INDUSTRIAL ARTS CURRICULUM GUIDE
FOR
POWER TECHNOLOGY

State Department of Education
Division of Vocational and Adult Education
Bureau of Vocational Services
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This curriculum was developed by the following people:

Charles P. Cassidy, Chairman
Danbury High School
Danbury

Frank C. Derato
Westhill High School
Stamford

Tom Hession
Guilford High School
Guilford

Richard Keizer
Rogers Park Jr. High School
Danbury

Mark J. Wininger
Windsor High School
Windsor

David M. Mordavsky
Industrial Arts Consultant
State Department of Education
Hartford
INTRODUCTION

This curriculum guide is written in general terms. It is realized that program lengths and objectives vary from one community to another. The purpose of this guide is not to restructure all existing programs, but rather to serve as an example of a complete Power Technology program. This guide will be particularly useful to a beginning teacher, but will also help an experienced teacher to update and upgrade his/her course of study.

This curriculum guide is broken down into three levels:

1. Power Technology
2. Introduction to the Automobile
3. Advanced Automotive Mechanics

In general, it is the school system that determines the type of program to be taught. Very rarely does the teacher have the choice of designing the program. The teacher must, however, fit a workable curriculum into the guidelines set forth by the school system. Some school systems have as little as two semesters of "Power Mechanics" in which the introductory level deals with small engines and the second level deals with the automobile. Other systems have three full years in which an entire, fully developed program may be presented.

This guide is written with these variables in mind. It is meant to be a flexible tool, not a rigid structured device in which everything must be
covered. If, for example, the school system has a full three year program, this guide will be useful in its entirety. If, however, the length of the program is two years, or only two semesters, then the first two levels may be presented if the school does not have good shop facilities. If the facilities are good, the last two levels may be presented. In addition, the degree to which the guide is followed in each particular level, is at the discretion of the teacher.

It should be realized, that this guide has been prepared with the intention of being as up to date as possible. With the rapid changes in technology however, it will soon be out of date. It is up to the teacher therefore, to keep both himself and his course of study up to date in terms of the latest developments in the field.
OBJECTIVES – INDUSTRIAL EDUCATION

1. To provide students with the curriculum content designed to develop fundamental tool and procedural skills which help prepare them to enter a family of occupations.

2. To provide students with courses that serve as vehicles which help them relate their academic knowledge to vocational competencies.

3. To provide students with the environment whereby they may develop sound attitudes, acceptable work habits, and achieve a feeling of accomplishment.

OBJECTIVES – SPECIFIC TO POWER TECHNOLOGY

The Power Technology courses should give students an opportunity to:

1. Obtain exposure to, and a basic understanding of, the career field.

2. To develop methods of analytical thinking related to power technology problems.

3. To develop technical knowledge, attitudes and skills required in the power technology service area.

4. To develop an awareness of the impact of power technology on society.
GENERAL SAFETY RULES

In schools, as well as at home and in industry, it is realized that all of our efforts are directed toward the betterment of man's life. Therefore, protection from the inherent dangers in the environment is essential.

The following is a list of general shop safety rules that are applicable to all shop areas. Specific additions and alterations may be necessary depending on the shop and the equipment available.

The student will demonstrate his/her knowledge and mastery of the following rules to the instructor before permission to work in any shop will be granted.

1. Proper attire must be worn
2. Eye protection must be worn when necessary
3. Horse-play is not permitted
4. Injuries (no matter how slight) must be reported to the instructor immediately
5. Do not use any equipment until properly instructed and permission is granted
6. The student will have a working knowledge of the following:

   How to get help

   School office

   School nurse

   Fire department
Use of fire extinguishers
Use of emergency shut-off switches
Ventilation of the shop
Handling of exhaust gas
Storage of oily rags
Storage of combustible liquid
Handling sharp tools
Lifting heavy objects
Safety glasses
Tool storage
LEVEL I, POWER TECHNOLOGY

I. HISTORY OF POWER - Upon completion of this unit, the student will understand:

   Early Man

   Muscle Power

      human

      animal

   Sun

   Wind

   Water

   Fire

   Modern Man (1000 BC to Present)

   Use of Animal Power

   Use of Wind Power

      early windmills

      early sailing ships

   Use of Water Power

      development of water wheel

      Chinese Water Chain

      undershot water wheel

      overshot water wheel

      Breast water wheel
Early Engines

External Combustion Engine

Herō's Engine - Greece 50 B.C.

First successful steam engine James Watt - 1765

Internal Combustion Engine

Christian Hygenes - later 17th century

Otto & Langen - 1878...1st practical internal combustion engine

diesel engine

gas turbine engine

jet engine

rocket engine
II. BASIC MACHINES - Upon completion of this unit, the student will understand:

Lever

1st Class Lever (e.g., seesaw)

2nd Class Lever (e.g., pry bar)

3rd Class Lever (e.g., hammer)

Wheel and Axle

Pulley

Inclined Plane

Screw

Wedge
III. FORMS OF POWER - Upon completion of this unit, the student will understand:

Work - force applied to cause motion

Measurement of Work

\[
\text{WORK (ft. lbs.)} = \frac{\text{FORCE (Pounds)}}{\text{DISTANCE (feet)}} \times \text{DISTANCE (feet)}
\]

Law of Conservation of Energy - energy can change form but it cannot be destroyed.

