accuracy
D. Programming

42. Machine ____________ is what allows us to come back to an exact point coordinate time after time.
A. Controller
B. Repeatability
C. Accuracy
D. Programming
43. The ______ measurement feedback system is free from the effects of machine backlash.
   A. Indirect
   B. Direct
   C. Closed loop
   D. Open loop

44. The ______ measurement feedback system is effected by machine backlash.
   A. Indirect
   B. Direct
   C. Closed loop
   D. Open loop

45. The ______ measurement feedback system is more accurate.
   A. Indirect
   B. Direct
   C. Closed loop
   D. Open loop

46. The machine axis designation by X,Y, and Z are the ______ machine axis.
   A. Tertiary linear
   B. Primary linear
   C. Secondary linear
   D. Primary rotary

47. The machine axis designation by A,B and C are the ______ machine axis.
   A. Tertiary rotary
   B. Primary rotary
   C. Secondary rotary
   D. Primary linear

48. The Cartesian coordinate system is often referred to as the ______ coordinate system.
   A. Polar
   B. Secondary
   C. Rectangular
   D. Primary
49. The data point X-1.0 Y-2.0 is located in the number _________ quadrant.
   A. 1
   B. 2
   C. 3
   D. 4

50. The data point X 1.0 Y 2.0 is located in the number _________ quadrant.
   A. 1
   B. 2
   C. 3
   D. 4

51. The data point X 1.0 Y-2.0 is located in the number _________ quadrant.
   A. 1
   B. 2
   C. 3
   D. 4

52. The data point X-1.0 Y 2.0 is located in the number _________ quadrant.
   A. 1
   B. 2
   C. 3
   D. 4

53. The _________ coordinate system defines the position of a point by its radius and an angle of rotation.
   A. Polar
   B. Secondary
   C. Rectangular
   D. Primary

54. If a data point was rotated 100 degrees from 0 it would be in the number _________ quadrant.
   A. 1
   B. 2
   C. 3
   D. 4

55. If a data point was rotated 295 degrees from 0 it would be in the number _________ quadrant.
   A. 1
   B. 2
   C. 3
   D. 4
56. If a data point was rotated 40 degrees from 0 it would be in the number ________ quadrant.
   A. 1
   B. 2
   C. 3
   D. 4

57. If a data point was rotated 195 degrees from 0 it would be in the number ________ quadrant.
   A. 1
   B. 2
   C. 3
   D. 4

58. In the ________ positioning system all positions are measured from a single fixed point.
   A. Incremental
   B. Polar
   C. Rectangular
   D. Absolute

59. In the ________ positioning system, the reference point is not fixed and moves from data point to data point.
   A. Incremental
   B. Polar
   C. Rectangular
   D. Absolute
TLD-H1
Discuss Fundamentals of CNC Machines and Controls
Self-Assessment Answer Key

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TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-H2

Subject: Tool & Die and EDM                                      Time: 50 Hrs.
Duty: Perform CAD/CAM and CNC Programming Tasks
Task: Program and Operate CNC Milling Machine and Machining Center

Objectives:

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

a. Describe history of vertical machining;
b. Describe theory of operation;
c. Describe nomenclature used in vertical machining;
d. Demonstrate safety practices related to vertical machining centers;
e. Set-up and program operation of vertical machine;
f. Demonstrate proper machining of objects;
g. Create program using machine controllers software, and cycles;
h. Set-up and utilize three dimensional digitizer; and,
i. Maintain vertical machine.

Instructional Materials:

MASTER Handout (TLD-H2-HO)
MASTER Laboratory Exercise/Self-Assessment (TLD-H2-LE/SA)
MASTER Laboratory Aid (TLD-H2-LA)

References:

Programming and Operation Manuals for your CNC machine(s)

Student Preparation:

Students should have previously completed the following Technical Modules:
TLD-H1 "Discuss Fundamentals of CNC Machines and Controls"

Introduction:

With the introduction of the first NC machines, machining was changed forever. In the beginning, ownership of NC machines was limited to those companies that
possessed great financial resources. The need for these machines, even if one had the capital, was limited to those companies that produced long production runs that required little (if any) design variation. These early machines were not user friendly nor were they quick to program, set up or operate. The advent of modern computers along with major changes in associated electronics has changed this scenario forever. Today the vast majority of companies have at least one CNC machine if not many. Most of the new employment is offered in the use and programming of these machines. It is no longer an option as to whether a technician wants to learn how to use a CNC machining center. The overall popularity of CNC machines is increasing dramatically and this trend demands that all technicians accept CNC as they have any other tool of their trade.

This module addresses the application of the CNC vertical machining center, which is really just a hybrid of the common milling machine, with the addition of many of its attachments.

This module can be used for individuals who will be using vertical machines at various levels from CNC operator to CNC technicians. The ability to complete these tasks both quickly and accurately in various settings will, in most cases, be one of the deciding factors of how long an individual will stay at the operator level or progress into the programming area.

Presentation Outline:

I. Describe Vertical Machining Process and Safety
   A. Describe History of Vertical Machining
      1. Describe proper use of various machines
   B. Describe Theory of Operation
      1. Describe open and closed loop systems
      2. Describe various oil and air requirements
      3. Describe how vertical machines function
   C. Describe Nomenclature Used in Vertical Machining
      1. Describe common tools used to:
         a. Mill
         b. Single point thread
         c. Drill
         d. Single point bore
         e. Tap
         f. Reaming
      2. Describe solid and collet type tool holders
   D. Demonstrate Safety Practices Related to Vertical Machining Centers
      1. Demonstrate operating safety practices, including:
         a. Safety door interlocks
         b. Machining vise loading and unloading
c. Power box interlocks
d. Machine coolant disposal
e. Tool loading and unloading
2. Describe/identify personal safety equipment

II. Describe Vertical Machining Functions
A. Describe Controller Functions, including:
1. Power meter
2. Automatic mode
3. Key lock
4. Emergency stop button
5. Option switches
6. Manual modes:
   a. Command mode
   b. MDI mode
7. Rapid travel over ride
8. Single step mode (Block-To-Block)
9. Feed rate override
10. Jog mode
11. Spindle speed override
12. Spindle On/Off
13. Axis selector
14. Slide hold
15. Increment of movement selector
16. Coolant 1 and 2 On/Off
17. Tool In/Out
18. Start button
19. Turret clockwise (CW) and turret counterclockwise (CCW)
20. Start function

III. Set-Up and Program Operation of Vertical Machine
A. Describe machine tool limitations, including:
1. Number of possible tools
2. Limits in X, Y and Z axes
3. Maximum spindle speed and horsepower
4. Memory size in controller
5. Fast feed rate
6. Oil and air requirements
7. Rapid positioning rate
8. Communication systems
B. Perform basic machine set-up
1. Check oil and air supply
2. Set tool changer numbers
3. Turn power on
4. Mount machine vise on machine table
5. Set machine home position
6. Indicate vise to within specified tolerances
7. Load tools into proper tool holders
8. Load part into vise
9. Load tools into tool carousel
   a. Load tools using spindle
   b. Load tools directly into carousel

C. Set part home
   1. Set part home using edge finder
   2. Set part home using test indicator and gauge block
   3. Set part home from tooling ball using fixture offsets

D. Set tool length offsets
   1. Set tool length offsets using work piece
   2. Set tool length offsets using gauge block
   3. Set tool length offsets using electronic probe
   4. Set tool length offsets using keyboard commands
   5. Modify length and diameter offsets using tool page editor.
   6. Upload and download tool information to storage

E. Load program
   1. Upload and download programs using RS-232 interface
   2. Upload and download programs using local area network

F. Edit program for machine tool
   1. Edit program at machine tool using editor in controller
   2. Edit program using DOS and Windows editors

G. Create program without CAD/CAM for common machine operations
   using machine controllers software to include:
   1. Proper use of cutter compensation
   2. Fixed cycles
   3. Fixed sub-routines
   4. Sub-routines (loops)
   5. Fixture offsets
   6. Trouble shoot and repair problems in programs
   7. Use machine verification options if available

IV. Demonstrate Machining of Objects on Vertical Machining Center
A. Machine objects, including:
   1. Outside contours
   2. Pockets
   3. Drilled holes
   4. Drill and tapped holes
      a. Rigid tapping
      b. Compression tapping
   5. Single point boring
   6. Reaming
   7. Single point thread, internal and external

B. Set-up three dimensional digitizer and machine model
   1. Mount model on machine table
   2. Install 3-dimensional digitizing unit
3. Establish communications with computer
4. Define grid pattern and feed rate required for given tolerances
5. Set part home
6. Digitize model
7. Process digital data for machining
8. Machine new model with program created from digitizer

C. Create work piece using 4th- and 5th-axes
   1. Mount, connect and indicate 4th- and 5th-axes attachment
   2. Set-tooling
   3. Machine work piece
   4. Remove 4th- and 5th-axes attachment

D. Maintain vertical machine
   1. Mix coolant
   2. Determine need for coolant change
   3. Change coolant
   4. Clean coolant tank
   5. Clean machine
   6. Change oil filters
   7. Add lubricating fluid
   8. Add hydraulic fluid
   9. Dispose of coolant and oils per EPA regulations

Practical Application:

In our program we have found it very important to require the students to do all aspects of vertical machining. It should be obvious that if an individual cannot set up a machine, then he will be limited to just “pushing buttons.”

We have developed this module for not only a specific group of individuals but also many different types of machines/controllers as well as local manufacturer requirements.

Most of the sections of this module are generic to all vertical machines as well as most machine controllers. Please note that there can be a great variation from one machine type to another; this becomes very evident in many of the sections covered in this module.

It is very important that the instructor design projects that are progressive in the level of required sophistication, so that the students will be reinforced as to their ability to complete these requirements.
**Evaluation and/or Verification:**

As with the Practical Application section above it will be necessary for you to design an evaluation instrument that best suits the environment in which you are presenting this information.

It is important to remember that the subject mastery is represented in the ability to not only perform the application of the technology, but also the ability to explain the process in both oral and written format.

**Summary:**

Review the main lesson points and answer student questions.

**Next Lesson Assignment:**

MASTER Technical Module (TLD-H3) dealing with programming and operating CNC lathe.
Objectives:

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

a. Describe history of vertical machining;
b. Describe theory of operation;
c. Describe nomenclature used in vertical machining;
d. Demonstrate safety practices related to vertical machining centers;
e. Set-up and program operation of vertical machine;
f. Demonstrate proper machining of objects;
g. Create program using machine controllers software, and cycles;
h. Set-up and utilize three dimensional digitizer; and,
i. Maintain vertical machine.

Module Outline:

I. Describe Vertical Machining Process and Safety
   A. Describe History of Vertical Machining
      1. Describe proper use of various machines
   B. Describe Theory of Operation
      1. Describe open and closed loop systems
      2. Describe various oil and air requirements
      3. Describe how vertical machines function
   C. Describe Nomenclature Used in Vertical Machining
      1. Describe common tools used to:
         a. Mill
         b. Single point thread
         c. Drill
         d. Single point bore
         e. Tap
         f. Reaming
      2. Describe solid and collet type tool holders
   D. Demonstrate Safety Practices Related to Vertical Machining Centers
      1. Demonstrate operating safety practices, including:
         a. Safety door interlocks
         b. Machining vise loading and unloading
         c. Power box interlocks
         d. Machine coolant disposal
         e. Tool loading and unloading
      2. Describe/identify personal safety equipment

II. Describe Vertical Machining Functions
A. Describe Controller Functions, including:
1. Power meter
2. Automatic mode
3. Key lock
4. Emergency stop button
5. Option switches
6. Manual modes:
   a. Command mode
   b. MDI mode
7. Rapid travel over ride
8. Single step mode (Block-To-Block)
9. Feed rate override
10. Jog mode
11. Spindle speed override
12. Spindle On/Off
13. Axis selector
14. Slide hold
15. Increment of movement selector
16. Coolant 1 and 2 On/Off
17. Tool In/Out
18. Start button
19. Turret clockwise (CW) and turret counterclockwise (CCW)
20. Start function

III. Set-Up and Program Operation of Vertical Machine
A. Describe machine tool limitations, including:
1. Number of possible tools
2. Limits in X, Y and Z axes
3. Maximum spindle speed and horsepower
4. Memory size in controller
5. Fast feed rate
6. Oil and air requirements
7. Rapid positioning rate
8. Communication systems

B. Perform basic machine set-up
1. Check oil and air supply
2. Set tool changer numbers
3. Turn power on
4. Mount machine vise on machine table
5. Set machine home position
6. Indicate vise to within specified tolerances
7. Load tools into proper tool holders
8. Load part into vise
9. Load tools into tool carousel
   a. Load tools using spindle
   b. Load tools directly into carousel
C. Set part home
   1. Set part home using edge finder
   2. Set part home using test indicator and gauge block
   3. Set part home from tooling ball using fixture offsets

D. Set tool length offsets
   1. Set tool length offsets using work piece
   2. Set tool length offsets using gauge block
   3. Set tool length offsets using electronic probe
   4. Set tool length offsets using keyboard commands
   5. Modify length and diameter offsets using tool page editor.
   6. Upload and download tool information to storage

E. Load program
   1. Upload and download programs using RS-232 interface
   2. Upload and download programs using local area network

F. Edit program for machine tool
   1. Edit program at machine tool using editor in controller
   2. Edit program using DOS and Windows editors

G. Create program without CAD/CAM for common machine operations
   using machine controllers software to include:
   1. Proper use of cutter compensation
   2. Fixed cycles
   3. Fixed sub-routines
   4. Sub-routines (loops)
   5. Fixture offsets
   6. Trouble shoot and repair problems in programs
   7. Use machine verification options if available

IV. Demonstrate Machining of Objects on Vertical Machining Center
A. Machine objects, including:
   1. Outside contours
   2. Pockets
   3. Drilled holes
   4. Drill and tapped holes
      a. Rigid tapping
      b. Compression tapping
   5. Single point boring
   6. Reaming
   7. Single point thread, internal and external

B. Set-up three dimensional digitizer and machine model
   1. Mount model on machine table
   2. Install 3-dimensional digitizing unit
   3. Establish communications with computer
   4. Define grid pattern and feed rate required for given tolerances
   5. Set part home
   6. Digitize model
   7. Process digital data for machining
8. Machine new model with program created from digitizer

C. Create work piece using 4th- and 5th-axes
   1. Mount, connect and indicate 4th- and 5th-axes attachment
   2. Set-tooling
   3. Machine work piece
   4. Remove 4th- and 5th-axes attachment

D. Maintain vertical machine
   1. Mix coolant
   2. Determine need for coolant change
   3. Change coolant
   4. Clean coolant tank
   5. Clean machine
   6. Change oil filters
   7. Add lubricating fluid
   8. Add hydraulic fluid
   9. Dispose of coolant and oils per EPA regulations
Note to the Instructor:

Because of the wide variety of CNC machining centers and CNC mills available, student laboratory and assessment activities must be developed by the instructor for his or her particular laboratory equipment. All laboratory exercises and student assessments should be "hands on" which stress machine safety and assess the student's mastery of each of the lesson objectives.
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Subject: Tool & Die and EDM  
Time: 50 Hrs.

Duty: Perform CAD/CAM and CNC Programming Tasks  
Task: Program and Operate CNC Lathe

Objectives:

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

a. Describe history of horizontal turning centers;
b. Describe theory of operation;
c. Describe nomenclature used in horizontal turning centers;
d. Demonstrate safety practices related to horizontal turning centers;
e. Set-up and program operation of horizontal turning centers;
f. Demonstrate proper machining of objects;
g. Create program using machine controllers software; and,
h. Maintain horizontal turning centers.

Instructional Materials:

MASTER Handout (TLD-H3-HO)  
MASTER Laboratory Exercise/Self Assessment (TLD-H3-LE/SA)  
MASTER Laboratory Aid (TLD-H3-LA)

References:


Student Preparation:

Students should have previously completed the following Technical Modules:

- TLD-H1 “Discuss Fundamentals of CNC Machines and Controls”
- TLD-H2 “Program and Operate CNC Milling Machine and Machining Center”
Introduction:

With the introduction of the first NC machines, machining was changed forever. In the beginning, ownership of NC machines was limited to those companies that possessed great financial resources. The need for these machines, even if one had the capital, was limited to those companies that produced long production runs that required little (if any) design variation. These early machines were not user friendly nor were they quick to program, set up or operate. The advent of modern computers along with major changes in associated electronics has changed this scenario forever. Today the vast majority of companies have at least one CNC machine if not many. Most of the new employment is offered in the use and programming of these machines. It is no longer an option as to whether a technician wants to learn how to use a CNC machining center. The overall popularity of CNC machines is increasing dramatically and this trend demands that all technicians accept CNC as they have any other tool of their trade.

This module addresses the application of the CNC turning center, which is really just a hybrid of the common lathe, its conventional counterpart with the addition of many of its attachments.

This module can be used for individuals who will be using turning centers at various levels from CNC operator to CNC technicians. The ability to complete these tasks both quickly and accurately in various settings will, in most cases, be one of the deciding factors of how long an individual will stay at the operator level or progress into the programming area.

Presentation Outline:

I. Explain CNC Turning Process, Equipment and Safety
   A. Describe CNC turning process
      1. Describe history of CNC turning
      2. Describe use of various turning machines
   B. Describe theory of operation
      1. Describe open and closed loop systems
      2. Describe various oil and air requirements
      3. Describe how turning centers function
   C. Describe nomenclature used in CNC turning
      1. Describe and identify common tools used to:
         a. Turn
         b. Drill
         c. Groove
         d. Face
         e. Bore
         f. Single point thread
2. Describe and identify work holding devices used in turning, including:
   a. 2-jaw chucks
   b. 3-jaw chuck
   c. 4-jaw chucks
   d. Soft jaw chucks
   e. Bar feed attachments
   f. Collets
   g. Centers
3. Select proper cutting inserts relative to:
   a. Roughing
   b. Finishing
   c. Threading
   d. Different types of materials

D. Demonstrate safety practices related to CNC turning centers
1. Demonstrate operating safety practices, including:
   a. Safety door interlocks
   b. Power box interlocks
   c. Tool loading and unloading
   d. Loading and unloading work holding devices
   e. Machine coolant disposal

2. Describe/identify personal safety equipment

II. Describe CNC Turning Center
A. Describe controller functions, including:
   1. Power meter
   2. Option switches
   3. Key lock
   4. Emergency stop button
   5. Rapid travel override
   6. Feed rate override
   7. Spindle speed override
   8. Axis selector
   9. Increment of movement selector
   10. Slide hold
   11. Start function

B. Describe keyboard functions, including:
   1. Automatic mode
   2. Manual MDI mode
   3. Single step mode (block-to-block)
   4. Jog mode
   5. Spindle on/off
   6. Coolant on/off
   7. Tool turret clockwise (CW) and tool turret counterclockwise (CCW)
III. Set-Up and Program Operation of CNC Turning Center
   A. Describe machine tool limitations, including:
      1. Number of possible tools
      2. Maximum spindle speed and horsepower
      3. Fast feed rate
      4. Rapid positioning rate
      5. Limits in X and Z axes
      6. Memory size in controller
      7. Oil and air requirements
      8. Communication systems
   B. Perform basic machine set-up
      1. Check oil and air supply
      2. Turn power on
      3. Set machine home position
      4. Load tools into proper tool holders
      5. Load tools into tool carousel
      6. Set tool changer numbers
      7. Mount work piece into chuck
      8. Indicate work piece within specified tolerances
   C. Set tool length offsets
      1. Set tool length offsets using work piece
      2. Set tool length offsets using keyboard commands
      3. Modify length and diameter offsets using tool page editor
      4. Modify length and diameter offsets using keyboard
      5. Upload and download tool information to storage
   D. Load program
      1. Upload and download programs using RS-232 interface
      2. Upload and download programs using local area network
   E. Edit program for machine tool
      1. Edit program at machine tool using editor in controller
      2. Edit program using DOS and Windows editors

IV. Create Program Without CAD/CAM for Common Machine Operations Using Machine Controllers Software to include:
    A. Proper use of cutter compensation
    B. Fixed cycles
    C. Fixed sub-routines
    D. Sub-routines (loops)
    E. Fixture offsets
    F. Trouble shoot and repair problems in programs
    G. Use machine verification options if available

V. Create Program for Common Machine Operations
    A. Use machine controller editor
    B. Use DOS editor
    C. Use Windows editor

VI. Demonstrate Machining of Objects on CNC Turning Center
A. Machine objects, including:
   1. External and internal contouring
   2. External and internal grooving
   3. Drill and tapped holes
   4. Single point boring
   5. Reaming
   6. Single point thread internal and external
   7. Facing operations
   8. Turning tapers

B. Maintain turning center
   1. Mix coolant
   2. Determine need for coolant change
   3. Change coolant
   4. Clean coolant tank
   5. Clean machine
   6. Change oil filters
   7. Add lubricating fluid
   8. Add hydraulic fluid
   9. Dispose of coolant and oils per EPA regulations

Practical Application:

In our program we have found it very important to require the students to do all aspects of vertical machining. It should be obvious that if an individual cannot set up a machine, then he will be limited to just “pushing buttons.”

We have developed this module for not only a specific group of individuals but also many different types of machines/controllers as well as local manufacturer requirements.

Most of the sections of this module are generic to all vertical machines as well as most machine controllers. Please note that there can be a great variation from one machine type to another; this becomes very evident in many of the sections covered in this module.

It is very important that the instructor design projects that are progressive in the level of required sophistication, so that the students will be reinforced as to their ability to complete these requirements.

Evaluation and/or Verification:

As with the Practical Application section above it will be necessary for you to design an evaluation instrument that best suits the environment in which you are presenting this information.
It is important to remember that the subject mastery is represented in the ability to not only perform the application of the technology, but also the ability to explain the process in both oral and written format.

Summary:

Review the main lesson points and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-H4) dealing with using Computer-Aided Drafting (CAD) system.
TLD-H3-HO
Program and Operate CNC Lathe
Attachment 1: MASTER Handout

Objectives:

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

a. Describe history of horizontal turning centers;
b. Describe theory of operation;
c. Describe nomenclature used in horizontal turning centers;
d. Demonstrate safety practices related to horizontal turning centers;
e. Set-up and program operation of horizontal turning centers;
f. Demonstrate proper machining of objects;
g. Create program using machine controllers software; and,
h. Maintain horizontal turning centers.

Module Outline:

I. Explain CNC Turning Process, Equipment and Safety
   A. Describe CNC turning process
      1. Describe history of CNC turning
      2. Describe use of various turning machines
   B. Describe theory of operation
      1. Describe open and closed loop systems
      2. Describe various oil and air requirements
      3. Describe how turning centers function
   C. Describe nomenclature used in CNC turning
      1. Describe and identify common tools used to:
         a. Turn
         b. Drill
         c. Groove
         d. Face
         e. Bore
         f. Single point thread
         g. Tap
      2. Describe and identify work holding devices used in turning, including:
         a. 2-jaw chucks
         b. 3-jaw chuck
         c. 4-jaw chucks
         d. Soft jaw chucks
         e. Bar feed attachments
         f. Collets
         g. Centers
3. Select proper cutting inserts relative to:
   a. Roughing
   b. Finishing
   c. Threading
   d. Different types of materials

D. Demonstrate safety practices related to CNC turning centers
   1. Demonstrate operating safety practices, including:
      a. Safety door interlocks
      b. Power box interlocks
      c. Tool loading and unloading
      d. Loading and unloading work holding devices
      e. Machine coolant disposal
   2. Describe/identify personal safety equipment

II. Describe CNC Turning Center
   A. Describe controller functions, including:
      1. Power meter
      2. Option switches
      3. Key lock
      4. Emergency stop button
      5. Rapid travel override
      6. Feed rate override
      7. Spindle speed override
      8. Axis selector
      9. Increment of movement selector
      10. Slide hold
      11. Start function
   B. Describe keyboard functions, including:
      1. Automatic mode
      2. Manual MDI mode
      3. Single step mode (block-to-block)
      4. Jog mode
      5. Spindle on/off
      6. Coolant on/off
      7. Tool turret clockwise (CW) and tool turret counterclockwise (CCW)

III. Set-Up and Program Operation of CNC Turning Center
   A. Describe machine tool limitations, including:
      1. Number of possible tools
      2. Maximum spindle speed and horsepower
      3. Fast feed rate
      4. Rapid positioning rate
      5. Limits in X and Z axes
      6. Memory size in controller
      7. Oil and air requirements
      8. Communication systems
B. Perform basic machine set-up
   1. Check oil and air supply
   2. Turn power on
   3. Set machine home position
   4. Load tools into proper tool holders
   5. Load tools into tool carousel
   6. Set tool changer numbers
   7. Mount work piece into chuck
   8. Indicate work piece within specified tolerances
C. Set tool length offsets
   1. Set tool length offsets using work piece
   2. Set tool length offsets using keyboard commands
   3. Modify length and diameter offsets using tool page editor
   4. Modify length and diameter offsets using keyboard
   5. Upload and download tool information to storage
D. Load program
   1. Upload and download programs using RS-232 interface
   2. Upload and download programs using local area network
E. Edit program for machine tool
   1. Edit program at machine tool using editor in controller
   2. Edit program using DOS and Windows editors

IV. Create Program Without CAD/CAM for Common Machine Operations Using Machine Controllers Software to include:
A. Proper use of cutter compensation
B. Fixed cycles
C. Fixed sub-routines
D. Sub-routines (loops)
E. Fixture offsets
F. Trouble shoot and repair problems in programs
G. Use machine verification options if available

V. Create Program for Common Machine Operations
A. Use machine controller editor
B. Use DOS editor
C. Use Windows editor

VI. Demonstrate Machining of Objects on CNC Turning Center
A. Machine objects, including:
   1. External and internal contouring
   2. External and internal grooving
   3. Drill and tapped holes
   4. Single point boring
   5. Reaming
   6. Single point thread internal and external
   7. Facing operations
   8. Turning tapers
B. Maintain turning center
1. Mix coolant
2. Determine need for coolant change
3. Change coolant
4. Clean coolant tank
5. Clean machine
6. Change oil filters
7. Add lubricating fluid
8. Add hydraulic fluid
9. Dispose of coolant and oils per EPA regulations
Note to the Instructor:

Because of the wide variety of CNC machining centers and CNC mills available, student laboratory and assessment activities must be developed by the instructor for his or her particular laboratory equipment. All laboratory exercises and student assessments should be “hands on” which stress machine safety and assess the student’s mastery of each of the lesson objectives.
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-H4

Subject: Tool & Die and EDM
Time: 40 Hrs.

Duty: Perform CAD/CAM and CNC Programming Tasks
Task: Use Computer-Aided Drafting (CAD) System

Objective(s):

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

a. Create geometry using CAD system;
b. Create 3-D solid models;
c. Interconvert CAD and accepted drawing exchange formats;
d. Configure CAD system parameters; and,
e. Use peripheral devices.

Instructional Materials:

MASTER Handout (TLD-H4-HO)
MASTER Self-Assessment

References:

Harnessing AutoCAD Release 12 & 13 for DOS and Windows, Thomas A. Stellman, G.V. Krishnan and Robert A. Rhea, Delmar Publishing Co., Latest Editions

Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-B1 through TLD-B5  "Apply Mathematical Concepts"
TLD-C1  "Interpret and Understand Basic Layout/Types of Drawings"
TLD-C2  "Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
TLD-C3  "Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
TLD-C4  "Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
TLD-G1 through TLD-G4  "Use Computers"

Introduction:

Computer-Aided Drafting (CAD) is just a tool to be used by any operator from senior designer to any and every employee. It can be used to perform tasks in the engineering design office, or in the manufacturing process, actual production and delivery of a product. This tool can be used by the tool and die maker to design, check, and produce programs, 2D and 3D, geometry, and actual products. This tool can be readily connected to almost any machine in the shop to complete almost any type of shop process of procedure.

Presentation Outline:

I. Identify System Requirements
   A. Hardware present and available
   B. Software present and available
   C. Equipment currently available
      1. Monitors
      2. CPU
      3. Keyboards
      4. Mouse
   D. Peripheral devices available
      1. Printer
      2. Plotters
      3. LCD
      4. Digitizer

II. Access and Maneuver Within CAD System
   A. Use basic DOS commands
      1. Copy
2. Move
3. Delete
4. List files
5. Make directory
6. Change directory
7. Root directory

B. Initiate graphics editor
1. Open existing files
2. Creating new files
3. Save/Save As files
4. Q Saves files
5. Quitting a graphic session
6. Ending a graphic session

C. Use various disk drives

D. Use command line

E. Use graphics area

F. Use graphics cursor

G. Use screen menus and submenus

H. Use status and coordinate display line

I. Use pull-down menus

J. Use cursor menu

K. Use keyboard
   1. Control keys
   2. Function keys
   3. Special keys
   4. Arrow keys
   5. Numeric value keys

III. Create Geometry Using CAD System
A. Use utility and services commands
   1. Help
   2. New
   3. Open
   4. Save
   5. Exit
   6. Config
   7. About
   8. Status
   9. Limits
   10. Units
   11. Tablet
   12. Reinit
   13. Menu
   14. Compile
   15. Files
   16. Audit
17. Recover
18. Multiple
19. Time
20. Setvar

B. Use the entity draw commands
1. Line
2. Point
3. Circle
4. Arc
5. Trace
6. Pline
7. Polygon
8. Doughnut
9. Ellipse
10. Sketch
11. Solid
12. Text
13. D text
14. Style

C. Use the edit and inquiry commands
1. Grips
2. Erase
3. Copy
4. Move
5. Rotate
6. Scale
7. Mirror
8. Stretch
9. Array
10. Change
11. Pedit
12. Break
13. Trim
14. Extend
15. Fillet
16. Chamfer
17. Offset
18. Divide
19. Measure
20. Pedit
21. Explode
22. U/undo
23. Redo
24. List
25. Dblist
26. 10
27. Dist
28. Area

D. Use the display control commands
   1. Model space
   2. Paper space
   3. Viewports
   4. Regeneration
   5. Redraw
   6. Zoom
   7. Pan
   8. View
   9. Mview
  10. Redraw all
  11. Regen all
  12. Fill Qtext
  13. RegenAuto
  14. Dragmode
  15. Blipmode
  16. Viewers

E. Use the entity properties commands
   1. Layer
   2. DDLmodes
   3. DDEmodes
   4. Color
   5. Linetype
   6. LtScale

F. Use the drawing aids commands
   1. DDRmodes
   2. Snap
   3. Grid
   4. Ortho
   5. UCS
   6. DDUCS
   7. Ultsicon
   8. Object snap
   9. DDOsnap
  10. Osnap
  11. Aperture

G. Use the blocks and attributes commands
   1. Block
   2. DDinsert
   3. Insert
   4. Minsert
   5. Wblock
6. Attributes
7. DDATTDEF
8. ATTDEF
9. ATTDISP
10. ATTEDIT
11. DDATTE
12. DDATTEXT
13. ATTEXT

H. Use the cross-section and pattern filling commands
1. BHATCH
2. HATCH
3. BPOLY
4. Hatching system variables

IV. Dimensioning Geometry Using CAD System
A. DIM and DIM I
B. Associative dimensioning
   1. Terms
   2. Variables
   3. Styles
   4. Points
   5. Model/Paper space
C. Dimension styles
   1. Override
   2. Restore
   3. Save
   4. Variables
   5. Stylenames
D. Dimension variables
   1. Style
   2. Scaling
   3. Color
   4. Dimension line
   5. Extension line
   6. Arrows
   7. Text location
   8. Text format
   9. Features
   10. Colors
E. Dimensioning geometry commands
   1. Linear
   2. Angular
   3. Diameter
   4. Radius
   5. Center marks and lines
   6. Ordinate
F. Dimension editing
   1. Home text
   2. New text
   3. Oblique
   4. TEDIT
   5. Trotate
   6. Update

G. Dimension utility
   1. Exit
   2. Leader
   3. Redraw
   4. Status
   5. Styles
   6. Undo

V. Use Peripheral Devices
A. Printers
B. Plotters
   1. CMDDIM system variable
   2. Plot
      a. Devices and defaults
      b. Pen parameters
      c. Additional parameters
      d. Paper size and orientation
      e. Scale
      f. Rotation
      g. Origin
      h. Plot preview

C. Liquid crystal displays
D. Overhead projectors
E. Digitizer tablets

VI. Interconvert CAD and Accepted Drawing Exchange Formats
A. Post Script Support
   1. PSOUT
   2. PSIN
   3. PSFILL
B. Slide shows
   1. MSLIDE
   2. VSLIDE
   3. Filmroll
C. Drawing interchange file (ASCII or Binary)
   1. DXFIIN
   2. DXFOUT
   3. DXBIN
D. Initial graphic exchange specification
   1. IGESIN
2. IGESOUT

Practical Application:

Students should be given several drawings of various types with varying degrees of complexity to read and answer questions about.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson, along with successful completion of blueprint reading exercises.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-H5) dealing with creating 3-D solid models.
Objective(s):

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

a. Create geometry using CAD system;
b. Create 3-D solid models;
c. Interconvert CAD and accepted drawing exchange formats;
d. Configure CAD system parameters; and,
e. Use peripheral devices.

Module Outline:

I. Identify System Requirements
   A. Hardware present and available
   B. Software present and available
   C. Equipment currently available
      1. Monitors
      2. CPU
      3. Keyboards
      4. Mouse
   D. Peripheral devices available
      1. Printer
      2. Plotters
      3. LCD
      4. Digitizer

II. Access and Maneuver Within CAD System
    A. Use basic DOS commands
       1. Copy
       2. Move
       3. Delete
       4. List files
       5. Make directory
       6. Change directory
       7. Root directory
    B. Initiate graphics editor
       1. Open existing files
       2. Creating new files
       3. Save/Save As files
       4. Q Saves files
       5. Quitting a graphic session
       6. Ending a graphic session
C. Use various disk drives  
D. Use command line  
E. Use graphics area  
F. Use graphics cursor  
G. Use screen menus and submenus  
H. Use status and coordinate display line  
I. Use pull-down menus  
J. Use cursor menu  
K. Use keyboard  
   1. Control keys  
   2. Function keys  
   3. Special keys  
   4. Arrow keys  
   5. Numeric value keys  

III. Create Geometry Using CAD System  
A. Use utility and services commands  
   1. Help  
   2. New  
   3. Open  
   4. Save  
   5. Exit  
   6. Config  
   7. About  
   8. Status  
   9. Limits  
  10. Units  
  11. Tablet  
  12. Reinit  
  13. Menu  
  14. Compile  
  15. Files  
  16. Audit  
  17. Recover  
  18. Multiple  
  19. Time  
  20. Setvar  
B. Use the entity draw commands  
   1. Line  
   2. Point  
   3. Circle  
   4. Arc  
   5. Trace  
   6. Pline  
   7. Polygon  
   8. Doughnut
9. Ellipse
10. Sketch
11. Solid
12. Text
13. D text
14. Style

C. Use the edit and inquiry commands
1. Grips
2. Erase
3. Copy
4. Move
5. Rotate
6. Scale
7. Mirror
8. Stretch
9. Array
10. Change
11. Pedit
12. Break
13. Trim
14. Extend
15. Fillet
16. Chamfer
17. Offset
18. Divide
19. Measure
20. Pedit
21. Explode
22. U/undo
23. Redo
24. List
25. Dblist
26. 10
27. Dist
28. Area

D. Use the display control commands
1. Model space
2. Paper space
3. Viewports
4. Regeneration
5. Redraw
6. Zoom
7. Pan
8. View
9. Mview
10. Redraw all
11. Regen all
12. Fill Qtext
13. RegenAuto
14. Dragmode
15. Blipmode
16. Viewers

E. Use the entity properties commands
1. Layer
2. DDLmodes
3. DDEmodes
4. Color
5. Linetype
6. LtScale

F. Use the drawing aids commands
1. DDRmodes
2. Snap
3. Grid
4. Ortho
5. UCS
6. DDUUCS
7. Ulsicon
8. Object snap
9. DDOSnap
10. Osnap
11. Aperture

G. Use the blocks and attributes commands
1. Block
2. DDinsert
3. Insert
4. Minsert
5. Wblock
6. Attributes
7. DDATTDEF
8. ATTTDEF
9. ATTDISP
10. ATTTEDIT
11. DDATTE
12. DDATTEXT
13. ATTEXT

H. Use the cross-section and pattern filling commands
1. BHATCH
2. HATCH
3. BPOLY
4. Hatching system variables
IV. Dimensioning Geometry Using CAD System

A. DIM and DIM I

B. Associative dimensioning
   1. Terms
   2. Variables
   3. Styles
   4. Points
   5. Model/Paper space

C. Dimension styles
   1. Override
   2. Restore
   3. Save
   4. Variables
   5. Stylenames

D. Dimension variables
   1. Style
   2. Scaling
   3. Color
   4. Dimension line
   5. Extension line
   6. Arrows
   7. Text location
   8. Text format
   9. Features
   10. Colors

E. Dimensioning geometry commands
   1. Linear
   2. Angular
   3. Diameter
   4. Radius
   5. Center marks and lines
   6. Ordinate

F. Dimension editing
   1. Home text
   2. New text
   3. Oblique
   4. TEDIT
   5. Trotate
   6. Update

G. Dimension utility
   1. Exit
   2. Leader
   3. Redraw
   4. Status
   5. Styles
6. Undo

V. Use Peripheral Devices
   A. Printers
   B. Plotters
      1. CMDDIM system variable
      2. Plot
         a. Devices and defaults
         b. Pen parameters
         c. Additional parameters
         d. Paper size and orientation
         e. Scale
         f. Rotation
         g. Origin
         h. Plot preview
   C. Liquid crystal displays
   D. Overhead projectors
   E. Digitizer tablets

VI. Interconvert CAD and Accepted Drawing Exchange Formats
   A. Post Script Support
      1. PSOUT
      2. PSIN
      3. PSFILL
   B. Slide shows
      1. MSLIDE
      2. VSLIDE
      3. Filmroll
   C. Drawing interchange file (ASCII or Binary)
      1. DXFIIN
      2. DXFOUT
      3. DXBIN
   D. Initial graphic exchange specification
      1. IGESIN
      2. IGESOUT
TLD-H4
Use Computer-Aided Drafting (CAD) System
Self-Assessment

1. Identify present and available software.

2. Identify present and available hardware.

3. Name three pieces of equipment currently available and describe their various uses.

4. Name and describe three peripheral devices.

5. Name and define five basic DOS commands used in a CAD system.

6. Identify and describe four graphic editor commands used in a CAD system.

7. What is a disk drive?
8. What is a command line?

9. Describe the graphics area.

10. Define screen menus and submenus.

11. Identify and describe status and coordinate display line.

12. Describe a pull-down menu.

13. What is a cursor menu?

14. List and define four types of keys used on a keyboard.

15. Name and define four utility commands used in a CAD system.

16. Name and describe four service commands used in a CAD system.
17. Identify and define five entity draw commands used in a CAD system.

18. What are inquiry commands?

19. Name and define three inquiry commands used in a CAD system.

20. What are edit commands?

21. Name and describe four edit commands used in a CAD system.

22. What are display commands?

23. Name and define five display control commands used in a CAD system.

24. What are entity properties commands?

25. List and describe three entity properties commands used in a CAD system.
26. What are drawing aid commands?

27. Identify and define four drawing aid commands used in a CAD system.

28. What are block commands?

29. List and describe two block commands used in a CAD system.

30. What are attributes commands?

31. Name and define three attribute commands used in a CAD system.

32. What is cross-section and pattern filling commands?

33. Name and describe three associative dimensioning commands used in a CAD system.

34. Identify and define three dimension styles commands used in a CAD system.
35. Name and describe three dimension variable commands used in a CAD system.

36. Identify and define three dimension drawing commands used in a CAD system.

37. List and describe three dimension editing commands used in a CAD system.

38. Name and define three dimension utility commands used in a CAD system.

39. Identify and describe 4 plot parameters that must be set prior to plotting using a CAD system.

40. Name and define three types of peripheral devices that could be used with a CAD system.

41. List and describe three types of postscript support which could be used with a CAD system.

42. What do slide show presentations consist of in use with a CAD system?
43. Name and describe three drawing interchange files that could be used with a CAD system.

____________________________________

____________________________________

44. Identify and define two initial graphic exchange specifications that could be used with a CAD system.

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TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-H5

Subject: Tool & Die and EDM Time: 60 Hrs.
Duty: Perform CAD/CAM and CNC Programming Tasks
Task: Create 3-D Solid Models

Objective(s):

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

a. Access and maneuver within a CAD system;
b. Create 3-D solid geometry models;
c. Dimension 3-D geometry;
d. Display commands to generate prototype borders;
e. Display commands to control drawing representation on the screen;
f. Display commands used to generate and manipulate viewports;
g. Setting commands to assist with 3-D geometry;
h. Layer commands to place entities into specified layer options;
i. Use isometric geometry commands;
j. Use 3-D surface and object commands;
k. Use utility to manage files;
l. Use utility commands to generate slides, script files, and access external commands of the system;
m. Use keyboard to manipulate function keys, special keys, control, and special character keys;
n. Use presentation graphics and rendering commands;
o. Use solid commands to generate 3-D solid model geometry;
p. Use 3-D solid modifiers commands;
q. Use solid 3-D inquiry commands;
r. Use solid 3-D representation commands;
s. Use solid 3-D utility commands;
t. Use LISP programs to generate 3-D solid model geometry;
u. Use Application Programming Interface (API) functions;
v. Use bonus 3-D solid feature commands; and,
w. Use CAD system to digitize paper drawings.

Instructional Materials:

MASTER Handout (TLD-H5-HO)
MASTER Self-Assessment
References:


Student Preparation:

Students should have previously completed the following Technical Modules:

- TLD-H4  "Use Computer-Aided Drafting (CAD) System"

Introduction:

Humans learn primarily from concrete concepts. One must be able to touch an object physically to better understand its purpose or operation. Before three-dimensional geometry generated by computers was ever possible a model maker was employed to make a tangible prototype. A model generated on a computer consists of numerical data that describes the geometry of an object. This is easier and quicker to change than the model maker prototype. Once the model database has been constructed the computer recognizes it has three dimensions. The tool and die maker can then manipulate and massage data to change the object and its display quickly and efficiently, which could not have possibly been done with a physical model.

