

Mercer County Community College

Division of Business and Technology

AUT 114

Automotive Electricity and Electronics

COURSE DESCRIPTION

How electrical/electronic principles are used in current automotive systems. Subject areas include starting and charging systems, use of wiring diagrams and manuals, chassis wiring service, passive restraint systems, electronic speed control and other automotive accessories. Major emphasis is on diagnostic skills, testing procedures, and proper service and repair of components.

Text (s): **Reference Division Booklist**

Prerequisites: **AUT111 and EET171**

Co-requisites:

Credits: **3** Lecture Hours: **2** Studio/Lab Hours: **2**

Food and drink are strictly prohibited in classrooms as per health and safety laws. Students may not bring in chemicals or cleaning fluids of any kind without the appropriate MSD sheets.

Course Coordinator: Fred C. Bassini

Latest Review: Fall 2004

GENERAL LEARNING OBJECTIVES

1. To have the student/apprentice apply his/her diagnostic skills to problems relating to the electrical and electronic systems currently in use.
2. To provide the student/apprentice with the ability to successfully diagnose and service the starting and charging systems used on today's engines.
3. To acquaint the student/apprentice with the theories of operation and service procedures used on the electrical accessories found on the automobile.

TOPIC

I. REVIEW OF BASIC ELECTRONIC FUNDAMENTALS

Performance Tasks

A. VOLTAGE/CURRENT/RESISTANCE

1. Definition
2. Relationship
3. Ohm's Law

B. DIGITAL VOLT/OHM METERS

1. Reading Display
2. Decimals

C. REVIEW: THE SIX-STEP ELECTRICAL DIAGNOSIS

1. Procedure:
 - a. Verify the Complaint
 - b. Determine Related Systems
 - c. Analyze the Symptoms
 - d. Isolate the Trouble
 - e. Correct the Trouble
 - f. Check for Proper Operation
2. Applying to Solve Electrical Problems
 - a. Sample Problems

D. REVIEW: ELECTRICAL CIRCUITS AND WIRING DIAGRAMS EE01

1. Wiring Code Identification
2. Component Symbols
3. Locating Components in Diagrams
4. Understanding Electrical Circuits
 - a. Sample Problems

II. CHARGING SYSTEM PRINCIPLES

A. ALTERNATOR CONSTRUCTION AND COMPONENTS

1. Types of Systems, Design and Identification
 - a. Chrysler Alternator
 - b. Bosch Alternators
 - i). Internal Voltage Regulator
 - ii). External Voltage Regulator
 - iii) Mitsubishi Alternator with Internal Regulator
2. Alternator Construction
 - a. Housing
 - b. Rotor
 - c. Stator
 - d. Brushes
 - i). Delta and “y” Winding
 - e. Diodes or Rectifiers
3. Principles of Operation
 - a. Magnetic Fields
 - b. Output Factors
 - c. Energizing the Rotor
 - d. Stator Windings
 - i). “Y” Type
 - ii). Delta Type
 - e. Rectification
 - i). Open and Shorted Rectifiers
 - ii). Effects on Output
 - f. Reverse Polarity
4. Principles of Voltage Regulation
 - a. Types of Voltage Regulators
 - i). Chrysler - External
 - ii). Bosch
 - (a) Internal
 - (b) External
 - (c). Mitsubishi - Internal
 - b. Current Flow
 - c. Temperature and Voltage

LAB ACTIVITY C-1: CHARGING SYSTEM OUTPUT CHECK - AVR TESTER

B. 1985 - 1994 EFI AND TURBO CHARGING SYSTEM

1. Theory of Operation
 - a. Components
 - b. Methods of Controlling System Voltage
 - i). System Voltage Control

**HOMEWORK ASSIGNMENT: READ PAGES 538-552
QUESTIONS 1-20; PAGES 551-552
ASE 1 - 10, page 552**

Performance Tasks

- ii). Internal Field Control
- iii). Direct Battery and Ignition Circuits
- iv). Battery Temperature Circuit

- c. Types of Systems
 - i). Chrysler
 - ii). Bosch

- 2. On-Board Diagnostics
 - a. Fault Codes
 - b. Performing Circuit Tests
 - c. Using the DRB-II

C. OVERHAUL, BENCH TESTING AND DIAGNOSIS

E20

- 1. Visual Inspection
 - a. Inspection
 - b. Belts
 - c. Cables and Wiring
 - d. Voltage Regulator Installation