Efficiency of Machines

\[
\text{EFFICIENCY} = \frac{\text{OUTPUT}}{\text{INPUT}} \times 100 \quad \text{or}
\]

\[
\text{EFFICIENCY} = \frac{\text{INPUT} - \text{LOSSES}}{\text{INPUT}} \times 100 \quad \text{or}
\]

\[
\text{EFFICIENCY} = \frac{\text{OUTPUT}}{\text{OUTPUT} + \text{LOSSES}} \times 100
\]

Power - is the rate of doing work and the rate of energy conversion.

Measurement of Power

\[
\text{POWER} = \frac{\text{WORK (ft. lbs.)}}{\text{TIME (sec.)}}
\]

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Horse Power

\[
\text{HORSEPOWER} = \frac{\text{WORK}}{\text{Time (in sec.)} \times 550}
\]

\[
\text{HORSEPOWER} = \frac{\text{WORK}}{\text{Time (in min.)} \times 33,000}
\]

Potential Energy - "energy, a body has due to its position, its condition, or its chemical state."

Position - water at the top of a waterfall

Condition - a tightly wound spring

Chemical - fuels

Kinetic Energy - energy of motion, released potential energy.
IV. POWER RESOURCES – Upon completion of this unit, the student will understand:

Nuclear Power

Nature of Matter

atom

electron

neutron

proton

elements

compounds

Atomic Fission

Atomic Fusion

Nuclear Reactor

Solar Power – Sun gives light and heat

Early experiments with reflectors and mirrors

Thermopile – 1863

Photogalvanic Cell – 1839

Barrier – laser photovoltaic cell – 1876

Improved photovoltaic cell – 1954 (solar battery)

Fuel Cell

Components

Operation

Thermo Electricity

Geothermal Power

Bio-Fuels
V. BASICS OF ELECTRICITY - Upon completion of this unit, the student will understand:

Electricity

atomic theory

structure of atom

electron
neutron
proton
nucleus

Conductors and insulators

Electrical Terms

Voltage -

Unit of measurement - volts

Current -

Unit of measurement - Amperes (AMPS)

Resistance -

Unit of measurement - OHMS

OHMS LAW - Relationship between VOLTAGE, CURRENT, AND RESISTANCE.

Use of Magic Circle - Used to find a missing value. In this equation when two values are known.
Formulas

To find Voltage  
\[ E = I \times R \]

To find Current  
\[ I = \frac{E}{R} \]

To find Resistance  
\[ R = \frac{E}{I} \]

Series Circuits

Definitions and terms related to Series Circuits

Operation of a Series Circuit in Terms of Voltage, Current, and Resistance

Parallel Circuits

Definitions and Terms related to Parallel Circuits

Operation of a Parallel Circuit in Terms of Voltage, Current, and Resistance

Meters

Instruments for Measuring Voltage, Current, and Resistance Values.

Application of Meters

Set-up of meters

Safety requirements in their use
VI. MEASURING ENERGY - Upon completion of this unit, the student will understand these units of measurement.

Work

Motion caused by applying force

Work is measured in foot/lbs.

Work is found by multiplying the force times the distance

Force

Any push that can be measured on a scale is force

Force may be measured the same as weight in ounces, pounds, and tons

Usually measured in Ft/Lbs. or Lbs. per Ft.

Torque

Torque is a measurement of twisting or turning force

Usually measured in Ft/Lbs or In/Lbs.

Found by multiplying force x radius

Power

How long it takes to do the work

The rate of work being done

Measured in Ft/Lbs per second or minute

Horse Power

The amount of work that could be done by the average horse

1 Hp = Move 550 ft/lbs in one second

1 Hp = Move 33,000 ft/lbs in one minute
Watts

Usually a measurement of electrical energy

May be found by using the power formula \[ W = \text{Volts} \times \text{Amps} \]

746 Watts = 1 Horse Power

British Thermal Unit

A measurement of heat energy

276 BTU/hour = 1 horse power

One BTU = 252 Calories
VII. THE ENERGY OF MOTION - Upon completion of this unit, the student will be able to apply these terms:

**INERTIA**

A body at rest tends to remain at rest unless acted upon by another force. A body in motion tends to remain in motion going in a straight line unless acted upon by another force.

**FRICTION**

Is the resistance to motion that occurs between two objects when they touch each other. When motion is altered by friction, energy is given off as heat.

**MECHANICAL ADVANTAGE**

Is a change in ratio between force and distance while the work input and the work output remain the same.

**MECHANICAL TRANSFER OF ENERGY**

Pulleys and Belts

V-Belts

V-Belt Pulleys

Multiple V-Belt Assemblies

Toothed Pulleys

Timing Belt Assemblies

Chains and Sprockets

Roller Chains and Sprockets

High Speed Chains and Sprockets

Specialty Chains
Gears

Spur Gears

Helical Gears

Bevel and Miter Gears

Worm Gears

Clutches

Friction Clutches

Positive Drive Clutches

Overrunning or Freewheeling Clutches

Couplings
VIII. HYDRAULICS - Upon completion of this unit, the student will understand the basic principles of hydraulics:

A liquid cannot be compressed

Pascal's Law: "The pressure at any point in a static liquid is the same in every direction and exerts equal force on equal areas".

The ratios for input and output of a static fluid power system may be equated to a lever.

\[
\text{(WORK} = \text{FORCE} \times \text{DISTANCE})
\]

HYDRAULIC COMPONENTS

Reservoir
Tubing pipes and hoses
Pumps
Valves
Motors
Cylinders
Hydraulic Fluids
IX. PNEUMATICS - Upon completion of this unit, the student will understand the basic principles of pneumatics:

Pascals Law: "The pressure at any point in a static fluid is the same in every direction and exerts equal force on equal areas".