Presentation Outline:

I. Access and Maneuver Within a CAD System
   A. Use Disk Operating System commands
   B. Use the initial graphics editor within a CAD system

II. Create 3-D Solid Geometry Models
    A. Use the blocks and attributed commands
       1. Block
       2. Insert
       3. DDI insert
       4. MInset
       5. WBlock
       6. 3-DBlock
       7. Attributes
       8. DDATTDEF
       9. ATTDEF
       10. ATTDISP
       11. ATTEDIT
       12. DDATTE
       13. DDATTEXT
       14. ATTEXT

III. Dimension 3-D Geometry
A. Dim and Dim1
B. Associative dimensioning drawing commands
   1. Linear
   2. Angular
   3. Diameter
   4. Radius
   5. Ordinate
   6. Aligned
   7. Baseline
   8. Center
   9. Continue
   10. Vertical
   11. Horizontal
   12. Rotated
C. Dimension style command
   1. Override
   2. Restore
   3. Save
   4. Variable
   5. Style name
D. Dimension editing commands
   1. Hometext
   2. Newtext
   3. Oblique
   4. Tedit
   5. Trotate
   6. Update
E. Dimension utility commands
   1. Exit
   2. Leader
   3. Redraw
   4. Status
   5. Style
   6. Undo
F. Dimension variable commands
   1. DIMALT
   2. DIMALTD
   3. DIMALTF
   4. DIMAPOST
   5. DIMASO
   6. DIMAZ
   7. DIMBLK
   8. DIMCEN
   9. DIMCLR
   10. DIMCLRE
11. DIMCLRT  
12. DIMDLE  
13. DIMDLI  
14. DIMEXE  
15. DIMEXO  
16. DIMGAP  
17. DMLFAC  
18. DIMLIM  
19. DIMPOST  
20. DMRND  
21. DIMSAH  
22. DIMSCALE  
23. DIMSE1  
24. DIMSE2  
25. DIMSHO  
26. DMTAD  
27. DMTFAC  
28. DMTIH  
29. DMTIX  
30. DMTM  
31. DMTOL  
32. DMTOP  
33. DMTP  
34. DMTSZ  
35. DMTVP  
36. DMTVP  
37. DMTXT  
38. DMTZIN

IV. Display Commands to Generate Prototype Borders  
A. View  
B. Layout  
C. MVSetup

V. Display Commands to Control Drawing Representation on the Screen  
A. View  
B. DView  
C. DView Slide Bar  
D. Plan  
E. Vpoint  
F. Shade  
G. Zoom  
H. Redraw  
I. Pan  
J. Hide  
K. Viewports  
L. REGEN
Display Commands Used to Generate and Manipulate Viewports

A. MView
B. On
C. Off
D. HidePlot
E. Fit
F. MView
G. MSpace
H. PSpace
I. TileMode
J. VPlayer

Setting Commands to Assist With 3-D Geometry

A. DDEMODES
B. DDRMODES
C. APERTURE
D. AXIS
E. BLIPS
F. COLOR
G. DRAGMODE
H. ELEVATION
I. GRID
J. LINETYPE
K. LIMITS
L. LTSCALE
M. OSNAP
N. QTEXT
O. SETVARIABLE
P. SNAP
Q. STYLE
R. TABLET
S. UCS
T. UCSICON
U. DDUCS
V. DDOSNAP
W. GRIPS
X. DDGRIPS
Y. UNITS

Layer Commands to Place Entities into Specified Layer Options

A. New layer
B. Current layer
C. Rename
D. On and off
E. Freeze and thaw
F. Lock and unlock
G. Set color
H. Set linetype
I. Filters
J. DDLMODES

IX. Use Isometric Geometry Commands
A. Snap
B. Style
C. Isometric
D. Ellipse
E. Isometric circle

X. Use 3-D Surface and Object Commands
A. 3-D surface
   1. Edgesurf
   2. Rulesurf
   3. RevSurf
   4. TabSurf
   5. SurfTab1
   6. SurfTab2
   7. PEdit
   8. 3-DFace
   9. 3-DMesh
  10. PFace
  11. 3-DPoly
B. 3-D objects
   1. 3-D box
   2. Pyramid
   3. Wedge
   4. Dome
   5. Sphere
   6. Cone
   7. Torus
   8. Dish
   9. Mesh

XI. Use Utility to Manage Files
A. Audit
B. DXF/DFB
C. DXFIN
D. DXFOUT
E. DXBIN
F. IGES
G. IGESIN
H. IGESOUT
I. PURGE

XII. Use Utility Commands to Generate Slides, Script Files, and Access External Commands of the System

A. Slide files
   1. MSlide
   2. VSlide
   3. Redraw

B. Script files
   1. Script
   2. RScript
   3. Resume
   4. Delay
   5. Graphscr
   6. Textscr

C. External commands
   1. Delete
   2. Directory
   3. Edit
   4. Type
   5. Shell

XIII. Use Keyboard to Manipulate Function Keys, Special Keys, Control, and Special Character Keys

A. Function keys
   1. F1
   2. F6
   3. F7
   4. F8
   5. F9
   6. F10

B. Special keys
   1. Ctrl “C”
   2. Ctrl “B”
   3. Ctrl “Q”
   4. Ctrl “G”
   5. Ctrl “D”
   6. Ctrl “E”
   7. Ctrl “T”
   8. Ctrl “V”
   9. Ctrl “X”
   10. Ctrl “Q”

C. Control and special characteristics
   1. % %d
   2. % %c
   3. % %o
4. \% \%p
5. \% \%u
6. \% \%nnn
7. \%\%

XIV. Use Presentation Graphics and Rendering Commands
A. Light
B. VLight
C. Camera
D. VCamera
E. Scene
F. FilmRoll
G. Open
H. Quit
I. Shading
J. PlanView
K. WireFrame
L. Fast Shade
M. Full Shade
N. Replay
O. Replay all
P. Record
Q. Hard Copy

XV. Use Solid Commands to Generate 3-D Solid Model Geometry
A. SOLBOX
B. SOLBOX (cube option)
C. SOLCONE
D. SOLCYL
E. SOLSPHERE
F. SOLTORUS
G. SOLWEDGE
H. SOLEXTRUDE
I. SOLREVOLVE
J. SOLIDIFY

XV1. Use 3-D Solid Modifiers Commands
A. SOLINT
B. SOLSUB
C. SOLUNION
D. SOLSEP
E. SOLCUT
F. SOLCHAM
G. SOLFILL
H. SOLCHP
I. SOLMOVE

XVII. Use Solid 3-D Inquiry Commands
A. LLIST
B. LMASSP
C. LAREA
D. LINTERF

XVIII. Use Solid 3-D Representation Commands
A. SOLMESH
B. SOLWIRE
C. SOLFEAT
D. SOLPROF
E. SOLSECT
F. SOLHPAT
G. SOLHSIZE
H. SOLHANGLE

XIX. Use Solid 3-D Utility Commands
A. SOLIN
B. SOLOUT
C. SOLMAT
D. SOLPURGE
E. SOLUCS
F. SOLVAR
G. UNLOAD

XX. Use LISP Programs to Generate 3-D Solid Model Geometry
A. SOLMAINT
B. WBLKSOL
C. HOLE
D. STLSUP

XXI. Use Application Programming Interface (API) Functions
A. TUTOR
B. ASM
C. DRILL
D. DESIGN
E. LAYOUT
F. SYMMETRY
G. OFFSOL

XXII. Use Bonus 3-D Solid Feature Commands
A. SOLSTLOUT
B. SOLVIEW
C. AMELINK

XXIII. Use CAD System to Digitize Paper Drawings
A. Tablet mode
B. Tablet on/off
C. Tablet calibration
D. Tablet configuration
Practical Application:

Students will access and maneuver within a CAD system. Each student will then create and dimension 3-D solid geometry models. The student will then use the display, settings, layers, surfaces, objects, and rendering commands to present their 3-D solid geometry model. Each student will use 3-D representation, utility, LISP, and bonus commands to graphically display and represent their 3-D solid geometry models.

Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson, along with assigned projects pertaining to topics covered.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-H6) dealing with using Computer-Aided Manufacturing (CAM) system.
Objective(s):

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

a. Access and maneuver within a CAD system;
b. Create 3-D solid geometry models;
c. Dimension 3-D geometry;
d. Display commands to generate prototype borders;
e. Display commands to control drawing representation on the screen;
f. Display commands used to generate and manipulate viewports;
g. Setting commands to assist with 3-D geometry;
h. Layer commands to place entities into specified layer options;
i. Use isometric geometry commands;
j. Use 3-D surface and object commands;
k. Use utility to manage files;
l. Use utility commands to generate slides, script files, and access external commands of the system;
m. Use keyboard to manipulate function keys, special keys, control, and special character keys;
n. Use presentation graphics and rendering commands;
o. Use solid commands to generate 3-D solid model geometry;
p. Use 3-D solid modifiers commands;
q. Use solid 3-D inquiry commands;
r. Use solid 3-D representation commands;
s. Use solid 3-D utility commands;
t. Use LISP programs to generate 3-D solid model geometry;
u. Use Application Programming Interface (API) functions;
v. Use bonus 3-D solid feature commands; and,
w. Use CAD system to digitize paper drawings.

Module Outline:

I. Access and Maneuver Within a CAD System
   A. Use Disk Operating System commands
   B. Use the initial graphics editor within a CAD system

II. Create 3-D Solid Geometry Models
   A. Use the blocks and attributed commands
      1. Block
      2. Insert
      3. DDInsert
      4. MInset
5. WBlock
6. 3-DBlock
7. Attributes
8. DDATTDEF
9. ATTDEF
10. ATTDISP
11. ATTEDIT
12. DDATTE
13. DDATTTEXT
14. ATTEXT

III. Dimension 3-D Geometry
A. Dim and Dim1
B. Associative dimensioning drawing commands
   1. Linear
   2. Angular
   3. Diameter
   4. Radius
   5. Ordinate
   6. Aligned
   7. Baseline
   8. Center
   9. Continue
  10. Vertical
  11. Horizontal
  12. Rotated
C. Dimension style command
   1. Override
   2. Restore
   3. Save
   4. Variable
   5. Style name
D. Dimension editing commands
   1. Hometext
   2. Newtext
   3. Oblique
   4. Tedit
   5. Trotate
   6. Update
E. Dimension utility commands
   1. Exit
   2. Leader
   3. Redraw
   4. Status
   5. Style
   6. Undo
F. Dimension variable commands
1. DIMALT
2. DIMALTDD
3. DIMALTDF
4. DIMAPPOST
5. DIMASO
6. DIMAZ
7. DIMBLK
8. DIMCEN
9. DIMCLRD
10. DIMCLRE
11. DIMCLRT
12. DIMDLE
13. DIMDLI
14. DIMEXE
15. DIMEXO
16. DIMGAP
17. DIMLFAC
18. DIMLIM
19. DIMPOST
20. DIMRND
21. DIMSAH
22. DIMSCALE
23. DIMSE1
24. DIMSE2
25. DIMSHO
26. DIMTAD
27. DIMTFAC
28. DIMTIH
29. DIMTIX
30. DIMTM
31. DIMTOFL
32. DIMTOH
33. DIMTOL
34. DIMTP
35. DIMTSZ
36. DIMTVP
37. DIMTXT
38. DIMZIN

IV. Display Commands to Generate Prototype Borders
A. View
B. Layout
C. MVSetup

V. Display Commands to Control Drawing Representation on the Screen
A. View
B. DView
C. DView Slide Bar
D. Plan
E. Vpoint
F. Shade
G. Zoom
H. Redraw
I. Pan
J. Hide
K. Viewports
L. REGEN
M. REDRAWALL
N. REGENALL
O. REGENAUTO
P. VIEWERS
Q. FILL

VI. Display Commands Used to Generate and Manipulate Viewports
A. MView
B. On
C. Off
D. HidePlot
E. Fit
F. MView
G. MSpace
H. PSpace
I. TileMode
J. VPlayer

VII. Setting Commands to Assist With 3-D Geometry
A. DDEMODES
B. DDRMODES
C. APERTURE
D. AXIS
E. BLIPS
F. COLOR
G. DRAGMODE
H. ELEVATION
I. GRID
J. LINETYPE
K. LIMITS
L. LTSCALE
M. OSNAP
N. QTEXT
O. SETVARIABLE
P. SNAP
Q. STYLE

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R. TABLET
S. UCS
T. UCSICON
U. DDUUCS
V. DDOSNAP
W. GRIPS
X. DDGRIPS
Y. UNITS

VIII. Layer Commands to Place Entities into Specified Layer Options
A. New layer
B. Current layer
C. Rename
D. On and off
E. Freeze and thaw
F. Lock and unlock
G. Set color
H. Set linetype
I. Filters
J. DDLMODES

IX. Use Isometric Geometry Commands
A. Snap
B. Style
C. Isometric
D. Ellipse
E. Isometric circle

X. Use 3-D Surface and Object Commands
A. 3-D surface
   1. Edgesurf
   2. Rulesurf
   3. RevSurf
   4. TabSurf
   5. SurfTab1
   6. SurfTab2
   7. PEdit
   8. 3-DFace
   9. 3-DMesh
  10. PFace
  11. 3-DPoly

B. 3-D objects
   1. 3-D box
   2. Pyramid
   3. Wedge
   4. Dome
   5. Sphere
   6. Cone
7. Torus
8. Dish
9. Mesh

XI. Use Utility to Manage Files
A. Audit
B. DXF/DFB
C. DXFIN
D. DXFOUT
E. DXBIN
F. IGES
G. IGESIN
H. IGESOUT
I. PURGE

XII. Use Utility Commands to Generate Slides, Script Files, and Access External Commands of the System
A. Slide files
   1. MSlide
   2. VSlide
   3. Redraw
B. Script files
   1. Script
   2. RScript
   3. Resume
   4. Delay
   5. Graphscr
   6. Textscr
C. External commands
   1. Delete
   2. Directory
   3. Edit
   4. Type
   5. Shell

XIII. Use Keyboard to Manipulate Function Keys, Special Keys, Control, and Special Character Keys
A. Function keys
   1. F1
   2. F6
   3. F7
   4. F8
   5. F9
   6. F10
B. Special keys
   1. Ctrl “C”
   2. Ctrl “B”
   3. Ctrl “Q”
4. Ctrl "G"
5. Ctrl "D"
6. Ctrl "E"
7. Ctrl "T"
8. Ctrl "V"
9. Ctrl "X"
10. Ctrl "Q"

C. Control and special characteristics
1. % %d
2. % %c
3. % %o
4. % %p
5. % %u
6. % %nnn
7. %%%

XIV. Use Presentation Graphics and Rendering Commands
A. Light
B. VLight
C. Camera
D. VCamera
E. Scene
F. FilmRoll
G. Open
H. Quit
I. Shading
J. PlanView
K. WireFrame
L. Fast Shade
M. Full Shade
N. Replay
O. Replay all
P. Record
Q. Hard Copy

XV. Use Solid Commands to Generate 3-D Solid Model Geometry
A. SOLBOX
B. SOLBOX (cube option)
C. SOLCONE
D. SOLCYL
E. SOLSPHERE
F. SOLTORUS
G. SOLWEDGE
H. SOLEXTRUDE
I. SOLREVOLVE
J. SOLIDIFY

XVI. Use 3-D Solid Modifiers Commands
A. SOLINT
B. SOLSUB
C. SOLUNION
D. SOLSEP
E. SOLCUT
F. SOLCHAM
G. SOLFILL
H. SOLCHP
I. SOLMOVE

XVII. Use Solid 3-D Inquiry Commands
A. LLIST
B. LMASSP
C. LAREA
D. LINTERF

XVIII. Use Solid 3-D Representation Commands
A. SOLMESH
B. SOLWIRE
C. SOLFEAT
D. SOLPROF
E. SOLSECT
F. SOLHPAT
G. SOLHSIZE
H. SOLHANGLE

XIX. Use Solid 3-D Utility Commands
A. SOLIN
B. SOLOUT
C. SOLMAT
D. SOLPURGE
E. SOLUCS
F. SOLVAR
G. UNLOAD

XX. Use LISP Programs to Generate 3-D Solid Model Geometry
A. SOLMAINT
B. WBLKSOL
C. HOLE
D. STLSUP

XXI. Use Application Programming Interface (API) Functions
A. TUTOR
B. ASM
C. DRILL
D. DESIGN
E. LAYOUT
F. SYMMETRY
G. OFFSOL

XXII. Use Bonus 3-D Solid Feature Commands
A. SOLSTLOUT
B. SOLVIEW
C. AMELINK

XXIII. Use CAD System to Digitize Paper Drawings
A. Tablet mode
B. Tablet on/off
C. Tablet calibration
D. Tablet configuration
TLD-H5
Create 3-D Solid Models
Self-Assessment

1. List and define five Disk Operating System commands.

2. Identify and define four parts of the graphic editor within a CAD system.

3. What type of block commands are used to generate 3-D solid geometry?

4. What type of attribute commands are used to generate 3-D solid geometry?

5. List three dimensioning commands used to dimension 3-D geometry.

6. List and define two dimension styles used to dimension 3-D geometry.

7. Name and describe three dimension editing commands used to dimension 3-D geometry.
8. Identify three dimension utility commands used to dimension 3-D geometry.


9. What are four dimension variable commands used to dimension 3-D geometry?


10. List and define two display commands used to generate prototype borders.


11. Identify and describe four display commands used to control drawing representation on the screen.


12. Name three display commands used to generate and manipulate viewports.


13. List and define five setting commands used to assist with generating 3-D geometry.


14. Identify and describe four layer entity commands used to assist with generating 3-D geometry.


15. List and define three isometric geometry commands.

16. Name and describe three 3-D object commands.

17. Identify and define three 3-D surface commands.

18. What are three utility commands used to manage various types of files?

19. What are three utility commands used to generate slides?

20. What are three utility commands used to generate script files?

21. What are three external commands used on the system?

22. Identify four function keys used with the system to assist with the generation of 3-D geometry.
23. Name and describe five special keys used with the system to assist with the generation of 3-D geometry.

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24. List and define three control or special character keys used with the system to assist with the generation of 3-D geometry.

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25. Identify and describe four 3-D render commands used to present 3-D geometry.

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26. Name and define four 3-D solid commands used to generate 3-D geometry.

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27. List and define three 3-D solid modifiers used to assist in the generation of 3-D geometry.

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28. Identify and describe two 3-D solid inquiry commands used to assist in the generation of 3-D geometry.

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29. Name and define four 3-D solid representation commands.

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30. List and describe three 3-D solid utility commands.

31. Identify and define three 3-D LISP programs used to assist in the generation of 3-D geometry.

32. Name and describe three Application Programming Interface functions used to assist in the generation of 3-D geometry.

33. List and define three 3-D solid feature commands.

34. Identify and describe three commands used to digitize paper drawings using the CAD system.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-H6

Subject: Tool & Die and EDM

Time: 30-50 Hrs.

Duty: Perform CAD/CAM and CNC Programming Tasks

Task: Use Computer-Aided Manufacturing (CAM) System

Objectives:

Upon completion of this unit the student will be able to:
1. Access CAD program options; and,
2. Create basic geometric entities.

Instructional Materials:

MASTER Handout (TLD-H6-HO)
MASTER Laboratory Aid (TLD-H6-LA)

References:

There are not many books available that discuss CAD/CAM with an emphasis on CAM, but normally there is an instructional manual that comes with the purchase of the software packages.

In the area of CAD there are many after market books available. Please check to see what is available for your software.

If you are using either MasterCam or SurfCam, there is now an aftermarket book for each. To get more information about these books contact:
Dr. Su-Chen Jonathan Lin
Scholars International Publishing Corporation
2675 Georgetown Blvd.
Ann Arbor, MI. 48105
Telephone: (313) 930-0813
Fax. Number: (313) 741-1927

Student Preparation:

Students should have previously completed the following Technical Modules:
TLD-H1 "Discuss Fundamentals of CNC Machines and Controls"
TLD-H2 "Program and Operate CNC Milling Machine and Machining Center"
Introduction:

Part I:

In this module we will discuss the actual use of CAD/CAM software to create electronic images. For those students who are using MasterCam you will notice that the information listed in the outline below relates directly to the menu commands in MasterCam.

For those of you who are not using MasterCam, your software will have menu selections that, although they are not the exactly the same as the ones listed in the outline below, they will have similar commands to perform the same type operations.

Also for anyone using either MasterCam or SurfCam, I would recommend the book listed in the resource section of this outline written by Dr. Jonathan Lin.

For those of you who are using some other company's software, there should be some type of written information that will allow you to become familiar with the basic operations listed below.

Part II:

There is no doubt that in the long term CAD/CAM saves a tremendous amount of time, and is much more flexible than paper drawings. Having made this statement it is important to note that the process of using CAD/CAM software to generate designs is a process that can be very time consuming. There is no automatic design creation that I am aware of as of this writing. Using computers to create designs is like everything else: it takes practice to become good at it.

The outline listed below covers the basic geometric elements used in creating designs. This outline only discusses wire frame geometry creation; it does not discuss either surface modeling or solid modeling. Wire frame design, although not as sophisticated as surfaces and solid modeling, encompasses the building blocks that will be used later on in more advanced CAD designs.

In CNC/CAM, we are interested in CAD as a method of generating the necessary geometric entities that will allow us to guide a cutting tool along a defined boundary or a set of boundaries to create the necessary information that will control the actions of a CNC machine tool to create a machined part to given specifications.
When we have completed the CAD component, we are only getting started. We then have to complete the CAM component as required to move onto the CNC machine.

In the overall process of CAD/CAM/CNC, the CAD section can often consume a vast majority of the time used in completion of a manufactured object. The ability to create a quality design in a short amount of time is definitely an important part of the complete process.

Presentation Outline:

I. Access CAD Program Options
   A. Explain the configuration of CAD/CAM software
      1. Explain configuration of:
         a. File and path names
         b. Installation, including DOS and Windows
         c. Configure software
         d. Interaction of files between each other
      2. Describe the “flow” process of CAD/CAM
   B. Access CAD software
      1. Access CAD software, including AutoCAD and CadKey, to:
         a. Create basic 2-dimensional designs
         b. Create 3-dimension designs
         c. Dimension designs to be used as drawings
         d. Create title blocks and borders for prints
         e. Print drawings
         f. Plot drawings
         g. Create general and local drawing notes and tolerances
      2. Describe various file conversion formats
      3. Import and export designs using conversions, including:
         a. IGES
         b. CADL
         c. DXF
         d. STL
   C. Access CAM software
      1. Load existing design
      2. Import and export design files from various file format standards, including:
         a. IGES
         b. DXF
         c. CADL
         d. STL
      3. Save design files to “permanent” memory
      4. Access CAD section of CAM software to create
         a. Create basic 2-dimensional designs

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b. Create 3-dimension designs
c. Dimension designs to be used as drawings
d. Create title blocks and borders for prints
e. Print drawings
f. Plot drawings
g. Create general and local drawing notes and tolerances

II. Create Basic Geometric Entities
A. Create basic geometric entities, including:
   1. Points
   2. Fillets
   3. Lines
   4. Splines
   5. Arcs
   6. Chamfers
   7. Circles
   8. Letters including various machinable fonts
B. Dimension completed designs to create detailed drawings
C. Transform geometric entities using CAD commands
   1. Transform geometric entities, including:
      a. Mirror entities
      b. Rotate entities
      c. Scale complete entities using single scale option
      d. Translate using move and copy options
      e. Offset single and grouped geometric entities
      f. Use group function to effect multiple entities simultaneously
      g. Use result function to effect group movements
D. Set menu selections to:
   1. View planes
   2. Construction planes
   3. Color choices
E. Use Delete command:
   1. Use Delete commands, including:
      a. Chained and duplicate entities
      b. Exclusive entities (only)
      c. Inclusive entities (all)
      d. Enclosed in window
      e. Intersecting window
F. Execute screen and display functions
   1. Use screen and display functions to:
      a. List screen statistics
      b. Display entity endpoints
      c. Clear group and result color designation
      d. Change colors of entities
      e. Display window
f. Un-zoom display

G. Use analyze function
   1. Use analyze function to interpret:
      a. Point descriptions
      b. Single entity information
      c. Locations of entities
      d. Distance between points
      e. Area calculations
      f. Calculation of angles

Practical Application:

For those of you that are using the Jonathan Lin book it is recommended that you complete the first 8 chapters of the book. Concern yourself with the CAD design for this module only.

It is also suggested that the Instructor interject some basic designs that they may get from local companies, this will give the students the experience of working on real drawings.

For those of you who will not be using the Lin book, most CAD/CAM software comes with a basic instruction book that may include basic designs. In addition, as stated above, the Instructor may add some basic drawings that would be used by local companies as an addition to the designs provided in the instructional books.

Evaluation and/or Verification:

A combination of written and hands-on testing should be used to establish the proficiency of the students.

For the written portion of the test a multiple choice test is recommended. Jonathan Lin's book has tests at the end of each chapter. These can be used as sample tests.
For the hands on testing, all students should create the same design and record their time. The time is then used to generate their grade for the hands on portion of the test. To tabulate a student's overall grade, written test time with the student’s hands on test time are averaged.

Summary:

Review the main lesson points and answer students questions

Next Lesson Assignment:

MASTER Technical Module (TLD-I1) dealing with basic types and functions of jigs and fixtures.
Objectives:

Upon completion of this unit the student will be able to:
1. Access CAD program options; and,
2. Create basic geometric entities.

Module Outline:

I. Access CAD Program Options
   A. Explain the configuration of CAD/CAM software
      1. Explain configuration of:
         a. File and path names
         b. Installation, including DOS and Windows
         c. Configure software
         d. Interaction of files between each other
      2. Describe the “flow” process of CAD/CAM
   B. Access CAD software
      1. Access CAD software, including AutoCAD and CadKey, to:
         a. Create basic 2-dimensional designs
         b. Create 3-dimension designs
         c. Dimension designs to be used as drawings
         d. Create title blocks and borders for prints
         e. Print drawings
         f. Plot drawings
         g. Create general and local drawing notes and tolerances
      2. Describe various file conversion formats
      3. Import and export designs using conversions, including:
         a. IGES
         b. CADL
         c. DXF
         d. STL
   C. Access CAM software
      1. Load existing design
      2. Import and export design files from various file format
         standards, including:
         a. IGES
         b. DXF
         c. CADL
         d. STL
      3. Save design files to “permanent” memory
4. Access CAD section of CAM software to create
   a. Create basic 2-dimensional designs
   b. Create 3-dimension designs
   c. Dimension designs to be used as drawings
   d. Create title blocks and borders for prints
   e. Print drawings
   f. Plot drawings
   g. Create general and local drawing notes and tolerances

II. Create Basic Geometric Entities
A. Create basic geometric entities, including:
   1. Points
   2. Fillets
   3. Lines
   4. Splines
   5. Arcs
   6. Chamfers
   7. Circles
   8. Letters including various machinable fonts
B. Dimension completed designs to create detailed drawings
C. Transform geometric entities using CAD commands
   1. Transform geometric entities, including:
      a. Mirror entities
      b. Rotate entities
      c. Scale complete entities using single scale option
      d. Translate using move and copy options
      e. Offset single and grouped geometric entities
      f. Use group function to effect multiple entities simultaneously
      g. Use result function to effect group movements
D. Set menu selections to:
   1. View planes
   2. Construction planes
   3. Color choices
E. Use Delete command:
   1. Use Delete commands, including:
      a. Chained and duplicate entities
      b. Exclusive entities (only)
      c. Inclusive entities (all)
      d. Enclosed in window
      e. Intersecting window
F. Execute screen and display functions
   1. Use screen and display functions to:
      a. List screen statistics
      b. Display entity endpoints
      c. Clear group and result color designation
d. Change colors of entities
e. Display window
f. Un-zoom display
g. Change levels of entities
h. Fit entities to screen
i. Set various view ports
j. Refresh screen
k. Change views
l. Set active levels
m. Change entities between levels
m. Set screen center "pan"
n. Initialize display "clear"
o. Rotate display

G. Use analyze function
1. Use analyze function to interpret:
   a. Point descriptions
   b. Single entity information
   c. Locations of entities
   d. Distance between points
   e. Area calculations
   f. Calculation of angles
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TOOL AND DIE MAKER ... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

<table>
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TOOL AND DIE MAKER ... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-I1

Subject: Tool & Die and EDM
Time: 6 Hrs.

Duty: Perform Tool and Die Making Operations

Task: Discuss Basic Types and Functions of Jigs and Fixtures

Objective(s):

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

a. Distinguish between jigs and fixtures;
b. Discuss boring and drill jigs;
c. Discuss open and closed (box) jigs;
d. Discuss the various names used to identify jig types; and,
e. Discuss the various types and functions of fixtures.

Instructional Materials:

MASTER Handout (TLD-I1-HO)
MASTER Self-Assessment

References:

NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744
Basic Fixture Design, Paul Campbell, Industrial Press, Latest Edition
Student Preparation:

Students should have previously completed the following Technical Modules:

- **TLD-A1 through TLD-A6** “Practice Safety”
- **TLD-B1 through TLD-B5** “Apply Mathematical Concepts”
- **TLD-C1 through TLD-C5** “Interpret Engineering Drawings and Related Documents”
- **TLD-D1 through TLD-D3** “Demonstrate Knowledge of Manufacturing Materials”
- **TLD-E1 through TLD-E6** “Measure/Inspect”
- **TLD-F1 through TLD-F10** “Demonstrate Knowledge of Manufacturing Processes”

Introduction:

With the demand for increased production and tighter tolerances facing manufacturing companies, emphasis is being placed on more efficient and cost-effective tooling. Managers are constantly seeking ways of improving tooling performance, decreasing setup and change-over times, and increasing production. An appropriate jig or fixture, in many cases, will determine the success of a particular product within a company. Tool designers have responded with more complex and precise workholding methods and devices, placing greater demands on toolmakers. A prerequisite, therefore, for toolmakers is a knowledge of the various types and functions of tooling used in industry.

Presentation Outline:

I. Distinguish Between Jigs and Fixtures and Discuss Need and Characteristics of Each

II. Discuss Various Applications of Jigs and Fixtures
   A. External-machining
   B. Internal-machining
   C. Non-machining

III. Identify Two General Classes of Jigs
   A. Boring jigs
   B. Drill jigs

IV. Discuss Types of Open Jigs
   A. Template jigs
   B. Plate jigs
   C. Table jigs
   D. Sandwich jigs
   E. Angle-plate jigs

V. Discuss Types of Closed Jigs
   A. Box, or tumble, jigs
B. Channel jigs  
C. Leaf jigs  

VI. Discuss Types of Jigs Which Can Be Either Open or Closed  
A. Indexing, or rotary, jigs  
B. Trunnion jigs  
C. Pump jigs  
D. Multi-station jigs  

VII. Discuss Types and Functions of Fixtures  
A. Plate fixtures  
B. Angle-plate fixtures  
C. Vise-jaw fixtures  
D. Indexing fixtures  
E. Multi-station fixtures  
F. Profiling fixtures  

VIII. Discuss Classification of Fixtures by Machine Type or Operation  

IX. Discuss Modular Fixturing  
A. Sub-plate systems  
B. “T”-slot systems  
C. Dowel-pin systems  

Practical Application:  
Students should be shown actual examples of as many types of jigs and fixtures as possible, along with the actual parts and operations to be performed. If feasible, a demonstration of the jig and/or fixture operation would be helpful as well.  

Evaluation and/or Verification:  
Students should successfully complete the Self-Assessment found at the end of this lesson.  

Summary:  
Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.  

Next Lesson Assignment:  
MASTER Technical Module (TLD-I2) dealing with utilizing concepts of jig and fixture design.
Objective(s):

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

a. Distinguish between jigs and fixtures;
b. Discuss boring and drill jigs;
c. Discuss open and closed (box) jigs;
d. Discuss the various names used to identify jig types; and,
e. Discuss the various types and functions of fixtures.

Module Outline:

I. Distinguish Between Jigs and Fixtures and Discuss Need and Characteristics of Each
II. Discuss Various Applications of Jigs and Fixtures
   A. External-machining
   B. Internal-machining
   C. Non-machining
III. Identify Two General Classes of Jigs
     A. Boring jigs
     B. Drill jigs
IV. Discuss Types of Open Jigs
    A. Template jigs
    B. Plate jigs
    C. Table jigs
    D. Sandwich jigs
    E. Angle-plate jigs
V. Discuss Types of Closed Jigs
   A. Box, or tumble, jigs
   B. Channel jigs
   C. Leaf jigs
VI. Discuss Types of Jigs Which Can Be Either Open or Closed
    A. Indexing, or rotary, jigs
    B. Trunnion jigs
    C. Pump jigs
    D. Multi-station jigs
VII. Discuss Types and Functions of Fixtures
     A. Plate fixtures
     B. Angle-plate fixtures
     C. Vise-jaw fixtures
     D. Indexing fixtures
E. Multi-station fixtures
F. Profiling fixtures

VIII. Discuss Classification of Fixtures by Machine Type or Operation

IX. Discuss Modular Fixturing
A. Sub-plate systems
B. "T"-slot systems
C. Dowel-pin systems
TLD-I1
Discuss Basic Types and Functions of Jigs and Fixtures
Self-Assessment

1. Define jig.

2. Define fixture.

3. List 2 external-machining applications of jigs and fixtures. Give an example of a type of jig or fixture for each.

4. List an internal-machining application of a jig or fixture and give an example.

5. List 2 non-machining applications of jigs and fixtures and give examples of each.

6. What are the two general classes that jigs are divided into?

7. How are fixtures normally classified and/or subclassified?
8. Give 5 examples of fixture classification. Include a subclassification for at least 2 of them.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

9. A/An _______ jig is the least expensive and simplest to use. It fits over, on, or into the work and is not usually clamped. If bushings are not used, the entire jig plate is hardened.
   a. Closed
   b. Sandwich
   c. Template
   d. Angle-plate

10. _______ jigs are a form of plate jig with a back plate for support of thin or soft parts which could bend or warp during the operation.
    a. Angle-plate
    b. Channel
    c. Closed
    d. Sandwich

11. _______ jigs are similar to templates. The primary difference is built-in clamps to hold the work.
    a. Plate
    b. Angle-plate
    c. Box, or tumble
    d. Closed

12. For large work, plate jigs are sometimes made with legs to raise the jig off the table. This type jig is called a ____________.
    a. Leaf jig
    b. Box, or tumble jig
    c. Table jig
    d. Trunnion jig

13. To machine a part at right angles to the mounting locators, a/an _______ jig is used.
    a. Modified box
    b. Indexing
    c. Multi-station
    d. Angle-plate
14. _________ jigs usually totally surround the part, allowing it to be completely machined on every surface without repositioning.
   a. Rotary
   b. Box
   c. Tumble
   d. Both b and c

15. Which of the following are types of box jigs?
   a. Channel and leaf
   b. Sandwich and plate
   c. Trunnion and channel
   d. Indexing and rotary

16. These jigs are used to accurately space a machining operation around a part.
   a. Trunnion
   b. Spacing jigs
   c. Indexing, or rotating
   d. Both a and c

17. _________ fixtures are used for machining small parts. Usually standard vise jaws are replaced with formed jaws that fit the part.
   a. Sandwich
   b. Formed
   c. Profiling
   d. Vise-jaw

18. Gears and splines are examples of shapes machined with a/an _________ fixture.
   a. Template
   b. Indexing
   c. Duplex
   d. Both b and c

19. A straddle-milling fixture is _________.
   a. A milling fixture designed to straddle the piece part
   b. A straddle fixture designed for use on a milling machine
   c. A fixture designed to be used on a mill and whose purpose is straddle milling
   d. A fixture (for any machine) that references the part from a straddle milled area
20. Multi-station fixtures are used primarily for _________.
   a. High speed, high volume production runs where the machining cycle must be continuous
   b. Low speed, high volume production runs where the machining cycle is divided by transit time between operations
   c. High speed, high volume production runs requiring multiple parts to be machined simultaneously
   d. Instances requiring mating parts to be machined together, using one setup and one reference point

21. Modular workholding is _________.
   a. Tooling customized for only one style and size part
   b. Special purpose, or permanent, workholders
   c. Special purpose workholders assembled from general-purpose (standard) components
   d. Tooling designed for modular machines

22. What applications are ideal for modular workholding? _________.
   a. One-time jobs
   b. Infrequent production runs
   c. Recurring production runs
   d. Both a and b

23. Which modular system of workholding uses a series of precisely machined base plates and mounting blocks with machined and ground "T" slots?
    _________.
   a. Angle-plate systems
   b. Dowel-pin systems
   c. Bolt type systems
   d. None of the above

24. Which modular systems uses a grid pattern of holes to locate and mount other accessories?
    _________.
   a. Angle-plate systems
   b. Dowel-pin systems
   c. Bolt type systems
   d. None of the above

25. A major advantage of dowel-pin systems over other systems is better clamping. This statement is _________.
   a. True
   b. False
   c. True for most situations; False for some
   d. Neither. There is no advantage or disadvantage to dowel-pin systems.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-I2

Subject: Tool & Die and EDM
Time: 6 Hrs.

Duty: Perform Tool and Die Making Operations
Task: Utilize Concepts of Jig and Fixture Design

Objective(s):

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

a. Identify basic components of jigs and fixtures;
b. Discuss supporting and locating principles;
c. Discuss clamping and workholding principles; and,
d. Discuss basic construction principles.

Instructional Materials:

MASTER Handout (TLD-I2-HO)
MASTER Laboratory Aid (TLD-I2-LA)
MASTER Self-Assessment

References:

NTMA Machinist Training Program Module(s), National Tooling and Machining Association, 9399 Livingston Road, Fort Washington, MD 20744
Basic Fixture Design, Paul Campbell, Industrial Press, Latest Edition
Student Preparation:

Students should have previously completed the following Technical Modules:

TLD-II "Discuss Basic Types and Functions of Jigs and Fixtures"

Introduction:

Toolmakers and tool designers share the responsibility of the success of a particular jig or fixture. They must work together to produce a functional tool that fulfills its intent and is of the highest quality. This requires that each maintains a basic knowledge of the other's functions. It is imperative that tool designers have an understanding of toolmaking fundamentals in order to ensure the tool can reasonably be manufactured. It is also imperative that toolmakers have knowledge of the basic principles of tool design in order to better interpret the design and to construct the tool in the best possible manner. For this reason, many toolmakers are eventually moved to design positions to take advantage of their expertise in both areas.

Presentation Outline:

I. Generally Discuss the Following Components of Jigs and Fixtures
   A. Tool bodies and plates (or bases)
   B. Locators
   C. Clamping or locking devices
   D. Bushings or guides
   E. Supports
   F. Keys
   G. Feet or legs

II. Define and Discuss Supporting and Locating Principles
   A. Referencing
   B. Repeatability
   C. Locator position
   D. Tool tolerance (relative to part tolerance)
   E. Foolproofing
   F. The twelve planes of movement ("degrees of freedom")
   G. The three forms of location: plane, concentric, and radial
   H. External and internal locating

III. Discuss the Primary Types of Supports
    A. Solid
    B. Adjustable
    C. Equalizing

IV. Discuss Locator Types
    A. Locating pins
    B. Nesting locators
    C. Vee locators
C. Locator position
D. Tool tolerance (relative to part tolerance)
E. Foolproofing
F. The twelve planes of movement ("degrees of freedom")
G. The three forms of location: plane, concentric, and radial
H. External and internal locating

III. Discuss the Primary Types of Supports
A. Solid
B. Adjustable
C. Equalizing

IV. Discuss Locator Types
A. Locating pins
B. Nesting locators
C. Vee locators
D. Fixed-stop locators
E. Adjustable locators
F. Sight locators
G. Spring-loaded devices

V. Discuss Clamping and Workholding Principles
A. The role of clamps
B. Tool forces
C. Clamping forces
D. Position of the clamps

VI. Discuss Types of Clamps
A. Strap clamps
B. Screw clamps
C. Swing and hook clamps
D. Edge clamps
E. Wedge clamps
F. Cam-action clamps
G. Toggle-action clamps
H. Power clamping (general discussion)

VII. Discuss Basic Construction Principles
A. Tool bodies
B. Blocks
C. Bushings
D. Fastening devices

Practical Application:

Students should be shown actual jigs and fixtures with special attention on the design. During each phase of instruction or topic, emphasis should be placed on that particular area of the tool. If possible, demonstrations of various types of each phase would be helpful.
Evaluation and/or Verification:

Students should successfully complete the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-I3) which is an introduction to industrial dies.
Objective(s):

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

a. Identify basic components of jigs and fixtures;

b. Discuss supporting and locating principles;

c. Discuss clamping and workholding principles; and,

d. Discuss basic construction principles.

Module Outline:

I. Generally Discuss the Following Components of Jigs and Fixtures
   A. Tool bodies and plates (or bases)
   B. Locators
   C. Clamping or locking devices
   D. Bushings or guides
   E. Supports
   F. Keys
   G. Feet or legs

II. Define and Discuss Supporting and Locating Principles
   A. Referencing
   B. Repeatability
   C. Locator position
   D. Tool tolerance (relative to part tolerance)
   E. Foolproofing
   F. The twelve planes of movement ("degrees of freedom")
   G. The three forms of location: plane, concentric, and radial
   H. External and internal locating

III. Discuss the Primary Types of Supports
   A. Solid
   B. Adjustable
   C. Equalizing

IV. Discuss Locator Types
   A. Locating pins
   B. Nesting locators
   C. Vee locators
   D. Fixed-stop locators
   E. Adjustable locators
   F. Sight locators
   G. Spring-loaded devices

V. Discuss Clamping and Workholding Principles
A. The role of clamps
B. Tool forces
C. Clamping forces
D. Position of the clamps

VI. Discuss Types of Clamps
A. Strap clamps
B. Screw clamps
C. Swing and hook clamps
D. Edge clamps
E. Wedge clamps
F. Cam-action clamps
G. Toggle-action clamps
H. Power clamping (general discussion)

VII. Discuss Basic Construction Principles
A. Tool bodies
B. Blocks
C. Bushings
D. Fastening devices
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-I2
Utilize Concepts of Jig and Fixture Design
Self-Assessment

1. List and define the components of jigs and fixtures.

2. List and define the primary types of supports.

3. List 5 types of locators.

4. List 5 types of clamps.

5. Identify the three forms of location.

6. Positioning the work with respect to the cutter or other tool is called
   a. Proper positioning
   b. Foolproofing
   c. Locating the work
   d. Referencing
7. As a general rule, what percentage of the part tolerance should the tool tolerance be? 
   a. 100 
   b. 75-100 
   c. 20-50 
   d. 0-25 

8. The feature of location that permits the parts to be made within their stated tolerances, part after part, throughout the production run is 
   a. Referencing 
   b. Repeatability 
   c. Accuracy 
   d. Precision 

9. The major concerns in locating a part are 
   a. Position of locators and locational tolerances 
   b. Foolproofing the location and avoiding duplicate location 
   c. All of the above 
   d. None of the above 

10. Locating a part by a single center hole will restrict _______ planes of movement with a single locator. By positioning a second locator in another hole in the part, a total of _______ planes of movement are restricted. 
    a. 9 and 11 
    b. 9 and 10 
    c. 7 and 11 
    d. 7 and 10 

11. The function of a clamp is to hold the part against the _______ during the machining cycle. 
    a. Locators 
    b. Mounting plate 
    c. Tool body 
    d. Cutting tool 

12. A properly designed tool _______: 
    a. Can use cutting forces to aid in holding the workpiece against the locators 
    b. Will utilize large amounts of clamping pressure 
    c. Will have clamps that hold all of the tool thrust 
    d. Will not need clamps
13. Which of the following is not a condition of a clamp? (Which is not true?)

   a. Clamps must be strong enough to hold the part and resist movement.
   b. Clamps must not damage or deform the part.
   c. Clamps must be flexible enough to allow “growth” of the part during machining.
   d. None of the above. They are all true.

14. When clamping a single part using a strap clamp, the fastener should be positioned ________________:

   a. In the center of the strap to apply equal pressure at both ends of the clamp.
   b. 1/3 of the strap length from the part and 2/3 from the heel support.
   c. 1/3 of the strap length from the heel support and 2/3 from the part.
   d. Between the fulcrum and the part.

15. The main disadvantage of welded tool bodies is ________________:

   a. Very low strength and rigidity.
   b. Longer lead times than built-up tool bodies.
   c. Added cost of paint and finishing.
   d. Added cost of secondary machining.

16. Which of the following best describes the dimensions of an ANSI P-20-16-1250 drill bushing? ________________

   a. .200" O.D. X .125" I.D. X .160" long
   b. 20/32" O.D. X .125" I.D. X 16/16" long
   c. 20mm O.D. X 16mm long X 125mm I.D.
   d. 5/16" O.D. X 1" long X .125" I.D.

17. When determining the appropriate length and placement of drill bushings, which of the following is true? ________________

   a. The end of the bushing should touch the work for maximum effectiveness.
   b. A clearance of one to one and a half times the tool diameter is sufficient for chip clearance.
   c. If the bushing is too far away from the work, the bushings wear rapidly.
   d. For extreme accuracy, the bushings should be placed as far away from the work as possible.
18. When more than one operation is performed at a single location, such as drilling and reaming, which type bushings should be used? 
   a. Renewable  
   b. Slip-renewable  
   c. Fixed-renewable  
   d. Head-type press fit

19. For holes that are close together, thin wall bushings can be used. What other method is used? 
   a. Grind flats on adjacent bushings  
   b. Reposition the part within the jig  
   c. Only install one bushing but use a multiple spindle drill  
   d. Do not drill the other hole. It is probably not needed anyway.