- 2. Circuit Testing
 - a. Circuit Resistance Test
 - b. Current Output Test
 - i). Sun VAT-40
 - c. Voltage Regulator Test
 - i). Voltmeter Tester

EE22

- 3. Alternator Component Testing
 - a. Disassembly
 - b. Rotor Field Coil
 - c. Stator Coil
 - d. Rectifier
 - e. Field Brush
 - f. Alternator Bearing Service

EE24

- 4. Checking Condition and Output on Test Bench
 - a. SUN Alternator Tester

- 5. Overhaul Procedures
 - a. Component Replacement
 - i). Rectifiers
 - ii). Brushes
 - iii). Bearing
 - b. Assembly Procedures
 - c. Alternator Remove/Reinstall

EE23

LAB ACTIVITY: C-2: 1985-94 Computer Controlled Charging System Check. C-3: Alternator Overhaul

**HOMEWORK ASSIGNMENT: READ PAGES 553-569
QUESTIONS 1-15, PAGE 568
ASE Questions 1-10, pages 568-569**

III. STARTING SYSTEM FUNDAMENTALS

Performance Tasks

- A. Review Electric Motor Principles
 - 1. Motor Principles
 - a. Magnetic Fields
 - b. Armature
 - c. Armature Rotation
 - d. Drive Pinion
 - e. Overrunning Clutch
 - 2. Starter Motor Types and Construction
 - a. Construction
 - b. Types and Applications
 - (1) Bosch
 - (2) Mitsubishi
 - (3) Nippondenso
 - (4) Chrysler Gear Reduction
 - (5) Bosch Permanent Magnet
- B. Components - Starter Circuit
 - 1. Types
 - a. Battery
 - b. Ignition Switch
 - c. Neutral Start Switch
 - d. Starter Relay
 - e. Starter Solenoid
 - f. Starter
 - g. Wiring
 - 2. Starter Relay
 - a. Connects Battery to Starter Solenoid
 - b. Current Flow
 - c. Neutral Start Switch
 - 3. Starter Solenoid
 - a. Solenoid Windings
 - (1) Pull-In Torque
 - b. Pinion Engagement
- C. System Testing and Diagnosis
 - 1. Starter Motor Diagnosis - Voltage Drop Test
 - 2. Current Draw Test
 - a. Visual Inspection
 - b. Current Draw Test
 - 3. Insulated Circuit Test
 - a. Battery to Solenoid Terminal
 - b. Battery to Starter Field Coil

EE16

**HOMEWORK ASSIGNMENT: READ PAGES 508-519
QUESTIONS 1-15, PAGE 518
ASE 1-10, page 519**

Performance Tasks

4. Starter Ground Test
 - a. Battery to Starter Case
 - b. Battery to Engine Block

5. Control Circuit Tests **EE17**
 - a. Description
 - b. Starter Solenoid Test in Chassis
 - c. Starter Solenoid Bench Test
 - d. Starter Relay Test

LAB ACTIVITY C-4: Starter Motor Removal/Reinstall **EE18**

6. Starter Armature Testing
 - a. Using the Growler
 - b. Armature Short Test
 - c. Armature Ground Test

7. Starter Component Testing
 - a. Field Coil Test
 - b. Brush Holder Test
 - c. Starter Brush Inspection
 - d. Starter Clutch Drive Unit
 - e. Starter Bushing Service
 - f. Free Running Bench Test **EE19**

- D. Overhaul Procedures
1. Disassembly Procedures
 2. Armature Service
 - a. Commutator Turning
 3. Brush Replacement
 4. Clutch Drive Replacement
 5. Reassembly

LAB ACTIVITY C-5: Starter Component Testing and Overhaul

HOMEWORK ASSIGNMENT: READ PAGES 520-537
QUESTIONS 1-15, PAGE 535
ASE Questions 1-10, PAGES 535-536

IV. SYSTEMS

- A. Instrument Clusters
1. Types
 - a. Mechanical
 - (1) Bi-Metallic/Thermal-Type Gauges
 - (a) Operation
 - (b) Diagnosis and Testing
 - (2) Magnetic Gauges
 - (a) Operation
 - (b) Diagnosis and Testing
 - b. Huntsville Electronic
 - (1) Applications and Types