Gases may be compressed

Temperatures cause a wide variation in pressure

Boyle's Law: "The absolute pressure of a combined body of gas is inversely proportional to the volume, provided the temperature remains constant".

Air is the most common pneumatic fluid

PNEUMATIC COMPONENTS

Pump or compressor

Reservoir or storage tank

Hoses or pipes

Valves

Motor or Pneumatic cylinder
TYPES OF ENGINES

RECIPROCATING STEAM ENGINE

Uses an external boiler
Piston and cylinder
Slide valve
Crankshaft and flywheel

STEAM TURBINES

In wide use today
Use rotors instead of pistons
Uses an external boiler

INTERNAL COMBUSTION ENGINES

Two stroke reciprocating gasoline engines
Four stroke reciprocating gasoline engines
Diesel engines
Gas turbine engines
Rotary Engines
Jet engines
Rocket engines
XI. SMALL GASOLINE ENGINES

At this time in the development of technology, the internal combustion engine is the most widely used of all engines. Millions of automobiles and millions more small gasoline engines are manufactured each year. The small gasoline engine being readily available and representative in design was chosen here to represent the principles and theory of operation of the internal combustion engine.

SAFETY RULES FOR SMALL GASOLINE ENGINES

Never put gasoline in the throat of a carburetor

Always use the right tool for the job

Do not attempt to start an engine unless it is mounted properly

Start an engine only with the instructors permission

Always store gasoline in the proper container and keep the container in the proper storage area

Have a fire extinguisher near by

Only start an engine in an area with the proper ventilation

* Always REMOVE the spark plug before working under a lawn mower. Many hands and feet have less than five fingers or toes because of not following this rule.
SMALL GASOLINE ENGINES

Theory of the four-stroke cycle reciprocating gasoline power engine.

Power at every other rotation.

THE BASIC ENGINE

Cylinder block and head
Piston, pin and rod
Crankshaft and bearings
Camshaft and timing gears
Valves and lifters

FUEL SYSTEMS

Carburetors
Storage, filters and fuel lines
Fuel pumps

LUBRICATION

Classifications of oil
Oil pumps and splasher

IGNITION SYSTEM

Magneto theory and operation
Battery ignition

STARTING SYSTEMS
COOLING SYSTEMS

THEORY OF 2 STROKE CYCLE ENGINE

- Power at every rotation
- Reed valves
- Rotary valves
- Loop Scavenging
- Cross Scavenging
- Oil/Gasoline Mixtures
LEVEL II, INTRODUCTION TO THE AUTOMOBILE

I. INTRODUCTION TO THE COURSE

Upon completion of this unit, the student will understand:

Reasons for taking this course
Course content
Course philosophy
Student goals and objectives
Student responsibilities
The value of reading and self study
The emphasis placed on safety
Effect of the automobile industry on the economy
Career opportunities in the automotive field
A brief history of the automobile

The basic construction of the automobile with respect to:

   Engine
   Frame
   Power train
   Body

II. ENGINE OPERATION

Upon completion of this unit, the student will understand:

Types of engines

   External combustion
   Internal combustion

   Spark ignition

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Four stroke cycle
Two stroke cycle
Rotary

Compression ignition (Diesel)

Four stroke cycle engine operation

Definition of cylinder and engine designation by number of cylinders
Construction of the engine block, and the materials used
Piston and nomenclature of component parts
Combustion of fuel in terms of the change of chemical energy into energy of motion
The crank as a means of converting reciprocating motion into rotary motion
Crankshaft and the function of main bearings
The need for systematic movement of air and fuel into cylinder and end products out of cylinder
Cylinder head, spark plug opening, valves, valve train and camshaft Sequence of strokes
Methods of driving the camshaft and the relationship between camshaft and crankshaft speed
Intake manifold and carburetor, and method of fuel delivery to the intake valve
Exhaust manifold and method of exhaust flow out away from the exhaust valve
Water jacket
Flywheel and its purposes

Two stroke cycle engine operation (as covered in Level I)

Compression Ignition (Diesel) Operation

Diesel engine cycles

Four stroke cycle
Two stroke cycle

Similarities of diesel and gasoline engines

Cylinder block, pistons, connecting rods, crankshaft lubrication system, cooling system, camshafts, valve arrangements, starting motors
Differences between diesel and gasoline engines

Diesels have heavier construction, compression ignition, higher compression ratios, injection type fuel systems, and are more efficient.

Differences among diesels

Fuel systems, combustion chamber design, method of supplying air, speed of operation.

Rotary engine operation

Component identification

Rotary engine theory of operation

Two rotor vs. one rotor engines

Comparison of rotary engine to piston engine

Engine measurements

Definition of terms (as covered in Level I)

Work
Energy
Power
Torque
Horsepower
Inertia
Friction

Definitions of:

Bore and Stroke
Piston displacement
Compression ratio
Volumetric efficiency
Brake horsepower
Indicated horsepower
Friction horsepower
Engine torque
Engine efficiency
III. COOLING SYSTEM

Upon completion of this unit, the student will understand:

Need for cooling the engine

Two basic types of cooling systems (Air and Liquid cooling)

Air cooling

The purpose of cooling fins as an increase in surface area

Liquid cooling

Components identification and their purposes

Engine water jacket

Water pump

Nomenclature and purposes of component parts (housing, impeller, seal and bearing)
Operation of impeller and water flow through pump
Failure modes and identification of same
Bearing squeal
Seal leak