20. Draw and label each direction (plane) of movement in the following sketch. Be sure to indicate the X, Y, and Z axes.
# Tool & Die and EDM Series

## MASTER Technical Module No. TLD-I3

**Subject:** Tool & Die and EDM

**Time:** 6 Hrs.

**Duty:** Perform Tool and Die Making Operations

**Task:** Demonstrate Understanding of Different Types of Industrial Dies

### Objective(s):

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

1. Describe the operation of blanking or piercing dies;
2. Describe the operation of bending or forming dies;
3. Describe the operation of compound dies;
4. Describe the operation of progressive dies;
5. Describe the operation of draw dies;
6. Describe the operation of compression dies; and,
7. Describe the operation of combination dies.

### Instructional Materials:

- MASTER Handout (TLD-I3-HO)
- MASTER Laboratory Aid (TLD-I3-LA)
- MASTER Self-Assessment

### References:

Student Preparation:

Students should have previously completed the following Technical Modules:

- TLD-A1 through TLD-A6 “Practice Safety”
- TLD-B1 through TLD-B5 “Apply Mathematical Concepts”
- TLD-C1 “Interpret and Understand Basic Layout/Types of Drawings”
- TLD-C2 “Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances”
- TLD-C3 “Use and Apply Geometric Dimensioning and Tolerancing (GD&T)”
- TLD-C4 “Demonstrate Traditional Mechanical Drafting and Sketching Techniques”
- TLD-D1 through TLD-D3 “Demonstrate Knowledge of Manufacturing Materials”
- TLD-E1 through TLD-E6 “Measure/Inspect”
- TLD-F1 through TLD-F10 “Demonstrate Knowledge of Manufacturing Processes”
- TLD-I1 “Discuss Basic Types and Functions of Jigs and Fixtures”
- TLD-I2 “Utilize Concepts of Jig and Fixture Design”

Introduction:

Although the lowly punch press seldom draws attention like the more modern automated processes, few areas of tooling are more fascinating and challenging. Because press technology allows efficient and economic production of such a wide range of products, the tooling must be just as diverse. Several operations can be performed simultaneously to produce a complex and detailed part with each machine cycle. In many cases, a press die performs tasks in only a couple of seconds that would employ several machinist for several hours to accomplish the same feat. From simple piercing to blanking, from drawing to coining, manufacturers have come to rely heavily on the consistency and efficiency of stamping their products.

Presentation Outline:

I. Describe the Operation of Cutting Dies
   A. Piercing dies
   B. Notching and slotting dies
   C. Horn-type (mandrel) cutting dies
   D. Blanking dies
   E. Trimming and shaving dies
   F. Cutoff dies
   G. Broaching dies

II. Describe Operation of Bending and Forming Dies
   A. V-dies
B. U-dies  
C. Radius dies  
D. Offset dies  
E. Gooseneck dies  
F. Miscellaneous dies (Curling, bulging, beading, etc.)

III. Describe Operation of Compound Dies  
A. Blank-and-pierce dies  
B. Blank, pierce, and notch dies  
C. Trim-and-pierce dies  
D. Shave-and-pierce dies  
E. Broach, cutoff, and pierce dies

IV. Describe Operation of Draw Dies

V. Describe Operation of Compression Dies  
A. Sizing dies  
B. Swaging (wedging) dies  
C. Coining and embossing dies  
D. Extruding dies

VI. Describe Operation of Combination Dies  
A. Cutoff-and-form dies  
B. Lance-and-form dies  
C. Cutoff, form, and pierce dies  
D. Blank, draw, form, and pierce dies  
E. Pierce, blank, lance, and emboss dies  
F. Cutoff, form, and curl dies  
G. Blank and draw dies

VII. Describe Operation of Progressive Dies

**Practical Application:**

Students should be shown examples of as many types of the above dies as possible along with actual parts and operations performed. If feasible, a demonstration would be helpful as well.

**Evaluation and/or Verification:**

Students should successfully complete the Self-Assessment found at the end of this lesson.

**Summary:**

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (TLD-I4) dealing with utilizing basic die theory.
TLD-I3-HO
Demonstrate Understanding of Different Types of Industrial Dies
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
a. Describe the operation of blanking or piercing dies;
b. Describe the operation of bending or forming dies;
c. Describe the operation of compound dies;
d. Describe the operation of progressive dies;
e. Describe the operation of draw dies;
f. Describe the operation of compression dies; and,
g. Describe the operation of combination dies.

Module Outline:

I. Describe the Operation of Cutting Dies
   A. Piercing dies
   B. Notching and slotting dies
   C. Horn-type (mandrel) cutting dies
   D. Blanking dies
   E. Trimming and shaving dies
   F. Cutoff dies
   G. Broaching dies

II. Describe Operation of Bending and Forming Dies
    A. V-dies
    B. U-dies
    C. Radius dies
    D. Offset dies
    E. Gooseneck dies
    F. Miscellaneous dies (Curling, bulging, beading, etc.)

III. Describe Operation of Compound Dies
     A. Blank-and-pierce dies
     B. Blank, pierce, and notch dies
     C. Trim-and-pierce dies
     D. Shave-and-pierce dies
     E. Broach, cutoff, and pierce dies

IV. Describe Operation of Draw Dies

V. Describe Operation of Compression Dies
    A. Sizing dies
    B. Swaging (swedging) dies
    C. Coining and embossing dies
    D. Extruding dies
VI. Describe Operation of Combination Dies
   A. Cutoff-and-form dies
   B. Lance-and-form dies
   C. Cutoff, form, and pierce dies
   D. Blank, draw, form, and pierce dies
   E. Pierce, blank, lance, and emboss dies
   F. Cutoff, form, and curl dies
   G. Blank and draw dies

VII. Describe Operation of Progressive Dies
Rule of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
1. List and explain four types of cutting performed by dies.

2. List and explain four types of bending and forming dies.

3. Identify and define four types of operations performed by compression dies.

4. Distinguish between compound and combination dies.

5. Distinguish between draw and compression dies.

6. A die which cuts out a slug (which is usually scrap) in sheet or plate material is called a ________ die.
   a. Perforating
   b. Piercing
   c. Blanking
   d. Slug
7. A secondary shearing or cutting operation in which the surface of a previously cut edge is finished or smoothed is called ________.
   a. Finishing
   b. Smoothing
   c. Shearing
   d. Shaving

8. A die used to cut or shear a piece out of stock to a predetermined contour is a ________ die.
   a. Blanking
   b. Cutoff
   c. Cutting
   d. Bulging

9. A die which permanently deforms sheet or strip metal along a straight axis is called a ________ die.
   a. Forming
   b. Dinking
   c. Parallel
   d. Bending

10. A die in which the shape of the punch and die is directly reproduced in the metal with little or no metal flow is called a ________ die.
    a. Forming
    b. Dinking
    c. Parallel
    d. Bending

11. If a return flange is required on a part, you would want to use a/an ________ die.
    a. Return
    b. Flange
    c. Offset
    d. Gooseneck

12. A blank-and-pierce die is an example of a ________ die.
    a. Compound
    b. Compression
    c. Combination
    d. Dual-purpose
13. Press tools in which a cutting operation is combined with a shaping or deforming operation are called _______ dies.
   a. Compound
   b. Compression
   c. Combination
   d. Dual-purpose

14. A process in which a punch causes flat metal to flow into a die cavity to assume the shape of a seamless hollow vessel is called ________.
   a. Flowing
   b. Drawing
   c. Molding
   d. Magic

15. ________ operations compress and force metal to flow plastically through a shaped die orifice.
   a. Sizing
   b. Extruding
   c. Swaging
   d. Compressing

16. Coining is ________:
   a. Inventing a phrase
   b. Forming an edge of circular cross section along a sheet
   c. Stamping a design into a metal blank without affecting the part dimensionally
   d. A squeezing operation in which all surfaces of the work are confined or restrained

17. A progressive die is so named because ____________:
   a. It is only one die in a progressive line
   b. The punches in the die progressively increase in size
   c. The work progresses through two or more stations in the die
   d. The technology employed is so much more progressive than earlier dies

18. An open-frame press for bending, cutting, and forming (usually handling long work in strips) is called a ________.
   a. Press-brake
   b. Hydraulic press
   c. Triple-action press
   d. Punch press
19. U-dies are so named because ______________:
   a. They can only be operated on a U-type press.
   b. They were first invented and used by Irkslov Uosablol.
   c. The bending operations produced in them bear a resemblance to the letter U.
   d. They are made for punching and forming channel iron which resembles the letter U.

20. The following part is 2" wide X 12GA X 4" long with (2) 1/2" holes. It is to be stamped from 12 GA X 2-1/2" wide coil steel. It would be made in a __________ die.
   a. Combination
   b. Compound pierce and radius
   c. Compound blank and pierce
   d. Good
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-I4

Subject: Tool & Die and EDM
Time: 6 Hrs.

Duty: Perform Tool and Die Making Operations
Task: Utilize Basic Die Theory

Objective(s):

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

a. Discuss shearing action on metal (3 stages);
b. Explain notch, pierce, pilot, form, and cut-off stations;
c. Explain operation of die set to make piece part;
d. Explain spring back in form dies;
e. Explain bending action in V-form dies; and,
f. Explain coining in dies.

Instructional Materials:

MASTER Handout (TLD-I4-HO1)
MASTER Laboratory Aid (TLD-I4-LA)
MASTER Self-Assessment

References:

Fundamentals of Pressworking, David A. Smith, Society of Manufacturing Engineers, Latest Edition
Student Preparation:

Students should have previously completed the following Technical Modules:

- **TLD-A1 through TLD-A6** “Practice Safety”
- **TLD-B1 through TLD-B5** “Apply Mathematical Concepts”
- **TLD-C1** “Interpret and Understand Basic Layout/Types of Drawings”
- **TLD-C2** “Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances”
- **TLD-C3** “Use and Apply Geometric Dimensioning and Tolerancing (GD&T)”
- **TLD-C4** “Demonstrate Traditional Mechanical Drafting and Sketching Techniques”
- **TLD-D1 through TLD-D3** “Demonstrate Knowledge of Manufacturing Materials”
- **TLD-E1 through TLD-E6** “Measure/Inspect”
- **TLD-F1 through TLD-F10** “Demonstrate Knowledge of Manufacturing Processes”
- **TLD-I1** “Discuss Basic Types and Functions of Jigs and Fixtures”
- **TLD-I2** “Utilize Concepts of Jig and Fixture Design”
- **TLD-I3** “Demonstrate Understanding of Different Types of Industrial Dies”

Introduction:

Before a student can begin his/her journey toward learning how to build even the simplest dies, a fundamental understanding of the die’s operation is required. The theory of die operation cannot (and should not) be adequately explained on the die blueprint. Often, problems encountered during the manufacture of a die could be avoided if the toolmaker understood the tool’s function and operation.

Presentation Outline:

I. Explain Operation of Die Set to Make Piece Part
   II. Discuss Critical Stages of Shearing Action on Metal
       A. Plastic deformation
       B. Penetration
       C. Fracture
   III. Explain Cutting Operations
       A. Blanking
       B. Piercing
       C. Notching
       D. Lancing
       E. Cutting off and parting
       F. Trimming and Shaving
IV. Discuss Bending Stresses
   A. The neutral plane
   B. The elastic limit of materials
   C. Plastic deformation and flow
   D. Springback
   E. Bend allowance curve

V. Explain Bending and Forming Operations
   A. Bending
      1. V-bending
      2. U-bending
      3. L-bending
   B. Forming
      1. Solid forming
      2. Pad type forming
      3. Miscellaneous methods (bulging, curling, coining and embossing)
   C. Drawing

Practical Application:

Students should be shown demonstrations of die operations and given exercises to demonstrate material science concepts.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-I5) dealing with utilizing the principles of die design.
Objective(s):

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

a. Discuss shearing action on metal (3 stages);
b. Explain notch, pierce, pilot, form, and cut-off stations;
c. Explain operation of die set to make piece part;
d. Explain spring back in form dies;
e. Explain bending action in V-form dies; and,
f. Explain coining in dies.

Module Outline:

I. Explain Operation of Die Set to Make Piece Part

II. Discuss Critical Stages of Shearing Action on Metal
   A. Plastic deformation
   B. Penetration
   C. Fracture

III. Explain Cutting Operations
   A. Blanking
   B. Piercing
   C. Notching
   D. Lancing
   E. Cutting off and parting
   F. Trimming and Shaving

IV. Discuss Bending Stresses
   A. The neutral plane
   B. The elastic limit of materials
   C. Plastic deformation and flow
   D. Springback
   E. Bend allowance curve

V. Explain Bending and Forming Operations
   A. Bending
      1. V-bending
      2. U-bending
      3. L-bending
   B. Forming
      1. Solid forming
      2. Pad type forming
      3. Miscellaneous methods (bulging, curling, coining and embossing)
   C. Drawing
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
1. List in order the critical stages of shearing action on metal.

2. Briefly explain the characteristic appearance of piece parts produced by blanking and/or shearing.

3. What is the general purpose of a blanking die?

4. Distinguish between bending and forming.

5. Identify the four phases of bending action in a U-bending die.

6. The process of removing the punch from the penetrated material is called
   a. Withdrawal
   b. Punch reversal
   c. Stripping
   d. Wiping
7. The space between a side of the punch and the corresponding side of the die opening at the cut edge when the punch is entered in the die opening is called the __________.
   a. Excessive clearance
   b. Cutting clearance
   c. Angular clearance
   d. Burr side

8. During bending, the inner surface tends to become shorter as force is applied and the outer surface tends to become longer. This suggests that the inside material is in __________ and the outside material is in __________.
   a. Distortion, stress
   b. Compression, tension
   c. Tension, compression
   d. Force, tension

9. The curved neutral plane of the bend area is called the __________.
   a. Bend allowance
   b. Curved plane
   c. Bend radius
   d. Bend angle

10. The cutting out of various shapes from the edge of a strip, blank, or part is called __________.
    a. Shaving
    b. Trimming
    c. Lancing
    d. Notching

11. Cutting along a line in the workpiece without producing a detached slug from the workpiece is called __________.
    a. Shaving
    b. Trimming
    c. Lancing
    d. Notching

12. During bending, the axis between the outer and inner surfaces where the length remains constant and where bending is considered to take place is called the __________.
    a. Neutral plane or axis
    b. Bend line
    c. Bend radius
    d. Bend axis
13. The extent to which metal tends to return to its original shape or position after undergoing a forming operation is called _________.
   a. Strain
   b. Springback
   c. Plastic deformation
   d. Elasticity

14. During _________, the line of bend is curved instead of straight and the metal is subjected to plastic flow or deformation.
   a. Forming
   b. Bending
   c. Drawing
   d. Bulging

15. Proper _________ is necessary to the life of the die and the quality of the piece part. If it is excessive, the piece part is unacceptable; if it is insufficient, there is undue stress and wear on the cutting members of the tool.
   a. Punch relief
   b. Material oxidation
   c. Gaging
   d. Cutting clearance
TLD-I4
Utilize Basic Die Theory
Self-Assessment Answer Key

6. c
7. b
8. b
9. a
10. d
11. c
12. a
13. b
14. a
15. d
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-I5

Subject: Tool & Die and EDM
Time: 40 Hrs.

Duty: Perform Tool and Die Making Operations
Task: Utilize Principles of Die Design

Objective(s):

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

a. Identify components of die set;
b. Discuss materials of die components;
c. Calculate proper shut-height of die set;
d. Design stock strip layout;
e. Calculate blank length for developed parts;
f. Calculate cutting length of piece part;
g. Determine press tonnage requirements;
h. Calculate die progression;
i. Calculate stripping pressure;
j. Calculate slug clearance;
k. Calculate cutting clearance; and,
l. Calculate offset displacement.

Instructional Materials:

MASTER Handout (TLD-I5-HO)
MASTER Laboratory Aid (TLD-I5-LA)
MASTER Self-Assessment

References:

Fundamentals of Pressworking, David A. Smith, Society of Manufacturing Engineers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
- TLD-A1 through TLD-A6 "Practice Safety"
- TLD-B1 through TLD-B5 "Apply Mathematical Concepts"
- TLD-C1 "Interpret and Understand Basic Layout/Types of Drawings"
- TLD-C2 "Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
- TLD-C3 "Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
- TLD-C4 "Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
- TLD-D1 through TLD-D3 "Demonstrate Knowledge of Manufacturing Materials"
- TLD-E1 through TLD-E6 "Measure/Inspect"
- TLD-F1 through TLD-F10 "Demonstrate Knowledge of Manufacturing Processes"
- TLD-I1 "Discuss Basic Types and Functions of Jigs and Fixtures"
- TLD-I2 "Utilize Concepts of Jig and Fixture Design"
- TLD-I3 "Demonstrate Understanding of Different Types of Industrial Dies"
- TLD-I4 "Utilize Basic Die Theory"

Introduction:

Although toolmakers will typically be given a blueprint to build a die from, rarely does it contain all the information needed. Certain specifications and dimensions are absent to allow the toolmaker enough flexibility to ensure the die performs as required. Therefore, to build a functional die, toolmakers must be familiar with basic principles of die design and capable of making the required calculations as he/she progresses along.

Presentation Outline:

I. Identify Components of a Typical Die
   A. Die set
   B. Punch
C. Punch plate or holder  
D. Die block  
E. Stripper  
F. Pilot  
G. Stock guide or back gage  
H. Stop  
I. Fasteners  

II. Identify Components of a Typical Die Set  
A. Die shoe  
B. Guidepost  
C. Guidepost bushing  
D. Punch shoe  
E. Shank  
F. Flange and bolt slot  

III. Discuss Stock Strip Design  
A. Determining feed direction  
B. Locating stations  
C. Using strip layouts for die design  
D. Calculation of die progression  

IV. Discuss Shut Height of Die  
A. Definition  
B. Calculation  
C. Determining stop block length  

V. Discuss Punch Design  
A. Types  
B. Shear  
C. Material  

VI. Discuss Design of Punch Plates  
A. Material  
B. Mounting  

VII. Discuss Die Block Design  
A. Cutting clearances  
1. Definition and importance  
2. Calculation  
   a. Type of cut  
   b. Type of material  
3. Angular clearance  
B. Material  
C. Mounting  

VIII. Discuss Cutting Force and Blanking Tonnage  
A. Determining the cutting area and length  
B. Shear or tensile strength of materials  
C. Calculation  

IX. Discuss Stripper Design  
A. Types
B. Stripping force
   1. Relationship with blanking tonnage
   2. Calculation
   3. Spring tables
   4. Rule of thumb for stripping bolts

C. Knockouts

D. Material

E. Mounting

X. Discuss Pilot Design
   A. Methods
   B. Length and nose contour
   C. Material

XI. Discuss Design of Stock Guides and Back Gages
    A. Types
    B. Material

XII. Discuss Fasteners and Hardware
     A. Types
     B. Spacing

Practical Application:

Students should be given exercises in component identification, component design, and the various calculations discussed above.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-I6) dealing with performing tool and die repair.
TLD-I5-HO
Utilize Principles of Die Design
Attachment 1: MASTER Handout

Objective(s):

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

a. Identify components of die set;
b. Discuss materials of die components;
c. Calculate proper shut-height of die set;
d. Design stock strip layout;
e. Calculate blank length for developed parts;
f. Calculate cutting length of piece part;
g. Determine press tonnage requirements;
h. Calculate die progression;
i. Calculate stripping pressure;
j. Calculate slug clearance;
k. Calculate cutting clearance; and,
l. Calculate offset displacement.

Module Outline:

I. Identify Components of a Typical Die
   A. Die set
   B. Punch
   C. Punch plate or holder
   D. Die block
   E. Stripper
   F. Pilot
   G. Stock guide or back gage
   H. Stop
   I. Fasteners

II. Identify Components of a Typical Die Set
    A. Die shoe
    B. Guidepost
    C. Guidepost bushing
    D. Punch shoe
    E. Shank
    F. Flange and bolt slot

III. Discuss Stock Strip Design
     A. Determining feed direction
     B. Locating stations
     C. Using strip layouts for die design
     D. Calculation of die progression
IV. Discuss Shut Height of Die
A. Definition
B. Calculation
C. Determining stop block length

V. Discuss Punch Design
A. Types
B. Shear
C. Material

VI. Discuss Design of Punch Plates
A. Material
B. Mounting

VII. Discuss Die Block Design
A. Cutting clearances
   1. Definition and importance
   2. Calculation
      a. Type of cut
      b. Type of material
   3. Angular clearance
B. Material
C. Mounting

VIII. Discuss Cutting Force and Blanking Tonnage
A. Determining the cutting area and length
B. Shear or tensile strength of materials
C. Calculation

IX. Discuss Stripper Design
A. Types
B. Stripping force
   1. Relationship with blanking tonnage
   2. Calculation
   3. Spring tables
   4. Rule of thumb for stripping bolts
C. Knockouts
D. Material
E. Mounting

X. Discuss Pilot Design
A. Methods
B. Length and nose contour
C. Material

XI. Discuss Design of Stock Guides and Back Gages
A. Types
B. Material

XII. Discuss Fasteners and Hardware
A. Types
B. Spacing
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
1. List the components of a typical die.

2. List the components of a typical die set.

3. Explain what is meant by "shear" when referring to punch shape. What is its purpose?

4. Explain the "rule of thumb" for stripper bolts.

5. Explain the use of dowel pins in die making.

6. The distance the stock must be fed is the ________.
   a. Advance
   b. Feed
   c. Projection
   d. Cycle

7. What is the most important single factor in determining the relationship of a blank or piece part to the stock strip? ________
   a. Length-to-width ratio
   b. Contour finish requirements
   c. Grain direction
   d. Nestability
8. Calculate the shut-height of a die with the following component dimensions:
   Top shoe 1-1/2"
   Bottom shoe 2"
   Die block 1-1/2"
   Punch length 2-1/2"
   Backing plate 1/4"
   Punch entry 1/8"

   The shut height of this die is __________; the stop block length is __________.
   a. 7-3/4; 4-1/4
   b. 7-5/8; 4-1/8
   c. 7-5/8; 7-3/4
   d. 3-1/2; 4-1/4

9. Of the two major punch groups, which one requires another component, such as a punch plate, to locate and position them? __________
   a. Cutting punches
   b. Segregated punches
   c. Integrated punches
   d. Hybrid punches

10. Calculate the cutting force required to punch a 0.50" (12.7 mm) diameter hole in 20 gage (0.038") mild steel (shear strength of 25 tons) using the formula \( F=SLT \).
    a. 0.5 tons
    b. 0.75 tons
    c. 1.5 tons
    d. 15 tons

11. Calculate the amount of clearance and die opening for a rectangle punch with the following dimensions: 2.032" X 2.187" with .125 corner radii. Use 6 ga (.194) mild steel with a shear strength of 25 tons and required clearance of 5% per side.
    a. .010" per side clearance; 2.042" X 2.197" die opening
    b. .02" per side clearance; 2.072" X 2.227" die opening
    c. .02" total clearance; 2.032" X 2.187" die opening
    d. .01" per side clearance; 2.052" X 2.207" die opening

12. A good general practice in calculating angular clearance for sidewalls of the die opening is __________:
    a. 2 degrees per side
    b. 1/4 to 3/4 degrees per side
    c. 0.002" per in. per side
    d. 1/8 degrees per side
13. Calculate the stripping force required for the punch operation in question #11.
   a. 40 tons
   b. 41 tons
   c. 2 tons
   d. 8.2 tons

14. Strippers can be classified into two categories: ________________.
   a. Fixed and traveling
   b. Box and spring
   c. Hardened and soft
   d. Segregated and integrated

15. To ensure accuracy, the pilot for a .500" diameter punch piercing 16 ga.
(0.0625") material would be ________________:
   a. 0.500" diameter
   b. 0.4375" diameter
   c. 0.4982" diameter
   d. Not enough information given

16. What material should gages be made of? ________________
   a. Cold-rolled steel
   b. Commercial gage stock
   c. Finished tool steel
   d. Either b or c

17. Calculate the flat blank length of the following piece part:
   a. 7.455
   b. 9.455
   c. 6.407
   d. 8.407
18. In the above problem, how far from the left end would the center of the V-form be?
   a. 3.7275
   b. 3.2035
   c. 2.7275
   d. Cannot tell; not enough information

19. Calculate the offset displacement (delta) for the following part. Formulas needed:

\[ P = (R + T/3)(0.0349); \quad Q = 2R + T \quad Y_{min} = Q(1 - \cos \alpha) \]
\[ S = Y - Y_{min} \quad L = P \alpha + S \csc \alpha \quad \Delta = L - X \]

\[ \Delta \ (\text{Delta}) = \]
   a. 7.5
   b. .232
   c. 2.732
   d. .0189

20. Which of the following die components would require heat treatment?
   a. Die block
   b. Pilot
   c. Punch
   d. All of the above
TLD-I5
Utilize Principles of Die Design
Self-Assessment Answer Key

6. a
7. c
8. b
9. c
10. c
11. d
12. b
13. c
14. a
15. c
16. d
17. a
18. c
19. b
20. d
# TOOL & DIE and EDM SERIES

## MASTER Technical Module No. TLD-I6

<table>
<thead>
<tr>
<th>Subject:</th>
<th>Tool and Die and EDM</th>
<th>Time: 40 Hrs.</th>
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<tbody>
<tr>
<td>Duty:</td>
<td>Perform Tool and Die Making Operations</td>
<td></td>
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<td>Task:</td>
<td>Perform Tool and Die Repair</td>
<td></td>
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### Objective(s):

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

- a. Disassemble and assemble die set, jig, or fixture;
- b. Visually inspect components for damage;
- c. Determine method of repairing/sharpening;
- d. Determine material for replacement parts; and,
- e. Manufacture replacement parts.

### Instructional Materials:

- MASTER Handout (TLD-I6-HO)
- MASTER Laboratory Aid (TLD-I6-LA)
- MASTER Self-Assessment

### References:

Student Preparation:

Students should have previously completed the following Technical Modules:

- **TLD-A1 through TLD-A6**  "Practice Safety"
- **TLD-B1 through TLD-B5**  "Apply Mathematical Concepts"
- **TLD-C1**  "Interpret and Understand Basic Layout/Types of Drawings"
- **TLD-C2**  "Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
- **TLD-C3**  "Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
- **TLD-C4**  "Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
- **TLD-D1 through TLD-D3**  "Demonstrate Knowledge of Manufacturing Materials"
- **TLD-E1 through TLD-E6**  "Measure/Inspect"
- **TLD-F1 through TLD-F10**  "Demonstrate Knowledge of Manufacturing Processes"
- **TLD-I1**  "Discuss Basic Types and Functions of Jigs and Fixtures"
- **TLD-I2**  "Utilize Concepts of Jig and Fixture Design"
- **TLD-I3**  "Demonstrate Understanding of Different Types of Industrial Dies"
- **TLD-I4**  "Utilize Basic Die Theory"
- **TLD-I5**  "Utilize Principles of Die Design"

Introduction:

A necessary part of a Tool and Die Maker's job is to repair tooling. In fact, many smaller companies will buy their tooling from a tooling specialist and employ a tool maker to maintain it, making repair the primary responsibility. In larger companies, beginning tool makers might be assigned to the repair shop to gain experience before being given the responsibility of building a new tool. Many times, a tool maker has responsibility for both new and existing tooling. In either case, students should be given training in tooling repair in order to emphasize what must happen when the tooling wears. This will allow the tool maker to build in provisions for later maintenance, easing the potential problems for the repair.

Presentation Outline:

I. **Discuss Safety in the Die Shop**
   A. Proper die handling and transport
   B. Safety in the machine shop

II. **Discuss Die Life**
   A. Punch life
   B. Die block life
C. Characteristic cutting wear
D. Excessive wear

III. Discuss Inspection of Die Components
   A. Identify and inspect component parts
   B. Inspection of piece part

IV. Discuss Disassembly of Die
   A. Removal and organization of component parts
   B. Cleaning component parts

V. Discuss Repair of Damaged Parts
   A. Sharpening
      1. Amount of material to remove
      2. Procedures and techniques
   B. Replacement
      1. Material
      2. Construction

VI. Discuss Assembly of Die Set
    A. Cleaning and deburring component parts
    B. Mounting procedures
    C. Checking clearances, depths, stop blocks, and shut-heights

VII. Documentation
    A. Maintenance work orders
    B. Die records
    C. Preventive maintenance plan
    D. Inspection tags

Practical Application:

Students should be given damaged dies and components to repair, rebuild, and mount.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-I7) dealing with tool and die making skills.
Objective(s):

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

a. Disassemble and assemble die set, jig, or fixture;
b. Visually inspect components for damage;
c. Determine method of repairing/sharpening;
d. Determine material for replacement parts; and,
e. Manufacture replacement parts.

Module Outline:

I. Discuss Safety in the Die Shop
   A. Proper die handling and transport
   B. Safety in the machine shop

II. Discuss Die Life
   A. Punch life
   B. Die block life
   C. Characteristic cutting wear
   D. Excessive wear

III. Discuss Inspection of Die Components
    A. Identify and inspect component parts
    B. Inspection of piece part

IV. Discuss Disassembly of Die
    A. Removal and organization of component parts
    B. Cleaning component parts

V. Discuss Repair of Damaged Parts
    A. Sharpening
       1. Amount of material to remove
       2. Procedures and techniques
    B. Replacement
       1. Material
       2. Construction

VI. Discuss Assembly of Die Set
    A. Cleaning and deburring component parts
    B. Mounting procedures
    C. Checking clearances, depths, stop blocks, and shut-heights

VII. Documentation
    A. Maintenance work orders
    B. Die records
    C. Preventive maintenance plan
    D. Inspection tags
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-J6
Perform Tool and Die Repair
Self-Assessment

1. Discuss proper die handling, clamping, and transport.

2. Define die life.

3. Discuss characteristic cutting wear for normally functioning punches and dies.

4. Name 8 conditions which will cause abnormal wear.

5. Discuss how examining the piece part can identify problems with tooling.

6. Discuss sharpening of damaged or worn component parts, including how to determine the amount of material to remove and procedures for sharpening.
7. Discuss mounting procedures for a re-sharpened punch.

8. Identify how to check clearances, depths, stop block length and shut-height after resharpening or replacing components.

9. Discuss the need for a recording system to document history of dies.

10. Discuss the need for a preventive maintenance plan.
TOOL & DIE and EDM SERIES
MASTER Technical Module NO. TLD-17

Subject: Tool & Die and EDM
Time: 40 Hrs.

Duty: Perform Tool and Die Making Operations
Task: Demonstrate Tool and Die Making Skills

Objective(s):

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

a. Identify component parts from tool blueprint
b. Determine material / purchased part requirements
c. Utilize tool making procedures to make and assemble component parts
d. Demonstrate mounting and operation of die set in press machine
e. Inspect operation of tooling and piece part for accuracy

Instructional Materials:

MASTER Handout (TLD-17-HO)
MASTER Laboratory Aid (TLD-17-LA)

References:

Fundamentals of Pressworking, David A. Smith, Society of Manufacturing Engineers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
Introduction:

For many years, a tool maker has been considered the most skilled worker in any given shop. To build tooling requires the most refined machining skills along with knowledge and expertise in tooling and dies. Tool makers often make subjective decisions that ultimately affect the success of the tooling and its ability to perform the necessary function. This “higher thinking” requires many years of experience and cannot simply be taught in a semester or two. Students can, however, be taught some of the fundamentals of tool making and given some introductory experience. This will equip them with skills which can be enhanced with actual industrial experience on their road to being a qualified tool and die maker.

Presentation Outline:

I. Handout the Tool Blueprint and Discuss
II. Discuss Acquisition of Material and Purchased Components
III. Discuss Tool Making Procedures
IV. Discuss Mounting Procedures
V. Discuss Mounting and Operation of Die Set in Press Machine
Practical Application:

Students should be given blueprints of tools and dies to be built.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-J1) dealing with EDM fundamentals.
Objective(s):

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

a. Identify component parts from tool blueprint
b. Determine material / purchased part requirements
c. Utilize tool making procedures to make and assemble component parts
d. Demonstrate mounting and operation of die set in press machine
e. Inspect operation of tooling and piece part for accuracy

Module Outline:

I. Handout the Tool Blueprint and Discuss
II. Discuss Acquisition of Material and Purchased Components
III. Discuss Tool Making Procedures
IV. Discuss Mounting Procedures
V. Discuss Mounting and Operation of Die Set in Press Machine
TLD-I7-LA
Demonstrate Tool and Die Making Skills
Attachment 2: MASTER Laboratory Aid

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
**TOOL AND DIE MAKER**...skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

### Duties

| A | Practice Safety |
| B | Apply Mathematical Concepts |
| C | Interpret Engineering Drawings and Related Documents |
| D | Demonstrate Knowledge of Manufacturing Materials |
| E | Measure/Inspect |
| F | Demonstrate Knowledge of Manufacturing Processes |
| G | Use Computers |
| H | Perform CAD/CAM and CNC Programming Tasks |
| I | Perform Tool and Die Making Operations |
| J | Operate Electrical Discharge Machines (EDM) |

### Tasks

- **A.1** Follow safety manuals and all safety regulations/requirements.
- **A.2** Maintain safe equipment and machinery.
- **A.3** Use safe operating procedures for hand and machine tools.
- **A.4** Maintain a clean and safe work environment.
- **A.5** Use safe material handling practices.
- **A.6** Consult and apply MSDS for hazards of various materials.
- **B.1** Perform basic arithmetic functions.
- **B.2** Perform basic algebraic operations.
- **B.3** Use basic geometric principles.
- **B.4** Perform trigonometric functions.
- **B.5** Use and apply Cartesian Coordinate System.
- **C.1** Interpret and understand basic layetypes of drawings.
- **C.2** Interpret, review, and apply blueprints, dimensions, and tolerances.
- **C.3** Use and apply Geometric Dimensioning and Tolerancing (GD&T).
- **C.4** Demonstrate traditional drafting and sketching techniques.
- **C.5** Understand and use quality systems.
- **D.1** Identify materials with desired properties.
- **D.2** Identify materials and processes to produce a part.
- **D.3** Discuss classification systems for metal.
- **E.1** Understand metrology terms.
- **E.2** Select measurement tools.
- **E.3** Measure with handheld instruments.
- **E.4** Eliminate measurement variables.
- **E.5** Measure using surface plate and accessories.
- **E.6** Inspect using stationary equipment.
- **F.1** Discuss metal cutting and metal cutting tools.
- **F.2** Operate metal saws.
- **F.3** Operate drill presses and tooling.
- **F.4** Operate engine and turret lathes and tooling.
- **F.5** Operate vertical and horizontal mills and tooling.
- **F.6** Operate precision grinders.
- **F.7** Operate heat treating equipment and processes.
- **F.8** Operate sheet metal equipment.
- **F.9** Operate welding equipment and processes.
- **F.10** Estimate time required/cost to produce a part.
- **G.1** Use computer operating systems.
- **G.2** Understand computer terminology.
- **G.3** Use file management systems.
- **G.4** Install and use software packages.
- **H.1** Discuss fundamentals of CNC machines and controls.
- **H.2** Program and operate CNC milling machine and machining center.
- **H.3** Program and operate CNC lathe.
- **H.4** Use Computer-Aided Drafting (CAD) system.
- **H.5** Create 3D solid models.
- **H.6** Use Computer-Aided Manufacturing (CAM) system.
- **I.1** Discuss basic types and functions of jigs and fixtures.
- **I.2** Utilize concepts of jig and fixture design.
- **I.3** Demonstrate understanding of different types of industrial dies.
- **I.4** Utilize basic die theory.
- **I.5** Utilize principles of die design.
- **I.6** Utilize principles of die repair.
- **I.7** Perform tool and die making skills.
- **J.1** Discuss fundamentals of EDM.
- **J.2** Setup and operate conventional sinker EDM.
- **J.3** Program, setup, and operate CNC sinker EDM and EDM drill.
- **J.4** Program, setup, and operate CNC wire EDM.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-J1

Subject: Tool & Die and EDM
Time: 4 Hrs.

Duty: Operate Electrical Discharge Machine (EDM)
Task: Discuss Fundamentals of EDM

Objectives:

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

a. Explain the principles of Electrical Discharge Machining (EDM);
b. Discuss the advantages, limitations, and applications of EDM;
c. Discuss EDM safety;
d. Name and state the purpose of the main components of the EDM process; and,
e. Explain the types of EDM processes.

Instructional Materials:

MASTER Handout (TLD-J1-HO)
MASTER Laboratory Aid (TLD-J1-LA)
MASTER Self-Assessment

References:

NTMA Machinist Training Program Module(s)

Student Preparation:

Students should have previously completed the following Technical Modules:
Introduction:

Electrical Discharge Machining (EDM) is now recognized, not only as a viable manufacturing solution, but as a required process and capability for almost every metal working company. Many time-consuming, tedious, and costly tasks have been replaced with EDM and, in some cases, otherwise impossible tasks have been made simple and routine. Tool and die makers have possibly realized the most benefits of EDM. It has virtually revolutionized the way tools and dies are made.

Presentation Outline:

I. Explain the Principles of Electrical Discharge Machining (EDM)
II. Discuss the Advantages, Limitations, and Applications of EDM
III. Discuss EDM Safety
IV. Name and State the Purpose of the Main Components of the EDM Process
   A. Electrode
      1. Characteristics
      2. Types
      3. Materials used
   B. Dielectric fluid
      1. Functions
      2. Characteristics
      3. Methods of circulating
   C. Servomechanism
   D. Power supply
   E. Machine Control Unit
V. Explain the Types of EDM Processes
A. Sinker (plunge or ram type) EDM  
B. Traveling wire EDM  

Practical Application:

Students should be given demonstration of and parts produced by EDM processes.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-J2) dealing with setting up and operating conventional sinker EDM.
Objectives:

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

a. Explain the principles of Electrical Discharge Machining (EDM);
b. Discuss the advantages, limitations, and applications of EDM;
c. Discuss EDM safety;
d. Name and state the purpose of the main components of the EDM process; and,
e. Explain the types of EDM processes.

Module Outline:

I. Explain the Principles of Electrical Discharge Machining (EDM)
II. Discuss the Advantages, Limitations, and Applications of EDM
III. Discuss EDM Safety
IV. Name and State the Purpose of the Main Components of the EDM Process
   A. Electrode
      1. Characteristics
      2. Types
      3. Materials used
   B. Dielectric fluid
      1. Functions
      2. Characteristics
      3. Methods of circulating
   C. Servomechanism
   D. Power supply
   E. Machine Control Unit
V. Explain the Types of EDM Processes
   A. Sinker (plunge or ram type) EDM
   B. Traveling wire EDM
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-J1
Discuss Fundamentals of EDM
Self-Assessment

1. Define Electrical Discharge Machining (EDM).

2. List and explain five advantages of EDM.

3. List and explain five limitations of EDM.

4. List some applications of EDM.

5. List some safety precautions concerning EDM.

6. Name and state the purpose of the main components of an EDM.

7. What are the characteristics of a good electrode?
8. What materials are used for electrodes?


9. What are the functions of the dielectric?


10. What are the four methods of circulating the dielectric?


11. Explain the sinker EDM process.


12. Explain the wire EDM process.


13. Why must the workpiece be electrically conductive?


14. Give two advantages of the sinker EDM process over the wire EDM process.


15. Give two advantages of the wired EDM process over the sinker EDM process.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-J2

Subject: Tool & Die and EDM
Time: 10 Hrs.

Duty: Operate Electrical Discharge Machine (EDM)
Task: Setup and Operate Conventional Sinker EDM

Objective(s):

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

a. Identify the components of the sinker EDM process;
b. Explain the terms and principles of the sinker EDM process;
c. Discuss electrode design and construction;
d. Practice safety with sinker EDM;
e. Set-up and operate sinker EDM; and,
f. Practice preventive maintenance measures for the sinker EDM

Instructional Materials:

MASTER Handout (TLD-J2-H0)
MASTER Laboratory Aid (TLD-J2-LA)
MASTER Self-Assessment

References:

NTMA Machinist Training Program Module(s)

Student Preparation:

Students should have previously completed the following Technical Modules:
TLD-A1 through TLD-A6 “Practice Safety”
TLD-B1 through TLD-B5  “Apply Mathematical Concepts”
TLD-C1  “Interpret and Understand Basic Layout/Types of Drawings”
TLD-C2  “Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances”
TLD-C3  “Use and Apply Geometric Dimensioning and Tolerancing (GD&T)”
TLD-C4  “Demonstrate Traditional Mechanical Drafting and Sketching Techniques”
TLD-D1 through TLD-D3  “Demonstrate Knowledge of Manufacturing Materials”
TLD-E1 through TLD-E6  “Measure/Inspect”
TLD-F1 through TLD-F10  “Demonstrate Knowledge of Manufacturing Processes”
TLD-H1  “Discuss Fundamentals of CNC Machines and Controls”
TLD-H6  “Use Computer-Aided Manufacturing (CAM) System”
TLD-J1  “Discuss Fundamentals of EDM”

Introduction:

The die-sinking, or ram, EDM has a cutting tool (electrode) shaped to the form of the cavity, mounted in the ram of the machine. This machine tool was first used to remove broken taps from machined parts but was soon discovered as a useful and powerful asset in the manufacture of intricate parts from hardened material. While the latest technology includes the addition of CNC controllers to EDMs, several shops still use conventional types. Therefore, this module will introduce the concepts of sinker EDMing by looking at the conventional machine.

Presentation Outline:

I. Review the Components of the Sinker EDM Process
   A. Electrode
   B. Dielectric fluid
   C. Servomechanism
   D. Power supply
   E. Machine Control Unit

II. Explain the Principles and Terms of the Sinker EDM Process
   A. Amperage
   B. Frequency
   C. Voltage (gap and striking)
   D. Capacitance
   E. Polarity
   F. Ionization
   G. Overcut
   H. Swarf
I. Flushing
J. Surface Finish
K. Dither or vibration
L. Metal-removal rate
M. On-time
N. Off-time

III. Discuss Electrode Design and Construction
A. Material selection
   1. Workpiece material
   2. Wear characteristics
   3. Machinability
   4. Cost
B. Accuracy
C. Surface finish
D. Coolant Flushing

IV. Discuss Sinker EDM Safety

V. Discuss Set-Up and Operation of EDM
A. Workpiece set-up
B. Tooling
C. Locating principles
D. Power supply controls
E. Machine tool controls
F. Cutting procedures and adjustments
G. Rough and finish cuts

VI. Practice Preventive Maintenance Measures for the Sinker EDM

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Practical Application:

Students should be given projects to complete using the sinker EDM process.

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Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

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Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.
Next Lesson Assignment:

MASTER Technical Module (TLD-J3) dealing with programming, setting up, and operating the CNC sinker EDM and EDM drill.
Objective(s):

Upon completion of this unit the student will be able to:
a. Identify the components of the sinker EDM process;
b. Explain the terms and principles of the sinker EDM process;
c. Discuss electrode design and construction;
d. Practice safety with sinker EDM;
e. Set-up and operate sinker EDM; and,
f. Practice preventive maintenance measures for the sinker EDM

Module Outline:

I. Review the Components of the Sinker EDM Process
   A. Electrode
   B. Dielectric fluid
   C. Servomechanism
   D. Power supply
   E. Machine Control Unit

II. Explain the Principles and Terms of the Sinker EDM Process
   A. Amperage
   B. Frequency
   C. Voltage (gap and striking)
   D. Capacitance
   E. Polarity
   F. Ionization
   G. Overcut
   H. Swarf
   I. Flushing
   J. Surface Finish
   K. Dither or vibration
   L. Metal-removal rate
   M. On-time
   N. Off-time

III. Discuss Electrode Design and Construction
    A. Material selection
       1. Workpiece material
       2. Wear characteristics
       3. Machinability
       4. Cost
    B. Accuracy
C. Surface finish
D. Coolant Flushing

IV. Discuss Sinker EDM Safety

V. Discuss Set-Up and Operation of EDM
A. Workpiece set-up
B. Tooling
C. Locating principles
D. Power supply controls
E. Machine tool controls
F. Cutting procedures and adjustments
G. Rough and finish cuts

VI. Practice Preventive Maintenance Measures for the Sinker EDM
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
1. List and explain the function of the five main components of the EDM process.