Performance Tasks

- (2) Theory of Operation
 - (a) Vacuum-Tube Fluorescent
 - (i) Instrumentation
 - (b) Microprocessor Inputs
 - (c) Vehicle Speed Sensor
- (3) Self-Diagnostic Operation
 - (a) Test Procedure
 - (i) Interpretation of Data
- (4) Diagnosing Problems Outside of Cluster **EE31**
 - (a) Sensors
 - (b) Wiring
 - (c) Diagnostic Charts
- c. Motorola Electronic
 - (1) Application
 - (a) "H" - Body Car Only: 1986 Model Year
 - (2) Theory of Operation
 - (a) Instrumentation
 - (b) Programmable Odometer
 - (i) RAM Chip
 - (ii) Sensor Inputs
 - (3) Self-Diagnostic Operation
 - (a) Test Procedures
 - (i) Interpretation
 - (4) Diagnosing Input Problems
 - (a) Sensors
 - (b) Wiring
 - (c) Diagnostic Charts
 - (5) Cluster Service
 - (a) Cluster R/R
 - (b) Cluster Exchange Program

LAB ACTIVITY C-6: Instrument Cluster Diagnosis

**EE26, EE27, EE28,
EE29, EE30**

- B. Electronic Radio and Accessories
 - 1. Operation and Identification

- a. AM Radio
 - (1) Features
 - b. AM/FM Stereo
 - (1) Features
 - c. AM Stereo/FM Stereo
 - (1) Features
 - d. AM Stereo/FM Stereo With Cassette Player
 - (1) Features
 - e. Ultimate Sound System
 - (1) Graphic Equalizer (EQ)
 - (2) Ambience Control (AMB)
 - (3) Dynamic Noise Reduction Circuit (DNR)
2. Radio (Sound System) Diagnosis
- a. Diagnosis Questionnaire
 - b. Radio Noise
 - (1) Radiated Noise
 - (2) Conducted Noise
 - c. System Checks
 - (1) Sound System
 - (2) Speaker System
 - (3) Interference/Noisy Reception
 - (a) Noise Sections: 1,2,3
 - (4) Weak Radio Signal
 - (5) Intermittent Reception
 - (6) Radio Inoperative
 - (7) Memory Loss
 - (8) Only AM Inoperative
 - (9) Cassette Tape Player
 - d. Various Known Radio Problems
 - e. Sample System Wiring Schematics
 - (1) Radio Connector Pinouts
3. Noise Suppression
- a. Dash Panel Ground Strap
 - b. Windshield Wiper and Ignition Coil Capacitor Suppression
 - c. Power Amp Choke E & M Body
 - d. Engine to Dash Panel Ground Straps - FWD Vehicles
 - e. Alternator Capacitor

LAB ACTIVITY C-7: Electronic Radio Service

- C. Speed Controls
 - 1. Systems Components and Operation

Performance Tasks

- a. Safety Features
 - (1) Rapid Deceleration Cutoff
 - (2) Wheel Spin Cutoff
 - (3) Select System Malfunction Cutoff
 - b. Components
 - (1) Electronic Control Module
 - (2) Control Stick
 - (3) Speed/Distance Sensor
 - (4) Speed Control Assembly
 - (5) Solenoid Valve Body
 - (6) Vacuum Servo
 - (7) Vacuum Reservoir
 - (8) Throttle Cable
 - c. Operation
 - (1) Driver Controls
 - (2) System Operation
 - (a) 8000 Speed Sensor Pulses/Mile
 - (b) Supply Solenoid
 - (c) Vent Solenoid
 - (d) Dump Solenoid
 - (e) One-Way Check Valve
2. Diagnosis
- a. Road Test
 - (1) Verify the Malfunction
 - (2) System Inspection
 - b. System Diagnosis Flow Chart
 - c. Component Tests
 - (1) Electrical Test Equipment
 - (2) Ground Test
 - (3) Speed Control Switch Test
 - (4) Stop Lamp Speed Control Switch Test
 - (5) Clutch Switch Test (Manual Transmission)
 - (6) Speed Sensor Test
 - (7) Vacuum Servo and Reservoir Test
 - (8) Valve Body Test
 - (9) Electronic Module Test

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LAB ACTIVITY C-8: Electronic Speed Control Component Tests

- D. Windshield Wiper/Washer
1. Motor Designs
 - a. Non-Reversing
 - b. Reversing
 - c. Three-Speed
 2. Two-Speed Motor Operation
 - a. Park Switch
 - b. Park Cam
 - c. Control Switch
 - (1) Speed Control