Fan

Purpose of fan and method of drive
Clutch type fan
Electric fans
Safety hazard of moving fan
Safety hazard of fan blade breakage
Safety hazard of V-belt
Procedure for belt inspection
Procedure for belt adjustment

Radiator

Purpose of radiator
Two basic types of radiators
Down flow
Cross flow
Inlet and outlet fittings, cap opening, drain petcock and transmission cooler fittings

Heater

Purpose and operation as a small radiator
Methods of heat control
Air flow control
Water flow control

Hoses

Need for flexibility of hoses
Types of hoses (molded and universal)
Direction of coolant flow through all components and hoses
Hose inspection

Thermostat
Location and purpose
Bypass methods
Effect of failure modes:
Stuck open
Stuck closed

Pressure caps
Blow-off valve and vacuum valve
Purposes of cap:
Prevents surge losses when cornering
Permits pressure build-up to raise boiling point
Prevents vacuum condition in system during cool-down
Safety hazard of removing hot radiator cap

Cooling recovery systems
Procedure for testing pressure caps

Antifreeze
Purposes of antifreeze
Lowers freezing point
Raises boiling point
Contains rust inhibitor
Replacement interval
Cast iron blocks
Aluminum blocks

Determination of amount required
Draining and flushing system
Refilling system
Conventional system
Coolant recovery system
Antifreeze testing
Hydrometer theory of operation
Procedure for testing antifreeze with a hydrometer

Workshop activities
Pressure testing system
Removal and replacement of hoses
Flushing system
Removal and replacement of fan belts
Adjusting fan belts
Antifreeze testing
IV. BRAKES

Upon completion of this unit, the student will understand:

The need for and the importance of properly operating brakes
That brakes convert kinetic energy into heat by means of friction
Drum brake operation
Types of brakes
  Mechanical brakes
  Hydraulic brakes
The basics of hydraulics (from Level I)
Master cylinder and wheel cylinder operation
Procedure for master cylinder fluid level check
Types and qualities of brake fluid
The need for bleeding brake hydraulic system in terms of compressibility
  of air, and relation to pedal "feel"
Procedure for brake bleeding
Nomenclature of drum brake components
Bendix brake operation and self energizing feature
Operation of self adjustors
Types of linings
  Riveted
  Bonded
  Composition vs. metallic
Wear limits of linings (riveted and bonded)
Procedure for performing a brake job
Emergency brake adjustment
Disc brake operation and advantages over drum brakes
Disc brake wear limits and disc sensors
Procedure for performing a disc brake job
Hydraulic assist rear disc brakes
Safety hazard of high pressure in accumulator
Purpose of front wheel bearings
Procedure for repacking front wheel bearings
Procedure for adjusting wheel bearings
Workshop activities
  Brake inspection
  Repacking front wheel bearings
  Adjusting front wheel bearings
V. ELECTRICAL SYSTEM

Upon completion of this unit, the student will understand:

The fundamentals of electricity as covered in Level I
Operation of voltmeters, ammeters and ohmmeters
Automotive wiring in terms of one-wire and two-wire systems
Circuit faults
  - Open circuits
  - Short circuits
Fuses and fusible links (theory of operation and methods of replacement)
General lamp replacement
Test lamps and circuit checks
Checks of various accessories using a test lamp
Volmeter circuit checks
Battery theory of operation and cell construction
Charge and discharge in terms of chemical composition of battery
Electrolyte composition as an indicator of state of charge
Hydrometer theory of operation
Hydrometer check of battery state of charge
Safety hazard of working with battery without safety glasses
Danger of hydrogen gas in terms of sparks, cigarettes, etc.
First aid for acid spills on skin, eyes, clothes, etc.
Electrolyte level check and refill
Procedure for battery terminal cleaning
Proper use of jumper cables
Proper method of removing and replacing a battery
Proper method of charging a battery
Maintenance free batteries and comparison to conventional batteries
Charging of maintenance free batteries and possible safety hazards
Operation of the charging system
Generators and alternators: theory of operation
Voltage regulator operation
Charging system voltage test
Starter motor operation and starter drives
Operation of relays and solenoids
Neutral safety switches
Basic ignition operation (Conventional and Solid State)
Workshop activities
  - Fuse and lamp replacement
  - Circuit checks with a test light
  - Circuit checks with a voltmeter
  - Hydrometer tests
  - Battery electrolyte level check
  - Battery terminal cleaning
  - Use of jumper cables
  - Use of battery charger
VI. LUBRICATION

Upon completion of this unit, the student will understand:

Purpose of lubrication
Need to adopt a periodic maintenance routine

Engine lubrication
- Oil pan, oil pump, oil filter, oil pressure sending unit, and oil galleries
- Oil flow to valve train, main and connecting rod bearings
- Viscosity and SAE ratings
- Body and fluidity of oil
- The formation of sludge
- Procedure for checking oil
- Procedure for changing oil and filter
- Oil change interval recommendations
- Proper disposal of drained oil (Environmental considerations)
- Origin of crankcase vapors and operation of crankcase ventilation systems
- Road draft tube and effect on air pollution
- PCV system
- Procedure for servicing PCV valve, PCV inlet air filter and/or breather cap

Transmission lubrication
- Purpose of transmission in terms of power flow and gear ratios
- Manual transmission fluid check and types of gear oil
- Automatic transmission fluid check and types of ATF
- Purposes of ATF in terms of lubricating, cooling and transmitting forces
- Need to change fluid at regular intervals

Power steering systems
- Operation of power steering system
- Power steering fluid level check

Differential
- Purpose of differential in terms of power flow and gear ratio
- Differential gear operation
- Differential gear oil check and types of gear oil
- Limited slip differential and relation to conventional differential
- Gear oil used with limited slip differential

Chassis lubrication
- Identification of steering linkage components
- Procedure for lubrication of steering linkage components and types of chassis grease
- Procedure for lubrication of door latches, hinges, etc.