2. Explain the following terms or principles as they apply to the sinker EDM process:
   a. Amperage
   b. Frequency
   c. Voltage
   d. Overcut
   e. On-time

3. What factors are considered in determining the electrode material?

4. Explain the use of a "stepped" electrode to rough and finish machine a through hole.
5. Why does coolant flushing have to be considered when making the electrode?

6. What factors affect the surface finish?

7. What factors affect the metal removal rate?

8. Explain how to locate an electrode to the workpiece?

9. During operation, what should the operator continually monitor?

10. Discuss general safety precautions for sinker EDM.
TOOL & DIE and EDM SERIES
MASTER Technical Module No. TLD-J3

Subject: Tool & Die and EDM Time: 20 Hrs.

Duty: Operate Electrical Discharge Machine (EDM)
Task: Program, Setup, and Operate CNC Sinker EDM and EDM Drill

Objective(s):

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

a. Review the components of the sinker EDM process;
b. Discuss sinker EDM safety;
c. Discuss applications and benefits of sinker EDM (specifically in Tool and Die);
d. Discuss CNC programming of CNC sinker EDM;
e. Discuss set-up and operation of CNC sinker EDM; and,
f. Practice preventive maintenance measures for the CNC sinker EDM.

Instructional Materials:

MASTER Handout (TLD-J3-HO)
MASTER Laboratory Aid (TLD-J3-LA)
MASTER Self-Assessment

References:

NTMA Machinist Training Program Module(s)

Student Preparation:

Students should have previously completed the following Technical Modules:
Introduction:

The addition of Computer Numerical Control to EDM technology has increased its flexibility and usefulness tremendously. CNC sinker EDMs and EDM drills are now available to allow faster and more accurate machining with shaped electrodes. In many cases, otherwise impossible shapes can be machined using CNC technology.

Presentation Outline:

I. Review the Components of the Sinker EDM Process
   A. Electrode
   B. Dielectric fluid
   C. Servomechanism
   D. Power supply
   E. Machine Control Unit

II. Discuss Sinker EDM Safety

III. Discuss Applications and Benefits of Sinker EDM (specifically in Tool and Die)

IV. Discuss CNC Programming of CNC Sinker EDM
   A. Coordinate Words (X, Y, U, V, Z, I, J)
   B. Basic "G" codes
   C. Basic "M" codes
   D. Program origin point
   E. Simple programming
   F. CANNED cycles, subprograms, and macros
V. Discuss Set-Up and Operation of CNC Sinker EDM
   A. Workpiece set-up and requirements
   B. Electrode
   C. Tooling
   D. Locating principles
   E. Power supply controls
   F. Machine tool controls
   G. Program operation
      1. Manual Data Input (MDI)
      2. DNC and transfer
      3. Program edit
      4. Memory storage
   H. Cutting procedures and adjustments
   I. Starter and pilot holes
   J. Rough and finish cuts

VI. Practice Preventive Maintenance Measures for the CNC Sinker EDM

Practical Application:

Students should be given projects to complete using the sinker EDM process.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (TLD-J4) dealing with programming, setting up, and operating the CNC wire EDM.
Objective(s):

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

a. Review the components of the sinker EDM process;

b. Discuss sinker EDM safety;

c. Discuss applications and benefits of sinker EDM (specifically in Tool and Die);

d. Discuss CNC programming of CNC sinker EDM;

e. Discuss set-up and operation of CNC sinker EDM; and,
f. Practice preventive maintenance measures for the CNC sinker EDM.

Module Outline:

I. Review the Components of the Sinker EDM Process
   A. Electrode
   B. Dielectric fluid
   C. Servomechanism
   D. Power supply
   E. Machine Control Unit

II. Discuss Sinker EDM Safety

III. Discuss Applications and Benefits of Sinker EDM (specifically in Tool and Die)

IV. Discuss CNC Programming of CNC Sinker EDM
   A. Coordinate Words (X, Y, U, V, Z, I, J)
   B. Basic "G" codes
   C. Basic "M" codes
   D. Program origin point
   E. Simple programming
   F. CANNED cycles, subprograms, and macros

V. Discuss Set-Up and Operation of CNC Sinker EDM
   A. Workpiece set-up and requirements
   B. Electrode
   C. Tooling
   D. Locating principles
   E. Power supply controls
   F. Machine tool controls
   G. Program operation
      1. Manual Data Input (MDI)
      2. DNC and transfer
      3. Program edit
4. Memory storage
H. Cutting procedures and adjustments
I. Starter and pilot holes
J. Rough and finish cuts

VI. Practice Preventive Maintenance Measures for the CNC Sinker EDM
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-J3
Program, Setup, and Operate CNC Sinker EDM and EDM Drill
Self-Assessment

1. List and explain the function of the five main components of the sinker EDM process.

2. Explain the following terms or principles as they apply to the sinker EDM process:

3. List five applications of a CNC sinker EDM.

4. List and explain three advantages of a CNC sinker EDM.

5. List five safety warnings concerning the CNC sinker EDM.

6. List and explain the steps to set-up and machine a .250" diameter hole through the center of a 5" cube. Include the CNC program.
7. Discuss preventive maintenance measures to observe on a CNC sinker EDM.
Subject: Tool & Die and EDM

Time: 30 Hrs.

Duty: Operate Electrical Discharge Machine (EDM)

Task: Program, Setup, and Operate CNC Wire EDM

Objective(s):

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

a. Review the components of the CNC wire EDM process;

b. Explain the wire EDM process;

c. Identify the three types of Wire EDM;

d. Discuss applications and benefits of wire EDM (specifically in Tool and Die);

e. Explain the principles and terms of the wire EDM process;

f. Discuss wire EDM safety;

g. Discuss CNC programming of wire EDM;

h. Discuss set-up and operation of wire EDM; and,

i. Practice preventive maintenance measures for the wire EDM.

Instructional Materials:

MASTER Handout (TLD-J4-HO)
MASTER Laboratory Aid (TLD-J4-LA)
MASTER Self-Assessment

References:


NTMA Machinist Training Program Module(s)


Student Preparation:

Students should have previously completed the following Technical Modules:

- **TLD-A1 through TLD-A6** "Practice Safety"
- **TLD-B1 through TLD-B5** "Apply Mathematical Concepts"
- **TLD-C1** "Interpret and Understand Basic Layout/Types of Drawings"
- **TLD-C2** "Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances"
- **TLD-C3** "Use and Apply Geometric Dimensioning and Tolerancing (GD&T)"
- **TLD-C4** "Demonstrate Traditional Mechanical Drafting and Sketching Techniques"
- **TLD-D1 through TLD-D3** "Demonstrate Knowledge of Manufacturing Materials"
- **TLD-E1 through TLD-E6** "Measure/Inspect"
- **TLD-F1 through TLD-F10** "Demonstrate Knowledge of Manufacturing Processes"
- **TLD-H1** "Discuss Fundamentals of CNC Machines and Controls"
- **TLD-H6** "Use Computer-Aided Manufacturing (CAM) System"
- **TLD-J1** "Discuss Fundamentals of EDM"
- **TLD-J2** "Setup and Operate Conventional Sinker EDM"
- **TLD-J3** "Program, Setup, and Operate CNC Sinker EDM and EDM Drill"

Introduction:

A brochure published by the Society of Manufacturing Engineers states: "EDM can no longer be considered nontraditional machining." Several advances and improvements are then mentioned to justify the statement. With the emergence of CNC wire EDM technology, the EDM process has become one of the most utilized in the machine tool industry. Practically no tool and die shop can compete successfully without a wire EDM or, at least, access to one. Wire EDM has changed the methodology used in building dies with its ability to machine hardened parts. Tool and die students must have a foundation of knowledge pertaining to the EDM process.

Presentation Outline:

I. Review the Components of the CNC Wire EDM Process
   A. Electrode
   B. Dielectric fluid
   C. Servomechanism
   D. Power supply
   E. Machine Control Unit

II. Explain the Wire EDM Process
III. Identify the Three Types of Wire EDM
   A. Two axis
   B. Simultaneous four axis
   C. Independent four axis

IV. Discuss Applications and Benefits of Wire EDM (specifically in Tool and Die)

V. Explain the Principles and Terms of the Wire EDM Process
   A. Kerf
   B. Overcut
   C. On-time/Off-time
   D. Flushing
   E. Flow rate
   F. Amperage
   G. Voltage
   H. Current
   I. Polarity
   J. Dielectric fluid resistivity
   K. Wire tension
   L. Wire feed

VI. Discuss Wire EDM Safety

VII. Discuss CNC Programming of Wire EDM
   A. Coordinate words (X, Y, U, V, Z, I, J)
   B. Basic “G” codes
   C. Basic “M” codes
   D. Program origin point
   E. Simple two-axis programming
   F. CANNED cycles, subprograms, and macros
   G. Four-axis programming

VIII. Discuss Set-Up and Operation of Wire EDM
   A. Workpiece set-up and requirements
   B. Electrode (wire)
   C. Tooling
   D. Locating principles
   E. Power supply controls
   F. Machine tool controls
   G. Program operation
      1. Manual Data Input (MDI)
      2. DNC and transfer
      3. Program edit
      4. Memory storage
   H. Cutting procedures and adjustments
   I. Starter and pilot holes
   J. Rough and finish cuts

IX. Practice Preventive Maintenance Measures for the Wire EDM
Practical Application:

Students should be given projects to complete using the wire EDM.

Evaluation and/or Verification:

Students should successfully complete the Practical Application above and the Self-Assessment found at the end of this lesson.

Summary:

Review the main lesson points and topics during review for exam. Hold class discussion and answer student questions.

Next Lesson Assignment:

This completes the series of Tool & Die and EDM technical modules.
TLD-J4-HO
Program, Setup, and Operate CNC Wire EDM
Attachment 1: MASTER Handout

Objective(s):

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

a. Review the components of the CNC wire EDM process;
b. Explain the wire EDM process;
c. Identify the three types of Wire EDM;
d. Discuss applications and benefits of wire EDM (specifically in Tool and Die);
e. Explain the principles and terms of the wire EDM process;
f. Discuss wire EDM safety;
g. Discuss CNC programming of wire EDM;
h. Discuss set-up and operation of wire EDM; and,
i. Practice preventive maintenance measures for the wire EDM.

Module Outline:

I. Review the Components of the CNC Wire EDM Process
   A. Electrode
   B. Dielectric fluid
   C. Servomechanism
   D. Power supply
   E. Machine Control Unit

II. Explain the Wire EDM Process

III. Identify the Three Types of Wire EDM
   A. Two axis
   B. Simultaneous four axis
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IV. Discuss Applications and Benefits of Wire EDM (specifically in Tool and Die)

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   A. Kerf
   B. Overcut
   C. On-time/Off-time
   D. Flushing
   E. Flow rate
   F. Amperage
   G. Voltage
   H. Current
   I. Polarity
   J. Dielectric fluid resistivity
   K. Wire tension
L. Wire feed

VI. Discuss Wire EDM Safety

VII. Discuss CNC Programming of Wire EDM
A. Coordinate words (X, Y, U, V, Z, I, J)
B. Basic "G" codes
C. Basic "M" codes
D. Program origin point
E. Simple two-axis programming
F. CANNED cycles, subprograms, and macros
G. Four-axis programming

VIII. Discuss Set-Up and Operation of Wire EDM
A. Workpiece set-up and requirements
B. Electrode (wire)
C. Tooling
D. Locating principles
E. Power supply controls
F. Machine tool controls
G. Program operation
   1. Manual Data Input (MDI)
   2. DNC and transfer
   3. Program edit
   4. Memory storage
H. Cutting procedures and adjustments
I. Starter and pilot holes
J. Rough and finish cuts

IX. Practice Preventive Maintenance Measures for the Wire EDM
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
1. List and explain the main components of a CNC wire EDM.

2. Briefly describe how wire EDM works.

3. Explain what is meant by “super precision band saw”.

4. List and explain the three types of wire EDM.

5. List five applications of wire EDM.

6. List and explain three advantages or benefits of wire EDM.

7. Explain the following terms or principles as they apply to the wire EDM process:
   a. Amperage
   b. Kerf
c. Voltage

d. Overcut

e. On-time

f. Wire Tension

8. List five safety warnings concerning wire EDM.

9. List and explain the steps to set-up and machine a 5" square part with a 2" diameter hole on a wire EDM, including the CNC program.

10. Discuss preventive maintenance measures to observe on a wire EDM.
EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY

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
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 Mississippi
Evolving from a previously agrarian economy, the region served by Itawamba Community College now contains a significant industrial base. Approximately 45% of employed adults in the surrounding area work in manufacturing, with the predominant industries including metal-working, machinery, paper products, rubber/plastics, electrical components, furniture, apparel, and wood products. About 35-40% of all manufacturing employees work in the furniture industry. After World War II, several major metal-working companies established branch plants in the Tupelo area, a trend that has continued into the 1990's. Between 1975 and 1980, pressures of competition and technology caused a number of these companies to reconsider their continued presence in northern Mississippi, spurring action by regional economic development organizations to preserve an employment and tax base essential to the community. Many of their economic development initiatives involved the community college, leading directly to the establishment of its Tool and Die Making Technology program and introduction of training in CAD, CNC, robotics, and lasers.

Itawamba Community College
Itawamba Community College (ICC) provides university transfer programs, associate degree career programs, non-credit customized industry training, and continuing education to a rural five-county area in northeast Mississippi. Of the local population of approximately 170,000 persons, 79% are white and 19% black; the student profile at the College roughly mirrors the racial composition of the general population, and a high percentage of students are from low-income households. The mission of the College includes the mandate to provide "educational services which contribute to the needs of new, expanding, or existing businesses and industries and to the training needs of the people." Accordingly, the College's instructional programs are designed with national trends and the needs of business and industry in mind, and the objective of all courses and training is to provide both students and companies with what they need to succeed. The main campus is in Fulton and the vocational-technical campus in Tupelo.

Development Team
- **Project Director:** Don Benjamin, Associate Dean of Career Education, served as program manager and academic coordinator for the MASTER project.
- **Site Coordinator:** Barry Emison was responsible for industrial assessment and skills validation, as well as development of skill standards and course/program materials for the Tool and Die Technology component of the MASTER project.
- **Subject Matter Experts:** Several college academic and technology instructors served as advisors for basic academic competencies, sharing responsibility with Mr. Emison for compiling data from industry surveys and interviews during the skill standards development process. Donald Taylor and Terry Kitchens, Tool and Die Technology Instructors, served as technical advisors for workplace competencies and developed course curricula and program materials. They also served as co-instructors and coordinators for the MASTER pilot program in Tool and Die Technology.
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.
TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

### Duties

<table>
<thead>
<tr>
<th>A</th>
<th>Practice Safety</th>
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</thead>
<tbody>
<tr>
<td>B</td>
<td>Apply Mathematical Concepts</td>
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<tr>
<td>C</td>
<td>Interpret Engineering Drawings and Related Documents</td>
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<tr>
<td>D</td>
<td>Demonstrate Knowledge of Manufacturing Materials</td>
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<tr>
<td>E</td>
<td>Measure/Inspect</td>
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<tr>
<td>F</td>
<td>Demonstrate Knowledge of Manufacturing Processes</td>
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<tr>
<td>G</td>
<td>Use Computers</td>
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<tr>
<td>H</td>
<td>Perform CAD/CAM and CNC Programming Tasks</td>
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<tr>
<td>I</td>
<td>Perform Tool and Die Making Operations</td>
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<td>J</td>
<td>Operate Electrical Discharge Machine (EDM)</td>
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</tbody>
</table>

### Tasks

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<tr>
<th>A-1</th>
<th>Follow safety manuals and all safety regulations/requiments</th>
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<tr>
<td>A-2</td>
<td>Maintain safe equipment and machinery</td>
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<tr>
<td>A-3</td>
<td>Use safe operating procedures for hand and machine tools</td>
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<td>A-4</td>
<td>Maintain a clean and safe work environment</td>
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<td>A-5</td>
<td>Use safe material handling practices</td>
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<td>A-6</td>
<td>Consult and apply MSDS for hazards of various materials</td>
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<tr>
<td>B-1</td>
<td>Perform basic arithmetic functions</td>
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<tr>
<td>B-2</td>
<td>Perform basic algebraic operations</td>
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<td>B-3</td>
<td>Use basic geometric principles</td>
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<td>Perform basic trigonometric functions</td>
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<td>B-5</td>
<td>Use and apply Cartesian Coordinate System</td>
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<tr>
<td>C-1</td>
<td>Interpret and understand basic layout/types of drawings</td>
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<td>C-2</td>
<td>Interpret, review, and apply blue-print notes, dimensions, and tolerances</td>
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<tr>
<td>C-3</td>
<td>Use and apply Geometric Dimensioning and Tolerancing (GD&amp;T)</td>
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<td>C-4</td>
<td>Demonstrate traditional mechanical drafting and sketching techniques</td>
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<tr>
<td>C-5</td>
<td>Understand and use quality systems</td>
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<tr>
<td>D-1</td>
<td>Identify materials with desired properties</td>
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<tr>
<td>D-2</td>
<td>Identify materials and processes to produce a part</td>
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<td>D-3</td>
<td>Discuss classification systems for metal</td>
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<td>E-1</td>
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<td>E-5</td>
<td>Measure using surface plate and accessories</td>
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<td>E-6</td>
<td>Inspect using stationary equipment</td>
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<td>F-1</td>
<td>Discuss metal cutting and metal cutting tools</td>
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<td>F-2</td>
<td>Operate metal saws</td>
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<td>F-3</td>
<td>Operate drill presses and tooling</td>
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<td>F-4</td>
<td>Operate engine and turret lathes and tooling</td>
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<tr>
<td>F-5</td>
<td>Operate vertical and horizontal mills and tooling</td>
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<td>F-6</td>
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<td>F-7</td>
<td>Operate heat treating equipment and processes</td>
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<td>F-8</td>
<td>Operate sheet metal equipment</td>
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<td>F-9</td>
<td>Operate welding equipment and processes</td>
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<td>F-10</td>
<td>Estimate time required/cost to produce a part</td>
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<td>G-1</td>
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<td>Understand computer terminology</td>
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<td>Use file management systems</td>
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<td>G-4</td>
<td>Install and use software packages</td>
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<td>H-1</td>
<td>Discuss fundamentals of CNC machines and controls</td>
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<td>H-2</td>
<td>Program and operate CNC milling machine and machining center</td>
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<td>Program and operate CNC lathe</td>
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<td>Use Computer-Aided Drafting (CAD) system</td>
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<td>Create 3-D solid models</td>
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<td>H-6</td>
<td>Use Computer-Aided Manufacturing (CAM) system</td>
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<td>I-1</td>
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<td>I-2</td>
<td>Utilize concepts of jig and fixture design</td>
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<td>I-3</td>
<td>Demonstrate understanding of different types of industrial jigs</td>
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<td>I-4</td>
<td>Utilize basic die theory</td>
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<td>Utilize principles of die design</td>
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<td>I-6</td>
<td>Perform tool and die repair</td>
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<td>I-7</td>
<td>Demonstrate tool and die making skills</td>
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<td>J-1</td>
<td>Discuss fundamentals of EDM</td>
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<td>J-2</td>
<td>Setup and operate conventional sinker EDM</td>
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<tr>
<td>J-3</td>
<td>Program, setup, and operate CNC sinker EDM and EDM drill</td>
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<td>Program, setup, and operate CNC wire EDM</td>
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TOOL AND DIE MAKER ... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

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<td><strong>C</strong> Interpret Engineering Drawings and Related Documents</td>
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<td>J-1 Discuss fundamentals of EDM</td>
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- **Tasks**
  - A-2 Maintain safe equipment and machinery
  - B-2 Perform basic algebraic operations
  - C-2 Interpret, review, and apply blueprints, notes, dimensions, and tolerances
  - D-2 Identify materials and processes to produce a part
  - E-2 Select measurement tools
  - F-2 Operate metal saws
  - G-2 Understand computer terminology
  - H-2 Program and operate CNC milling machine and machining center
  - I-2 Utilize concepts of jigs and fixture design
  - J-2 Setup and operate conventional sinker EDM
  - A-3 Use safe operating procedures for hand and machine tools
  - B-3 Use basic geometric principles
  - C-3 Use and apply geometric dimensioning and tolerancing (GD&T)
  - D-3 Discuss classification systems for metal
  - E-3 Measure with hand held instruments
  - F-3 Operate drill presses and tooling
  - G-3 Use file management systems
  - H-3 Program and operate CNC lathe
  - I-3 Demonstrate understanding of different types of industrial dies
  - J-3 Program, setup, and operate CNC sinker EDM and EDM drill
  - A-4 Maintain a clean and safe work environment
  - B-4 Perform basic trigonometric functions
  - C-4 Demonstrate traditional machining and sketching techniques
  - D-4 Perform tool and die making operations
  - E-4 Eliminate measurement variables
  - F-4 Operate engine and turret lathes and tooling
  - G-4 Install and use software packages
  - H-4 Use Computer-Aided Drafting (CAD) system
  - I-4 Utilize basic die theory
  - J-4 Program, setup, and operate CNC wire EDM
  - A-5 Use safe material handling practices
  - B-5 Use and apply Cartesian Coordinate System
  - C-5 Understand and use quality systems
  - D-5 Discuss material selection systems
  - E-5 Measure and inspect using surface plate and accessories
  - F-5 Operate vertical and horizontal mills and tooling
  - G-5 Measure and inspect using surface plate and accessories
  - H-5 Create 3-D solid models
  - I-5 Utilize principles of die design
  - J-5 Trace
  - A-6 Consult and apply MSDS for hazards of various materials
  - B-6 Operate metal saws
  - C-6 Demonstrate traditional machining and sketching techniques
  - D-6 Operate precision grinders
  - E-6 Operate grinding equipment and processes
  - F-6 Operate sheet metal equipment and processes
  - G-6 Operate welding equipment and processes
  - H-6 Use Computer-Aided Manufacturing (CAM) system
  - I-6 Perform tool and die repair
  - J-6 Demonstrate tool and die making skills
  - A-7 Use safe operating procedures for hand and machine tools
  - B-7 Operate engine and turret lathes and tooling
  - C-7 Operate grinding equipment and processes
  - D-7 Perform tool and die making operations
  - E-7 Use stationary equipment
  - F-7 Operate sheet metal equipment and processes
  - G-7 Inspect using stationary equipment
  - H-7 Use Computer-Aided Manufacturing (CAM) system
  - I-7 Demonstrate tool and die making skills
  - J-7 Trace
Objective(s):

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

a. Assume responsibility for the personal safety of oneself and others;
b. Develop a personal attitude towards safety;
c. Interpret safety manual directives;
d. Identify and control common machine shop hazards; and,
e. Comply with established company safety practices.

Module Outline:

I. Assume Responsibility for the Personal Safety of Oneself and Others
   A. Safety is a way of life not an option
   B. Always operate with alertness and safety foremost in mind

II. Develop a Personal Attitude Towards Safety
    A. The key to safety is individual safety
    B. Everyone must develop a safe attitude
    C. Each step of the operation must be carefully planned

III. Interpret Safety Manual Directives
     A. Read and understand safety manual
     B. Read machine operation instructions

IV. Comply with Established Safety Practices
    A. Personal safety
       1. Body: keep body out of line of tool edge
          a. Personal lifting
             1) Lift with the legs, not the back
             2) Proper physical position while lifting
             3) Proper clearance for carrying
             4) “Buddy system” for heavy lifting
          b. Equipment lifting
             1) Checking ratings for lifting devices
             2) Checking lifting points on lifted item
             3) Overhead clearance requirements
             4) Static lifting devices (slings, jack stands) should be used instead of moving lifting devices (jacks or forklifts) for actually holding heavy items up while working on them
    B. Eyes: always wear safety glasses
    C. Head: keep long hair up; wear hard hat whenever required
D. Ears: wear protection to prevent damage from noise
E. Jewelry: no rings, watches, bracelets, necklaces (they can get caught in machinery and they are conductors of electricity)
F. Clothing: keep sleeves and pant legs rolled down; and ties, strings, and belts away from moving parts
G. No horse-play
H. Do not talk to someone while that person is operating a machine
I. Do not talk to someone while you are operating a machine

V. Identify and Control Common Machine Shop Hazards
A. Chip formation
B. Moving machine parts
C. Spills and other debris
D. Electrical lines
E. Hydraulic and pneumatic lines

VI. Cover specific safety policies of the company
The purpose of this exercise is to learn to recognize hazards in the workplace. Many of the hazards which you will find there are common practices by people who simply no longer see the danger.

The instructor will guide all students through part of the facility. Each student should write down, in the space provided below, as many safety hazards as are found.

Remember, anyone can cause a hazard merely by failing to see the mop bucket that sits in front of the fire exit every day. Such tunnel vision is the result of familiarity and demonstrates the importance of keeping a fresh perspective everyday.

Due to the nature of this laboratory exercise, no answer key is possible.

<table>
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<tr>
<th>Safety Hazards</th>
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</table>
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Objective(s):

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

a. Wear protective safety clothing as required;

b. Maintain and use protective guards and equipment on machinery;

c. Locate and properly maintain safe equipment and machinery; and,

d. Use lifting aids when necessary.

Module Outline:

I. Wear Protective Safety Clothing as Required
   A. Different types of safety clothing
      1. Protective from debris, cuts, and blows
         a. Hard hat, safety glasses or goggles, work gloves when necessary
         b. Sturdy footwear
         c. Long sleeved shirt (sleeves rolled down and buttoned)
      2. Fire-retardant and fire-resistant clothing
         a. Long sleeved, 100% cotton shirt
         b. Long pants, 100% cotton
         c. Leather chest protector, sleeves
      3. Optical filters to protect vision from intense light
         a. Welding hood or goggles
         b. Safety glasses or goggles for grinding
         c. Tinted goggles for cutting torch work
      4. Breathing protection
         a. Mask for dust, lint, smoke
   B. Function and use of safety clothing
      1. Man made fiber clothing melts to worker's skin when ignited
      2. Prevents cuts and abrasions
      3. Keep shirt sleeves rolled down (hangs on equipment)
      4. Do not cuff pant legs (causes tripping)
      5. Do not wear jewelry
         a. Catches in moving parts
         b. Conducts electricity
      6. Do not wear neckties around moving parts of machinery
      7. Keep belts and apron strings tied and away from moving equipment

II. Maintain and Use Protective Guards and Equipment on Machinery
   A. Purposes of various guards
1. Do not operate a machine until guards are in place
2. Stop the machine to make adjustments or repairs
3. Disconnect power before removing guards or panels

B. Evaluation and maintenance of protective equipment
   1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
   2. Do not use defective equipment
   3. Report defective or unsafe equipment immediately
   4. Make sure equipment is properly grounded

III. Locate and Properly Maintain Safe Equipment and Machinery
   A. Install safety barriers
   B. Use caution signs
   C. Install lock and tag devices
   D. Know where fire extinguishers are and how to use them

IV. Use Lifting Aids When Necessary
   A. Discuss recommended limits on single-person lifting
   B. Discuss proper lifting methods (use of the legs)
      1. Use your legs (bend your knees)
      2. Keep the load close to your body
      3. Don't twist your body while lifting
      4. Make sure you can see where you are going
      5. Wear support belts
   C. Discuss team-lifting
      1. Keep load the same height while lifting
      2. Move and lift on command
      3. Use dolly, wheelbarrow, or forklift
   D. Determine lifting ratings of lifting equipment
      1. Know how your forklift operates
      2. Understand load characteristics (weight, size, shape)
   E. Determine holding ratings of static lifting devices
   F. Evaluate positions on the workpiece for placement of lifting and holding devices
The instructor will display as much protective equipment, such as welding masks, breathers, and hard hats as is practical and desirable. The instructor should demonstrate the proper use of this equipment.

Due to the nature of this exercise, no answer key is possible.
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Use Safe Operating Procedures for Hand and Machine Tools
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
a. Identify and understand safe machine operating procedures; and,
b. Demonstrate safe machine operation.

Module Outline:

I. Identify and Understand Safe Machine Operating Procedures
   A. Never make adjustments on a machine while it is running
      1. Keep guards in place at all times
      2. Discontinue power before servicing
      3. Keep body parts clear of moving machinery
      4. Beware of sharp edges and flying debris
      5. Secure work pieces to prevent slipping
      6. Never stand directly in line with blades or knives
      7. Avoid kickback
      8. Feed stack into machine correctly
   B. Electrical safety
      1. Use only those electrical devices which have been approved by UL (Underwriters' Laboratories)
      2. Stand on dry surface when working on electrical equipment
      3. Replace defective cords or plugs on equipment
      4. Use only those tools that are in good condition
      5. Use only carbon dioxide or dry chemical fire extinguishers for control of electrical fires
      6. Obtain help when working on equipment that may become energized
   C. Avoid horseplay and practical jokes
   D. Keep work area clean.

II. Demonstrate Safe Machine Operation
   A. Good housekeeping
      1. Materials and equipment should be stacked straight and neat
      2. Keep aisles and walkways clear of tools, materials, and debris
      3. Dispose of scraps and rubbish daily
      4. Clean up spills
      5. Clean and store hand tools
   B. Good techniques
      1. Always walk - do not run
      2. Never talk to or interrupt anyone who is operating a machine
3. Never leave tools or pieces of stock lying on table surface of a machine being used
4. When finished with a machine, turn power OFF and wait until blades or cutters have come to a complete stop before leaving
5. Check stock for defects before machining
   a. Do not use a machine until you understand it thoroughly
   b. Do not jam or rush stock into machinery
   c. Keep guards in place
   d. Make sure power is OFF before working on or servicing
6. Keep hands and fingers away from moving parts
7. Don't try to run too small a piece through the machine
8. Use a brush to clean the surface table
9. Keep your eyes focused on what you are working on
10. Never use an air hose to blow debris off yourself or other workers
11. Report faulty machinery to your supervisor
12. Make sure machinery is properly grounded
13. Never leave a piece of machinery that is running unattended
14. Make sure stack is solidly supported

C. Miscellaneous materials
1. Molten metal - can splash and cause serious burns
2. Chemicals - burn or irritate the skin or cause eye damage
3. Broken glass - causes cuts, can get in the eyes
4. Pointed objects - knives, screwdrivers, punches, staples can puncture the skin
5. Rough material - can scrape your skin and cause infections

D. Machinery
1. Understand the safety regulations that involve the guarding of moving parts
2. Know what parts of the equipment are energized
3. Use all safeguards that have been provided to protect people from machinery
4. See that all guards and protectors are in place before you start to work
5. If you must work nearer, turn the machine off and lock out the power
6. Never work in, around, or near dangerous, unguarded openings without wearing a safety belt and a lifeline that is properly seamed

E. One-fifth of all injuries on the job involve moving parts, machinery, or tools
For this exercise, the instructor should allow the students to observe other workers at their stations. The students should look for only practices related to safety. Upon returning to class, the students and instructor should discuss what they saw.

NOTE TO ALL STUDENTS: Unless your instructor tells you otherwise, all questions are to be directed to the instructor only. Do not disturb your fellow workers at their stations. Such distractions, in and of themselves, pose risks!

Due to the nature of this exercise, no answer key is possible.
Use Safe Operating Procedures for Hand and Machine Tools
Attachment 3: MASTER Laboratory Aid

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-A4-HO
Maintain a Clean and Safe Work Environment
Attachment 1: MASTER Handout

Objective(s):

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

a. Keep work areas clean;
b. Clean machine/hand tools when work is completed;
c. Put tools away when work is finished;
d. Keep isles clear of equipment and materials;
e. Perform preventive maintenance as required; and,
f. Understand chemical hazards and the use of Material Safety Data Sheets (MSDS).

Module Outline:

I. Keep Work Areas Clean
   A. Discuss the associated dangers of the most common hazards of the work place
      1. Tripping/falling hazards caused by spills, loose objects, etc.
         a. Wipe up spills immediately
         b. Dispose of scrap material
         c. Do not wear loose clothing
         d. Never roll sleeves or pants
         e. keep shoe strings tied
         f. Position electrical cords and air hoses in safe areas
      2. Chemical hazards
         a. Inhalants
         b. Chemical burns
         c. Flammable liquids
         d. Explosives and explosive combinations
         e. Toxins
      3. Electrical hazards
      4. High-pressure hazards
   B. Discuss methods of avoiding and correcting common hazards

II. Clean Machine/Hand Tools When Work Is Completed

III. Put Tools Away When Work Is Finished

IV. Keep Isles Clear of Equipment and Materials

V. Perform Preventive Maintenance as Required
   A. Discuss that certain machines require extra precautions
   B. Discuss how general maintenance enhances general safety

VI. Understand the Use of Material Safety Data Sheets (MSDS)
   A. What chemicals have MSDS?
B. Where are the MSDS kept?

C. What information is on the MSDS?

1. Product identification
   a. Specific product name and common name
   b. Precautionary labeling
   c. Safety equipment
   d. Precautionary label statements
   e. Storage color code

2. Hazardous components

3. Physical data
   a. Boiling point
   b. Vapor pressure
   c. Melting point
   d. Vapor density
   e. Specific gravity
   f. Evaporation rate
   g. Solubility in water
   h. Percentage of volatile components by volume
   i. Appearance & odor

4. Fire and explosion hazard data
   a. Flash point
   b. NFPA 704M rating
   c. Flammable limits (upper and lower)
   d. Fire extinguishing media
   e. Special fire-fighting procedures
   f. Toxic gases produced

5. Health hazard data
   a. Threshold limit value
   b. Permissible exposure limit
   c. Toxicity
   d. Carcinogenicity
   e. Effects of over-exposure
   f. Target organs (those most affected by exposure)
   g. Medical conditions aggravated by exposure
   h. Routes of entry
   i. Emergency and first-aid procedures

6. Reactivity data
   a. Stability
   b. Hazardous polymerization
   c. Conditions to avoid
   d. Incompatible materials
   e. Decomposition products

7. Spill and disposal procedures
   a. Procedures: spill or discharge
   b. Procedures: disposal
c. EPA hazardous waste number

8. Protective equipment
   a. Ventilation
   b. Respiratory protection
   c. Eye/skin protection

9. Storage and handling precautions
   a. Storage color code
   b. Special precautions

10. Transportation data and additional information
    a. Domestic transport
        1) DOT shipping name
        2) Hazard class
        3) UN/NA
        4) Labels
        5) Reportable quantity
    b. International
        1) IMO shipping name
        2) Hazard class
        3) UN/NA
        4) Labels
The instructor will guide all students through part of the facility. Each student should write down as many safety hazards as are found. While this may appear to be an exact duplicate of TLD-A1, the purpose of this exercise is to determine how much more aware of safety and hazards the students have become.

Upon returning to class, the students and the instructor should discuss what the students observed on this tour. Each student should compare his answers to those from TLD-A1, noting any differences and the reasons for those differences.

Due to the nature of this laboratory exercise, no answer key is possible.
Rules of Conduct

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   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Standards of Performance:

Student shall demonstrate safety 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; and,
d. Identify safety concerns to be addressed when lifting rough, sharp or fragile items.

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.
Let the legs do the lifting. To rise, straighten your legs, letting the powerful leg, arm, and shoulder muscles do the lifting.

Do not turn the body at the waist while carrying a load.

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. 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

IV. Discuss Equipment for Material Handling
A. Hand Trucks
B. Powered Trucks
C. Conveyers

V. 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

VI. Discuss and Demonstrate Use of Powered Hand Trucks
A. Watch out for people
B. Drive unit slowly
C. Use manual lifting rules

VII. 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

VIII. 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

IX. Discuss and Demonstrate Safe Use of Chains and Slings
Use Safe Material Handling Practices
Attachment 2: MASTER Laboratory Exercise

EXERCISE

1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   Hand truck
   Conveyor
   Chains
   Sling
   Face shield
   Side shields

3. Exercises below must be taken in sequence. Instructor must confirm proficiency prior to student’s progressing to next exercise.
   a. Practice manual lifting.
   b. Practice using hand truck to carry objects.
   c. Practice using powered truck to carry objects.
   d. Practice handling specific shapes.
   e. Practice lifting with slings.
   f. Practice lifting with chains.

4. Instructor will guide each exercise.

5. Instructor will grade each exercise.
Rules of Conduct

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   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Consult and Apply MSDS for Hazards of Various Materials  
Attachment 1: MASTER Handout

Objective(s):

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

a. Define hazardous material;
b. Identify hazardous material;
c. Know the physical and chemical characteristics;
d. Describe storage, transportation, disposal of hazardous waste; and,
e. Explain material safety data sheets.

Module Outline:

I. Define Hazardous Materials According to the EPA
   A. What makes a material hazardous?
      1. It is hazardous if it causes harm to people or environment

II. Identify Hazardous Materials
   A. Material Safety Data Sheets (MSDS)
      1. Companies that make and distribute hazardous substances
         must provide your company with a MSDS on hazardous material
      2. MSDS developed by OSHA
      3. MSDS is part of the Hazard Communication Standard or Right to Know regulation
      4. MSDS is an easy reference for information on hazardous substances
   B. Information in MSDS
      1. What it is
      2. Who makes or sells it
      3. Where they are located
      4. Why it is hazardous
      5. How you can be exposed to the hazard
      6. Conditions that could increase the hazard
      7. How to handle the substance safely
      8. Protection to use while working with it
      9. What to do if exposed
     10. What to do if there is a spill or emergency

III. Know the Chemical and Physical Characteristics
    A. Corrosive
       1. Burns skin or eyes on contact
    B. Explosive
    C. Flammable
1. Catches fire easily

D. Radioactive

E. Reactive
   1. Burns, explodes
   2. Releases toxic vapors

F. Toxic
   1. Causes illness or possibly death

IV. Describe Storage, Transportation, Disposal

A. Resource Conservation and Recovery Act (RCRA)
   1. Designed to reduce hazards of waste by tracking and regulating the substance
   2. Method used is called from cradle (creation) to grave (disposal)
   3. Tells what hazards are and how to keep track of them
   4. Sets up rules for handling wastes
   5. Provides strict documentation system to track them

B. Your employer may have to report to the Environmental Protection Agency (EPA) on how the company is meeting the RCRA responsibilities

C. The law requires companies that treat, store, or dispose of hazardous wastes to:
   1. Must have a permit
   2. Identify and analyze new hazardous waste
   3. Provide a secure facility that keeps unauthorized people out
   4. Inspect the facility regularly
   5. Have a contingency plan for fire, explosion, and spills
   6. Practice emergency response for fire, explosion, spills
   7. Provide proper protective clothing and equipment
   8. Maintain EPA-required records
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
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   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TOOL AND DIE MAKER ... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

### Duties

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<tr>
<td>A-1</td>
<td>Follow safety manuals and all safety regulations/requirements</td>
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<td>A-2</td>
<td>Maintain safe equipment and machinery</td>
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<td>A-3</td>
<td>Use safe operating procedures for hand and machine tools</td>
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<td>A-4</td>
<td>Keep a clean and safe work environment</td>
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<td>A-5</td>
<td>Use safe material handling practices</td>
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<td>A-6</td>
<td>Consult and apply MSDS for hazards of various materials</td>
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<td>B-1</td>
<td>Perform basic arithmetic functions</td>
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<td>Perform basic algebraic operations</td>
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<td>B-3</td>
<td>Use basic geometric principles</td>
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<td>B-4</td>
<td>Perform basic trigonometric functions</td>
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<td>B-5</td>
<td>Use and apply Cartesian Coordinate System</td>
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<tr>
<td>C-1</td>
<td>Interpret and understand basic layout/typeset drawings</td>
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<tr>
<td>C-2</td>
<td>Interpret, review, and apply blueprint notes, dimensions, and tolerances</td>
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<td>C-3</td>
<td>Use and apply Geometric Dimensioning and Tolerancing (GD&amp;T)</td>
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<td>C-4</td>
<td>Demonstrate traditional mechanical drafting and sketching techniques</td>
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<td>C-5</td>
<td>Understand and use quality systems</td>
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<td>D-1</td>
<td>Identify materials with desired properties</td>
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<td>D-2</td>
<td>Identify materials and processes to produce a part</td>
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<td>D-3</td>
<td>Discuss classification systems for metal</td>
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<tr>
<td>D-4</td>
<td>Identify and define machining processes</td>
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### Tasks

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<td>B-37</td>
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<td>B-41</td>
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<tr>
<td>B-42</td>
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<td>B-44</td>
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<td>B-45</td>
<td>Keep a clean and safe work environment</td>
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<td>B-46</td>
<td>Use safe material handling practices</td>
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<tr>
<td>B-47</td>
<td>Consult and apply MSDS for hazards of various materials</td>
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<tr>
<td>B-48</td>
<td>Perform basic arithmetic functions</td>
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<td>B-49</td>
<td>Perform basic algebraic operations</td>
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<td>B-50</td>
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</tbody>
</table>
TLD-B1-HO
Perform Basic Arithmetic Functions
Attachment 1: MASTER Handout

Objective(s):

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

a. Add, subtract, multiply, and divide whole numbers;

b. Add, subtract, multiply, and divide fractions; and,

c. Add, subtract, multiply, and divide decimals.

Module Outline:

I. Add, Subtract, Multiply, and Divide Whole Numbers
   A. Addition of whole numbers
   B. Subtraction of whole numbers
   C. Multiplication of whole numbers
   D. Division of whole numbers
   E. Hierarchy of operations

II. Add, Subtract, Multiply, and Divide Fractions
   A. Common operations
      1. Least common denominator
      2. Factoring for reduction
      3. Improper fractions
      4. Mixed numbers
   B. Addition
   C. Subtraction
   D. Multiplication
   E. Division

III. Add, Subtract, Multiply, and Divide Decimals
   A. Aligning the decimal (addition and subtraction)
   B. Moving the decimal
      1. In division, move the decimal to the right until it is eliminated in the divisor. Move the decimal the same number of places to the right in the dividend.
      2. In multiplication, count the total number of decimals places in the two numbers being multiplied. Beginning in the product at the right-most digit, count off the same number of places and place the decimal.
TLD-B1-LA
Perform Basic Arithmetic Functions
Attachment 2: MASTER Laboratory Aid
TLD-B2-HO
Perform Basic Algebraic Operations
Attachment 1: MASTER Handout

Objective(s):

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

a. Understand basic algebraic symbols and expressions; and,
b. Use equations to solve problems.

Module Outline:

I. Understand Basic Algebraic Symbols and Expressions
   A. Symbols
      1. Addition “+”
      2. Subtraction “−”
      3. Multiplication “·”; “x”, and parentheses
      4. Division “÷” and “/”
      5. Exponents are generally limited to the term “square” in linear measurements. This is the “2” notation.
   
   B. Expressions
      1. Sum: the total amount resulting from addition
      2. Difference: the remaining amount resulting from subtraction
      3. Product: the total amount resulting from multiplication
      4. Exponent: a superscript which indicates the number of times a quantity is multiplied by itself
      5. Quotient: the amount resulting from division

II. Use a Few Easy-to-Remember Rules to Solve Equations
   A. Please Excuse My Dear Aunt Sue indicates the order in which equations are solved. Each letter shows one of the algebraic notations or functions: Parentheses, Exponents, Multiply, Divide, Add, Subtract.
      1. In the expression \((x - y)^2 + 2x^2 - y^2\), the parentheses, which must be worked first, indicate that \(y\) must be subtracted from \(x\). Since we don’t know what \(x\) and \(y\) are, we can’t do that, and must move on.
      2. The next step is to square the term \((x - y)\), as indicated by the exponent. This gives us \(x^2 - 2xy + y^2 + 2x^2 - y^2\).
      3. There is no operable multiplication or division in this expression, so we move on.
      4. Grouping all the like terms to make seeing the answer easier, we have \(x^2 + 2x^2 + y^2 - y^2 - 2xy\).
      5. Adding, we now have \(3x^2 + y^2 - y^2 - 2xy\).
      6. Subtracting, which is the final step, renders \(3x^2 - 2xy\).
B. **FOIL** gives the order in which you multiply the terms in expressions. Let us go back to squaring (multiplying by itself) \((x - y)\) from the expression above.