Workshop activities
- Engine oil check
- Oil and filter change
- Manual transmission gear oil level check
Automatic transmission fluid level check
Power steering fluid level check
Differential gear oil level check
Grease job

VII. FUEL SYSTEM

Upon completion of this unit, the student will understand:

Purpose of fuel system, and identification of components
- Fuel tank
- Fuel tank caps (vented and non-vented)
- Fuel tank sending unit
- Steel fuel line
- Flexible fuel line
- Fuel pump
- Fuel filters
- Carburetor

Gasoline
- Gasoline as a hydrocarbon compound
- The manufacturing process of refining crude oil
- Products of perfect combustion
- The pollutants emitted as a result of imperfect combustion
- Safety hazard of CO
- Volatility
- Detonation and preignition
- Octane ratings
- Use of tetraethyl lead and other additives
- Effect of compression ratio on detonation and octane requirement
- Lower compression ratios and lower octane unleaded fuels

Diesel fuel
- Diesel engine compression ratios
- Heat of compression
- Cetane rating

Fuel pump
- Identification of components (Diaphragm, inlet and outlet valves, etc.)
- Operation of pump during full flow and partial flow modes
- Failure modes and symptoms
- Operation of single and dual action fuel pumps

Fuel filters
- Location of fuel filters and service intervals
- Types of fuel filters and proper service procedures for each

Carburetor
- Air/fuel ratio requirements of engine with respect to engine operating modes and road speed
Carburetor air intake system
  Air filter and recommended service intervals
  Heated air inlet system
Intake manifold vacuum and relation to carburetor operation
Basic carburetor operation (Venturi effect, fuel nozzle, atomization vs. vaporization, air bleeds, etc.)
Throttle valve and effect on engine speed
Fuel inlet system
Carburetor jets, as a method of metering fuel
Idle system
Low speed system
High speed part throttle system
High speed full throttle system (fuel enrichment)
Accelerator pump system
Choke operation
Carburetor adjustments
  Use of a tachometer
  Procedure for adjusting idle speed
  Procedure for adjusting idle stop solenoid (anti-diesel solenoid)
Fuel injection
  Theory of fuel injection
  Types of fuel injection
  Component identification
  Electronic fuel injection
Workshop activities
  Air filter replacement
  Operational check of heated air inlet system
  Fuel filter replacement
  Disassembly and reassembly of a carburetor
  Idle speed adjustment
VIII. IGNITION SYSTEM

Upon completion of this unit, the student will understand:

Purpose of the ignition system
"Tune up" as a repair function of the ignition system
Identification and purpose of the following ignition components:
- Ballast resistor
- Ignition coil
- Distributor
- Ignition wires
- Spark plugs
- Points and condenser
- Rotor

Firing order
Ignition system schematic diagram
Detailed operation of the ignition system
Points, rotor and spark plug wear, and the effect on the ignition system operation
Points and condenser replacement on a Ford distributor
Point adjustment with a feeler gauge
Points and condenser replacement on a General Motors distributor
Dwell
Procedure for adjusting dwell with a dwellmeter
Spark timing and relation to engine power
Procedure for measuring ignition timing with a timing light
Centrifugal advance and relation to engine speed
Vacuum advance and relation to engine load
Spark plugs (thread diameter, washer vs. tapered seat, reach, heat range, etc.)
Procedure for spark plug removal and replacement using proper torque specifications
Proper sequence of tune-up operations
Solid state ignition systems and comparison to breaker point ignition systems
Component identification of the various solid state systems
Magnetic triggering of spark
Hall Effect triggering of spark
Tune up operations and adjustments on solid state systems
Workshop activities
- Replacement of points, condenser and rotor
- Adjustment of points with a feeler gauge
- Adjustment of points with a dwellmeter
- Timing measurement and adjustment
- Spark plug replacement
- Air gap adjustment on Chrysler magnetic distributor
IX. INTRODUCTION TO SHOP ACTIVITIES

Upon completion of this unit, the student will understand:

Tire service
- Procedure for changing a wheel and tire (safely), with respect to placement of vehicle jack, proper body mechanics, etc.
- Procedure for proper use of floor jack
- Differences between bias ply and radial tires
- Tire rotation patterns (bias and radial ply)
- Tire pressure
- Tire sizes, grades, etc.
- Tire inspection (wear bars, tread defects, ply separation, etc.)
- Tire repair techniques
- Tire balancing (static, dynamic)

Windshield wiper service
- Removal and replacement of various wiper insert types

Exhaust systems
- Exhaust system inspection
- Procedure for removal and replacement of exhaust system components

Workshop activities
- Tire changing and rotation
- Checking tire pressure
- Removal and replacement of windshield wiper inserts
- Replacement of exhaust system components
X. MANUAL TRANSMISSION

At the end of this unit, the student will understand:

The purpose and operation of manual transmissions
   Torque multiplication
   Power flow
   Sliding gears
   Constant mesh gears
   Synchronizer action
   Shift mechanisms
   Lubrication