1. *First terms first,* so, in \((x - y)(x - y)\), multiply the two x's first. This give us \(x^2\).
2. *Outside terms come next,* so multiply the first x by the second y. This gives us \(x^2 - xy\).
3. *Inside terms come next,* so multiply the first y by the second x. This gives us \(x^2 - xy - xy\).
4. *Last terms are last,* so multiply the two y's. This gives us a complete (if complex) \(x^2 - xy - xy + y^2\).
5. *Simplifying gives us the expression* \(x^2 - 2xy + y^2\).

C. Thinking about algebra can be daunting to almost anybody, but once you see that algebra is just juggling done with numbers and with a lot of two-dollar words stuck all over it, algebra becomes rather simple. Remember, algebra is just taking the four basic mathematic operations (addition, subtraction, multiplication, and division) and using them to find out something that you didn’t know to start with.

D. Word problems are what you will encounter every day in the shop. Someone will tell you to get so much material and make so many parts from it. As you progress in skill, they will tell you to get such-and-such material and make so many parts from it. Your mastery of basic algebra will make these problems easy to solve.
Use Basic Geometric Principles
Attachment 1: MASTER Handout

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; and,
d. Understand the applications of planar geometry to solid forms.

Module Outline:

I. Some Rules of Angles
   A. Angles are usually expressed in degrees, minutes, and seconds
   B. No angle has more than 360°
   C. Angles have three points which determine them
   D. An angle having 90° is a right angle

II. Triangles
   A. Pythagorean Theorem: $a^2 + b^2 = c^2$
   B. All the angles in a triangle will add up to 180°, every day, every time, every triangle
   C. Have three corners. If one of them is 90°, then it is a right triangle.
   D. The absolute size of a triangle cannot be determined by its angles alone. At least one side must be known.

III. Circle
   A. 360°, every day, every time, every circle
   B. Pi ($\pi$) 3.1416 and its importance
   C. $2\pi r = d$, where $r$ is the circle's radius and $d$, its diameter

IV. Rectangles and Parallelograms
   A. Squares and rectangles
      1. Have four 90° corners
      2. Squares are rectangles all of whose sides are equal
   B. Parallelograms
      1. Have four corners not 90°
      2. Have (at least) two parallel sides

V. Relating Planar Geometry to Solid Forms
   In reality, planar geometry is an abstract way of looking at parts of solid things. Look at a piece of 1" CRS—at each end, it is a circle, so all the rules of circles apply to it, but only when looked at from the end. When you look at it from the sides, the rules for lines apply. So, that piece of 1" CRS, which is actually a cylinder, can be looked at as two circles joined by a line. Square workpieces have the same properties. No matter which way you look at them, each face is a
rectangle or a parallelogram; and each face is subject to the rules of rectangles and parallelograms. Tapers are unequal circles joined by an incomplete triangle.
Perform Basic Trigonometric Operations
Attachment 1: MASTER Handout

Objective(s):

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

a. Solve for unknown angles;
b. Solve for unknown sides; and,
c. Calculate bolt hole patterns.

Module Outline:

I. Solve for Unknown Angles
   A. Right triangles
      1. Sine Law: \( \sin a = \text{side opposite divided by hypotenuse} \)
      2. Cosine Law: \( \cos a = \text{side adjacent divided by hypotenuse} \)
      3. Tangent Law: \( \tan a = \text{side opposite divided by side adjacent} \)
      4. Oscar Has A Heap Of Apples is a quick device to remember the above three runes.
         a. Sine \( \subset = \frac{\text{Opposite}}{\text{Hypoteneuse}} \)
         b. Cosine \( \subset = \frac{\text{Adjacent}}{\text{Hypoteneuse}} \)
         c. Tangent \( \subset = \frac{\text{Opposite}}{\text{Adjacent}} \)
   B. Oblique Triangles
      1. Lengths of three sides (A, B, C) all known
         a. \( \cos a = \frac{(B^2 + C^2 - A^2)}{2BC} \)
         b. \( \sin b = \frac{(B \times \sin a)}{A} \)
         c. \( c = 180° - (a + b) \)
      2. Two angles (a and b) known
         \( c = 180° - (a + b) \)
      3. Two sides and interior angle (A, c, B) known
         a. \( \tan a = \frac{(A \times \sin c)}{B - (A \times \cos c)} \)
         b. \( b = 180° - (a + c) \)
         c. \( C = \frac{(A \times \sin c)}{\sin a} \)
      4. Two sides and an opposite angle (a, A, B) known
         a. \( \sin b = \frac{(B \times \sin a)}{A} \)
         b. \( c = 180° - (a + b) \)
         c. \( C = \frac{(A \times \sin c)}{\sin a} \)

II. Solve for Unknown Sides
   A. Right triangles, any two sides known, where C is the hypotenuse
      \( A^2 + B^2 = C^2 \)
   B. One side and two angles (a, b, A) known
      1. \( c = 180° - (a + b) \)
      2. \( B = \frac{(A \times \sin b)}{\sin a} \)
3. \[ C = \frac{(A \times \sin c)}{\sin \alpha} \]

C. Two sides and the interior angle (A, B, c) known
\[ C = \sqrt{A^2 + B^2 - (2AB \times \cos c)} \]

D. Three angles known
It is impossible to determine the actual length of any side when only the sizes of the three angles are known. The length of at least one side must be known in order to calculate the lengths of the other sides.

III. Calculate Bolt Hole Patterns
A. Discuss the construction of reference triangles to solve bolt-hole patterns
B. Discuss circles and their uses in figuring bolt-hole patterns.
TLD-B4-LA
Perform Basic Trigonometric Operations
Attachment 2: MASTER Laboratory Aid
Objective(s):

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

a. Identify points using the Cartesian coordinate system;
b. Identify points using the absolute dimensioning system;
c. Identify points using the incremental dimensioning system; and,
d. Identify points using the polar coordinate system.

Module Outline:

I. Identify Points Using the Cartesian Coordinate System
   A. Describe the Cartesian (rectangular) coordinate system - the basis for all machine movement
      1. Define axis - any direction of movement on a machine tool. The spindle is always defined as the Z axis on 3 axis systems.
      2. Discuss the plus and minus aspects of an axis
      3. Discuss the quadrants I, II, III, and IV. Note that the signs for the X- and Y-axes change for the different quadrants.
      4. Discuss the concept of three dimensional locations
      5. Discuss how points are described in both 2- and 3-axis systems
      6. Describe how a part fits into the axis system

II. Identify Points Using the Polar Coordinate System
    A. Describe the polar coordinate system - a system by which all points are located around a known location (or pole).
       1. Points are usually identified by a known distance from the pole and a given angle from the horizontal (3:00 o'clock position equals zero degrees)
       2. Positive angles are measured from angle zero in a counterclockwise direction
       3. Negative angles are measured from angle zero in a clockwise direction
    B. Student practice

III. Locate Points Using the Absolute Dimensioning System
     A. Define absolute positioning- in absolute positioning, all machine locations are taken from one fixed zero (origin) point. This origin point does not change.
     B. This corresponds to the datum dimensioning method used by drafters. In datum dimensioning, all dimensions on a drawing are placed in reference to one fixed zero point.
     C. Student practice
IV. Locate Points Using the Incremental Dimensioning System
A. Define incremental positioning: in incremental positioning, the X0/Y0 moves with each position change. The current position, in fact, becomes the X0/Y0 for the next positioning move.
B. This corresponds to the delta dimensioning method used by drafters. In delta dimensioning, all dimensions on a drawing are "chain-linked." Each location is dimensioned from the previous one.
C. Student practice
TOOL AND DIE MAKER ... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

### 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>
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<tr>
<td>C</td>
<td>Interpret Engineering Drawings and Related Documents</td>
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<td>D</td>
<td>Demonstrate Knowledge of Manufacturing Materials</td>
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<td>E</td>
<td>Measure/Inspect</td>
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<td>F</td>
<td>Demonstrate Knowledge of Manufacturing Processes</td>
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<td>G</td>
<td>Use Computers</td>
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<tr>
<td>H</td>
<td>Perform CAD/CAM and CNC Programming Tasks</td>
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<tr>
<td>I</td>
<td>Perform Tool and Die Making Operations</td>
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<td>J</td>
<td>Operate Electrical Discharge Machine (EDM)</td>
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### Tasks

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<td>B-5</td>
<td>Use and apply Cartesian Coordinate System</td>
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<td>C-1</td>
<td>Interpret drawings and understand basic layout/types of drawings</td>
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<td>C-2</td>
<td>Interpret review and apply blueprints, dimensions, and tolerances</td>
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<tr>
<td>C-3</td>
<td>Use and apply dimensional and tolerancing (DIT)</td>
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<td>Demonstrate traditional machining and tooling techniques</td>
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<td>Understand and use quality systems</td>
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<td>C-6</td>
<td>Discriminate between mechanical drafting and sketching techniques</td>
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<td>E-1</td>
<td>Understand metrology terms</td>
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<td>Select measurement tools</td>
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<td>Measure with hand held instruments</td>
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<td>Eliminate measurement variables</td>
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<td>Measure using surface plate and accessories</td>
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<td>Inspect using stationary equipment</td>
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<td>F-1</td>
<td>Discuss metal cutting and metal cutting tools</td>
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<td>Operate metal saws</td>
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<td>Operate drill presses and tooling</td>
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<td>Operate engine and turret lathes and tooling</td>
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<td>Operate vertical and horizontal mills and tooling</td>
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<td>Operate precision grinders</td>
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<td>Operate heat treating equipment and processes</td>
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<td>F-8</td>
<td>Operate sheet metal equipment and processes</td>
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<td>F-9</td>
<td>Operate welding equipment and processes</td>
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<td>Estimate time required/cost to produce a part</td>
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<td>G-1</td>
<td>Use computer operating systems</td>
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<td>Understand computer terminology</td>
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<td>Use file management systems</td>
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<td>G-4</td>
<td>Install and use software packages</td>
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<tr>
<td>H-1</td>
<td>Discuss fundamentals of CNC machines and controls</td>
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<td>H-2</td>
<td>Program and operate CNC milling machine and machining center</td>
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<tr>
<td>H-3</td>
<td>Program and operate CNC lathe</td>
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<td>H-4</td>
<td>Use Computer Aided Drafting (CAD) system</td>
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<td>H-5</td>
<td>Create 3-D solid models</td>
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<td>H-6</td>
<td>Use Computer Aided Manufacturing (CAM) system</td>
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<td>I-1</td>
<td>Discuss basic types and functions of jigs and fixtures</td>
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<td>I-2</td>
<td>Demonstrate understanding of different types of industrial dies</td>
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<td>I-3</td>
<td>Demonstrate basic die theory and principles of die design</td>
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<td>I-4</td>
<td>Demonstrate tool and die repair and maintenance skills</td>
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<tr>
<td>J-1</td>
<td>Discuss fundamentals of EDM</td>
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<tr>
<td>J-2</td>
<td>Setup and operate conventional sinker EDM</td>
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<td>J-3</td>
<td>Program, setup and operate CNC sinker EDM and EDM drill</td>
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<tr>
<td>J-4</td>
<td>Program, setup, and operate CNC wire EDM</td>
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**BEST COPY AVAILABLE**

397
TLD-C1-HO
Interpret and Understand Basic Layout/Types of Drawings
Attachment 1: MASTER Handout

Objective(s):

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

a. Identify types of drawings;
b. Identify parts of a drawing and list components of each;
c. Identify types of lines on a drawing;
d. List and describe the different views found on a drawing;
e. List and apply the three primary planes of projection;
f. List and apply the six principle views;
g. Apply auxiliary views; and,
h. Apply sectional views.

Module Outline:

I. Interpret and Understand Basic Layout of Drawings
   A. ANSI & ISO sheet size layout
   B. ANSI & ISO forms of lettering arrangements

II. Interpret and Understand Types of Drawings
   A. Orthographic and multi-view projection
   B. Perspective or central projection
   C. Oblique projection
   D. Axonometric projection

III. Identify Parts of a Blue Print/Drawing and List Components of Each
   A. Body
   B. Title block
      1. Drawing number
      2. Drawing title
      3. Scale
      4. Signatures
      5. Job number
      6. Material list number
      7. Reference drawings
      8. Distribution section
      9. Revision
      10. Work order number
   C. Bill of Materials
      1. Piece mark number
      2. Number of pieces required for each piece mark
      3. Description of materials
      4. Traceability requirements
5. Material specifications
6. Length
7. Gross weight
8. Total weight

IV. Identify Types of Lines on a Drawing
   A. Visible line
   B. Hidden line
   C. Center line
   D. Section line
   E. Dimension line
   F. Extension line
   G. Leaders line
   H. Cutting plane/viewing plane line
   I. Short-break line
   J. Long-break line
   K. Phantom line
   L. Stitch line
   M. Chain line
   N. Cylindrical break/conventional break lines

V. List and Describe the Different Views Found on a Drawing
   A. One view
      1. Sphere
      2. Plate
   B. Two view
      1. Cylinder
      2. Rectangle
   C. Three view
      1. Pyramids
      2. Multi-view projection

VI. List and Apply the Three Primary Planes of Projection
   A. Frontal projection plane
   B. Profile projection plane
      1. Right side
      2. Left side
   C. Horizontal projection plane

VII. List and Apply the Six Principal Views
    A. Front view
    B. Rear view
    C. Right side view
    D. Left side view
    E. Top view
    F. Bottom view

VIII. List and Apply Auxiliary Views
     A. Surfaces needing auxiliary views
        1. Inclined surfaces
2. Oblique surfaces

B. Primary auxiliary views

C. Secondary auxiliary views

D. To generate an auxiliary view
   1. Folding-line method
   2. Reference-plane method

E. Classifications of auxiliary views
   1. Depth auxiliary views
   2. Height auxiliary views
   3. Width auxiliary views

F. Dihedral angles

G. Partial auxiliary views

H. Half auxiliary views

I. Auxiliary sections

J. Basic four uses of auxiliary views
   1. True length of line
   2. Point view of line
   3. Edge view of plane
   4. True size of plane

IX. List and Apply Sectional Views

A. Need for sectional views

B. Cutting plane
   1. Direction
   2. Labels
   3. Alternate styles

C. Section lining
   1. Techniques
   2. Symbols

D. Types of sectional views
   1. Full section
   2. Half/partial section
   3. Broken-out section
   4. Revolved section
   5. Removed section
   6. Offset section
   7. Aligned section
   8. Auxiliary section
   9. Partial section
TLD-C2-HO
Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
a. Distinguish between general and specific notes;
b. Interpret and apply general and specific notes;
c. Determine and apply dimensions on a drawing;
d. Identify basic symbols and abbreviations found on a drawing;
e. Identify tolerances or limits on a drawing; and,
f. Identify ANSI limits and fits.

Module Outline:

I. Distinguish Between General and Specific Notes
   A. General notes
   B. Specific notes/local notes

II. Interpret and Apply General and Specific Notes
   A. General notes applied
      1. Title strip/title block
      2. Parts list/bill of material
   B. Interpret general notes
      1. Including material
      2. General tolerances
      3. Heat treatment
      4. Pattern information
      5. Processes of manufacture
      6. Requirements of the product
   C. Interpret specific notes
      1. Apply to specific operations
      2. Apply to specific processes of manufacture
      3. Apply to the requirements of the product

III. Determine and Apply Dimensions on a Drawing
   A. Identify organizations that determine dimension standards
      1. American National Standards Institutes (ANSI)
      2. International Standards Organization (ISO)
   B. Determine dimensions on a drawing
      1. Size dimensions
      2. Location dimensions
   C. Applying dimensions on a drawing
      1. Scale of drawing
      2. Techniques of dimensioning
3. Placement of dimensions
4. Choice of dimensions
5. Types of lines used in the dimensioning process
6. Arrowheads used on drawings
7. Leaders used on drawings
8. Dimensioning systems
   a. Fractional
   b. Decimal
   c. Metric
   d. Combination dimensioning
9. Dimension figures
10. Direction of dimension figures
    a. Unidirectional system
    b. Aligned system
11. Dimensioning angles
12. Dimensioning arcs
13. Dimensioning fillets and rounds
14. Identify surfaces to be machined
15. Contour dimensioning
16. Dimensioning of curves
17. Dimensioning of rounded-end shapes
18. Dimensioning of threads
19. Dimensioning of tapers
20. Dimensioning of chamfers
21. Dimensioning shaft centers
22. Dimensioning keyways
23. Dimensioning knurls
    a. Diamond
    b. Straight
24. Dimensioning along curved surfaces
25. Tabular dimensions
26. Dimensioning standards
27. Coordinate dimensioning

IV. Identify Basic Symbols and Abbreviations Found on a Drawing
A. Traditional terms used to describe various shapes, processes, and size
B. Identify abbreviations used to describe various shapes, processes, and size
C. Identify a variety of dimensioning symbols used to replace traditional terms and abbreviations

V. Identify Tolerances or Limits on a Drawing
A. Identify tolerances or limits
   1. Nominal size
   2. Basic size or dimension
   3. Actual size
   4. Tolerance
5. Limits
6. Allowance

B. Methods of expressing tolerances
   1. General tolerances
   2. Limit dimensioning
   3. Plus and minus dimensioning
      a. Unilateral system
      b. Bilateral system
   4. Single-limit dimensioning
   5. Angular tolerances

VI. Identify ANSI Limits and Fits
   A. Fits between mating parts
      1. Clearance fit
      2. Interference fit
      3. Transition fit
      4. Line fit
   B. Limits and fits for cylindrical parts
      1. Running or sliding clearance fits
      2. Locational clearance fits
      3. Transition clearance interference fits
      4. Locational interference fits
      5. Force or shrink fits
Objective(s):

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

a. Distinguish between conventional and geometric dimensioning and tolerancing;

b. Explain and use geometric positional tolerancing and symbols;

c. Explain and use tolerances of form and symbols;

d. Explain and use the feature control symbol; and,

e. Explain and use modifiers in geometric dimensioning and tolerancing.

Module Outline:

I. Distinguish Between Conventional and Geometric Dimensioning and Tolerancing
   A. General/conventional tolerancing
      1. Definitions of general/conventional tolerancing
         a. Dimension
         b. Reference dimension
         c. Feature
         d. Feature of size
         e. Actual size
         f. Stock size
      2. Maximum material condition
      3. Least material condition
      4. Basic fits
      5. Clearance fit
      6. Allowance
      7. Clearance
      8. Force fit
   B. Geometric dimensioning and tolerancing
      1. Definition of geometric dimensioning and tolerancing
      2. Dimensioning rules
      3. Dimensioning units

II. Explain and Use Geometric Positional Tolerancing and Symbols
   A. Explain positional / location tolerances
   B. Identify and use geometric position tolerancing symbols
      1. Position
      2. Concentricity
      3. Symmetry

III. Explain and Use Tolerances of Form Symbols
   A. Explain form tolerances
B. Identify and use tolerances of form symbols
   1. Straightness
   2. Flatness
   3. Circularity
   4. Cylindrical

IV. Explain and Use Profile Tolerances
A. Explain profile tolerance
B. Identify and use profile tolerance symbols
   1. Profile of a line
   2. Profile of a surface
   3. Profile of an arc
   4. Profile of irregular curves
   5. Profile of coplanar surfaces

V. Explain and Use Tolerances of Orientation
A. Explain orientation tolerances
B. Identify and use orientation tolerance symbols
   1. Parallelism
   2. Perpendicularity
   3. Angularity

VI. Explain and Use Runout Tolerances
A. Explain runouts
   1. Circular
   2. Total
B. Identify and use runout tolerances symbols
   1. Circular
   2. Total

VII. Explain and Use Modifiers in Geometric Dimensioning and Tolerancing
A. Maximum material condition (MMC)
B. Regardless of feature size (RFS)
C. Least material condition (LMC)
D. Datum feature symbol
E. Datum reference frame concept
   1. Primary datum plane
   2. Secondary datum plane
   3. Tertiary datum plane
F. Datum target symbol
   1. Target point
   2. Target line
   3. Target area

VIII. Explain and Use the Feature Control Frame
A. Explain feature control frame
B. Explain the compartments of a feature control frame
   1. Geometric characteristic symbol
   2. Geometric tolerance
   3. Zone descriptor
4. Material condition symbol
5. Primary datum reference
6. Secondary datum reference
7. Tertiary datum reference

IX. Additional Supplementary Modifying Symbols
A. Explain and use additional modifying symbols.
   1. Diameter
   2. Radius R
   3. Reference ( )
   4. Counterbore/spotface L/
   5. Square □
   6. Dimension origin O
   7. Slope
   8. Projected tolerance zone
   9. Spherical diameter
  10. Spherical radius
  11. Arc length
  12. Counter sink
  13. Depth
  14. Conical taper
  15. Place, times, or by
  16. Basic dimension
Objective(s):

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

a. Demonstrate use of drafting machine;
b. Demonstrate use of drafting instruments;
c. Demonstrate drafting techniques used to create basic geometric elements;
d. Demonstrate sketching techniques;
e. Demonstrate isometric sketching;
f. Demonstrate oblique sketching; and,
g. Demonstrate perspective sketching.

Module Outline:

I. Demonstrate Use of Drafting Machine
   A. Types of drafting machines
      1. Elbow drafting machines
         a. Controlling head
         b. Vernier
      2. Track drafting machines
         a. Controlling head
         b. Vernier

II. Demonstrate Use of Drafting Instruments
   A. Drawing pencil types
      1. Drawing pencil
         a. Grade
         b. Sharpening
      2. Mechanical pencil
         a. Grade
         b. Sharpening
      3. Thin-lead mechanical pencil
         a. Grade
         b. Lead diameter
   B. Types of erasers
      1. Pink pearl
      2. Mars - plastiz
      3. Artgum
      4. Electric erasing machine
   C. Erasing shield
   D. Dusting brush
E. Types of triangles
   1. 45° triangle
   2. 30° x 60° triangle
   3. Adjustable triangle

F. Protractor

G. Types of scales
   1. Metric scale
   2. Engineers’ scale
   3. Mechanical engineers’ scale
   4. Decimal scale
   5. Architects’ scale
   6. Combination scale

H. Drawing instruments
   1. Compass
      a. Giant bow compass
      b. Beam attachment
   2. Beam compass/trammel
   3. Dividers

I. Irregular/french curve

J. Templets
   1. Circle
   2. Ellipse
   3. Chemical
   4. Electrical
   5. Architectural
   6. Mechanical

K. Lettering guide

L. Calculator

M. Drafting tape

N. Pencil lead sharpening devices
   1. Lead pointer
   2. Sandpaper pad

O. Drafting board table

P. Drafting paper/detail paper

Q. Tracing papers kinds
   1. Treated with oils, waxes, and similar substances (vellums)
   2. Non-treated papers

R. Tracing cloth

S. Polyester film

III. Demonstrate Drafting Techniques to Create Basic Geometric Elements
   A. Perform drafting techniques necessary to bisect a line or a circular arc
   B. Perform drafting techniques necessary to bisect an angle and to
      transfer an angle
   C. Perform drafting techniques necessary to construct a line parallel to a
      given line at a given distance
D. Perform drafting techniques necessary to divide a line into equal or proportional parts
E. Perform drafting techniques necessary to construct a triangle with the length of the sides given
F. Perform drafting techniques necessary to inscribe a circle in a triangle
G. Perform drafting techniques necessary to construct a right triangle with hypotenuse and one side given
H. Perform drafting techniques necessary to construct a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line
I. Perform drafting techniques necessary to construct a square with a side given
J. Perform drafting techniques necessary to inscribe a regular pentagon in a given circle
K. Perform drafting techniques necessary to inscribe and circumscribe a hexagon on a given circle
L. Perform drafting techniques necessary to inscribe an octagon in a given square
M. Perform drafting techniques necessary to construct a circle through three given points not in a straight line
N. Perform drafting techniques necessary to construct a circle of a given size tangent to a given line and passing through a given point
O. Perform drafting techniques necessary to construct a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line
P. Perform drafting techniques necessary to construct a circle of a given size tangent to a given circle and passing through a given point
Q. Perform drafting techniques necessary to construct an arc of a given size tangent to two given intersecting lines at acute or obtuse angles
R. Perform drafting techniques necessary to construct a given size circle tangent to two given circles
S. Perform drafting techniques necessary to construct an ellipse using the concentric circle method with major and minor diameters given
T. Perform drafting techniques necessary to construct an approximate ellipse with major and minor diameters given

IV. Demonstrate Sketching Techniques
   A. Horizontal lines
   B. Vertical lines
   C. Inclined lines
   D. Circles
   E. Arcs
   F. Ellipses

V. Demonstrate Isometric Sketching
   A. Box construction technique
   B. Blocking recesses and projections
C. Dim all construction lines
D. Heavy in all final lines

VI. Demonstrate Oblique Sketching
A. Block in front view
B. Sketch receding lines
C. Dim all construction lines
D. Heavy in all final lines

VII. Demonstrate Perspective Sketching
A. One-point perspective
   1. Sketch the true front view and select vanishing point
   2. Sketch receding lines to vanishing point
   3. Estimate the depth
   4. Dim all construction lines
   5. Heavy in all final lines

B. Two-point perspective
   1. Sketch the front corner of view in true height and locate two vanishing points on a horizontal line
   2. Estimate depth and width and sketch enclosing box
   3. Block in all details
   4. Dim all construction lines
   5. Heavy in all final lines
   6. Make contour lines thicker and inside lines thinner
Demonstrate Traditional Mechanical Drafting and Sketching Techniques
Attachment 2: MASTER Laboratory Exercise

1. The instructor will:
   a. Demonstrate use of drafting machine;
   b. Demonstrate use of drafting instruments;
   c. Demonstrate drafting techniques to create basic geometric elements;
   d. Demonstrate sketching techniques, including:
      (1) Isometric sketching;
      (2) Oblique sketching; and,
      (3) One-point and two-point perspective sketching.

2. The student will:
   a. Demonstrate use of drafting machine;
   b. Demonstrate use of drafting instruments;
   c. Demonstrate drafting techniques to create basic geometric elements, which include:
      (1) Bisecting a line or a circular arc;
      (2) Bisecting an angle and to transfer an angle;
      (3) Constructing a line parallel to a given line at a given distance;
      (4) Dividing a line into equal or proportional parts;
      (5) Constructing a triangle with the length of the sides given;
      (6) Inscribing a circle in a triangle;
      (7) Constructing a right triangle with hypotenuse and one side given;
      (8) Constructing a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line;
      (9) Constructing a square with a side given;
      (10) Inscribing a regular pentagon in a given circle;
      (11) Inscribing and circumscribing a hexagon on a given circle;
      (12) Inscribing an octagon in a given square;
      (13) Constructing a circle through three given points not in a straight line;
      (14) Constructing a circle of a given size tangent to a given line and passing through a given point;
      (15) Constructing a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line;
      (16) Constructing a circle of a given size tangent to a given circle and passing through a given point;
(17) Constructing an arc of a given size tangent to two given intersecting lines at acute or obtuse angles;
(18) Constructing a given size circle tangent to two given circles;
(19) Constructing an ellipse using the concentric circle method with major and minor diameters given;
(20) Construct an approximate ellipse with major and minor diameters given;

d. Demonstrate sketching techniques, including:
   (1) Isometric sketching;
   (2) Oblique sketching; and,
   (3) One-point and two-point perspective sketching.

3. The instructor will grade the student’s performance on the student’s ability to:
   a. Demonstrate use of drafting machine;
   b. Demonstrate use of drafting instruments;
   c. Demonstrate drafting techniques to create basic geometric elements, which include:
      (1) Bisecting a line or a circular arc;
      (2) Bisecting an angle and to transfer an angle;
      (3) Constructing a line parallel to a given line at a given distance;
      (4) Dividing a line into equal or proportional parts;
      (5) Constructing a triangle with the length of the sides given;
      (6) Inscribing a circle in a triangle;
      (7) Constructing a right triangle with hypotenuse and one side given;
      (8) Constructing a line through a point and perpendicular to a given line at the prescribed point and from a point off the given line;
      (9) Constructing a square with a side given;
      (10) Inscribing a regular pentagon in a given circle;
      (11) Inscribing and circumscribing a hexagon on a given circle;
      (12) Inscribing an octagon in a given square;
      (13) Constructing a circle through three given points not in a straight line;
      (14) Constructing a circle of a given size tangent to a given line and passing through a given point;
      (15) Constructing a circle tangent to a given line at a prescribed point on that line and passing through a given point not on that line;
      (16) Constructing a circle of a given size tangent to a given circle and passing through a given point;
      (17) Constructing an arc of a given size tangent to two given intersecting lines at acute or obtuse angles;
      (18) Constructing a given size circle tangent to two given circles;
(19) Constructing an ellipse using the concentric circle method with major and minor diameters given;
(20) Construct an approximate ellipse with major and minor diameters given;

d. Demonstrate sketching techniques, including:
(1) Isometric sketching;
(2) Oblique sketching; and,
(3) One-point and two-point perspective sketching.
Objective(s):

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

a. Understand and apply quality principles, including continuous improvement; and,

b. Document paper trails for part revisions.

Module Outline:

I. Understand and Apply Quality Principles, Including Continuous Improvement
   A. Tolerances as basic quality control
   B. The technician as the first line of excellence
   C. Specific systems
      These systems are diverse. You, as the instructor, must tailor this portion of the lecture to the system used in your circumstances.
   D. The inspector as guarantor
   E. The consumer: the ultimate judge of top quality

II. ISO 9000
   A. Purpose
   B. What is ISO 9000?
   C. How does it work?
   D. Where do the standards come from?
   E. Who uses this stuff, anyway?

III. Document Paper Trails for Part Revisions
TOOL AND DIE MAKER ... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

### Duties
- **A** Practice Safety
- **B** Apply Mathematical Concepts
- **C** Interpret Engineering Drawings and Related Documents
- **D** Demonstrate Knowledge of Manufacturing Materials
- **E** Measure/Inspect
- **F** Demonstrate Knowledge of Manufacturing Processes
- **G** Use Computers
- **H** Perform CAD/CAM and CNC Programming Tasks
- **I** Perform Tool and Die Making Operations
- **J** Operate Electrical Discharge Machine (EDM)

### Tasks

<table>
<thead>
<tr>
<th>A-1 Follow safety manuals and all safety regulations and requirements</th>
<th>A-2 Maintain safe equipment and machinery</th>
<th>A-3 Use safe operating procedures for hand and machine tools</th>
<th>A-4 Maintain a clean and safe work environment</th>
<th>A-5 Use safe material handling practices</th>
<th>A-6 Consult and apply MSDS for hazards of various materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1 Perform basic arithmetic functions</td>
<td>B-2 Perform basic algebraic operations</td>
<td>B-3 Use basic trigonometric functions</td>
<td>B-4 Perform basic geometric principles</td>
<td>B-5 Use and apply Cartesian Coordinate System</td>
<td></td>
</tr>
<tr>
<td>C-1 Interpret and understand basic layouttypes drawings</td>
<td>C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances</td>
<td>C-3 Use and apply Geometric Dimensioning and Tolerancing (G.D.T)</td>
<td>C-4 Demonstrate traditional mechanical drafting and sketching techniques</td>
<td>C-5 Demonstrate technical drafting and sketching techniques</td>
<td></td>
</tr>
<tr>
<td>D-1 Identify materials with desired properties</td>
<td>D-2 Identify materials and processes to produce a part</td>
<td>D-3 Discuss classification systems for metal</td>
<td>D-4 Analyze and design metalworking parts</td>
<td>D-5 Demonstrate understanding of different types of industrial dies</td>
<td></td>
</tr>
<tr>
<td>E-1 Understand and apply measuring and testing terms</td>
<td>E-2 Select measurement tools</td>
<td>E-3 Measure and test materials</td>
<td>E-4 Eliminate measurement variables</td>
<td>E-5 Measure and test materials</td>
<td></td>
</tr>
<tr>
<td>F-1 Discuss metal cutting and metal cutting tools</td>
<td>F-2 Operate metal saws</td>
<td>F-3 Operate metal lathes and tooling</td>
<td>F-4 Operate engine and turret lathes and tooling</td>
<td>F-5 Operate precision grinding machines</td>
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<tr>
<td>G-1 Use computer and apply computer terminology</td>
<td>G-2 Use computer terminology</td>
<td>G-3 Use file management systems</td>
<td>G-4 Install and use software packages</td>
<td>G-5 Create 3-D solid models</td>
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</tr>
<tr>
<td>H-1 Discuss fundamentals of CNC machines and controls</td>
<td>H-2 Program and operate CNC machines, lathes, and milling centers</td>
<td>H-3 Program and operate CNC lathes and milling centers</td>
<td>H-4 Use Computer-Aided Drafting (CAD) system</td>
<td>H-5 Use Computer-Aided Manufacturing (CAM) system</td>
<td></td>
</tr>
<tr>
<td>I-1 Discuss basic types and functions of jigs and fixtures</td>
<td>I-2 Utilize concepts of jig and fixture design</td>
<td>I-3 Demonstrate understanding of different types of industrial dies</td>
<td>I-4 Utilize basic die theory</td>
<td>I-5 Utilize principles of die design</td>
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</tr>
<tr>
<td>J-1 Discuss fundamentals of EDM</td>
<td>J-2 Setup and operate conventional EDM</td>
<td>J-3 Program, setup, and operate CNC EDM and EDM drill</td>
<td>J-4 Program, setup, and operate CNC EDM and EDM drill</td>
<td>J-5 Demonstrate tool and die repair</td>
<td></td>
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</tbody>
</table>

**BEST COPY AVAILABLE**
Objective(s):

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

a. Discuss classification system for metals; and,
b. Describe general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals.

Module Outline:

I. Discuss the Physical Properties of Metal
   A. Brittleness - the property of a metal which permits no permanent distortion before breaking
   B. Ductility - the ability of the metal to be permanently deformed without breaking
   C. Elasticity - the ability of a metal to return to its original shape after any force acting upon it has been removed
   D. Hardness - the resistance to forcible penetration
   E. Malleability - the property of a metal which permits it to be hammered or rolled into other sizes and shapes
   F. Tensile strength - the maximum amount of pull that a material will withstand before breaking
   G. Toughness - the property of a metal to withstand shock or impact

II. Discuss the Classification System for Steel
   A. Carbon steels
      1. Low carbon steel - contains from 0.02 to 0.20 percent of carbon
      2. Medium carbon steel - contains from 0.30 to 0.60 percent of carbon
      3. High carbon steel (tool steel) - contains over 0.60 percent of carbon
   B. Alloy steels - alloying elements allow steels to possess special characteristics
      Discuss Table 1.1 "Effects of Alloying Elements on Steel"
      Discuss Table 1.2 "SAE-ANSI Numerical Designation of Alloy Steels"

III. Describe General Characteristics For:
   A. Carbon Steels
   B. Tool Steels
   C. Stainless Steels
   D. Structural Steels
   E. Cast Irons
F. Non-Ferrous Metals
   1. Aluminum and Its Alloys
   2. Copper and Its Alloys
   3. Nickel Alloys
   4. Precious Metals
   5. Others
### TABLE 1.1

**THE EFFECT OF ALLOYING ELEMENTS ON STEEL**

<table>
<thead>
<tr>
<th>EFFECT</th>
<th>Carbon</th>
<th>Chromium</th>
<th>Cobalt</th>
<th>Lead</th>
<th>Manganese</th>
<th>Molybdenum</th>
<th>Nickel</th>
<th>Phosphorus</th>
<th>Silicon</th>
<th>Sulfur</th>
<th>Tungsten</th>
<th>Vanadium</th>
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<tbody>
<tr>
<td>Increases tensile strength</td>
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<td>Increases hardness</td>
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<td>Increases wear resistance</td>
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<td>Increases hardenability</td>
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<td>Increases ductility</td>
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<td>Increases elastic limit</td>
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<td>Increases abrasion resistance</td>
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<td>Increases toughness</td>
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<td>Raises critical temperature</td>
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<td>Lowers critical temperature</td>
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<td>Causes hot shortness</td>
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<td>Reduces deformation</td>
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<td>Imparts air hardening properties</td>
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<td>Eliminates blow holes</td>
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<td>X</td>
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<td>Facilitates rolling and forging</td>
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<td></td>
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<td>X</td>
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<td>Improves machinability</td>
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# TABLE 1.2

**SAE-AISI NUMERICAL DESIGNATION OF ALLOY STEELS**

(X Represents Percent of Carbon in Hundredths)

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<th>Material Type</th>
<th>Designation</th>
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<td>Carbon Steels</td>
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<tr>
<td>Plain carbon</td>
<td>10xx</td>
</tr>
<tr>
<td>Free-cutting, resulfurized</td>
<td>11xx</td>
</tr>
<tr>
<td>Manganese Steels</td>
<td>13xx</td>
</tr>
<tr>
<td>Nickel Steels</td>
<td></td>
</tr>
<tr>
<td>.50% nickel</td>
<td>20xx</td>
</tr>
<tr>
<td>1.50% nickel</td>
<td>21xx</td>
</tr>
<tr>
<td>3.50% nickel</td>
<td>23xx</td>
</tr>
<tr>
<td>5.00% nickel</td>
<td>25xx</td>
</tr>
<tr>
<td>Nickel-Chromium Steels</td>
<td></td>
</tr>
<tr>
<td>1.25% nickel, .65% chromium</td>
<td>31xx</td>
</tr>
<tr>
<td>1.75% nickel, 1.00% chromium</td>
<td>32xx</td>
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<tr>
<td>3.50% nickel, 1.57% chromium</td>
<td>33xx</td>
</tr>
<tr>
<td>3.00% nickel, .80% chromium</td>
<td>34xx</td>
</tr>
<tr>
<td>Corrosion and heat-resisting steels</td>
<td>303xx</td>
</tr>
<tr>
<td>Molybdenum Steels</td>
<td></td>
</tr>
<tr>
<td>Chromium</td>
<td>41xx</td>
</tr>
<tr>
<td>Chromium-nickel</td>
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<tr>
<td>Nickel</td>
<td>46xx and 48xx</td>
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<td>Chromium-Vanadium Steels</td>
<td>6xxx</td>
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<tr>
<td>Tungsten Steels</td>
<td>7xxx and 7xxxx</td>
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<tr>
<td>Triple-Alloy Steels</td>
<td>8xxx</td>
</tr>
<tr>
<td>Silicon-Manganese Steels</td>
<td>9xxx</td>
</tr>
<tr>
<td>Leaded steels</td>
<td>11Lxx (example)</td>
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</table>
TLD-D2-HO
Identify Materials and Processes to Produce a Part
Attachment 1: MASTER Handout

Objective(s):

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

a. Briefly describe and list the advantages and disadvantages for each of the following: casting processes, hot working processes, and cold working processes;
b. Discuss service requirements (strength, hardness, etc.);
c. Discuss fastening processes (fasteners, welding, bonding, etc.); and,
d. Discuss corrosion resistance methods.

Module Outline:

I. Describe Casting Processes
   A. Discuss the following casting processes: sand, evaporative, shell molding, permanent mold, centrifugal, investment, and die casting
   B. Discuss pattern and mold design factors for each of the above casting processes
   C. List the advantages and disadvantages of the casting processes

II. Describe Hot Working Processes
   A. Discuss the following hot working processes: rolling, strand casting, forging, drawing, extrusion, spinning, and roll forming
   B. List the advantages and disadvantages of the hot working processes

III. Describe Cold Working Processes
   A. Discuss the following cold working processes: rolling, blanking, pressing, drawing, extruding, wire and bar drawing, bending, shearing, and roll forming
   B. List the advantages and disadvantages of the cold working process

IV. Evaluate Alternative Manufacturing Processes
   A. Discuss the powder metallurgy process (PM)
   B. Discuss the following nontraditional machining processes: EDM, laser machining, ultrasonic machining, hydrojet machining, electron beam machining, and plasma beam machining
TLD-D3-HO1
Discuss Classification Systems for Metal
Attachment 1: MASTER Handout No. 1

Objective(s):

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

a. Identify organizations that classify metals;
b. Distinguish between types of metal by manufacturing method and/or shape;
c. Identify designation of each digit of a metal classification;
d. Identify carbon and alloy content of a metal using classification system;
e. Identify content of an unknown metal using shop tests; and,
f. Identify conformity of a metal to a specification system.

Module Outline:

I. Identify the Organizations That Classify Metals and Discuss the Significance of Each
   A. American Iron and Steel Institute (AISI)
   B. Society of Automotive Engineers (SAE)
   C. American Society for Testing and Materials (ASTM)
   D. American National Standards Institute (ANSI)
   E. Aluminum Association

II. Identify Classifications by Manufacturing Methods or Processes
   A. Hot rolled
   B. Cold rolled
   C. Turned and polished (sometimes referred to as ground and polished)
   D. Castings
   E. Forgings
   F. Galvanized

III. Identify Classifications by Shape
   A. Sheet and plate
   B. Bar stock
   C. Pipe and tubing
   D. Rod and wire
   E. Coil or strip
   F. Structural steel

IV. Discuss the AISI-SAE Numbering Systems for Carbon Steels
   A. Plain carbon steels (AISI-SAE 10xx and 15xx)
   B. Free-cutting steels (AISI-SAE 11xx and 12xx)

V. Discuss the AISI-SAE Classification Systems for Alloy Steels
   A. Manganese steels (AISI-SAE 13xx)
B. Nickel steels (AISI-SAE 2xxx)
C. Nickel-chromium steels (AISI-SAE 3xxx)
D. Molybdenum steels (AISI-SAE 4xxx)
E. Low chromium steels (AISI-SAE 5xxx)
F. Other alloy steels (AISI-SAE 61xx, 8xxx, and 9xxx)

VI. Discuss the AISI-SAE Classification of Stainless Steels
A. Chromium-nickel austenitic steels (SAE 30xxx or AISI 20x and 3xx)
B. Ferritic chromium steels (SAE 51xxx or AISI 4xx and 50x)
C. Martensitic chromium steels (SAE 51xxx or AISI 4xx and 50x)

VII. Discuss the AISI Classification of Tool Steels
A. High speed tool steels (AISI type M and T)
B. Hot work tool steels (AISI type H)
C. Cold work tool steels (AISI type D, A, and O)
D. Shock resisting tool steels (AISI type S)
E. Mold steels (AISI type P)
F. Special purpose tool steels (AISI type L and F)
G. Water hardening tool steels (AISI type W)

VIII. Discuss the Classification of Nonferrous Alloys
A. Aluminum and aluminum alloys (Aluminum Association four digit system)
B. Magnesium alloys (SAE type 5x and 5xx)
C. Nickel and nickel alloys (by name)
D. Titanium and titanium alloys (titanium and chief alloying element)
E. Copper and copper alloys (by name and SAE standard number)

IX. Discuss the Classification of Castings
A. Brass and bronze castings (SAE standard number)
B. Aluminum casting alloys (Aluminum Association four digit system)
C. Cast Iron (ASTM grade)
D. Steel Castings (ASTM grade)

X. Discuss the Unified Numbering System (UNS) for Metals and Alloys

XI. Discuss the Basic Identification of an Unmarked Piece of Steel Using Shop Tests
A. Observation
B. Magnet test
C. Hardness test
D. Scratch test
E. File test
F. Chemical test
G. Spark test

XII. Identify Specification Systems for Metals and Alloys
A. American Society for Testing and Materials (ASTM)
B. American National Standards Institute (ANSI)
C. U.S. Department of Defense (military specifications)
D. General Accounting Office (federal specifications)
Discuss Classification Systems for Metal
Attachment 2: MASTER Handout No. 2

AISI-SAE STANDARD STEELS CLASSIFICATION

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<td>Carbon Steels</td>
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<tr>
<td>10xx</td>
<td>Plain Carbon (Max 1% Mn.)</td>
</tr>
<tr>
<td>15xx</td>
<td>Plain Carbon (Max 1% - 1.65% Mn.)</td>
</tr>
<tr>
<td>11xx</td>
<td>Free Cutting, Resulfurized</td>
</tr>
<tr>
<td>12xx</td>
<td>Free Cutting, Resulfurized and Rephosphorized</td>
</tr>
<tr>
<td></td>
<td>Manganese Steels</td>
</tr>
<tr>
<td>13xx</td>
<td>1.75% Manganese</td>
</tr>
<tr>
<td>23xx</td>
<td>3.50% Nickel</td>
</tr>
<tr>
<td>25xx</td>
<td>5.00% Nickel</td>
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<td></td>
<td>Nickel Steels</td>
</tr>
<tr>
<td></td>
<td>Nickel-Chromium Steels</td>
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<tr>
<td>31xx</td>
<td>1.25% Nickel; 0.65% and 0.80% Chromium</td>
</tr>
<tr>
<td>32xx</td>
<td>1.75% Nickel; 1.07% Chromium</td>
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<tr>
<td>33xx</td>
<td>3.50% Nickel; 1.50% and 1.57% Chromium</td>
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<tr>
<td>34xx</td>
<td>3.00% Nickel; 0.77% Chromium</td>
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<tr>
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<td>Molybdenum Steels</td>
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<tr>
<td>40xx</td>
<td>0.20% and 0.25% Molybdenum</td>
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<tr>
<td>44xx</td>
<td>0.40% and 0.52% Molybdenum</td>
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<td></td>
<td>Chromium-Molybdenum Steels</td>
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<tr>
<td>41xx</td>
<td>0.50% - 0.95% Chromium; 0.12% - 0.30% Molybdenum</td>
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<td>Nickel-Molybdenum Steels</td>
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<tr>
<td>46xx</td>
<td>0.85% and 1.82% Nickel; 0.20% and 0.25% Molybdenum</td>
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<tr>
<td>48xx</td>
<td>3.50% Nickel; 0.25% Molybdenum</td>
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<tr>
<td>50xx</td>
<td>0.27% - 0.65% Chromium</td>
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<td>51xx</td>
<td>0.80% - 1.05% Chromium</td>
</tr>
<tr>
<td>50xx</td>
<td>0.50% Chromium; Min. 1.00% Carbon</td>
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<tr>
<td>51xx</td>
<td>1.02% Chromium; Min. 1.00% Carbon</td>
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<td>52xx</td>
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<td>Tungsten-Chromium Steels</td>
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<td>72xx</td>
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<tr>
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<td>43xx</td>
<td>1.82% Nickel; 0.50% and 0.80% Chromium; 0.25% Molybdenum</td>
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<td>47xx</td>
<td>1.05% Nickel; 0.45% Chromium; 0.20% and 0.35% Molybdenum</td>
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<tr>
<td>8xx</td>
<td>0.30% - 0.55% Nickel; 0.40% - 0.50% Chromium; 0.12% - 0.35% Molybdenum</td>
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<td>92xx</td>
<td>1.40% and 2.00% Silicon; 0.00% and 0.65% Chromium; 0.65% - 0.85% Manganese</td>
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<td>SAE</td>
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924
### AISI TOOL STEELS CLASSIFICATION

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<th>GROUP DESIGNATION</th>
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<td>M</td>
<td>Molybdenum Types</td>
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<td>T</td>
<td>Tungsten Types</td>
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<tr>
<td>Hot Work Tool Steels</td>
<td>H1, H9, H29, H39, H40, H59</td>
<td>Chromium Types</td>
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<td>Tungsten Types</td>
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<td>Molybdenum Types</td>
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<td>High Carbon, High Chromium Types</td>
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<td>Medium Alloy, Air Hardening Types</td>
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<td>Oil Hardening Types</td>
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<td>Special Purpose Tool Steels</td>
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<td>Water Hardening Tool Steels</td>
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### UNIFIED NUMBERING SYSTEM (UNS) FOR METALS & ALLOYS

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<td>Aluminum and Aluminum Alloys</td>
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<tr>
<td>C00001 to C99999</td>
<td>Copper and Copper Alloys</td>
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<tr>
<td>E00001 to E99999</td>
<td>Rare Earth and Rare Earth-Like Metals and Alloys</td>
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<tr>
<td>F00001 to F99999</td>
<td>Cast Irons</td>
</tr>
<tr>
<td>G00001 to G99999</td>
<td>AISI and SAE Carbon and Alloy Steels (Except Tool Steels)</td>
</tr>
<tr>
<td>H00001 to H99999</td>
<td>AISI H-Steels</td>
</tr>
<tr>
<td>J00001 to J99999</td>
<td>Cast Steels (Except Tool Steels)</td>
</tr>
<tr>
<td>K00001 to K99999</td>
<td>Miscellaneous Steels and Ferrous Alloys</td>
</tr>
<tr>
<td>S00001 to S99999</td>
<td>Heat and Corrosion Resistant (Stainless Steels)</td>
</tr>
<tr>
<td>T00001 to T99999</td>
<td>Tool Steels</td>
</tr>
</tbody>
</table>
### HOT ROLLED CARBON STEEL BARS

<table>
<thead>
<tr>
<th>Size</th>
<th>Tolerance Plus</th>
<th>Tolerance Minus</th>
<th>Out-of-Section Size</th>
<th>Tolerance Plus</th>
<th>Tolerance Minus</th>
<th>Out-of-Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rounds, Squares and Round-Cornered Squares</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To 5/16</td>
<td>.005</td>
<td>.005</td>
<td>.008</td>
<td>Over 1-1/2 to 2</td>
<td>1/64</td>
<td>1/64</td>
</tr>
<tr>
<td>Over 5/16 to 7/16</td>
<td>.006</td>
<td>.006</td>
<td>.009</td>
<td>Over 2 to 2-1/2</td>
<td>1/32</td>
<td>0</td>
</tr>
<tr>
<td>Over 7/16 to 5/8</td>
<td>.007</td>
<td>.007</td>
<td>.010</td>
<td>Over 2-1/2 to 3-1/2</td>
<td>3/64</td>
<td>0</td>
</tr>
<tr>
<td>Over 5/8 to 7/8</td>
<td>.008</td>
<td>.008</td>
<td>.012</td>
<td>Over 3-1/2 to 4-1/2</td>
<td>1/16</td>
<td>0</td>
</tr>
<tr>
<td>Over 7/8 to 1</td>
<td>.009</td>
<td>.009</td>
<td>.013</td>
<td>Over 4-1/2 to 5-1/2</td>
<td>5/64</td>
<td>0</td>
</tr>
<tr>
<td>Over 1 to 1-1/8</td>
<td>.010</td>
<td>.010</td>
<td>.015</td>
<td>Over 5-1/2 to 6-1/2</td>
<td>1/8</td>
<td>0</td>
</tr>
<tr>
<td>Over 1-1/8 to 1-1/4</td>
<td>.011</td>
<td>.011</td>
<td>.016</td>
<td>Over 6-1/2 to 8-1/4</td>
<td>5/32</td>
<td>0</td>
</tr>
<tr>
<td>Over 1-1/4 to 1-3/8</td>
<td>.012</td>
<td>.012</td>
<td>.018</td>
<td>Over 8-1/4 to 9-1/2</td>
<td>3/16</td>
<td>0</td>
</tr>
<tr>
<td>Over 1-3/8 to 1-1/2</td>
<td>.014</td>
<td>.014</td>
<td>.021</td>
<td>Over 9-1/2 to 10</td>
<td>1/4</td>
<td>0</td>
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</tbody>
</table>

### COLD FINISHED CARBON STEELS

<table>
<thead>
<tr>
<th>Size</th>
<th>Max. % Carbon Up to .28</th>
<th>Over .28 to .55</th>
<th>Over .55</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Max. % Carbon Minus Tolerance</td>
<td></td>
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</tr>
<tr>
<td>Cold Drawn Rounds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To 1-1/2</td>
<td>.002</td>
<td>.003</td>
<td>.005</td>
</tr>
<tr>
<td>Over 1-1/2 to 2-1/2</td>
<td>.003</td>
<td>.004</td>
<td>.006</td>
</tr>
<tr>
<td>Over 2-1/2 to 4</td>
<td>.004</td>
<td>.005</td>
<td>.007</td>
</tr>
<tr>
<td>Over 4 to 6</td>
<td>.005</td>
<td>.006</td>
<td>.008</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold Drawn Hexagons</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To 3/4</td>
<td>.002</td>
<td>.003</td>
<td>.006</td>
</tr>
<tr>
<td>Over 3/4 to 1-1/2</td>
<td>.003</td>
<td>.004</td>
<td>.007</td>
</tr>
<tr>
<td>Over 1-1/2 to 2-1/2</td>
<td>.004</td>
<td>.005</td>
<td>.008</td>
</tr>
<tr>
<td>Over 2-1/2 to 3-1/8</td>
<td>.005</td>
<td>.006</td>
<td>.009</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold Drawn Squares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To 3/4</td>
<td>.002</td>
<td>.004</td>
<td>.007</td>
</tr>
<tr>
<td>Over 3/4 to 1-1/2</td>
<td>.003</td>
<td>.005</td>
<td>.008</td>
</tr>
<tr>
<td>Over 1-1/2 to 2-1/2</td>
<td>.004</td>
<td>.006</td>
<td>.009</td>
</tr>
<tr>
<td>Over 2-1/2 to 3-1/8</td>
<td>.005</td>
<td>.008</td>
<td>.011</td>
</tr>
<tr>
<td>Turned and Polished Rounds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To 1-1/2</td>
<td>.002</td>
<td>.003</td>
<td>.005</td>
</tr>
<tr>
<td>Over 1-1/2 to 2-1/2</td>
<td>.003</td>
<td>.004</td>
<td>.006</td>
</tr>
<tr>
<td>Over 2-1/2 to 4</td>
<td>.004</td>
<td>.005</td>
<td>.007</td>
</tr>
</tbody>
</table>
List of Materials for Shop Tests and Illustration

1. Observation Test
   Sample of round bars with various surface finishes (cold finished, hot rolled, ground and polished)

2. Magnet Test
   Sample of carbon steel, ferritic or martensitic stainless steel, austenitic stainless steel, aluminum, and nickel steel

3. Hardness Test
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

4. Scratch Test
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

5. File Test
   Sample of mild steel, medium carbon steel, high carbon steel, alloy steel, and tool steel

6. Chemical Test
   Sample of carbon steel, type 302 or 304 stainless steel, type 316 or 317 stainless steel

7. Spark Test
   Sample of low carbon steel, high carbon steel, cast iron, high speed steel, tool steel, and manganese steel

8. Observation Test
   Samples of bar stock (round and square), hot rolled sheet, cold finished coil strip, galvanized sheet, small diameter pipe, small diameter tubing, small gauge wire, hot rolled rod, and cold finished rod
I. Identify the following:

a. AISI

b. SAE

c. ASTM

d. ANSI

e. UNS

II. Complete the following charts:

A. Standard Steels and Alloy Steels

<table>
<thead>
<tr>
<th>AISI-SAE</th>
<th>APP. % CARBON</th>
<th>MAJOR ALLOYING ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex. 1020</td>
<td>.20</td>
<td>Only Carbon</td>
</tr>
<tr>
<td>Ex. 6118</td>
<td>.18</td>
<td>Chromium &amp; Vanadium</td>
</tr>
<tr>
<td>Ex. 4340</td>
<td>.40</td>
<td>Nickel, Chromium, Molybdenum</td>
</tr>
<tr>
<td>1. 1040</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. 1095</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. 1212</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. 1340</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. 2340</td>
<td></td>
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<tr>
<td>6. 2512</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. 3140</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. 3310</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. 4024</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. 4140</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. 4320</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. 4620</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. 5135</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. 52100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. 6150</td>
<td></td>
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</tbody>
</table>
### B. AISI-SAE-UNS Classification System

<table>
<thead>
<tr>
<th>AISI-SAE</th>
<th>UNS</th>
<th>TYPE METAL OR STEEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex.</td>
<td>1212</td>
<td>G12120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Free Cutting Carbon Steel</td>
</tr>
<tr>
<td>Ex.</td>
<td>48xx</td>
<td>G48xx0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nickel- Molybdenum Steel</td>
</tr>
<tr>
<td>Ex.</td>
<td>A6</td>
<td>T30106</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Air Harden Cold Work Tool Steel</td>
</tr>
<tr>
<td>1.</td>
<td>1527</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>1151</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>G10290</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td>G41xx0</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>G61500</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>Tungsten-Chromium Steels</td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td>Austenitic Stainless Steels</td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td>Nickel Steels</td>
</tr>
<tr>
<td>9.</td>
<td>H21</td>
<td>T20821</td>
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<tr>
<td>10.</td>
<td>T12002</td>
<td>Tungsten High Speed Tool Steels</td>
</tr>
<tr>
<td>11.</td>
<td>Sx</td>
<td>T4190x</td>
</tr>
<tr>
<td>12.</td>
<td>D2</td>
<td>T30402</td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td>T41906</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shock Resisting Tool Steels</td>
</tr>
<tr>
<td>14.</td>
<td>-----</td>
<td>Axxxxx</td>
</tr>
<tr>
<td>15.</td>
<td></td>
<td>Copper and Copper Alloy</td>
</tr>
</tbody>
</table>

### III. Answer the following questions:

A. What is the out-of-round tolerance for 2-1/2" diameter hot rolled bar?

B. What is the size tolerance for 1-3/4" cold finished hexagon bar made from 1045?
C. If the only requirements given you were 1" 1018 square bar with a size tolerance of -.006, would you choose hot rolled (much cheaper) or cold finished stock?

IV. Record the results of your shop test below.

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Test Used</th>
<th>Kind of Metal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

<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 Related Documents</td>
</tr>
<tr>
<td>D</td>
<td>Demonstrate Knowledge of Manufacturing Materials</td>
</tr>
<tr>
<td>E</td>
<td>Measure/Inspect</td>
</tr>
<tr>
<td>F</td>
<td>Demonstrate Knowledge of Manufacturing Processes</td>
</tr>
<tr>
<td>G</td>
<td>Use Computers</td>
</tr>
<tr>
<td>H</td>
<td>Perform CAD/CAM and CNC Programming Tasks</td>
</tr>
<tr>
<td>I</td>
<td>Perform Tool and Die Making Operations</td>
</tr>
<tr>
<td>J</td>
<td>Operate Electrical Discharge Machine (EDM)</td>
</tr>
</tbody>
</table>
TLD-E1-HO
Understand Metrology Terms
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
a. Discuss the use of metrology in manufacturing;
b. Discuss the Inch system of measurement;
c. Discuss the Metric system of measurement;
d. Discuss semi-precision and precision measurement; and,
e. Discuss the following: precision, reliability, discrimination, and accuracy.

Module Outline:

I. Discuss the Use of Metrology in Manufacturing
   A. Discuss the function and reason for measurements in manufacturing
   B. Discuss the changes (metrology related) in manufacturing today
      1. Interchangeable manufacture
      2. World trade
      3. High precision

II. Discuss the Inch System of Measurement
    A. Discuss fractional (scale) dimensions for linear measurement
    B. Discuss decimal dimensions for linear measurement
    C. Convert fractional to decimal
       1. Review mathematical conversion method
       2. Fractional/decimal conversion charts
    D. Practice and demonstration of skills listed above

III. Discuss the Metric System of Measurement
     A. Discuss the units of measure commonly used in the metric system
     B. Convert inch to metric
        1. Review mathematical method (1 inch = 25.4 mm)
        2. Conversion charts
     C. Practice and demonstration of skills listed above

IV. Discuss Semi-Precision and Precision Measurement
    A. Discuss the difference between semi-precision and precision measurement
       1. Semi-precision measurements are 1/64" (.5mm) or greater
       2. Precision measurements are less than 1/64" (.5mm)
    B. Discuss the five categories of precision measurement
       1. Outside measurement
       2. Inside measurement
       3. Depth measurement
4. Thread measurement
5. Height measurement

V. Discuss the Following Measurement Terms: Accuracy, Precision, Reliability, and Discrimination

A. **Accuracy** - whether or not something is made according to standard. (The standard for manufacturing is the blueprint.)

B. **Precision** - the degree of exactness required for an application or design requirement

C. **Reliability** - the ability to consistently obtain the desired result

D. **Discrimination** - the degree that a measuring instrument divides its basic unit of length
Select Measurement Tools
Attachment 1: MASTER Handout

Objective(s):

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

a. Identify basic semi-precision measuring tools;
b. Identify precision measuring tools;
c. Justify use of particular measurement tools based on tool characteristics;
d. Identify error possibilities in measurement tool selection; and,
e. Demonstrate proper care of precision measuring tools.

Module Outline:

I. Describe and Discuss the Following Semi-Precision Measuring Tools
   A. Steel rules
   B. Calipers
   C. Squares

II. Describe and Discuss the Following Precision Measuring Tools
   A. Micrometers (outside, inside and depth)
   B. Verniers (calipers and height gage)
   C. Gages (small hole, telescope, fixed, and dial bore)

III. Justify Use of Particular Measurement Tools Based on Tool Characteristics
   A. What tolerance is required by the print?
   B. What physical characteristics of the part influence tool selection?
   C. What is the discrimination of the tool?
   D. How much time is available for part measurement/inspection?
   E. Will the tool be used by itself or in conjunction with some other tool?
   F. What is the most reliable tool for this application?

IV. Identify Error Possibilities in Measurement Tool Selection
   A. Part not being produced to specifications
   B. Too much time spent trying to measure correctly by not having the right tool

V. Demonstrate Proper Care of Precision Measuring Tools
   A. Storage
   B. Handling
   C. Cleaning
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Objective(s):

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

a. Measure with steel rules (metric and inch);

b. Measure with micrometers;

c. Measure with comparison measuring instruments (e.g., calipers, telescope gages);

d. Measure with direct measuring instruments (e.g., vernier, dial and digital instruments); and,

e. Measure with fixed gages (go and no-go gages).

Module Outline:

I. Discuss the Importance of Learning and Practicing Proper Measurement Techniques
   A. Show the video "Measuring Tools"
   B. Give each student a copy of the handout "Proper Measuring Techniques"

II. Discuss and Demonstrate Proper Measurement Techniques Using the Steel Rule

III. Discuss and Demonstrate the Use of Micrometer Type Measuring Instruments
   A. Outside micrometers
   B. Inside micrometers
   C. Depth micrometers
   D. Practice and demonstration of skills listed above

IV. Discuss and Demonstrate the Use of Transfer Type Measuring Instruments
   A. Spring calipers (inside and outside)
   B. Telescope gages
   C. Small hole gages
   D. Practice and demonstration of skills listed above

V. Discuss and Demonstrate the Use of Direct Measuring Instruments
   A. Vernier calipers
   B. Dial calipers
   C. Digital calipers
   D. Practice and demonstration of skills listed above

VI. Discuss the Purpose of Fixed Gages and Demonstrate Their Use
   A. Cylindrical plug and ring gages
   B. Taper plug and ring gages
   C. Snap gages
D. Thread plug gages
E. Practice and demonstration of skills listed above
VII. Complete Practical Exercise (TLD-E3-LE1) and (TLD-E3-LE2) On All the Above Material
TLD-E3-LE1
Measure With Hand Held Instruments
Attachment 2: MASTER Laboratory Exercise No. 1

1. What is the reading on the vernier caliper below?
   a. .642
   b. 1.642
   c. 1.645
   d. 1.64

2. What is the reading on the vernier caliper below?
   a. .415
   b. 3.125
   c. 3.405
   d. 3.412
3. What is the reading on the vernier caliper below?
   a. 4.575
   b. 4.250
   c. 4.570
   d. 4.275

4. What is the reading on this vernier caliper?
   a. 3.785
   b. 3.800
   c. 3.473
   d. 3.793
Using the measuring instruments provided for you and the measuring specimens, measure for the following dimensions and record your answers in the space provided. Be sure to provide metric and inch answers for each dimension. Turn this sheet in to your instructor for evaluation.

<table>
<thead>
<tr>
<th>Specimen Number</th>
<th>Dimension</th>
<th>metric</th>
<th>inch</th>
<th>Dimension</th>
<th>metric</th>
<th>inch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.</td>
<td></td>
<td></td>
<td>7.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>2.</td>
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<td></td>
<td>8.</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>3.</td>
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<td>9.</td>
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<td></td>
<td>4.</td>
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<td>5.</td>
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<td>11.</td>
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<td></td>
<td>6.</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-E4-HO
Eliminate Measurement Variables
Attachment 1: MASTER Handout

Objective(s):

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

a. Discuss factors affecting accurate measurement (dirt, temperature, improper measuring tool calibration);
b. Explain calibration requirements of various precision instruments;
c. Illustrate measurement differences when taken with calibrated and non-calibrated instruments; and,
d. Calibrate a micrometer type measuring tool.

Module Outline:

I. Discuss Factors Affecting Accurate Measurement
   A. Tool selection
   B. Cleanliness
   C. Temperature
   D. Calibration
   E. “Feel”

II. Explain Calibration Requirements of Various Precision Instruments
   A. Individual responsibility vs. company responsibility
   B. Calibration standards

III. Illustrate Measurement Differences When Taken With Calibrated and Non-Calibrated Instruments

IV. Calibrate a Micrometer Type Measuring Tool
   A. 5 steps adjusting an outside micrometer which needs adjustment
      1. Clean the measuring faces of the micrometer
      2. Close the measuring faces carefully against the standard by turning the ratchet stop or friction thimble
      3. Insert the C-spanner into the hole or slot provided in the sleeve
      4. Carefully turn the sleeve until the index line on the sleeve coincides with the zero line on the thimble
      5. Recheck the accuracy of the micrometer by opening and then closing the micrometer faces by turning the ratchet stop or friction thimble
   B. Student practice of the above procedure
The student will perform the following:

1. Calibrate a micrometer by:
   a. Adjusting micrometer;
   b. Cleaning the measuring faces of the micrometer;
   c. Closing the measuring faces carefully against the standard by turning the ratchet stop or friction thimble;
   d. Inserting the C-spanner into the hole or slot provided in the sleeve;
   e. Carefully turning the sleeve until the index line on the sleeve coincides with the zero line on the thimble; and,
   f. Rechecking the accuracy of the micrometer by opening and then closing the micrometer faces by turning the ratchet stop or friction thimble.
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-E5-HO
Measure/Inspect Using Surface Plate and Accessories
Attachment 1: MASTER Handout

Objective(s):

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

a. Describe care of surface plate;
b. Use surface plate accessories correctly (sine bar, gage blocks, etc.);
c. Check for part squareness;
d. Check part dimensions for accuracy; and,
e. Align workpieces using height gage and dial indicators.

Module Outline:

I. Describe Types of Surface Plate and Surface Tables
   A. Cast iron and semi-steel surface plates
   B. Granite surface plate

II. Discuss the Different Surface Plate Accessories and Their Use
   A. Sine bar
   B. Gage blocks
   C. Vernier height gage
   D. Precision height gage
   E. Dial test indicator
   F. Squares
   G. Angle plate and clamps
   H. 1,2,3 blocks

III. Demonstrate Checking For Part Squareness

IV. Demonstrate Checking Part Dimensions For Accuracy

V. Demonstrate Aligning Workpieces Using Height Gage and Dial Indicators
1. Instructor will provide sample mechanical parts for students to:
   a. Demonstrate checking for part squareness;
   b. Demonstrate checking part dimensions for accuracy; and,
   c. Demonstrate aligning workpieces using height gage and dial indicators.

2. Students will practice:
   a. Checking for part squareness;
   b. Checking part dimensions for accuracy; and,
   c. Aligning workpieces using height gage and dial indicators.
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Objective(s):

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

a. Set up and use an Optical Comparator; and,

b. Set up and use a Coordinate Measuring Machine (CMM).

Module Outline:

I. Define the Term “Comparison Measurement”
   A. Describe the following comparison instruments:
      1. Dial indicator
      2. Mechanical comparator
      3. Optical comparator
      4. Mechanical-optical comparator
      5. Air gages
      6. Electronic comparator
   B. Demonstrate the setup and operation of the optical comparator
   C. Allow students to practice setup and operation of the optical comparator

II. Discuss the Advantages of Measuring with the Coordinate Measuring Machine (CMM)
    A. Demonstrate the setup and operation of the CMM
    B. Allow students to practice setup and operation of the CMM
1. The instructor will:
   a. Demonstrate the setup and operation of the optical comparator; and,
   b. Demonstrate the setup and operation of the Coordinate Measuring Machine (CMM).

2. The students will:
   a. Practice the setup and operation of the optical comparator; and,
   b. Practice the setup and operation of the Coordinate Measuring Machine (CMM).
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TOOL AND DIE MAKER ... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

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<td>Apply Mathematical Concepts</td>
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<td>Interpret Engineering Drawings and Related Documents</td>
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<td>Perform CAD/CAM and CNC Programming Tasks</td>
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<td>I</td>
<td>Perform Tool and Die Making Operations</td>
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<tr>
<td>J</td>
<td>Operate Electrical Discharge Machine (EDM)</td>
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</table>

A-1 Follow safety manuals and all safety regulations/requirements
A-2 Maintain safe equipment and machinery
A-3 Use safe operating procedures for hand and machine tools
A-4 Maintain a clean and safe work environment
A-5 Use safely handled practices
A-6 Consult and apply MSDS for hazards of various materials

B-1 Perform basic arithmetic functions
B-2 Perform basic algebraic operations
B-3 Use basic geometric principles
B-4 Perform basic trigonometric functions
B-5 Use and apply Cartesian Coordinate System

C-1 Interpret and understand basic layout/types of drawings
C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances
C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&T)
C-4 Demonstrate traditional mechanical drafting and sketching techniques
C-5 Understand and use quality systems

D-1 Identify materials with desired properties
D-2 Identify materials and processes to produce a part
D-3 Discuss classification systems for metal

E-1 Understand metrology terms
E-2 Select and use measurement tools
E-3 Measure with hand held instruments
E-4 Eliminate measurement variables
E-5 Measure using stationary equipment
E-6 Inspect using stationary equipment

F-1 Discuss metal cutting and metal cutting tools
F-2 Operate metal saws
F-3 Operate drill presses and tooling
F-4 Operate engine and turret lathes and tooling
F-5 Operate vertical and horizontal mills and tooling
F-6 Operate precision grinders
F-7 Operate heat treating equipment and processes
F-8 Operate sheet metal equipment
F-9 Operate welding equipment and processes
F-10 Estimate time required/cost to produce a part

G-1 Use computer operating systems
G-2 Understand computer terminology
G-3 Use file management systems
G-4 Install and use software packages

H-1 Discuss fundamentals of CNC machines and controls
H-2 Program and operate CNC milling machine and machining center
H-3 Program and operate CNC lathe
H-4 Use Computer-Aided Drilling (CAD) system
H-5 Create 3-D solid models
H-6 Use Computer-Aided Manufacturing (CAM) system

I-1 Discuss basic types and functions of jigs and fixtures
I-2 Demonstrate the use of jigs and fixture design
I-3 Demonstrate understanding of different types of industrial dies
I-4 Utilize basic dies theory
I-5 Utilize principles of die design
I-6 Perform tool and die repair
I-7 Demonstrate tool and die making skills

J-1 Discuss fundamentals of EDM
J-2 Setup and operate conventional sinker EDM
J-3 Program, setup, and operate CNC sinker EDM and EDM drill
J-4 Program, setup, and operate CNC wire EDM

BEST COPY AVAILABLE
TLD-F1-HO
Discuss Metal Cutting and Metal Cutting Tools
Attachment 1: MASTER Handout

Objective(s):

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

a. Discuss physics of metal cutting
b. Discuss cutting tools
c. Discuss cutting fluids and coolants
d. Select appropriate tooling for application

Module Outline:

I. Discuss Physics of Metal Cutting
   A. Explain the metal cutting process
   B. Define metal cutting terms
      1. Built-up edge
      2. Chip-tool interface
      3. Crystal elongation
      4. Deformed zone
      5. Plastic deformation
      6. Plastic flow
      7. Rupture
      8. Shear angle (plane)
      9. Shear zone
     10. Cutting force
     11. Feed force
     12. Cutting Speed
        a. Surface feet per minute (SFM)
        b. Revolutions per minute (RPM)
     13. Feed
   C. Discuss machinability of metals
      1. Low-carbon steel
      2. High-carbon steel
      3. Tool steel
      4. Alloys
      5. Cast iron
   D. Discuss chip formation
      1. Discontinuous
      2. Continuous
      3. Continuous with built-up edge

II. Discuss Cutting Tools
   A. Geometry

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1. Front, or end, relief (clearance)
2. Side relief
3. Side cutting edge angle
4. Nose radius
5. Side rake angle
6. Back rake angle

B. Materials
1. High-speed tool steel
2. Cemented carbide
   a. Brazed-tip
   b. Indexable disposable inserts
   c. Coated
3. Ceramic
4. Diamond

C. ANSI insert identification system

D. Discuss factors that affect tool life
1. Type material being cut
2. Microstructure of the material
3. Hardness of the material
4. Surface condition of the material
5. Cutting tool material
6. Profile of the cutting tool
7. Type machining operation being performed
8. Speed, feed, and depth of cut
9. Effectiveness of cutting fluid

E. Discuss grinding single-point tools

III. Discuss Cutting Fluids and Coolants
A. Function
1. Coolant
2. Lubricant
3. Prolong tool life
4. Control rust

B. Types
1. Cutting oils
2. Soluble oils
3. Chemical fluids

C. Desirable characteristics
1. Good cooling capacity
2. Good lubricating qualities
3. Rust resistance
4. Stability (long life)
5. Resistance to rancidity
6. Nontoxic
7. Transparent
8. Relatively low viscosity
9. Nonflammable

D. Application
   1. Flood method
   2. Mist method
   3. Coolant-fed tooling

IV. Discuss the Selection of Appropriate Tooling for an Application
   A. Tool geometry
   B. Tool material
   C. Cutting fluids
Objective(s):

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

a. Define bandsaw, horizontal and vertical;
b. Discuss bandsaw safety;
c. Explain machine components and accessories of bandsaws;
d. Discuss application of the various tooth forms, pitch sets, and gages of bandsaw blades;
e. Weld and maintain bandsaw blade;
f. Calculate proper length of bandsaw blade;
g. Use recommended cutting speed and feed rate for specific materials and tooling;
h. Define circular type metal saws, abrasive cutoff and cold circular;
i. Discuss circular saw safety;
j. Explain tooling (blades and wheels) on circular saws; and,
k. Setup and operate bandsaw and circular saw.

Module Outline:

I. Define Bandsaw and Identify Types
   A. Horizontal
   B. Vertical

II. Discuss Bandsaw Safety

III. Explain Machine Components and Accessories of Bandsaws
    A. Horizontal
       1. Saw frame
       2. Vise
       3. Stop gage
       4. Pulleys
       5. Blade tension handle
       6. Roller guide brackets
       7. Saw blade
       8. Power stock feed
       9. Coolant
    B. Vertical (contour)
       1. Column
       2. Head
       3. Base
       4. Pulleys
       5. Table
6. Saw guides
7. Table tilt handwheel
8. Butt welder
9. Blade grinder
10. Coolant
11. Power feed

IV. Discuss Bandsaw Blades
A. Tooth forms
   1. Precision or regular tooth
   2. Claw or hook tooth
   3. Buttress or skip tooth
B. Pitch
C. Set
   1. Raker
   2. Wave
   3. Straight
D. Width
E. Gage
F. Material
G. Specialty blades

V. Explain How to Calculate Proper Length of Bandsaw Blade

VI. Explain How to Weld and Maintain Bandsaw Blade

VII. Explain How to Determine Cutting Speed and Feed Rate for Specific Materials and Tooling Using Charts And/or Selector Dial

VIII. Define Circular Type Metal Saws and Identify Types and Uses
A. Cold circular
B. Abrasive cutoff

IX. Discuss Circular Metal Saw Safety

X. Discuss Tooling (Blades and Wheels) on Circular Saws
A. Cold circular blades (reiterate tooth forms, pitch, set, gage, and material)
B. Abrasive cut-off wheels
   1. Grade
   2. Material

XI. Setup and Operate Bandsaw and Circular Saw
A. Safety
B. Horizontal
C. Vertical
D. Cold circular
E. Abrasive cutoff
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Objective(s):

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

a. Identify types of drilling machines;
b. Discuss drilling machine safety;
c. Explain machine components and accessories of drilling machines;
d. Describe and give function of various types of tooling used on drilling machines;
e. Explain processes performed on drilling machines;
f. Calculate speeds and feeds based on materials and tooling; and,
g. Set-up and operate drilling machines.

Module Outline:

I. Identify Types of Drilling Machines
   A. Bench-type sensitive drill press
   B. Upright drilling machine
   C. Radial drilling machine
   D. Numerical controlled drilling machine

II. Discuss Drill Safety

III. Explain Machine Components and Accessories of Drilling Machines
   A. Major components
      1. Base
      2. Column
      3. Table
      4. Drilling head
      5. Radial Arm
   B. Accessories
      1. Tool-holding devices
         a. Chucks
         b. Sleeves and sockets
      2. Work-holding devices
         a. Vise (drill, angle, contour)
         b. V-blocks
         c. Clamps, straps, and step blocks
         d. Angle plate
         e. Drill jig

IV. Describe and Give Function and Maintenance of Various Types of Tooling Used on Drilling Machines
   A. Drills
1. Twist
   a. Geometry and parts
   b. Sizes
   c. Grinding
2. Center
3. Core
4. Spade
5. Step
B. Reamers
   1. Rose-type
   2. Shell-type
   3. Expansion-type
   4. Adjustable-type
C. Counterbore
D. Countersink
E. Tap

V. Explain Processes Performed on Drilling Machines
A. Layout for drilling operations
B. Drilling
C. Reaming
D. Counterboring
E. Spotfacing
F. Countersinking
G. Tapping

VI. Calculate Speeds and Feeds Based on Materials and Tooling
A. Drilling
B. Reaming
C. Counterboring/spotfacing
D. Countersinking
E. Tapping

VII. Set-Up and Operate Drilling Machines
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-F4-HO
Operate Engine and Turret Lathes and Tooling
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
a. Define lathes, engine and turret;
b. Discuss lathe safety;
c. Explain machine components and accessories of lathes;
d. Describe and give function and maintenance of various types of tooling used on lathes;
e. Explain turning processes, inside and outside;
f. Calculate speeds and feeds based on materials, tooling and setup; and,
g. Set-up and operate engine and turret lathes.

Module Outline:

I. Define Lathes and Identify Types
   A. Engine
   B. Turret
   C. Computer Numerical Control (CNC)

II. Discuss Lathe Safety

III. Explain Machine Components and Accessories of Lathes
   A. Major components
      1. Bed
      2. Headstock
      3. Gearbox
      4. Carriage
         a. Saddle
         b. Cross-slide
         c. Compound rest
      5. Tailstock
   B. Accessories
      1. Centers
      2. Chucks
         a. Three-jaw universal
         b. Four-jaw independent
         c. Collet-type
         d. Magnetic
      3. Faceplate
      4. Steadyrest
      5. Follower rest
      6. Lathe dogs
IV. Describe and Give Function and Maintenance of Various Types of Tooling Used on Lathes

A. Types
1. O.D. turning tools
2. I.D. turning tools
3. Face turning tools
4. Threading tools
5. Grooving tools
6. Knurling tools
7. Form tools

B. Maintenance and grinding

V. Explain Turning Processes

A. Inside operations
1. Drilling, tapping, reaming
2. Boring
3. Threading
4. Chamfering
5. Grooving
6. Taper boring

B. Outside operations
1. Turning
   a. Chuck turning
   b. Between centers
   c. Form turning
   d. Taper turning
2. Facing
3. Threading
4. Grooving
5. Knurling
6. Chamfering
7. Cut-off

C. Explain depth of cut

VI. Calculate Speeds and Feeds Based on Materials, Tooling, and Setup

VII. Set-Up and Operate Engine and Turret Lathes
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Objective(s):

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

a. Define milling machines, horizontal and vertical;
b. Discuss mill safety;
c. Explain machine components and accessories of milling machines;
d. Describe and give function of different types of tooling used on milling machines;
e. Explain milling processes;
f. Explain boring processes on milling machine;
g. Explain precision set-ups on the milling machine;
h. Calculate speeds, feeds, and depth of cut based on materials, tooling and setup; and,
i. Set-up and operate horizontal and vertical milling machine for milling and boring operations.

Module Outline:

I. Define Milling Machines
   A. Horizontal
      1. Manufacturing type
      2. Knee-and-column type
   B. Vertical
      1. Standard
      2. Ram type
   C. CNC Machining Centers

II. Discuss Mill Safety

III. Explain Machine Components and Accessories of Milling Machines
   A. Major components
      1. Base
      2. Column
      3. Overarm
      4. Table
      5. Saddle
      6. Knee
   B. Accessories
      1. Fixtures
      2. Vises
      3. Parallel bars
      4. Arbors, collets, and adapters
5. Milling attachment
6. Slotting attachment
7. Indexing or dividing head
8. Rotary table
9. Backlash eliminator

IV. Describe and Give Function of Different Types of Tooling Used on Milling Machines
A. Arbor type cutters
   1. Plain
   2. Side-milling
   3. Face-milling
   4. Angular
   5. Formed
B. End mills
   1. Standard
   2. Ball
   3. Bull
   4. Formed
   5. Shell
C. Specialty cutters
   1. T-slot
   2. Dovetail
   3. Woodruff keyseat
   4. Flycutter
D. Tooling materials
   1. High speed steel
   2. Carbide brazed
   3. Carbide inserted

V. Explain Milling Processes
A. Face milling
B. Side milling
C. Straddle milling
D. Slot or keyseat milling
E. Gang milling
F. Sawing or slitting
G. Specialty milling (T-slot, dovetail, woodruff keyseat, etc.)

VI. Explain Boring Processes on Milling Machine

VII. Explain Precision Set-Ups on the Milling Machine
A. Using the dial indicator
B. Digital readout devices
C. Aligning the head and table
D. Aligning the vise or fixture
E. Finding edge, center, or face locations

VIII. Calculate Speeds, Feeds, and Depth of Cut Based on Materials, Tooling and Setup
IX. Set-Up and Operate Horizontal and Vertical Milling Machine for Milling and Boring Operations
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-F6-HO
Operate Precision Grinders
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this module the student will be able to:
a. Define types of precision grinders;
b. Discuss grinding safety;
c. Identify major components and accessories of grinding machines;
d. Identify types, nomenclature, and uses of grinding wheels;
e. Discuss care and maintenance of grinding wheels;
f. Identify the factors involved in electing grinding wheel specifications;
g. Explain grinding processes; and,
h. Setup and operate precision grinding machines.

Module Outline:

I. Define Types and Uses of Precision Grinders
   A. Surface
      1. Horizontal with reciprocating or rotary motion table
      2. Vertical with reciprocating or rotary motion table
   B. Cylindrical
      1. Center type (universal)
      2. Centerless
   C. Universal tool and cutter

II. Discuss Grinding Safety

III. Identify Major Components and Accessories of Grinding Machines
   A. Hydraulic surface grinder
      1. Major Components
         a. Base
         b. Saddle
         c. Table
         d. Column
      2. Accessories
         a. Magnetic chuck
         b. Chuck blocks
         c. Sine chuck
         d. Adapter plate
         e. Angle plate
         f. Diamond dresser
   B. Cylindrical grinder
      1. Major Components
         a. Base
b. Wheelhead
c. Table
d. Headstock
e. Footstock
f. Work rest blade (centerless)
g. Regulating wheel (centerless)

2. Accessories
a. Backrest or steadyrest
b. Center rest
c. Internal grinding attachment

C. Tool and cutter grinder
1. Major components
a. Base
b. Wheelhead
c. Saddle
d. Table

2. Accessories and attachments
a. Headstock
b. Footstock
c. Centering gage
d. Tooth rest
e. Tooth rest blade
f. Mandrel

IV. Identify Types, Nomenclature, and Uses of Grinding Wheels
A. Abrasive Types
   1. Aluminum Oxide
   2. Silicon Carbide
B. Grain Size
C. Grade
D. Structure
E. Bond Type
F. Shapes

V. Discuss the Procedures to Care and Maintain Grinding Wheels
A. Inspecting
B. Mounting
C. Balancing
D. Truing and dressing

VI. Identify the Factors Involved in Selecting Grinding Wheel Specifications
A. Type of grinding operation
B. Material to be ground
C. Amount of stock to be removed
D. Area of contact
E. Finish required
F. Wheel speed
G. Method of cooling
VII. Explain Grinding Processes
A. Surface grinding operations
   1. Squaring blocks (flat and edge grinding)
   2. Vertical surfaces
   3. Angular surfaces
   4. Form grinding
   5. Cutoff operations
B. Cylindrical grinding operations
   1. Outside diameters
   2. Tapers
   3. Internal diameters
   4. Centerless grinding
C. Tool and cutter grinder operations
   1. Cylindrical grinding
   2. Plain helical milling cutter
   3. End mill
   4. Side and face milling cutters
   5. Form-relieved cutter

VIII. Setup and Operate Grinding Machines (Surface, Cylindrical, and Tool and Cutter)
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Objective(s):

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

a. Define heat treatment;
b. Identify types of heat treating equipment;
c. Identify the three major steps for all heat-treatment processes;
d. Explain heat treating processes and procedures;
e. Explain the terms relevant to heat treatment processes; and,
f. Set-up and operate heat treating equipment.

Module Outline:

I. Define Heat Treatment
II. Identify Types of Heat Treating Equipment
III. Identify the Three Major Steps for All Heat-treatment Processes
   A. Heating
   B. Soaking
   C. Cooling
IV. Explain Heat Treating Processes and Procedures
   A. Hardening
      1. Hardening temperature
      2. Quenching and quenching solutions
      3. Factors affecting hardness
   B. Tempering, or drawing
      1. Need for tempering
      2. Tempering temperatures (and factors)
      3. Procedure
   C. Annealing
      1. Need for annealing
      2. Types of annealing (and procedures)
         a. Full annealing
         b. Process annealing
         c. Spheroidizing annealing
   D. Normalizing
      1. Normalizing temperature
      2. Procedure
   E. Other methods of heat treatment
      1. Case-hardening
         a. Methods
         b. Hardening
2. Flame Hardening
3. Induction Hardening
4. Laser and electron beam hardening

V. Explain the Terms Relevant to Heat Treatment Processes
A. Pearlite
B. Cementite
C. Austenite
D. Martensite
E. Troosite, sorbite, or tempered martensite
F. Eutectoid Steel
G. Hypereutectoid steel
H. Hypoeutectoid steel
I. Decalescence point
J. Recalescence point
K. Lower critical temperature point
L. Upper critical temperature point
M. Critical range
N. Body-centered cube
O. Face-centered cube

VI. Set-Up and Operate Heat Treating Equipment
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-F8-HO
Operate Sheet Metal Equipment
Attachment 1: MASTER Handout

Objective(s):

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

a. Discuss fabrication of sheet metal parts;
b. Discuss gas/plasma cutting equipment and processes;
c. Discuss shearing operation and equipment;
d. Discuss pressworking processes;
e. Demonstrate sheet metal layout; and,
f. Apply conservation-of-material concepts.

Module Outline:

I. Discuss Fabrication of Sheet Metal Parts
   A. Sheet metal definition
   B. Sheet metal sizes
   C. Pattern development
   D. Hems, edges, and seams

II. Discuss Gas Cutting Equipment
    A. Oxygen-acetylene gas torch
    B. Plasma torch (nitrogen and oxygen)
    C. Single and gantry types
    D. Control methods
       1. Tracer and “Electric Eye”
       2. CNC

III. Discuss Shearing Operations and Equipment

IV. Discuss Pressworking Processes
    A. Punch press
    B. CNC turret punch press
    C. Press brake
    D. Roll forming machine

V. Discuss Sheet Metal Layout
    A. Templates
    B. Layout-on-metal

VI. Discuss Conservation-of-Material Concepts
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-F9-HO
Operate Welding Equipment and Processes
Attachment 1: MASTER Handout

Objectives:

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

a. Discuss welding safety;
b. Identify and discuss types of welds;
c. Identify and discuss weld joints;
d. Identify and interpret weld symbols;
e. Identify and discuss welding processes;
f. Discuss weld characteristics; and,
g. Discuss edge preparation and fit-up.