Transmission components
   Mainshaft assembly
   Countershaft assembly
   Reverse idler assembly
   Input shaft
   Gears
   Synchronizers
   Shifter fork assemblies
   Bearings
   Seals and gaskets
   Case

Troubleshooting and diagnosis
   Transmission shifts hard
   Gears clash when shifting
   Transmission is noisy
   Transmission jumps out of gear
   Transmission is locked in one gear and cannot be shifted out of that gear

Transmission servicing
   Transmission removal
      Remove shift rods and speedometer cable
      Drain lubricant
      Remove drive shaft
      Support engine
      Remove transmission cross member
      Unbolt and remove transmission
   Disassembly
      Follow steps listed in service manual
   Clean and inspect
   Reassemble
   Install in vehicle
XI. CLUTCHES

At the end of this unit, the student will understand:

The purpose and operation of clutches
Clutch components
   Flywheel
   Pilot bearing
   Driven plate assembly
   Pressure plate and cover assembly
   Throwout bearing
   Clutch fork
   Clutch housing
Clutch linkage
   Mechanical - levers
   Mechanical - cable
   Hydraulic
Troubleshooting and diagnosis
   Clutch chatter
   Clutch slippage
   Clutch drag
   Clutch pedal pulsation
   Clutch - related vibration
   Clutch area noises
Clutch servicing
   Adjustments
      Pedal height
      Clutch pedal free play
   R & R
      Remove transmission and drive shaft
      Remove clutch assembly and disc
      Remove clutch release bearing and sleeve assembly
      Clean and inspect components
      Assemble
LEVEL III, ADVANCED AUTOMOTIVE MECHANICS

INTRO TO THE COURSE

Discuss the following:

Reason for taking course
Course content

(Student) Goals and objectives
Student responsibilities
Nature of reading and self-study
Career opportunities
Influence of technology on the vehicle
Influence of fuel conservation and Federal Clean Air Act Ammended 1970

COOLING SYSTEM

Upon completion of this unit, the student will understand:

The purpose and components of cooling system
The by-pass system
The proper pressure testing procedures
  - Radiator testing technique
  - Radiator cap testing technique
  - Safety hazard of pressure testing on a hot engine
Purpose of engine freeze-out plugs
R & R of engine expansion, freeze plug (types, dish, cup, rubber moly)
Engine gaskets failure and detection of damaged or failed gaskets
  - Exhaust bubbles in radiator
  - Coolant in engine oil
  - Fouled spark plugs, etc.
Radiator repair techniques
  - Sealers
  - Soldering
  - Recoring
  - Rodding out
  - Flow testing
Heater core trouble shooting
  - Heater core leakage and diagnosis is W/OA/C, W/AC
  - W/AC probability of having to discharge A/C system
R & R waterpump procedures
  - Importance of checking two-piece pump bolts
  - Importance of thoroughly cleaning mating surfaces and torque on aluminum components
IGNITION

Engine Tune-up

Upon completion of this unit, the student will understand:

- The purpose of an engine tune-up
  - Restore fuel mileage
  - Power
  - Maintain clean air
- The difference between major and minor tune-ups
- Dwell angle and breaker point theory
  - Procedure for installing and setting air gap of breaker pts.
  - Installation and use of dwell meter to set or check points
- Where to find and how to interrupt tune-up specifications
  - Professional manuals
  - Manufacturer's decals, etc.
- The proper sequence of a tune-up
  - The battery
  - Compression test, etc.
  - Point setting
  - Engine R.P.M.
  - Advanced mechanism to correct ignition timing
- Advance curve theory
  - Mechanical adjustments
    - Diagnostic procedures
    - Theory of operation
    - Diagnostic procedures
- Vacuum advance units (single and dual advance units)
  - Theory of operation
  - Adjustment
  - Diagnostic procedures
- The importance of a complete visual inspect
  - Fluid levels
  - Belts and hoses
  - Reading spark plugs
- How to mark or index dist. for removal and replacement
  - Causes of dwell variation
- Static and monolithic timing and dwell advance settings
- Setting curb idle, throttle solenoid and fast idle speed
- Technique for checking R & R PCV valve
- Checking and cleaning various emission control devices
- Proper road test procedures and clean-up before returning vehicle to owner, if authorized by local educational assoc.
Upon completion of this unit, the student will understand:


The three basic emissions
- Hydrocarbons
- Carbon monoxide
- Oxides of nitrogen

Reference sources for related emission specifications

Crankcase emission devices
- Road tubes
- PCV systems
  - Closed
  - Open
- Discuss PCV testing, cleaning procedures

Exhaust system control devices (catalytic converter theory of operation)
- Pellet type
- Honeycomb servicing

Major engine modifications used to reduce emissions, i.e.,
- Compression ratios
- Combustion chamber shape
- Valve port shape
- Camshaft designs
- Raising engine temperatures
- Leaner mixtures
- On-board computers

Engine Control devices theory
- Exhaust gas recirculation valves
- Transducer valves
- Thermactor (air pump systems)
- Anti-backfire valves/one-way check valves
- Dump valves/Decel valves
- Temperature control switches
- Spark Delay valves/Ported vacuum switches
- Electric chokes/heat risers

Evaporative emission control theory & components
- Charcoal canister
  - Fuel caps
    - Vented
    - Non-vented

The use of exhaust gas analyzer
- Demonstrate calibration
- Testing of an engine
FUELS

Upon completion of this unit, the student will understand:

Fuel pump testing procedures
  Pressure tests
  Capacity testing
  Suction side testing
The need for visual check of fuel lines, hoses, evaporative emissions systems
Electric fuel pumps
  Pusher type
  Suction type
The use of resistor lines and oil pressure control switches for special by-pass circuits
Fuel vapor lock
Super-charger
  Centrifugal type
  Roots type
The theory of turbo chargers including related gate or diverter control valves
Carburetors
  Float
  Idle
  Low speed transfer
  High speed
    Main metering jets
    Their identification and relationship to normal high speed
Power
  Power valves
  Metering rods
  Power piston types
Accelerator
  Cup type accelerator pump
  Pump diaphragm type
Choke circuit
  Bimetallic
  Electric
  Coolant types
Where to find carburetor specification
Setting float height and float drop adjustments
Fuel idle mixture screws, limiter caps, and adjustments
  External adjustments - primary
  Secondary choke pull offs
  Dechoke
Accelerator pump rods
Idle setting procedures and methods
Lean roll
Propane enrichment
Vacuum gauge adjustment
Fuel injection

ENGINES

Upon completion of this unit, the student will understand:

The need for proper cleaning and inspection of engine components
  Hot tank
  Steam
  Ultrasonic
Proper procedure for removal of engine or engine and transmission assembly from a vehicle
Block inspection procedures
  Determine defects
  Extent of wear
  Warpage
  Internal and external cracks
    Magnaflux
    Sonoflux inspection
  Stripped threads, etc.
  Checking for excessive corrosion
Cylinder reconditioning procedures
  Remove cylinder ridge
  Reboring with boring bar
  Honing with various stones to produce crosshatch pattern
  Sleeving
    Wet cylinder sleeves; its installation and sealing
    Dry cylinder sleeves; its installation and sealing
How to measure piston clearances in the cylinder
How to measure cylinder bore, cylinder taper and cylinder out of round
Maximum taper and out-of-round limits
Piston sizing
  Resizing-heat
  Knurling
Inspection of crankshaft
  Taper
  Abnormal wear
  Bends

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Flat spots
Cracks
Reground crankshafts fitted with undersized fitted bearings
Typical bearing wear, patterns
Normal
Use of plastic gauge
Need for cleaning all oil passages - leak detection testing
Lift
Duration
The procedure for inspection and measuring of camshafts or dial
indicating the necessity of special cam bearing installation tools
and precaution about proper bearing installation
The measurement of crankshaft end play - and connecting rod side
clearance
Purpose and techniques for marking and keeping rods and caps
together
How and why rods should be checked
Proper technique of fitting and installing bearing shell, sleeve-type
bearings - "crush, spread"
Shells
Sleeve
Proper torquing and locking practices
Removing bearing shells and main seals
"Roll-out-pin"
"Chinese finger"
Replacement of freezeout plugs and oil gallery plugs
Various oil pumps and relief valves
Gear type
Rotor type
How to "prime" an oil pump and why this procedure is performed
Cylinder head reconditioning--general removal technique and pre-
cautions
Cast iron
Aluminum engines
Head assembly cleaning and inspecting
Checking for warpage
Cracks
Corrosion
Procedure for disassembly of heads (valves and springs in original
position)
The cleaning, inspection, and grinding of valves
Inspection of valves for
Burns
Cracks
Warpage
How to inspect valve guides
Various techniques for repair of valve guides
Use of reamer and oversized valves
Rebushing of guide
Knurling guides

The procedure for reconditioning valve seats
Determining valve seat concentricity
Various seat types
Induction hardened, inspect
How and when they are replaced
Narrowing and lapping

The various types of guide seals and their proper installation

Valve spring theory
Checking procedures squareness
Length
Compressing length
Positive rotation devices

Inspection of push rods, rockers, fulcrums and lock nuts, rocker arm assemblies

Proper valve adjustment procedures
Proper mechanical lifter adjustments: cold lash, hot lash, silent lash adjustment
Hydraulic lifter cleaning and checking, bleed down and time standards

Piston cleaning and inspection
Sizing rings for end gap and side clearance (mention use of spacers)
Piston resizing
Reheating
Knurling
Steel expander rings

Inspection techniques for timing belts, sprockets and chains, and gear assemblies
Upon completion of this unit, the student will understand:

Suspension—refer to front and rear springs used to suspend a vehicle's frame, body, engine, and power train above the wheels. "Sprung" "Unsprung weight"

The various types of springing devices

Leaf
Coil springs
Torsion bars

The two types of front axle suspension generally used

Independent systems
Solid axle systems

Independent suspension use of coil springs and torsion bars to include their mounting and non-interchangeability

Shock mounting designs (including MacPherson strut)

Ball joints—theory
Inspection and testing
Removal and installation procedures

Upper and lower control arms, short-long arm design, stabilizer and sway bars

Stabilizer and sway bar purpose
Solid axle systems
King pin spindle designs
Leaf spring construction and mounting

Rear axle suspension combinations

Coil spring
Upper and lower control arms (strut rods)
Stabilizer bars

Leaf spring
Shock absorbers
Double action
Air assisted shocks

Why shocks are mounted on the bias
The procedures for checking shocks
Bounce test
Leakage test

Alternative suspension devices
MacPherson struts
Air suspension systems
Automatic leveling devices

Steel wheel fabrication
Care
Service
Proper torquing procedures
Upon completion of this unit, the student will understand:

The two basic types of steering systems
Manual systems
  Theory
  Components of steering gear system
  Steering wheel shaft (collapsible)
  Gear box
  Linkage
  Knuckles
  Wheel spindle assemblies
Types of manual steering gear
  Worm and sector
  Worm and recirculating ball
  Rack and pinion systems
Sector shaft and worm gear adjustment
Flexible couplers
The theory of steering linkages and their inspection
  Tie rods
  Drag links
  Connector sleeves
  Idler arms
Power steering systems
  Integral type
  Linkage - booster type power steering assemblies
The purpose and various types of common hydraulic pump
  Vane
  Slipper ring
Typical hydraulic control valve
Reading of a hydraulic schematic
ALIGNMENT

Upon completion of this unit, the student will understand:

The changes in demands on steering components from early times—horse-drawn wagons to today's vehicles

Front wheel angles
  Caster
  Camber
  Toe-in
  Steering axis inclination
  Toe-out on turns

Tools and equipment used to measure camber, caster, and toe-in

The relationship of steering axis indication to
  Toe-out on turns
  Camber
  Caster

The importance of inspection of front-end components, suspension condition, and tire size

The methods of adjusting the various angles
  Shims
  Eccentric adjustments
  Bending techniques

The effects of vehicle loading on
  Tire wear
    Normal war patterns
    Wear "characteristics" which help in diagnosing alignment problems

Alignment problems
  Hunt
  Pull
  Wander
Upon completion of this unit, the student will understand:

- Operation of charging system and voltage regulators
- The construction and basic operating theory of an alternator
- The similarities and differences between alternators and generators
- Physical components (fields, poles, permanent magnets, brushes) of alternators
- The differences in type of current produced (direct current v. alternating current)
- Converting AC to DC by use of rectifiers
- Why an alternator voltage regulator need not have a cut-out relay
- The use of transistors in voltage regulators
- All electrical testing must be done when a fully charged battery
- Basic technique used to check a charging system (voltmeter)
- The need to isolate individual component in order to properly diagnose charging system
- A voltage regulator isolation test
- An alternator output test and the factors effecting the results
- General alternator repairs
  - Replacing brushes
  - Bearing
  - Rectifier bridge or ring
- Diode testing procedures
- Rotor testing procedures
- The need to properly ground all electrical components
- Direct current generator devices, Types 1, 2, 3. Shunted
- "Polarizing" of generators
- Common generator repairs
  - Service lubrication
  - Replacing bearings
  - Brushes
  - Cleaning and cutting of commutator surface
- Inspection of generator components
  - Brushes
  - Brush holders and springs
  - Armature
  - Field coils
- The use of the "growler"
- The Importance of proper voltage regulator setting to generator output and service
- Basic automotive electrical symbols and schematics
- "Circuits" and various electrical devices (control and protection)
- Use of volt, ohm and ammeter and their proper hook-up (parallel and series connections)
STARTING SYSTEMS

Upon completion of this unit, the student will understand:

The components of starting system
- Battery
- Cables
- Solenoids
- Relay
- Starter motor
- Ring gear
- Ignition switch
- Neutral switches

The purpose of the battery and its function in the starting system
- Starter cranking voltage test
- A high rate discharge test/starter current draw test
- Battery terminal cleaning techniques
- Neutral-safety switches/clutch neutral switches
  - Their function
  - Trouble shooting

Starter relays and solenoids
- Operation
- Function
- Trouble shooting

Safety precaution to be remembered when removing or working on a starter in a vehicle (Disconnect battery from electrical system)

Starter drive inspection and replacement

Starter testing
- Cranking voltage test
- Cranking speed test
- Starter draw test

Basics of off-vehicle inspection (lock-up, bearings, and no-load test)

Starter components and starter disassembly technique

Starter motor reconditioning procedures
- Inspecting armature
- Replacing brushes
- Solenoids

Checking fields and internal connections and circuitry
DIFFERENTIALS

Upon completion of this unit, the student will understand:

- The purpose of a differential assembly
- The basic evolution of the differential
- The identification of an uses of non-hunting, partial hunting and hunting gears
- The power flow within a differential while driving straight ahead and while cornering
- The basic operating components—construction and operation
- The removable carrier and integral type assemblies
- Pinion bearing adjustments depth and preload
- Ring gear backlash adjustments—spanner and shim
- How to read ring/pinion tooth contact patterns
- How to inspect carrier components for wear and damage
- How to determine correct carrier lubricant and proper filling procedures
- How a "limited-slip" differential operates
- How to replace a pinion seal
- How to remove and service axle bearing and axle seals on flange and "C" clip type axle shafts
- The difference in theory and service between regular, semi-floating and full-floating axle shafts
- How to use a dial indicator to check carrier backlash and adjust axle lateral movement
- The basic theory of a rear transaxle and its theory of operation
- The basic construction of a front-drive transaxle and its theory of operation

AIR CONDITIONING

Upon completion of this unit, the student will understand:

- The purpose and components of an automotive air conditioner—cool, clean and dry air
- Basic "Physics" of states of matter
  - Solids, liquids and gases
- Latent heat required or given off in change of state
- The refrigerant R-12 and its physical properties and characteristics—safety precautions when working with Freon
- The effects of pressurization on both vaporization and condensation of a liquid
- The basic air conditioning components and each function
  - Compressor

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Condenser
Reliever - Dehydrator
Expansion valve
Evaporator
Suction throttling valve
Sight glass

The need for evacuating the system before recharging
Servicing procedures including checking oil and recharging
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