Module Outline:

I. Discuss Welding Safety

II. Identify and Discuss Types of Welds
   A. Surfacing weld
   B. Fillet weld
   C. Groove weld
   D. Plug and slot weld

III. Identify and Discuss Weld Joints
    A. Butt joint
    B. Tee joint
    C. Lap joint
    D. Corner joint
    E. Edge joint

IV. Identify and Interpret Weld Symbols

V. Identify and Discuss Welding Processes
   A. Oxyacetylene welding (OAW)
   B. Arc Welding
      1. Shielded Metal-Arc Welding (SMAW)
      2. Gas Shielded-Arc Welding (GTAW and GMAW)
   C. Other Welding Processes
      1. Brazing
      2. Surfacing
      3. Pipe Welding
      4. Cutting Operations
      5. Resistance

VI. Discuss Weld Characteristics
    A. Penetration
    B. Defects

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C. Residual Stresses
D. Distortion

VII. Discuss Edge Preparation and Fit-up
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-F10-HO
Estimate Time Required/Cost to Produce a Part
Attachment 1: MASTER Handout

Objective(s):

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

a. Determine component parts and requirements for assembly;
b. Determine processes required to produce piece parts;
c. Determine the material requirements and costs;
d. Determine tooling required;
e. Estimate time required to manufacture and assemble parts; and,
f. Estimate manufacturing costs.

Module Outline:

I. Determine Component Parts and Requirements for Assembly

II. Determine Processes Required to Produce Piece Parts
   A. Considerations
      1. Shape and size
      2. Fit and form tolerances and specifications
      3. Safety factors
   B. Order of operations
   C. Buy vs. make
      1. Capabilities
      2. Workload

III. Determine the Material Requirements and Costs
   A. Stock material
      1. Types and sizes
      2. Quantity required
         a. Finished quantity
         b. Machining excess
         c. Scrap factor
         d. Material conservation techniques
      3. Calculating material costs
         a. Cost per unit
         b. Total amount required
         c. Freight costs
         d. Overhead
   B. Purchased components

IV. Determine Tooling Required
   A. Fixtures, jigs, vices, etc.
   B. Cutting tools
   C. Lubrication/coolant requirements
D. Additional resources required

V. Estimate Manufacturing Time
   A. Setup
      1. Lot size
      2. Tooling
      3. Rigidity
   B. Cycle time
      1. Speeds and feeds
      2. Depth of cut
   C. Tool life
   D. Handling time
      1. Transport
      2. Load/unload
   E. Personal allowance time

VI. Estimate Manufacturing Costs (MLO)
   A. Material
   B. Labor
   C. Overhead
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
**TOOL AND DIE MAKER** .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

### Duties

| A | Practice Safety |
| B | Apply Mathematical Concepts |
| C | Interpret Engineering Drawings and Related Documents |
| D | Demonstrate Knowledge of Manufacturing Materials |
| E | Measure/Inspect |
| F | Demonstrate Knowledge of Manufacturing Processes |
| G | Use Computers |
| H | Perform CAD/CAM and CNC Programming Tasks |
| I | Perform Tool and Die Making Operations |
| J | Operate Electrical Discharge Machine (EDM) |

### Tasks

| A-1 | Follow safety manuals and all safety regulations/requirements |
| A-2 | Maintain safe equipment and machinery |
| A-3 | Use safe operating procedures for hand and machine tools |
| A-4 | Maintain a clean and safe work environment |
| A-5 | Use safe material handling practices |
| A-6 | Consult and apply MSDS for hazards of various materials |
| B-1 | Perform basic arithmetic functions |
| B-2 | Perform basic algebraic operations |
| B-3 | Use basic geometric principles |
| B-4 | Perform basic trigonometric functions |
| B-5 | Use and apply Cartesian Coordinate System |
| C-1 | Interpret and understand basic layout/types of drawings |
| C-2 | Interpret, review, and apply blue-print notes, dimensions, and tolerances |
| C-3 | Use and apply Geometric Dimensioning and Tolerancing (GD&T) |
| C-4 | Demonstrate traditional mechanical drafting and sketching techniques |
| C-5 | Understand and use quality systems |
| D-1 | Identify materials with desired properties |
| D-2 | Identify materials and processes to produce a part |
| D-3 | Discuss classification systems for metal |
| D-4 | Use safe operating procedures for hand and machine tools |
| D-5 | Maintain a clean and safe work environment |
| D-6 | Consult and apply MSDS for hazards of various materials |
| E-1 | Understand manufacturing materials |
| E-2 | Select measurement tools |
| E-3 | Measure with hand held instruments |
| E-4 | Eliminate measurement variables |
| E-5 | Measure/inspect using surface plate and accessories |
| E-6 | Inspect using stationary equipment |
| F-1 | Discuss metal cutting and metal cutting tools |
| F-2 | Operate metal saws and metal cutting tools |
| F-3 | Operate drills/presses and tooling |
| F-4 | Operate engine and turret lathes and tooling |
| F-5 | Operate vertical and horizontal mills and tooling |
| F-6 | Operate precision grinders |
| F-7 | Operate heat treating equipment and processes |
| F-8 | Operate sheetmetal equipment and processes |
| F-9 | Operate welding equipment and processes |
| F-10 | Estimate time required/cost to produce a part |
| G-1 | Use computer operating systems |
| G-2 | Understand computer terminology |
| G-3 | Use file management systems |
| G-4 | Install and use software packages |
| H-1 | Discuss fundamentals of CNC machines and controls |
| H-2 | Program and operate CNC milling machine and machining center |
| H-3 | Program and operate CNC lathe |
| H-4 | Use Computer Aided Drafting (CAD) system |
| H-5 | Use Create 3-D solid models |
| H-6 | Use Computer Aided Manufacturing (CAM) system |
| I-1 | Discuss basic types and functions of jigs and fixtures |
| I-2 | Utilize concepts of jigs and fixtures design |
| I-3 | Demonstrate understanding of different types of industrial dies |
| I-4 | Use basic die theory |
| I-5 | Utilize principles of die design |
| I-6 | Perform tool and die repair |
| I-7 | Demonstrate tool and die making skills |
| J-1 | Discuss fundamentals of EDM |
| J-2 | Setup and operate conventional sinker EDM |
| J-3 | Program, setup, and operate CNC sinker EDM and EDM drill |
| J-4 | Program, setup, and operate CNC wire EDM |
| J-5 | Demonstrate the use of EDM machines |

**BEST COPY AVAILABLE**
Objective(s):

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

a. Distinguish between a directory/file folder and a file;
b. Understand data organization and terminology;
c. Explain the function of an operating system;
d. Explain what the term "IBM compatible" means;
e. Use a mouse;
f. Utilize file manager in Windows 3.1 to view directories and files;
g. Utilize explorer in Windows 95 to view folders and files; and,
h. Explain and use basic network concepts.

Module Outline:

I. Introduction to Computers
   A. Discuss hardware components
   B. Explain disk drive configurations
   C. Discuss software
      1. Application programs
      2. Operating systems
         a. DOS
         b. Windows
         c. Windows 95
         d. Network operating systems
   D. Discuss brands of computers
      1. Apple & MacIntosh
      2. IBM & compatibles
   E. Explain data organization
      1. Files
      2. Filenames and extensions
      3. Root directory & backward slash (\)
      4. Directory and subdirectory structure
   F. Explain the terms directory path and file specification

II. Introduction to the Windows Operating System
   A. Discuss how to start Windows
   B. Discuss basic mouse operations
      1. Pointing
      2. Clicking
      3. Double clicking
      4. Dragging
C. Discuss Windows elements
   1. Window borders
   2. Title bar
   3. Control-menu box
   4. Mouse pointer
   5. Sizing buttons
   6. Scroll bar and arrows
   7. Menu bar
   8. Pull-down menus
   9. Work area
  10. Icons

D. Use File Manager
   1. Explain the file manager screen
   2. Change drives
   3. Expand directories
   4. Collapse directories
   5. Change file information displayed
   6. Run an application

E. Run an application from an icon in Program Manager

III. Introduction to Windows 95 Operating System
A. Discuss Windows 95 desktop components
   1. My Computer icon
   2. Recycle Bin icon
   3. Network Neighborhood icon
   4. Start button
   5. Taskbar

B. Use Windows 95
   1. Open a window from an icon
   2. Use sizing buttons and close button
   3. Discuss Start menu
   4. Open an application using the Start button
   5. Explain shut down menu under Start
   6. Use Windows Explorer
      a. Explain Windows Explorer toolbar buttons
      b. Explain folders and subfolders
      c. Select folders
      d. Open and close folders
      e. Change drives
      f. Change file list display

IV. Introduction to Computer Network Systems
A. Explain what a network is
B. Discuss basic network components
   1. File server
   2. Network operating system (NOS)
   3. Local area network (LAN) cable
4. Network devices

C. Explain types of networks
   1. Campus
   2. National
   3. International

D. Explain and use basic network concepts
   1. File server login/logout
   2. Application sharing
   3. Document sharing
   4. Electronic mail
Introduction to Using Windows 3.1

1. Double-click the Main Group and open the File Manager. Click Tree and choose Indicate Expandable Branches, if it has not been selected. What lets you know this selection has been made? What does this selection do?

2. Select the root of drive C. Choose Tree from the command bar. Then clock Collapse Branch. What does this selection do?

3. Choose Tree again and click Expand One Level. How many directories/folders are on drive C?

4. In the command bar, select Tree and choose Expand All. What happened?

5. Find the folder WPWIN. How many subdirectories/subfolders are listed under the directory/folder name TEMPLATE?

6. Double-click a directory/folder that contains a subdirectory/subfolder. What happened?

7. What happens if you double-click the folder again?

8. Place a disk in drive A. How can you view the contents of the file in drive A?

9. Select drive C again. Under View, choose All File Details. What happened?

10. Select the MACROS subdirectory/subfolder under WPWIN. Go to View and choose Sort by Name. What is the first file listed? Sort by Type. The first file listed is
Sort by Size. The first file listed is ________________________________

Sort by Date. The first file listed is ________________________________

11. How can the list of files in a particular folder be viewed?

12. Exit File Manager and close the Main Group. How did you do this?

13. How could an application package, such as WordPerfect for Windows, be loaded and run from Windows 3.1?
Introduction to Using Windows 95

1. Click Start, go to Programs, and click Windows Explorer.

2. Maximize the window, if necessary.

3. Click in the square to the left of the My Computer icon.

4. What does a + in the square mean? What happens when you click the +?

5. What does a - in the square mean? What happens when you click the -?

6. Click on C: How many directories/folders are at the root of drive C? How many files are at the root of drive C?

7. Expand drive C. How many directories under drive C are expandable?

8. How do you expand and collapse directories/folders?

9. Click View and select Details, what happened?

10. Put a disk in drive A and select drive A. How many directories/folders and files are at the root of drive A?

11. Select drive C again and open the DOS folder. How can you sort the file list by name, type, size, or date?

12. Exit Explorer. How did you do this?
13. How do you run an application package, such as WordPerfect, from Windows 95?
Introduction to Using Networks

1. Locate the file server? Where is it?

2. What type of NOS is being used in this lab?

3. How do you login to the file server? What is the purpose of this?

4. Can you send an e-mail message in this lab? If so, what steps must be taken to do this?

5. What type of “sharing” can be done?

6. How can the directory structure of the file server be viewed?

7.Logout of the network. What is the purpose of this?
Objective(s):

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

a. Explain what RAM is;
b. Explain what ROM is;
c. Explain memory caching;
d. Define and convert bytes, kilobytes, and megabytes;
e. Discuss the function of a central processing unit;
f. Discuss processor speed; and,
g. Understand RS-232 protocol.

Module Outline:

I. Explain What Memory Is
   A. RAM
   B. ROM
   C. Cache memory
   D. Measuring memory
      1. Byte
      2. Kilobyte
      3. Megabyte

II. Discuss Purpose and Function Of:
    A. Central Processing Units (CPUs)
    B. Processor performance
       1. Speed
       2. Generation
       3. Type
    C. RS-232 serial port

III. Determine the Amount of Available Memory on a System
    A. Choose About from the Help menu in Program Manager for Windows 3.1
    B. Choose About from the Help menu in Windows Explorer for Windows 95
Upon completion of this unit the student will be able to:

a. Explain file management concepts;
b. Create and delete directories/folders;
c. Copy a file(s) from one directory to another;
d. Copy a file(s) between a floppy disk and a hard drive;
e. Rename, move, and delete a file(s); and,
f. Format disks and make system disks.

Module Outline:

I. Explain and Discuss File Management Concepts
   A. Copying a file(s)
   B. Deleting a file(s)
   C. Moving a file(s)
   D. Renaming a file(s)
   E. Creating a directory
   F. Deleting a directory
   G. Copying a disk
   H. Formatting a disk
   I. Making a system disk

II. Use File Manager in Windows 3.1 to Perform File Management Operations
   A. Use the file menu to:
      1. Create a directory
         a. On the hard drive
         b. On a floppy disk
      2. Copy a file(s)
         a. From one directory to another
         b. From a floppy disk to the hard drive
         c. From the hard drive to a floppy disk
      3. Move a file(s)
      4. Rename a file(s)
      5. Delete a file(s)
      6. Delete a directory
   B. Use the disk menu to:
      1. Copy a disk
      2. Format a disk
      3. Make a system disk

III. Use Windows 95 to Perform File Management Operations
A. Use the file menu in Windows Explorer to:
   1. Create a new folder on the hard drive
   2. Create a new folder on the floppy drive

B. Use the edit menu in Windows Explorer to:
   1. Copy a file(s) from one directory to another
   2. Copy a file(s) from a floppy disk to the hard drive
   3. Copy a file(s) from the hard drive to a floppy disk
   4. Cut a file(s)
   5. Paste a file(s)

C. Use the file menu in Windows Explorer to:
   1. Rename a file(s)
   2. Delete a file(s)
   3. Delete a folder

D. Use My Computer on the Windows 95 desktop to:
   1. Format a disk
   2. Make a system disk
Using Windows 3.1 to Perform File Management Operations

*** A DATA DISK WILL BE NEEDED TO COMPLETE THESE EXERCISES. ***

1. Open the Main window and start File Manager.

2. Maximize the directory tree window.

3. View the contents of drive A and create a directory called RAINBOW.

4. View the contents of the hard drive by selecting the root icon for drive C.

5. Expand the directory named WINDOWS and view the files in the SYSTEM subdirectory.

6. Sort the files in SYSTEM by size and select the four smallest files.

7. Copy these files to the RAINBOW directory on drive A.

8. Check to see that these four files are still in the SYSTEM subdirectory. Now, view the contents of the RAINBOW directory on drive A to make sure the files were copied.

9. Rename each of the files under RAINBOW on drive A as Red, Blue, Green, and Yellow.

10. Create another directory on drive A named COLORS.

11. Move the files Red and Green from RAINBOW to COLORS.

12. Check to see that RAINBOW now contains only the files named Blue and Yellow.

13. Check to see that COLORS contains two files named Red and Green.

14. Delete the Yellow file in the RAINBOW directory.

15. Delete the RAINBOW directory.
16. Create a directory on the hard drive named your first name.

17. Copy the files on the disk in drive A to the directory on the hard drive with your name.

18. Format your data disk and then view its contents.

19. Make a system disk with your data disk. Use this system disk to restart the computer.
Using Windows 95 to Perform File Management Operations

*** A DATA DISK WILL BE NEEDED TO COMPLETE THESE EXERCISES. ***

1. Click START and choose Windows Explorer under Programs.
2. Maximize this window.
3. View the contents of your data disk in drive A and create a folder named SAMPLE on your data disk.
4. View the contents of the hard drive by selecting the root icon for drive C.
5. Expand the WINDOWS folder and view the files in the HELP subdirectory.
6. View the details of the files and arrange the files by size.
7. Select the four smallest files and copy them to the SAMPLE folder on drive A.
8. Check to see that these four files are still in the HELP folder on the hard drive. Now, view the contents of the SAMPLE folder on drive A to make sure the files were copied.
10. Create another folder on drive A named EXERCISE.
11. Move the files File1 and File3 under SAMPLE to the folder named EXERCISE.
12. Check to see that SAMPLE now contains the files named File2 and File4.
13. Check to see that EXERCISE contains File1 and File3.
14. Delete File2 in SAMPLE.
15. Delete the folder SAMPLE.

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16. Create a folder on the hard drive named PRACTICE.
17. Copy the files on the disk in drive A to the PRACTICE folder on the hard drive.
18. Format your data disk. Does it still contain your files?
19. Make your data disk a system disk. Explain the value of having a system disk.
Objectives:

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

a. Install a software package to a hard disk;
b. Configure the system parameters upon installation;
c. Create a word processing document;
d. Create a spreadsheet; and,
e. Open, edit, enhance, save, and print word processing and spreadsheet files.

Module Outline:

I. Explain How to Install Software Packages Using Windows 3.1
   A. Install from a CD-ROM
   B. Install from diskettes
II. Explain How to Install Software Packages Using Windows 95
    A. Install from a CD-ROM
    B. Install from diskettes
III. Explain How to Configure System Parameters for a Software Package
     A. Modification to AUTOEXEC.BAT and CONFIG.SYS
     B. Modification of INI files (e.g. WIN.INI, SYSTEM.INI)
     C. Plotter/printer driver configurations
     D. Digitizer pad/mouse driver configurations
IV. Use a Word Processor Software Package (e.g. WordPerfect, MS Word)
    A. Typing a document
    B. Using cursor movement keys
    C. Editing a document with backspace and delete
    D. Using the spelling checker
    E. Saving a file
    F. Printing a file
    G. Closing a file
    H. Opening a file
    I. Changing the margins
    J. Using bold, italics, and underline
    K. Changing alignment
V. Use a Spreadsheet Software Package (e.g. Lotus 123, MS Excel)
   A. Entering values and labels
   B. Editing the spreadsheet
   C. Using formulas and functions
   D. Changing column widths
E. Changing number format
F. Changing alignment
G. Copying formulas and functions
H. Printing the spreadsheet
I. Saving the spreadsheet and chart
Creating a Word Processing Document

I. Creating Documents

A. Key the following document in a word processing software package.

   The Vernier Caliper
   The basic parts of a vernier caliper are a main scale which is similar to a steel rule with a fixed jaw and a sliding jaw with a vernier scale. They are available in a wide range of lengths with different types of jaws and scale graduations.

B. Check your spelling.

C. Save the document on your data disk as CALIPERS and print.

D. Close the document.

E. Create another new document and enter the text below.

   Micrometers
   Micrometers are basic measuring instruments used by technicians in the processing and checking of parts. They are available in a wide range of sizes and types.

   Outside micrometers are used to measure dimensions between parallel surfaces of parts and outside diameters of cylinders. Other types, such as depth micrometers, screw thread micrometers, disc and blade micrometers, and inside micrometers, also have wide application in the machine shop.

F. Boldface and italicize the title.

G. Change the top margin to 2.8 inches and check the spelling.

H. Save the document on your data disk under the name MICS and print.

I. Close the document.
II. Opening Documents and Editing

A. Open the document CALIPERS.

B. Insert Decimal-Inch in the title between “The” and “Vernier”, so the title will read The Decimal-Inch Vernier Caliper. Also, boldface the title.

C. Insert the following text as the second sentence.

The vernier scale slides parallel to the main scale and provides a degree of precision to 0.001”.

D. In the last sentence, change “They” to “Calipers”.

E. Change the top margin to 2.7 inches and check your spelling.

F. Save under the same name and print.

G. Open the document MICS.

H. Make the two paragraphs one.

I. Save the document under the same name and print.
Creating a Spreadsheet

I. Create a Spreadsheet, Change Column Widths, and Alignment

A. Enter the following labels as shown below to create a spreadsheet. Change the column width as necessary.

<table>
<thead>
<tr>
<th>Diametral Pitch</th>
<th>Number of Teeth</th>
<th>Pitch Diameter (inches)</th>
<th>Addendum (inches)</th>
<th>Dedendum (inches)</th>
</tr>
</thead>
</table>

B. Center the labels in the cells.

C. In the Diametral Pitch column enter the following values: 4, 6, 8, and 3.

D. In the Number of Teeth column enter the following values: 45, 75, 44, and 54.

E. Save the spreadsheet to your data disk as BEVEL and print.

F. Open a new document and enter the following information below. Change the column widths as necessary.

<table>
<thead>
<tr>
<th>Name</th>
<th>Rate</th>
<th>Hours</th>
<th>Gross Pay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natalie Nicholson</td>
<td>6.80</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Dave Miller</td>
<td>8.60</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Karen Lark</td>
<td>8.60</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Taylor Smithsonian</td>
<td>5.50</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

G. Center the values in the Hours column.

H. Set the number format in the Rate column to show two decimal places and the number format in the Hours column to show zero decimal places.

I. Save the spreadsheet to your data disk as PAYROLL and print.

II. Create and Copy Formulas/functions and Edit the Spreadsheet
A. Place BEVEL back on your desktop.

B. Enter the following formulas in the appropriate cell and copy to other cells where the formula is needed.

- Pitch Diameter = Number of Teeth / Diametral Pitch
- Dedendum = 1.157 / Diametral Pitch
- Addendum = 1 / Diametral Pitch

C. Save under the same name and print.

D. Change the Diametral Pitch in the first cell from 4 to 5.

E. Change the Number of Teeth in the last cell from 54 to 50

F. Add a Diametral Pitch of 10 with the Number of Teeth given as 80.

G. Copy the formulas to the new row.

H. Save and print.

I. Place PAYROLL back on the desktop and enter the formula to compute the Gross Pay. (Gross Pay = Rate * Hours)

J. Format the Gross Pay as currency.

K. Add the Hours column.

L. Change Dave Miller's rate of pay to $9.00.

M. Save and print.
TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1 Follow safety manuals and all safety regulations/requirements</td>
<td>A-2 Maintain equipment and machinery</td>
</tr>
<tr>
<td>A-3 Use safe operating procedures for hand and machine tools</td>
<td>A-4 Maintain a clean and safe work environment</td>
</tr>
<tr>
<td>A-5 Use material handling practices</td>
<td>A-6 Consult and apply MSDS for hazards of various materials</td>
</tr>
<tr>
<td>B-1 Perform basic arithmetic functions</td>
<td>B-2 Perform basic geometric operations</td>
</tr>
<tr>
<td>B-3 Use basic algebraic principles</td>
<td>B-4 Perform trigonometric functions</td>
</tr>
<tr>
<td>B-5 Use and apply Cartesian Coordinate System</td>
<td>B-6 Use and apply various materials</td>
</tr>
<tr>
<td>C-1 Interpret and understand basic layout types of drawings</td>
<td>C-2 Interpret, review, and apply blueprints, notes, dimensions, and tolerances</td>
</tr>
<tr>
<td>C-3 Use and apply geometric dimensioning and tolerancing (GD&amp;T)</td>
<td>C-4 Demonstrate traditional mechanical drafting and sketching techniques</td>
</tr>
<tr>
<td>C-5 Understand and use quality systems</td>
<td>C-6 Perform CA and CNC Programming</td>
</tr>
<tr>
<td>C-7 Demonstrate the ability to use various tools, dies, and fixtures</td>
<td></td>
</tr>
<tr>
<td>D-1 Identify materials with desired properties</td>
<td>D-2 Identify materials and processes to produce a part</td>
</tr>
<tr>
<td>D-3 Discuss classification systems for metal</td>
<td>D-4 Identify materials and processes to produce a part</td>
</tr>
<tr>
<td>D-5 Use safe operating procedures for hand and machine tools</td>
<td>D-6 Use safe material handling practices</td>
</tr>
<tr>
<td>D-7 Use safe operating procedures for hand and machine tools</td>
<td>D-8 Consult and apply MSDS for hazards of various materials</td>
</tr>
<tr>
<td>E-1 Understand standard terminology</td>
<td>E-2 Select measurement tools</td>
</tr>
<tr>
<td>E-3 Measure with hand held instruments</td>
<td>E-4 Eliminate measurement variables</td>
</tr>
<tr>
<td>E-5 Measure using surface plate and accessories</td>
<td>E-6 Inspect using stationary equipment</td>
</tr>
<tr>
<td>E-7 Use and apply various materials</td>
<td></td>
</tr>
<tr>
<td>F-1 Discuss metal cutting and metal cutting tools</td>
<td>F-2 Operate metal shears</td>
</tr>
<tr>
<td>F-3 Operate drills, presses and tooling</td>
<td>F-4 Operate engine and turret lathes and tooling</td>
</tr>
<tr>
<td>F-5 Operate vertical and horizontal mills and tooling</td>
<td>F-6 Operate precision grinders</td>
</tr>
<tr>
<td>F-7 Operate heat treating equipment and processes</td>
<td>F-8 Operate sheet metal equipment</td>
</tr>
<tr>
<td>F-9 Operate welding equipment and processes</td>
<td>F-10 Estimate time required/cost to produce a part</td>
</tr>
<tr>
<td>G-1 Use computer operating systems</td>
<td>G-2 Understand computer terminology</td>
</tr>
<tr>
<td>G-3 Use file management systems</td>
<td>G-4 Install and use software packages</td>
</tr>
<tr>
<td>H-1 Discuss fundamentals of CNC machines and controls</td>
<td>H-2 Program and operate CNC milling machine and machining center</td>
</tr>
<tr>
<td>H-3 Program and operate CNC lathe</td>
<td>H-4 Use Computer-Aided Drilling (CAD) system</td>
</tr>
<tr>
<td>H-5 Create 3-D solid models</td>
<td>H-6 Use Computer-Aided Manufacturing (CAM) system</td>
</tr>
<tr>
<td>I-1 Discuss basic types and functions of jigs and fixtures</td>
<td>I-2 Utilize basic principles of jig and fixture design</td>
</tr>
<tr>
<td>I-3 Demonstrate understanding of different types of industrial dies</td>
<td>I-4 Utilize basic die theory</td>
</tr>
<tr>
<td>I-5 Utilize principles of die design</td>
<td>I-6 Perform tool and die repair</td>
</tr>
<tr>
<td>I-7 Demonstrate tool and die making skills</td>
<td>J-1 Discuss fundamentals of EDM</td>
</tr>
<tr>
<td>J-2 Setup and operate conventional EDM and EDM drill</td>
<td>J-3 Program, setup, and operate CNC EDM and EDM drill</td>
</tr>
<tr>
<td>J-4 Program, setup, and operate CNC EDM and EDM drill</td>
<td></td>
</tr>
</tbody>
</table>
TLD-H1-HO
Discuss Fundamentals of CNC Machines and Controls
Attachment 1: MASTER Handout

Objectives:

Upon completion of this module the student will be able to:
a. Identify and describe essentials and safety of CNC systems;
b. Identify and describe types of CNC hardware and software;
c. Identify and describe machine axes and coordinate systems; and,
d. Identify and describe coordinate systems.

Module Outline:

I. Identify and Describe Essentials and Safety of CNC Systems
   A. Identify and explain essentials
      1. Define numerical control
      2. Explain history and future of CNC technology
      3. Identify basic elements of CNC system
      4. Define Computer Numerical Control (CNC)
      5. Explain advantages and limitations of CNC
      6. Identify applications of CNC technology
   B. Compare types of CNC systems
      1. Identify and describe modes on numerical control systems
      2. Explain difference between the following:
         a. Point-to-point
         b. Axial path
         c. 45° line type
         d. Linear path
         e. Continuous path
      3. Describe CNC interpolation
      4. Identify types of CNC interpolations
      5. Explain difference between open loop and closed loop systems
      6. List benefits and problems of open and closed loop systems
   C. Demonstrate safety practices related to CNC systems
      1. Demonstrate safety practices, including:
         a. Safety guard/door interlocks
         b. Power box interlocks
         c. Tool loading and unloading
         d. Loading and unloading work holding devices
         e. Machine coolant disposal
      2. Describe/identify personal safety equipment

II. Identify and Describe Types of CNC Hardware and Software
   A. Identify and describe CNC hardware
1. Compare NC and CNC systems
2. Identify components of CNC machine control unit (MCU)
3. Define applications of operator control panel
4. Explain functions of operator control panel
5. Define utilities found on typical control panel
6. Select appropriate CNC controls

B. Describe CNC software
   1. Describe software related to machine tool
   2. Describe applications of operation, interface and application software
   3. Describe interface of software and hardware

C. Explain feed back drive system
   1. Describe feed drive system
   2. Explain feed back mechanisms
   3. Compare direct and indirect measurement systems

III. Identify and Describe Machine Axes and Coordinate Systems
A. Identify and describe machine axes
   1. Define and identify machine axes X, Y and Z
   2. Identify and describe linear axes using right hand rule
   3. Identify and define primary rotary axes A, B and C

B. Describe coordinate systems
   1. Describe Cartesian coordinate system as used in NC program
   2. Define relationship of Cartesian coordinate system with machine axes

C. Define characteristics of positioning systems
   1. Define application of absolute positioning systems
   2. Define application of incremental positioning systems

D. Define reference systems
   1. Describe characteristics of:
      a. Machine reference coordinates
      b. Work reference coordinates
      c. Program reference coordinates
      d. Fixtures offset coordinates

IV. Describe and Interpret CNC Coding Systems
A. Interpret number bases
   1. Interpret decimal and binary bases
   2. Interpret octal and hexadecimal bases

B. Describe NC program storage media
   1. Describe the media
   2. Describe advantages and disadvantages of each media

C. Describe EIA and ASCII formatted tapes
   1. Describe EIA format on tapes
   2. Describe ASCII format on tapes
   3. Describe differences in EIA and ASCII formats
TLD-H2-HO
Program and Operate CNC Milling Machine and Machining Center
Attachment 1: MASTER Handout

Objectives:

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

a. Describe history of vertical machining;
b. Describe theory of operation;
c. Describe nomenclature used in vertical machining;
d. Demonstrate safety practices related to vertical machining centers;
e. Set-up and program operation of vertical machine;
f. Demonstrate proper machining of objects;
g. Create program using machine controllers software, and cycles;
h. Set-up and utilize three dimensional digitizer; and,
i. Maintain vertical machine.

Module Outline:

I. Describe Vertical Machining Process and Safety
   A. Describe History of Vertical Machining
      1. Describe proper use of various machines
   B. Describe Theory of Operation
      1. Describe open and closed loop systems
      2. Describe various oil and air requirements
      3. Describe how vertical machines function
   C. Describe Nomenclature Used in Vertical Machining
      1. Describe common tools used to:
         a. Mill
         b. Single point thread
         c. Drill
         d. Single point bore
         e. Tap
         f. Reaming
         2. Describe solid and collet type tool holders
   D. Demonstrate Safety Practices Related to Vertical Machining Centers
      1. Demonstrate operating safety practices, including:
         a. Safety door interlocks
         b. Machining vise loading and unloading
         c. Power box interlocks
         d. Machine coolant disposal
         e. Tool loading and unloading
      2. Describe/identify personal safety equipment

II. Describe Vertical Machining Functions
A. Describe Controller Functions, including:
   1. Power meter
   2. Automatic mode
   3. Key lock
   4. Emergency stop button
   5. Option switches
   6. Manual modes:
      a. Command mode
      b. MDI mode
   7. Rapid travel over ride
   8. Single step mode (Block-To-Block)
   9. Feed rate override
   10. Jog mode
   11. Spindle speed override
   12. Spindle On/Off
   13. Axis selector
   14. Slide hold
   15. Increment of movement selector
   16. Coolant 1 and 2 On/Off
   17. Tool In/Out
   18. Start button
   19. Turret clockwise (CW) and turret counterclockwise (CCW)
   20. Start function

III. Set-Up and Program Operation of Vertical Machine
A. Describe machine tool limitations, including:
   1. Number of possible tools
   2. Limits in X, Y, and Z axes
   3. Maximum spindle speed and horsepower
   4. Memory size in controller
   5. Fast feed rate
   6. Oil and air requirements
   7. Rapid positioning rate
   8. Communication systems

B. Perform basic machine set-up
   1. Check oil and air supply
   2. Set tool changer numbers
   3. Turn power on
   4. Mount machine vise on machine table
   5. Set machine home position
   6. Indicate vise to within specified tolerances
   7. Load tools into proper tool holders
   8. Load part into vise
   9. Load tools into tool carousel
      a. Load tools using spindle
      b. Load tools directly into carousel
C. Set part home
   1. Set part home using edge finder
   2. Set part home using test indicator and gauge block
   3. Set part home from tooling ball using fixture offsets

D. Set tool length offsets
   1. Set tool length offsets using work piece
   2. Set tool length offsets using gauge block
   3. Set tool length offsets using electronic probe
   4. Set tool length offsets using keyboard commands
   5. Modify length and diameter offsets using tool page editor.
   6. Upload and download tool information to storage

E. Load program
   1. Upload and download programs using RS-232 interface
   2. Upload and download programs using local area network

F. Edit program for machine tool
   1. Edit program at machine tool using editor in controller
   2. Edit program using DOS and Windows editors

G. Create program without CAD/CAM for common machine operations
   using machine controllers software to include:
   1. Proper use of cutter compensation
   2. Fixed cycles
   3. Fixed sub-routines
   4. Sub-routines (loops)
   5. Fixture offsets
   6. Trouble shoot and repair problems in programs
   7. Use machine verification options if available

IV. Demonstrate Machining of Objects on Vertical Machining Center
A. Machine objects, including:
   1. Outside contours
   2. Pockets
   3. Drilled holes
   4. Drill and tapped holes
      a. Rigid tapping
      b. Compression tapping
   5. Single point boring
   6. Reaming
   7. Single point thread, internal and external

B. Set-up three dimensional digitizer and machine model
   1. Mount model on machine table
   2. Install 3-dimensional digitizing unit
   3. Establish communications with computer
   4. Define grid pattern and feed rate required for given tolerances
   5. Set part home
   6. Digitize model
   7. Process digital data for machining
8. Machine new model with program created from digitizer

C. Create work piece using 4th- and 5th-axes
   1. Mount, connect and indicate 4th- and 5th-axes attachment
   2. Set-tooling
   3. Machine work piece
   4. Remove 4th- and 5th-axes attachment

D. Maintain vertical machine
   1. Mix coolant
   2. Determine need for coolant change
   3. Change coolant
   4. Clean coolant tank
   5. Clean machine
   6. Change oil filters
   7. Add lubricating fluid
   8. Add hydraulic fluid
   9. Dispose of coolant and oils per EPA regulations
Note to the Instructor:

Because of the wide variety of CNC machining centers and CNC mills available, student laboratory and assessment activities must be developed by the instructor for his or her particular laboratory equipment. All laboratory exercises and student assessments should be "hands on" which stress machine safety and assess the student's mastery of each of the lesson objectives.
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-H3-HO
Program and Operate CNC Lathe
Attachment 1: MASTER Handout

Objectives:

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

a. Describe history of horizontal turning centers;
b. Describe theory of operation;
c. Describe nomenclature used in horizontal turning centers;
d. Demonstrate safety practices related to horizontal turning centers;
e. Set-up and program operation of horizontal turning centers;
f. Demonstrate proper machining of objects;
g. Create program using machine controllers software; and,
h. Maintain horizontal turning centers.

Module Outline:

I. Explain CNC Turning Process, Equipment and Safety
   A. Describe CNC turning process
      1. Describe history of CNC turning
      2. Describe use of various turning machines
   B. Describe theory of operation
      1. Describe open and closed loop systems
      2. Describe various oil and air requirements
      3. Describe how turning centers function
   C. Describe nomenclature used in CNC turning
      1. Describe and identify common tools used to:
         a. Turn
         b. Drill
         c. Groove
         d. Face
         e. Bore
         f. Single point thread
         g. Tap
         2. Describe and identify work holding devices used in turning, including:
            a. 2-jaw chucks
            b. 3-jaw chuck
            c. 4-jaw chucks
            d. Soft jaw chucks
            e. Bar feed attachments
            f. Collets
            g. Centers
3. Select proper cutting inserts relative to:
   a. Roughing
   b. Finishing
   c. Threading
   d. Different types of materials

D. Demonstrate safety practices related to CNC turning centers
   1. Demonstrate operating safety practices, including:
      a. Safety door interlocks
      b. Power box interlocks
      c. Tool loading and unloading
      d. Loading and unloading work holding devices
      e. Machine coolant disposal
   2. Describe/identify personal safety equipment

II. Describe CNC Turning Center
   A. Describe controller functions, including:
      1. Power meter
      2. Option switches
      3. Key lock
      4. Emergency stop button
      5. Rapid travel override
      6. Feed rate override
      7. Spindle speed override
      8. Axis selector
      9. Increment of movement selector
      10. Slide hold
      11. Start function

   B. Describe keyboard functions, including:
      1. Automatic mode
      2. Manual MDI mode
      3. Single step mode (block-to-block)
      4. Jog mode
      5. Spindle on/off
      6. Coolant on/off
      7. Tool turret clockwise (CW) and tool turret counterclockwise (CCW)

III. Set-Up and Program Operation of CNC Turning Center
   A. Describe machine tool limitations, including:
      1. Number of possible tools
      2. Maximum spindle speed and horsepower
      3. Fast feed rate
      4. Rapid positioning rate
      5. Limits in X and Z axes
      6. Memory size in controller
      7. Oil and air requirements
      8. Communication systems
B. Perform basic machine set-up
   1. Check oil and air supply
   2. Turn power on
   3. Set machine home position
   4. Load tools into proper tool holders
   5. Load tools into tool carousel
   6. Set tool changer numbers
   7. Mount work piece into chuck
   8. Indicate work piece within specified tolerances

C. Set tool length offsets
   1. Set tool length offsets using work piece
   2. Set tool length offsets using keyboard commands
   3. Modify length and diameter offsets using tool page editor
   4. Modify length and diameter offsets using keyboard
   5. Upload and download tool information to storage

D. Load program
   1. Upload and download programs using RS-232 interface
   2. Upload and download programs using local area network

E. Edit program for machine tool
   1. Edit program at machine tool using editor in controller
   2. Edit program using DOS and Windows editors

IV. Create Program Without CAD/CAM for Common Machine Operations Using Machine Controllers Software to include:
   A. Proper use of cutter compensation
   B. Fixed cycles
   C. Fixed sub-routines
   D. Sub-routines (loops)
   E. Fixture offsets
   F. Trouble shoot and repair problems in programs
   G. Use machine verification options if available

V. Create Program for Common Machine Operations
   A. Use machine controller editor
   B. Use DOS editor
   C. Use Windows editor

VI. Demonstrate Machining of Objects on CNC Turning Center
   A. Machine objects, including:
      1. External and internal contouring
      2. External and internal grooving
      3. Drill and tapped holes
      4. Single point boring
      5. Reaming
      6. Single point thread internal and external
      7. Facing operations
      8. Turning tapers
   B. Maintain turning center
1. Mix coolant
2. Determine need for coolant change
3. Change coolant
4. Clean coolant tank
5. Clean machine
6. Change oil filters
7. Add lubricating fluid
8. Add hydraulic fluid
9. Dispose of coolant and oils per EPA regulations
Note to the Instructor:

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   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Objective(s):

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

a. Create geometry using CAD system;
b. Create 3-D solid models;
c. Interconvert CAD and accepted drawing exchange formats;
d. Configure CAD system parameters; and,
e. Use peripheral devices.

Module Outline:

I. Identify System Requirements
   A. Hardware present and available
   B. Software present and available
   C. Equipment currently available
      1. Monitors
      2. CPU
      3. Keyboards
      4. Mouse
   D. Peripheral devices available
      1. Printer
      2. Plotters
      3. LCD
      4. Digitizer

II. Access and Maneuver Within CAD System
   A. Use basic DOS commands
      1. Copy
      2. Move
      3. Delete
      4. List files
      5. Make directory
      6. Change directory
      7. Root directory
   B. Initiate graphics editor
      1. Open existing files
      2. Creating new files
      3. Save/Save As files
      4. Q Saves files
      5. Quitting a graphic session
      6. Ending a graphic session
C. Use various disk drives
D. Use command line
E. Use graphics area
F. Use graphics cursor
G. Use screen menus and submenus
H. Use status and coordinate display line
I. Use pull-down menus
J. Use cursor menu
K. Use keyboard
   1. Control keys
   2. Function keys
   3. Special keys
   4. Arrow keys
   5. Numeric value keys

III. Create Geometry Using CAD System
A. Use utility and services commands
   1. Help
   2. New
   3. Open
   4. Save
   5. Exit
   6. Config
   7. About
   8. Status
   9. Limits
  10. Units
  11. Tablet
  12. Reinit
  13. Menu
  14. Compile
  15. Files
  16. Audit
  17. Recover
  18. Multiple
  19. Time
  20. Setvar
B. Use the entity draw commands
   1. Line
   2. Point
   3. Circle
   4. Arc
   5. Trace
   6. Pline
   7. Polygon
   8. Doughnut
9. Ellipse
10. Sketch
11. Solid
12. Text
13. D text
14. Style

C. Use the edit and inquiry commands
1. Grips
2. Erase
3. Copy
4. Move
5. Rotate
6. Scale
7. Mirror
8. Stretch
9. Array
10. Change
11. Pedit
12. Break
13. Trim
14. Extend
15. Fillet
16. Chamfer
17. Offset
18. Divide
19. Measure
20. Pedit
21. Explode
22. U/undo
23. Redo
24. List
25. Dblist
26. 10
27. Dist
28. Area

D. Use the display control commands
1. Model space
2. Paper space
3. Viewports
4. Regeneration
5. Redraw
6. Zoom
7. Pan
8. View
9. Mview
10. Redraw all
11. Regen all
12. Fill Qtext
13. RegenAuto
14. Dragmode
15. Blipmode
16. Viewers

E. Use the entity properties commands
1. Layer
2. DDLmodes
3. DDEmodes
4. Color
5. Linetype
6. LtScale

F. Use the drawing aids commands
1. DDRmodes
2. Snap
3. Grid
4. Ortho
5. UCS
6. DDUCS
7. Ulsicon
8. Object snap
9. DDOsnap
10. Osnap
11. Aperture

G. Use the blocks and attributes commands
1. Block
2. DDinsert
3. Insert
4. Minsert
5. Wblock
6. Attributes
7. DDATTDEF
8. ATTDEF
9. ATTDISP
10. ATTEDIT
11. DDATTE
12. DDATTEXT
13. ATTEXT

H. Use the cross-section and pattern filling commands
1. BHATCH
2. HATCH
3. BPOLY
4. Hatching system variables
IV. Dimensioning Geometry Using CAD System
A. DIM and DIM I
B. Associative dimensioning
   1. Terms
   2. Variables
   3. Styles
   4. Points
   5. Model/Paper space
C. Dimension styles
   1. Override
   2. Restore
   3. Save
   4. Variables
   5. Stylenames
D. Dimension variables
   1. Style
   2. Scaling
   3. Color
   4. Dimension line
   5. Extension line
   6. Arrows
   7. Text location
   8. Text format
   9. Features
   10. Colors
E. Dimensioning geometry commands
   1. Linear
   2. Angular
   3. Diameter
   4. Radius
   5. Center marks and lines
   6. Ordinate
F. Dimension editing
   1. Home text
   2. New text
   3. Oblique
   4. TEDIT
   5. Trotate
   6. Update
G. Dimension utility
   1. Exit
   2. Leader
   3. Redraw
   4. Status
   5. Styles
6. Undo

V. Use Peripheral Devices
   A. Printers
   B. Plotters
      1. CMDDIM system variable
      2. Plot
         a. Devices and defaults
         b. Pen parameters
         c. Additional parameters
         d. Paper size and orientation
         e. Scale
         f. Rotation
         g. Origin
         h. Plot preview
   C. Liquid crystal displays
   D. Overhead projectors
   E. Digitizer tablets

VI. Interconvert CAD and Accepted Drawing Exchange Formats
   A. Post Script Support
      1. PSOUT
      2. PSIN
      3. PSFILL
   B. Slide shows
      1. MSLIDE
      2. VSLIDE
      3. Filmroll
   C. Drawing interchange file (ASCII or Binary)
      1. DXFIIN
      2. DXFOUT
      3. DXBIN
   D. Initial graphic exchange specification
      1. IGESIN
      2. IGESOUT
TLD-H5-HO
Create 3-D Solid Models
Attachment 1: MASTER Handout

Objective(s):

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

a. Access and maneuver within a CAD system;
b. Create 3-D solid geometry models;
c. Dimension 3-D geometry;
d. Display commands to generate prototype borders;
e. Display commands to control drawing representation on the screen;
f. Display commands used to generate and manipulate viewports;
g. Setting commands to assist with 3-D geometry;
h. Layer commands to place entities into specified layer options;
i. Use isometric geometry commands;
j. Use 3-D surface and object commands;
k. Use utility to manage files;
l. Use utility commands to generate slides, script files, and access external commands of the system;
m. Use keyboard to manipulate function keys, special keys, control, and special character keys;
n. Use presentation graphics and rendering commands;
o. Use solid commands to generate 3-D solid model geometry;
p. Use 3-D solid modifiers commands;
q. Use solid 3-D inquiry commands;
r. Use solid 3-D representation commands;
s. Use solid 3-D utility commands;
t. Use LISP programs to generate 3-D solid model geometry;
u. Use Application Programming Interface (API) functions;
v. Use bonus 3-D solid feature commands; and,
w. Use CAD system to digitize paper drawings.

Module Outline:

I. Access and Maneuver Within a CAD System
   A. Use Disk Operating System commands
   B. Use the initial graphics editor within a CAD system

II. Create 3-D Solid Geometry Models
   A. Use the blocks and attributed commands
      1. Block
      2. Insert
      3. DDInsert
      4. MInset
III. Dimension 3-D Geometry

A. Dim and Dim1

B. Associative dimensioning drawing commands
   1. Linear
   2. Angular
   3. Diameter
   4. Radius
   5. Ordinate
   6. Aligned
   7. Baseline
   8. Center
   9. Continue
   10. Vertical
   11. Horizontal
   12. Rotated

C. Dimension style command
   1. Override
   2. Restore
   3. Save
   4. Variable
   5. Style name

D. Dimension editing commands
   1. Hometext
   2. Newtext
   3. Oblique
   4. Tedit
   5. Trotate
   6. Update

E. Dimension utility commands
   1. Exit
   2. Leader
   3. Redraw
   4. Status
   5. Style
   6. Undo
F. Dimension variable commands
1. DIMALT
2. DIMALTD
3. DIMALTF
4. DIMAPPOST
5. DIMASO
6. DIMAZ
7. DIMBLK
8. DIMCEN
9. DIMCLRD
10. DIMCLRE
11. DIMCLRT
12. DIMDLE
13. DIMDLI
14. DIMEXE
15. DIMEXO
16. DIMGAP
17. DIMALFAC
18. DIMLIM
19. DIMPOST
20. DIMRND
21. DIMSAH
22. DIMSCALE
23. DIMSE1
24. DIMSE2
25. DIMSHO
26. DIMITAD
27. DIMITFAC
28. DIMITI
29. DIMITIX
30. DIMITM
31. DIMITOF
32. DIMITOH
33. DIMITOL
34. DIMITP
35. DIMITSZ
36. DIMITVP
37. DIMITXT
38. DIMITLN

IV. Display Commands to Generate Prototype Borders
A. View
B. Layout
C. MVSetup

V. Display Commands to Control Drawing Representation on the Screen
A. View
B. DView
C. DView Slide Bar
D. Plan
E. Vpoint
F. Shade
G. Zoom
H. Redraw
I. Pan
J. Hide
K. Viewports
L. REGEN
M. REDRAWALL
N. REGENALL
O. REGENAUTO
P. VIEWERS
Q. FILL

VI. Display Commands Used to Generate and Manipulate Viewports
A. MView
B. On
C. Off
D. HidePlot
E. Fit
F. MView
G. MSpace
H. PSpace
I. TileMode
J. VPlayer

VII. Setting Commands to Assist With 3-D Geometry
A. DDEMODES
B. DDRMODES
C. APERTURE
D. AXIS
E. BLIPS
F. COLOR
G. DRAGMODE
H. ELEVATION
I. GRID
J. LINETYPE
K. LIMITS
L. LTSCALE
M. OSNAP
N. QTEXT
O. SETVARIABLE
P. SNAP
Q. STYLE
R. TABLET
S. UCS
T. UCSICON
U. DDUCS
V. DDOSNAP
W. GRIPS
X. DDGRIPS
Y. UNITS

VIII. Layer Commands to Place Entities into Specified Layer Options
A. New layer
B. Current layer
C. Rename
D. On and off
E. Freeze and thaw
F. Lock and unlock
G. Set color
H. Set linetype
I. Filters
J. DDLMODES

IX. Use Isometric Geometry Commands
A. Snap
B. Style
C. Isometric
D. Ellipse
E. Isometric circle

X. Use 3-D Surface and Object Commands
A. 3-D surface
   1. Edgesurf
   2. Rulesurf
   3. RevSurf
   4. TabSurf
   5. SurfTab1
   6. SurfTab2
   7. PEdit
   8. 3-DFace
   9. 3-DMesh
  10. PFace
  11. 3-DPoly

B. 3-D objects
   1. 3-D box
   2. Pyramid
   3. Wedge
   4. Dome
   5. Sphere
   6. Cone
7. Torus
8. Dish
9. Mesh

XI. Use Utility to Manage Files
A. Audit
B. DXF/DFB
C. DXFIN
D. DXFOUT
E. DXBIN
F. IGES
G. IGESIN
H. IGESOUT
I. PURGE

XII. Use Utility Commands to Generate Slides, Script Files, and Access External Commands of the System
A. Slide files
   1. MSlide
   2. VSlide
   3. Redraw
B. Script files
   1. Script
   2. RScript
   3. Resume
   4. Delay
   5. Graphscr
   6. Textscr
C. External commands
   1. Delete
   2. Directory
   3. Edit
   4. Type
   5. Shell

XIII. Use Keyboard to Manipulate Function Keys, Special Keys, Control, and Special Character Keys
A. Function keys
   1. F1
   2. F6
   3. F7
   4. F8
   5. F9
   6. F10
B. Special keys
   1. Ctrl "C"
   2. Ctrl "B"
   3. Ctrl "Q"
4. Ctrl “G”
5. Ctrl “D”
6. Ctrl “E”
7. Ctrl “T”
8. Ctrl “V”
9. Ctrl “X”
10. Ctrl “Q”

C. Control and special characteristics
1. % %%d
2. % %c
3. % %o
4. % %p
5. % %u
6. % %nnn
7. %%%

XIV. Use Presentation Graphics and Rendering Commands
A. Light
B. VLight
C. Camera
D. VCamera
E. Scene
F. FilmRoll
G. Open
H. Quit
I. Shading
J. PlanView
K. WireFrame
L. Fast Shade
M. Full Shade
N. Replay
O. Replay all
P. Record
Q. Hard Copy

XV. Use Solid Commands to Generate 3-D Solid Model Geometry
A. SOLBOX
B. SOLBOX (cube option)
C. SOLCONE
D. SOLCYL
E. SOLSPHERE
F. SOLTORUS
G. SOLWEDGE
H. SOLEXTRUDE
I. SOLREVOLVE
J. SOLIDIFY

XVI. Use 3-D Solid Modifiers Commands
A. SOLINT
B. SOLSUB
C. SOLUNION
D. SOLSEP
E. SOLCUT
F. SOLCHAM
G. SOLFILL
H. SOLCHP
I. SOLMOVE

XVII. Use Solid 3-D Inquiry Commands
A. LLIST
B. LMASSP
C. LAREA
D. LINTERF

XVIII. Use Solid 3-D Representation Commands
A. SOLMESH
B. SOLWIRE
C. SOLFEAT
D. SOLPROF
E. SOLSECT
F. SOLHPAT
G. SOLHSIZE
H. SOLHANGLE

XIX. Use Solid 3-D Utility Commands
A. SOLIN
B. SOLOUT
C. SOLMAT
D. SOLPURGE
E. SOLUCS
F. SOLVAR
G. UNLOAD

XX. Use LISP Programs to Generate 3-D Solid Model Geometry
A. SOLMAINT
B. WBLKSOL
C. HOLE
D. STLSUP

XXI. Use Application Programming Interface (API) Functions
A. TUTOR
B. ASM
C. DRILL
D. DESIGN
E. LAYOUT
F. SYMMETRY
G. OFFSOL

XXII. Use Bonus 3-D Solid Feature Commands
A. SOLSTLOUT
B. SOLVIEW
C. AMELINK

XXIII. Use CAD System to Digitize Paper Drawings
A. Tablet mode
B. Tablet on/off
C. Tablet calibration
D. Tablet configuration
TLD-H6-HO
Use Computer-Aided Manufacturing (CAM) System
Attachment 1: MASTER Handout

Objectives:

Upon completion of this unit the student will be able to:
1. Access CAD program options; and,
2. Create basic geometric entities.

Module Outline:

I. Access CAD Program Options
   A. Explain the configuration of CAD/CAM software
      1. Explain configuration of:
         a. File and path names
         b. Installation, including DOS and Windows
         c. Configure software
         d. Interaction of files between each other
      2. Describe the “flow” process of CAD/CAM
   B. Access CAD software
      1. Access CAD software, including AutoCAD and CadKey, to:
         a. Create basic 2-dimensional designs
         b. Create 3-dimension designs
         c. Dimension designs to be used as drawings
         d. Create title blocks and borders for prints
         e. Print drawings
         f. Plot drawings
         g. Create general and local drawing notes and tolerances
      2. Describe various file conversion formats
      3. Import and export designs using conversions, including:
         a. IGES
         b. CADL
         c. DXF
         d. STL
   C. Access CAM software
      1. Load existing design
      2. Import and export design files from various file format standards, including:
         a. IGES
         b. DXF
         c. CADL
         d. STL
      3. Save design files to “permanent” memory
4. Access CAD section of CAM software to create
   a. Create basic 2-dimensional designs
   b. Create 3-dimension designs
   c. Dimension designs to be used as drawings
   d. Create title blocks and borders for prints
   e. Print drawings
   f. Plot drawings
   g. Create general and local drawing notes and tolerances

II. Create Basic Geometric Entities
A. Create basic geometric entities, including:
   1. Points
   2. Fillets
   3. Lines
   4. Splines
   5. Arcs
   6. Chamfers
   7. Circles
   8. Letters including various machinable fonts
B. Dimension completed designs to create detailed drawings
C. Transform geometric entities using CAD commands
   1. Transform geometric entities, including:
      a. Mirror entities
      b. Rotate entities
      c. Scale complete entities using single scale option
      d. Translate using move and copy options
      e. Offset single and grouped geometric entities
      f. Use group function to effect multiple entities simultaneously
      g. Use result function to effect group movements
D. Set menu selections to:
   1. View planes
   2. Construction planes
   3. Color choices
E. Use Delete command:
   1. Use Delete commands, including:
      a. Chained and duplicate entities
      b. Exclusive entities (only)
      c. Inclusive entities (all)
      d. Enclosed in window
      e. Intersecting window
F. Execute screen and display functions
   1. Use screen and display functions to:
      a. List screen statistics
      b. Display entity endpoints
      c. Clear group and result color designation
d. Change colors of entities
e. Display window
f. Un-zoom display
g. Change levels of entities
h. Fit entities to screen
i. Set various view ports
j. Refresh screen
k. Change views
l. Set active levels
m. Change entities between levels
m. Set screen center "pan"
n. Initialize display "clear"
o. Rotate display

G. Use analyze function
1. Use analyze function to interpret:
   a. Point descriptions
   b. Single entity information
c. Locations of entities
d. Distance between points
e. Area calculations
   f. Calculation of angles
Use Computer-Aided Manufacturing (CAM) System
Attachment 2: MASTER Laboratory Aid

Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TOOL AND DIE MAKER ... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Practice Safety</strong></td>
<td>A-1 Follow safety manuals and all safety regulations/requirements</td>
</tr>
<tr>
<td><strong>Apply Mathematical Concepts</strong></td>
<td>B-1 Perform basic arithmetic functions</td>
</tr>
<tr>
<td><strong>Interpret Engineering Drawings and Related Documents</strong></td>
<td>C-1 Interpret and understand basic layout/types of drawings</td>
</tr>
<tr>
<td><strong>Demonstrate Knowledge of Manufacturing Materials</strong></td>
<td>D-1 Identify materials with desired properties</td>
</tr>
<tr>
<td><strong>Measure/Inspect</strong></td>
<td>E-1 Understand metrology terms</td>
</tr>
<tr>
<td><strong>Demonstrate Knowledge of Manufacturing Processes</strong></td>
<td>F-1 Discuss metal cutting and metal cutting tools</td>
</tr>
<tr>
<td><strong>Use Computers</strong></td>
<td>G-1 Use computer operating systems</td>
</tr>
<tr>
<td><strong>Perform CAD, CAM and CNC Programming Tasks</strong></td>
<td>H-1 Discuss fundamentals of CNC machines and controls</td>
</tr>
<tr>
<td><strong>Perform Tool and Die Making Operations</strong></td>
<td>I-1 Discuss basic types and functions of jigs and fixtures</td>
</tr>
<tr>
<td><strong>Operate Electrical Discharge Machine (EDM)</strong></td>
<td>J-1 Discuss fundamentals of EDM</td>
</tr>
<tr>
<td>A-2 Maintain safe equipment and machinery</td>
<td>B-2 Perform basic geometric operations</td>
</tr>
<tr>
<td>A-3 Use safe operating procedures for hand and machine tools</td>
<td>C-2 Interpret, review, and apply blueprint notes, dimensions, and tolerances</td>
</tr>
<tr>
<td>A-4 Maintain a clean and safe work environment</td>
<td>C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&amp;T)</td>
</tr>
<tr>
<td>A-5 Use safe material handling practices</td>
<td>C-4 Demonstrate traditional mechanical drafting and sketching techniques</td>
</tr>
<tr>
<td>A-6 Consult and apply MSDS for hazards of various materials</td>
<td>C-5 Understand and use quality systems</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>D-2 Identify materials and processes to produce a part</td>
</tr>
<tr>
<td>A-7 Follow safety manuals and all safety regulations/requirements</td>
<td>D-3 Discuss classification systems for metal</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>D-4 Identify materials and processes to produce a part</td>
</tr>
<tr>
<td>A-8 Consult and apply MSDS for hazards of various materials</td>
<td>E-2 Select measurement tools</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>E-3 Measure with hand held instruments</td>
</tr>
<tr>
<td>A-9 Follow safety manuals and all safety regulations/requirements</td>
<td>E-4 Eliminate measurement variables</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>E-5 Measure/inspect using surface plate and accessories</td>
</tr>
<tr>
<td>A-10 Consult and apply MSDS for hazards of various materials</td>
<td>F-2 Operate metal saws</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>F-3 Operate drill presses and tooling</td>
</tr>
<tr>
<td>A-11 Consult and apply MSDS for hazards of various materials</td>
<td>F-4 Operate engine and turret lathes and tooling</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>F-5 Operate precision grinding and honing machines and tools</td>
</tr>
<tr>
<td>A-12 Consult and apply MSDS for hazards of various materials</td>
<td>F-6 Operate heat treating equipment and processes</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>F-7 Operate sheet metal equipment and processes</td>
</tr>
<tr>
<td>A-13 Consult and apply MSDS for hazards of various materials</td>
<td>F-8 Operate welding equipment and processes</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>F-9 Operate welding equipment and processes</td>
</tr>
<tr>
<td>A-14 Consult and apply MSDS for hazards of various materials</td>
<td>F-10 Estimate time required/ cost to produce a part</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>G-2 Understand computer terminology</td>
</tr>
<tr>
<td>A-15 Consult and apply MSDS for hazards of various materials</td>
<td>G-3 Use file management systems</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>G-4 Install and use software packages</td>
</tr>
<tr>
<td>A-16 Consult and apply MSDS for hazards of various materials</td>
<td>H-2 Program and operate CNC milling machine and machining center</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>H-3 Program and operate CNC lathe</td>
</tr>
<tr>
<td>A-17 Consult and apply MSDS for hazards of various materials</td>
<td>H-4 Use Computer-Aided Drafting (CAD) system</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>H-5 Create 3-D solid models</td>
</tr>
<tr>
<td>A-18 Consult and apply MSDS for hazards of various materials</td>
<td>H-6 Use Computer-Aided Manufacturing (CAM) system</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>I-2 Utilize concepts of jigs and fixtures design</td>
</tr>
<tr>
<td>A-19 Consult and apply MSDS for hazards of various materials</td>
<td>I-3 Demonstrate understanding of different types of industrial dies</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>I-4 Utilize basic die theory</td>
</tr>
<tr>
<td>A-20 Consult and apply MSDS for hazards of various materials</td>
<td>I-5 Utilize principles of die design</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>I-6 Perform tool and die repair</td>
</tr>
<tr>
<td>A-21 Consult and apply MSDS for hazards of various materials</td>
<td>I-7 Demonstrate tool and die making skills</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>J-2 Setup and operate conventional sinker EDM</td>
</tr>
<tr>
<td>A-22 Consult and apply MSDS for hazards of various materials</td>
<td>J-3 Program, setup, and operate CNC sinker EDM and EDM drill</td>
</tr>
<tr>
<td><strong>Tasks</strong></td>
<td>J-4 Program, setup, and operate CNC wire EDM</td>
</tr>
</tbody>
</table>
TLD-I1-HO
Discuss Basic Types and Functions of Jigs and Fixtures
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
a. Distinguish between jigs and fixtures;
b. Discuss boring and drill jigs;
c. Discuss open and closed (box) jigs;
d. Discuss the various names used to identify jig types; and,
e. Discuss the various types and functions of fixtures.

Module Outline:

I. Distinguish Between Jigs and Fixtures and Discuss Need and Characteristics of Each
II. Discuss Various Applications of Jigs and Fixtures
   A. External-machining
   B. Internal-machining
   C. Non-machining
III. Identify Two General Classes of Jigs
   A. Boring jigs
   B. Drill jigs
IV. Discuss Types of Open Jigs
   A. Template jigs
   B. Plate jigs
   C. Table jigs
   D. Sandwich jigs
   E. Angle-plate jigs
V. Discuss Types of Closed Jigs
   A. Box, or tumble, jigs
   B. Channel jigs
   C. Leaf jigs
VI. Discuss Types of Jigs Which Can Be Either Open or Closed
   A. Indexing, or rotary, jigs
   B. Trunnion jigs
   C. Pump jigs
   D. Multi-station jigs
VII. Discuss Types and Functions of Fixtures
   A. Plate fixtures
   B. Angle-plate fixtures
   C. Vise-jaw fixtures
   D. Indexing fixtures
E. Multi-station fixtures
F. Profiling fixtures

VIII. Discuss Classification of Fixtures by Machine Type or Operation

IX. Discuss Modular Fixturing
A. Sub-plate systems
B. "T"-slot systems
C. Dowel-pin systems
Objective(s):

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

a. Identify basic components of jigs and fixtures;
b. Discuss supporting and locating principles;
c. Discuss clamping and workholding principles; and,
d. Discuss basic construction principles.

Module Outline:

I. Generally Discuss the Following Components of Jigs and Fixtures
   A. Tool bodies and plates (or bases)
   B. Locators
   C. Clamping or locking devices
   D. Bushings or guides
   E. Supports
   F. Keys
   G. Feet or legs

II. Define and Discuss Supporting and Locating Principles
   A. Referencing
   B. Repeatability
   C. Locator position
   D. Tool tolerance (relative to part tolerance)
   E. Foolproofing
   F. The twelve planes of movement ("degrees of freedom")
   G. The three forms of location: plane, concentric, and radial
   H. External and internal locating

III. Discuss the Primary Types of Supports
   A. Solid
   B. Adjustable
   C. Equalizing

IV. Discuss Locator Types
   A. Locating pins
   B. Nesting locators
   C. Vee locators
   D. Fixed-stop locators
   E. Adjustable locators
   F. Sight locators
   G. Spring-loaded devices

V. Discuss Clamping and Workholding Principles
A. The role of clamps
B. Tool forces
C. Clamping forces
D. Position of the clamps

VI. Discuss Types of Clamps
A. Strap clamps
B. Screw clamps
C. Swing and hook clamps
D. Edge clamps
E. Wedge clamps
F. Cam-action clamps
G. Toggle-action clamps
H. Power clamping (general discussion)

VII. Discuss Basic Construction Principles
A. Tool bodies
B. Blocks
C. Bushings
D. Fastening devices
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-I3-HO
Demonstrate Understanding of Different Types of Industrial Dies
Attachment 1: MASTER Handout

Objective(s):

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

a. Describe the operation of blanking or piercing dies;
b. Describe the operation of bending or forming dies;
c. Describe the operation of compound dies;
d. Describe the operation of progressive dies;
e. Describe the operation of draw dies;
f. Describe the operation of compression dies; and,
g. Describe the operation of combination dies.

Module Outline:

I. Describe the Operation of Cutting Dies
   A. Piercing dies
   B. Notching and slotting dies
   C. Horn-type (mandrel) cutting dies
   D. Blanking dies
   E. Trimming and shaving dies
   F. Cutoff dies
   G. Broaching dies

II. Describe Operation of Bending and Forming Dies
    A. V-dies
    B. U-dies
    C. Radius dies
    D. Offset dies
    E. Gooseneck dies
    F. Miscellaneous dies (Curling, bulging, beading, etc.)

III. Describe Operation of Compound Dies
     A. Blank-and-pierce dies
     B. Blank, pierce, and notch dies
     C. Trim-and-pierce dies
     D. Shave-and-pierce dies
     E. Broach, cutoff, and pierce dies

IV. Describe Operation of Draw Dies

V. Describe Operation of Compression Dies
   A. Sizing dies
   B. Swaging (swedging) dies
   C. Coining and embossing dies
   D. Extruding dies
VI. Describe Operation of Combination Dies
   A. Cutoff-and-form dies
   B. Lance-and-form dies
   C. Cutoff, form, and pierce dies
   D. Blank, draw, form, and pierce dies
   E. Pierce, blank, lance, and emboss dies
   F. Cutoff, form, and curl dies
   G. Blank and draw dies

VII. Describe Operation of Progressive Dies
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Objective(s):

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

a. Discuss shearing action on metal (3 stages);
b. Explain notch, pierce, pilot, form, and cut-off stations;
c. Explain operation of die set to make piece part;
d. Explain spring back in form dies;
e. Explain bending action in V-form dies; and,
f. Explain coining in dies.

Module Outline:

I. Explain Operation of Die Set to Make Piece Part
II. Discuss Critical Stages of Shearing Action on Metal
   A. Plastic deformation
   B. Penetration
   C. Fracture
III. Explain Cutting Operations
   A. Blanking
   B. Piercing
   C. Notching
   D. Lancing
   E. Cutting off and parting
   F. Trimming and Shaving
IV. Discuss Bending Stresses
   A. The neutral plane
   B. The elastic limit of materials
   C. Plastic deformation and flow
   D. Springback
   E. Bend allowance curve
V. Explain Bending and Forming Operations
   A. Bending
      1. V-bending
      2. U-bending
      3. L-bending
   B. Forming
      1. Solid forming
      2. Pad type forming
      3. Miscellaneous methods (bulging, curling, coining and embossing)
   C. Drawing
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-I5-HO
Utilize Principles of Die Design
Attachment 1: MASTER Handout

Objective(s):

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

a. Identify components of die set;
b. Discuss materials of die components;
c. Calculate proper shut-height of die set;
d. Design stock strip layout;
e. Calculate blank length for developed parts;
f. Calculate cutting length of piece part;
g. Determine press tonnage requirements;
h. Calculate die progression;
i. Calculate stripping pressure;
j. Calculate slug clearance;
k. Calculate cutting clearance; and,
l. Calculate offset displacement.

Module Outline:

I. Identify Components of a Typical Die
   A. Die set
   B. Punch
   C. Punch plate or holder
   D. Die block
   E. Stripper
   F. Pilot
   G. Stock guide or back gage
   H. Stop
   I. Fasteners

II. Identify Components of a Typical Die Set
    A. Die shoe
    B. Guidepost
    C. Guidepost bushing
    D. Punch shoe
    E. Shank
    F. Flange and bolt slot

III. Discuss Stock Strip Design
     A. Determining feed direction
     B. Locating stations
     C. Using strip layouts for die design
     D. Calculation of die progression
IV. Discuss Shut Height of Die
   A. Definition
   B. Calculation
   C. Determining stop block length

V. Discuss Punch Design
   A. Types
   B. Shear
   C. Material

VI. Discuss Design of Punch Plates
   A. Material
   B. Mounting

VII. Discuss Die Block Design
   A. Cutting clearances
      1. Definition and importance
      2. Calculation
         a. Type of cut
         b. Type of material
      3. Angular clearance
   B. Material
   C. Mounting

VIII. Discuss Cutting Force and Blanking Tonnage
   A. Determining the cutting area and length
   B. Shear or tensile strength of materials
   C. Calculation

IX. Discuss Stripper Design
   A. Types
   B. Stripping force
      1. Relationship with blanking tonnage
      2. Calculation
      3. Spring tables
      4. Rule of thumb for stripping bolts
   C. Knockouts
   D. Material
   E. Mounting

X. Discuss Pilot Design
   A. Methods
   B. Length and nose contour
   C. Material

XI. Discuss Design of Stock Guides and Back Gages
   A. Types
   B. Material

XII. Discuss Fasteners and Hardware
    A. Types
    B. Spacing
Rules of Conduct

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3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
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   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-I6-HO
Perform Tool and Die Repair
Attachment 1: MASTER Handout

Objective(s):

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

a. Disassemble and assemble die set, jig, or fixture;
b. Visually inspect components for damage;
c. Determine method of repairing/sharpening;
d. Determine material for replacement parts; and,
e. Manufacture replacement parts.

Module Outline:

I. Discuss Safety in the Die Shop
   A. Proper die handling and transport
   B. Safety in the machine shop

II. Discuss Die Life
   A. Punch life
   B. Die block life
   C. Characteristic cutting wear
   D. Excessive wear

III. Discuss Inspection of Die Components
    A. Identify and inspect component parts
    B. Inspection of piece part

IV. Discuss Disassembly of Die
    A. Removal and organization of component parts
    B. Cleaning component parts

V. Discuss Repair of Damaged Parts
    A. Sharpening
       1. Amount of material to remove
       2. Procedures and techniques
    B. Replacement
       1. Material
       2. Construction

VI. Discuss Assembly of Die Set
    A. Cleaning and deburring component parts
    B. Mounting procedures
    C. Checking clearances, depths, stop blocks, and shut-heights

VII. Documentation
    A. Maintenance work orders
    B. Die records
    C. Preventive maintenance plan
    D. Inspection tags
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Objective(s):

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

a. Identify component parts from tool blueprint
b. Determine material / purchased part requirements
c. Utilize tool making procedures to make and assemble component parts
d. Demonstrate mounting and operation of die set in press machine
e. Inspect operation of tooling and piece part for accuracy

Module Outline:

I. Handout the Tool Blueprint and Discuss
II. Discuss Acquisition of Material and Purchased Components
III. Discuss Tool Making Procedures
IV. Discuss Mounting Procedures
V. Discuss Mounting and Operation of Die Set in Press Machine
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machining.

<table>
<thead>
<tr>
<th>Duties</th>
<th>Tasks</th>
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<tbody>
<tr>
<td><strong>A</strong> Practice Safety</td>
<td>A-1 Follow safety manuals and all safety regulations/requirements</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><strong>C</strong> Interpret Engineering Drawings and Related Documents</td>
<td>C-1 Interpret and understand basic layout/types of drawings</td>
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<tr>
<td><strong>D</strong> Demonstrate Knowledge of Manufacturing Materials</td>
<td>D-1 Identify materials with desired properties</td>
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<tr>
<td><strong>E</strong> Measure/Inspect</td>
<td>E-1 Understand metrology terms</td>
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<tr>
<td><strong>F</strong> Demonstrate Knowledge of Manufacturing Processes</td>
<td>F-1 Discuss metal cutting and metal cutting tools</td>
</tr>
<tr>
<td><strong>G</strong> Use Computers</td>
<td>G-1 Use computer operating systems</td>
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<tr>
<td><strong>H</strong> Perform CAD, CAM and CNC Programming Tasks</td>
<td>H-1 Discuss fundamentals of CNC machines and controls</td>
</tr>
<tr>
<td><strong>I</strong> Perform Tool and Die Making Operations</td>
<td>I-1 Discuss basic types and functions of jigs and fixtures</td>
</tr>
<tr>
<td><strong>J</strong> Operate Electrical Discharge Machine (EDM)</td>
<td>J-1 Discuss fundamentals of EDM</td>
</tr>
<tr>
<td><strong>A-2</strong> Maintain safe equipment and machinery</td>
<td>A-2 Maintain safe equipment and machinery</td>
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<tr>
<td><strong>B-2</strong> Perform basic algebraic operations</td>
<td>B-2 Perform basic algebraic operations</td>
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<tr>
<td><strong>C-2</strong> Interpret, review, and apply blueprints, dimensions, and tolerances</td>
<td>C-2 Interpret, review, and apply blueprints, dimensions, and tolerances</td>
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<td><strong>D-2</strong> Identify materials and processes to produce a part</td>
<td>D-2 Identify materials and processes to produce a part</td>
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<tr>
<td><strong>E-2</strong> Select measurement tools</td>
<td>E-2 Select measurement tools</td>
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<td><strong>F-2</strong> Operate metal saws</td>
<td>F-2 Operate metal saws</td>
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<tr>
<td><strong>G-2</strong> Understand computer terminology</td>
<td>G-2 Understand computer terminology</td>
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<tr>
<td><strong>H-2</strong> Program and operate CNC milling machine and machining center</td>
<td>H-2 Program and operate CNC milling machine and machining center</td>
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<tr>
<td><strong>I-2</strong> Utilize concepts of jigs and fixtures</td>
<td>I-2 Utilize concepts of jigs and fixtures</td>
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<tr>
<td><strong>J-2</strong> Setup and operate conventional sinker EDM</td>
<td>J-2 Setup and operate conventional sinker EDM</td>
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<tr>
<td><strong>A-3</strong> Use safe operating procedures for hand and machine tools</td>
<td>A-3 Use safe operating procedures for hand and machine tools</td>
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<tr>
<td><strong>B-3</strong> Use basic geometric principles</td>
<td>B-3 Use basic geometric principles</td>
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<tr>
<td><strong>C-3</strong> Use and apply Geometric Dimensioning and Tolerancing (GD&amp;T)</td>
<td>C-3 Use and apply Geometric Dimensioning and Tolerancing (GD&amp;T)</td>
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<tr>
<td><strong>D-3</strong> Discuss classification systems for metal</td>
<td>D-3 Discuss classification systems for metal</td>
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<tr>
<td><strong>E-3</strong> Measure with hand held instruments</td>
<td>E-3 Measure with hand held instruments</td>
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<tr>
<td><strong>F-3</strong> Operate drills, presses, and tooling</td>
<td>F-3 Operate drills, presses, and tooling</td>
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<td><strong>G-3</strong> Use file management systems</td>
<td>G-3 Use file management systems</td>
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<td><strong>H-3</strong> Program and operate CNC lathe</td>
<td>H-3 Program and operate CNC lathe</td>
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<tr>
<td><strong>I-3</strong> Demonstrate understanding of different types of industrial dies</td>
<td>I-3 Demonstrate understanding of different types of industrial dies</td>
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<tr>
<td><strong>J-3</strong> Program, setup, and operate CNC sinker EDM and EDM drill</td>
<td>J-3 Program, setup, and operate CNC sinker EDM and EDM drill</td>
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<tr>
<td><strong>A-4</strong> Maintain a clean and safe work environment</td>
<td>A-4 Maintain a clean and safe work environment</td>
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<tr>
<td><strong>B-4</strong> Perform basic trigonometric functions</td>
<td>B-4 Perform basic trigonometric functions</td>
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<tr>
<td><strong>C-4</strong> Demonstrate traditional mechanical drafting and sketching techniques</td>
<td>C-4 Demonstrate traditional mechanical drafting and sketching techniques</td>
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<td><strong>D-4</strong> Perform tool and die making operations</td>
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<td><strong>E-4</strong> Eliminate measurement variables</td>
<td>E-4 Eliminate measurement variables</td>
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<td><strong>F-4</strong> Operate engine and turret lathes and tooling</td>
<td>F-4 Operate engine and turret lathes and tooling</td>
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<tr>
<td><strong>G-4</strong> Install and use software packages</td>
<td>G-4 Install and use software packages</td>
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<tr>
<td><strong>H-4</strong> Use Computer-Aided Drafting (CAD) system</td>
<td>H-4 Use Computer-Aided Drafting (CAD) system</td>
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<td><strong>I-4</strong> Utilize basic die theory</td>
<td>I-4 Utilize basic die theory</td>
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<td><strong>J-4</strong> Program, setup, and operate CNC wire EDM</td>
<td>J-4 Program, setup, and operate CNC wire EDM</td>
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<tr>
<td><strong>A-5</strong> Use safe material handling practices</td>
<td>A-5 Use safe material handling practices</td>
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<tr>
<td><strong>B-5</strong> Use and apply Cartesian Coordinate System</td>
<td>B-5 Use and apply Cartesian Coordinate System</td>
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<tr>
<td><strong>C-5</strong> Understand and use quality systems</td>
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<td><strong>D-5</strong> Use safe operating procedures for hand and machine tools</td>
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<td><strong>E-5</strong> Maintain a safe and healthy environment</td>
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<tr>
<td><strong>F-5</strong> Operate precision grinding</td>
<td>F-5 Operate precision grinding</td>
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<td><strong>G-5</strong> Measure and inspect using surface plate and accessories</td>
<td>G-5 Measure and inspect using surface plate and accessories</td>
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<tr>
<td><strong>H-5</strong> Create 3-D solid models</td>
<td>H-5 Create 3-D solid models</td>
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<tr>
<td><strong>I-5</strong> Utilize principles of die design</td>
<td>I-5 Utilize principles of die design</td>
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<td><strong>J-5</strong> Perform tool and die repair</td>
<td>J-5 Perform tool and die repair</td>
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<td><strong>A-6</strong> Consult and apply MSDS for hazards of various materials</td>
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<tr>
<td><strong>B-6</strong> Use and apply Cartesian Coordinate System</td>
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<td><strong>C-6</strong> Understand and use quality systems</td>
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<td><strong>D-6</strong> Perform tool and die making operations</td>
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<td><strong>E-6</strong> Inspect using stationary equipment</td>
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<td><strong>F-6</strong> Operate sheet metal equipment</td>
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<td><strong>G-6</strong> Measure and inspect using surface plate and accessories</td>
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<td><strong>H-6</strong> Use Computer-Aided Manufacturing (CAM) system</td>
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<td><strong>I-6</strong> Demonstrate tool and die making skills</td>
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<td><strong>J-6</strong> Perform tool and die repair</td>
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<td><strong>A-7</strong> Maintain a safe and healthy environment</td>
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<td><strong>B-7</strong> Perform basic trigonometric functions</td>
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<td><strong>C-7</strong> Demonstrate traditional mechanical drafting and sketching techniques</td>
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<td><strong>D-7</strong> Perform tool and die making operations</td>
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<td><strong>E-7</strong> Inspect using stationary equipment</td>
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<td><strong>F-7</strong> Operate heat treating equipment and processes</td>
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<td><strong>G-7</strong> Measure and inspect using surface plate and accessories</td>
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<td><strong>I-7</strong> Demonstrate tool and die making skills</td>
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<td><strong>J-7</strong> Perform tool and die repair</td>
<td>J-7 Demonstrate tool and die repair</td>
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<tr>
<td><strong>A-8</strong> Estimate time required to produce a part</td>
<td>A-8 Estimate time required to produce a part</td>
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<td><strong>B-8</strong> Operate sheet metal equipment</td>
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<td><strong>I-8</strong> Demonstrate tool and die making skills</td>
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<td><strong>J-8</strong> Perform tool and die repair</td>
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<tr>
<td><strong>A-9</strong> Use computer operating systems</td>
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<td><strong>B-9</strong> Operate sheet metal equipment</td>
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<td><strong>J-9</strong> Perform tool and die repair</td>
<td>J-9 Demonstrate tool and die repair</td>
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<tr>
<td><strong>A-10</strong> Estimate time required to produce a part</td>
<td>A-10 Estimate time required to produce a part</td>
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<tr>
<td><strong>B-10</strong> Operate heat treating equipment and processes</td>
<td>B-10 Operate heat treating equipment and processes</td>
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<td><strong>C-10</strong> Demonstrate traditional mechanical drafting and sketching techniques</td>
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<td><strong>G-10</strong> Measure and inspect using surface plate and accessories</td>
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<td><strong>H-10</strong> Use Computer-Aided Manufacturing (CAM) system</td>
<td>H-10 Use Computer-Aided Manufacturing (CAM) system</td>
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<td><strong>I-10</strong> Demonstrate tool and die making skills</td>
<td>I-10 Demonstrate tool and die making skills</td>
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<tr>
<td><strong>J-10</strong> Perform tool and die repair</td>
<td>J-10 Demonstrate tool and die repair</td>
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</table>

**BEST COPY AVAILABLE**
Objectives:

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

a. Explain the principles of Electrical Discharge Machining (EDM);
b. Discuss the advantages, limitations, and applications of EDM;
c. Discuss EDM safety;
d. Name and state the purpose of the main components of the EDM process; and,
e. Explain the types of EDM processes.

Module Outline:

I. Explain the Principles of Electrical Discharge Machining (EDM)
II. Discuss the Advantages, Limitations, and Applications of EDM
III. Discuss EDM Safety
IV. Name and State the Purpose of the Main Components of the EDM Process
   A. Electrode
      1. Characteristics
      2. Types
      3. Materials used
   B. Dielectric fluid
      1. Functions
      2. Characteristics
      3. Methods of circulating
   C. Servomechanism
   D. Power supply
   E. Machine Control Unit
V. Explain the Types of EDM Processes
   A. Sinker (plunge or ram type) EDM
   B. Traveling wire EDM
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
TLD-J2-HO
Setup and Operate Conventional Sinker EDM
Attachment 1: MASTER Handout

Objective(s):

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

a. Identify the components of the sinker EDM process;
b. Explain the terms and principles of the sinker EDM process;
c. Discuss electrode design and construction;
d. Practice safety with sinker EDM;
e. Set-up and operate sinker EDM; and,
f. Practice preventive maintenance measures for the sinker EDM

Module Outline:

I. Review the Components of the Sinker EDM Process
   A. Electrode
   B. Dielectric fluid
   C. Servomechanism
   D. Power supply
   E. Machine Control Unit

II. Explain the Principles and Terms of the Sinker EDM Process
   A. Amperage
   B. Frequency
   C. Voltage (gap and striking)
   D. Capacitance
   E. Polarity
   F. Ionization
   G. Overcut
   H. Swarf
   I. Flushing
   J. Surface Finish
   K. Dither or vibration
   L. Metal-removal rate
   M. On-time
   N. Off-time

III. Discuss Electrode Design and Construction
   A. Material selection
      1. Workpiece material
      2. Wear characteristics
      3. Machinability
      4. Cost
   B. Accuracy
IV. Discuss Sinker EDM Safety

V. Discuss Set-Up and Operation of EDM
   A. Workpiece set-up
   B. Tooling
   C. Locating principles
   D. Power supply controls
   E. Machine tool controls
   F. Cutting procedures and adjustments
   G. Rough and finish cuts

VI. Practice Preventive Maintenance Measures for the Sinker EDM
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Objective(s):

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

a. Review the components of the sinker EDM process;
b. Discuss sinker EDM safety;
c. Discuss applications and benefits of sinker EDM (specifically in Tool and Die);
d. Discuss CNC programming of CNC sinker EDM;
e. Discuss set-up and operation of CNC sinker EDM; and,
f. Practice preventive maintenance measures for the CNC sinker EDM.

Module Outline:

I. Review the Components of the Sinker EDM Process
   A. Electrode
   B. Dielectric fluid
   C. Servomechanism
   D. Power supply
   E. Machine Control Unit

II. Discuss Sinker EDM Safety

III. Discuss Applications and Benefits of Sinker EDM (specifically in Tool and Die)

IV. Discuss CNC Programming of CNC Sinker EDM
   A. Coordinate Words (X, Y, U, V, Z, I, J)
   B. Basic “G” codes
   C. Basic “M” codes
   D. Program origin point
   E. Simple programming
   F. CANNED cycles, subprograms, and macros

V. Discuss Set-Up and Operation of CNC Sinker EDM
   A. Workpiece set-up and requirements
   B. Electrode
   C. Tooling
   D. Locating principles
   E. Power supply controls
   F. Machine tool controls
   G. Program operation
      1. Manual Data Input (MDI)
      2. DNC and transfer
      3. Program edit
4. Memory storage
H. Cutting procedures and adjustments
I. Starter and pilot holes
J. Rough and finish cuts

VI. Practice Preventive Maintenance Measures for the CNC Sinker EDM
**Rules of Conduct**

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
Objective(s):

Upon completion of this unit the student will be able to:
  a. Review the components of the CNC wire EDM process;
  b. Explain the wire EDM process;
  c. Identify the three types of Wire EDM;
  d. Discuss applications and benefits of wire EDM (specifically in Tool and Die);
  e. Explain the principles and terms of the wire EDM process;
  f. Discuss wire EDM safety;
  g. Discuss CNC programming of wire EDM;
  h. Discuss set-up and operation of wire EDM; and,
  i. Practice preventive maintenance measures for the wire EDM.

Module Outline:

I. Review the Components of the CNC Wire EDM Process
   A. electrode
   B. Dielectric fluid
   C. Servomechanism
   D. Power supply
   E. Machine Control Unit

II. Explain the Wire EDM Process

III. Identify the Three Types of Wire EDM
   A. Two axis
   B. Simultaneous four axis
   C. Independent four axis

IV. Discuss Applications and Benefits of Wire EDM (specifically in Tool and Die)

V. Explain the Principles and Terms of the Wire EDM Process
   A. Kerf
   B. Overcut
   C. On-time/Off-time
   D. Flushing
   E. Flow rate
   F. Amperage
   G. Voltage
   H. Current
   I. Polarity
   J. Dielectric fluid resistivity
   K. Wire tension
L. Wire feed

VI. Discuss Wire EDM Safety

VII. Discuss CNC Programming of Wire EDM
A. Coordinate words (X, Y, U, V, Z, I, J)
B. Basic “G” codes
C. Basic “M” codes
D. Program origin point
E. Simple two-axis programming
F. CANNED cycles, subprograms, and macros
G. Four-axis programming

VIII. Discuss Set-Up and Operation of Wire EDM
A. Workpiece set-up and requirements
B. Electrode (wire)
C. Tooling
D. Locating principles
E. Power supply controls
F. Machine tool controls
G. Program operation
   1. Manual Data Input (MDI)
   2. DNC and transfer
   3. Program edit
   4. Memory storage
H. Cutting procedures and adjustments
I. Starter and pilot holes
J. Rough and finish cuts

IX. Practice Preventive Maintenance Measures for the Wire EDM
Rules of Conduct

1. Absolutely no horseplay or practical joking will be tolerated.
2. Do not talk to anyone who is operating a machine.
3. Walk only in the designated traffic lanes.
4. Dress appropriately; at the absolute minimum, you must have:
   a. No loose clothing, including ties;
   b. Long hair properly stowed;
   c. No jewelry;
   d. Hard, closed-toe shoes;
   e. Eye protection (safety glasses); and,
   f. Ear protection (plugs or headset).
5. Follow all institutional safety rules.
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