Performance Tasks

3. Circuit Protection
 - a. Thermal Circuit Breaker
 - b. Fuse Panel
 4. Noise Suppression
 - a. External Capacitor
 5. Intermittent Wiper
 - a. Two-Speed Motor: Low Speed Circuit
 - b. Variable Resistor: Electronic Pause Control Unit
 - c. Delay Mode: 2 to 15 Seconds
 6. Windshield Washer
 - a. Electric Washer Pump
 - (1) Located in Reservoir
 - (2) Rotor-Type Design
 - b. Washer Nozzles
 - (1) Mounted on Hood
 - (2) Mounted on Wiper Blade
 - c. Low Speed Motor Circuit
 - d. Diagnosis
 - (1) Wiring Schematics
 - (2) Electrical Troubleshooting
 - (3) Component Replacement
 - (a) Motor
 - (b) Pump
 - (c) Switch
- E. Passive Restraint Systems
1. Safety, Storage and Packaging
 - a. System Components
 - (1) Driver Airbag Module
 - (2) Front Impact Sensors
 - (3) Safing Sensor
 - (4) Steering Column Clockspring
 - (5) Electronic Diagnostic Module
 - (6) Driver Airbag Warning Light
 - (7) Instrument Panel Kneeblocker
 - b. Driver Airbag Module Content
 - (1) Igniter Assembly (Squib)
 - (2) Inflator
 - (3) Bag Assembly
 - c. Driver Airbag System Concerns
 - d. Driver Airbag Module Safety Procedures
 2. Airbag Passive Restraint System
 - a. Operation Sequence
 - b. How the Airbag System Works
 - (1) Impact Sensors
 - (2) Driver Airbag Module
 - (3) Steering Column
 - (4) Airbag System Diagnostic Module

EE32, EE33

SS01

- (5) Additional System Features
- (6) Normal System Operation
- c. Servicing the Airbag System
 - (1) Storage and Handling
 - (2) Installation and Service
 - (3) Impact Sensors
 - (4) ASDM
 - (5) Airbag Module
 - (6) Airbag Module Disposal Procedures
 - (7) Clockspring Installation
 - (8) Wiring Harness
- 3. Motorized Passive Restraint Systems (Seatbelts)
 - a. How the System Works
 - (1) Components
 - b. Servicing the Motorized Seatbelt System
 - (1) Track and Drive Assembly
 - (2) Lap Retractor
 - (3) Torso Retractor Assembly
 - (4) Inboard Buckle-Lap Retractor
 - (5) Control Module
 - (6) Lubrication Procedures

LAB ACTIVITY C-9: Passive Restraint System Checks

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- F. Power Door Locks
 - 1. Operation and Components
 - a. Components
 - (1) Lock Motor
 - (2) Switches
 - (3) Circuit Breaker
 - (4) Rear Deck Solenoid
 - b. Operation
 - (1) Voltage Requirements
 - (2) Ground Connections
 - (3) Switch Operation
 - (4) Deck Lid Operation
 - (5) Door Lock Motor R & R
 - 2. Diagnosis
 - a. Circuit Breaker Test
 - b. Switch Voltage Test
 - c. Switch Test
 - d. Electric Motor Test

G. Power Window Assemblies

- 1. Operation
 - a. Components
 - (1) Lift Motor
 - (2) Gear and Pinion
 - (3) Regulator Assembly
 - (a) Conventional
 - (b) Flex Drive
 - b. Operation

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- 2. Diagnosis and Service
 - a. Switch Voltage Test
 - b. Lift Motor Test
 - c. Component Replacement
 - (1) Gear and Pinion
 - (2) Lift Motor
 - (3) Regulator Assembly

- H. Power Seat Mechanisms
 - 1. Operation
 - a. Components
 - (1) Six-Position Switch
 - (2) Motor-Permanent Magnet
 - (3) Gear Box Assemblies
 - (4) Cables
 - (5) Tracks
 - (6) 30 Amp Circuit Breaker
 - b. Basic Operation

 - 2. Diagnosis and Service
 - a. Preliminary Checks
 - (1) Harness Check
 - (2) Switch Test
 - (3) Motor Assembly Test
 - b. Component Replacement
 - (1) Cable
 - (2) Motor Assembly
 - (3) Adjuster

- I. Rear Window Defogger (Heat Rear Window)
 - 1. Operation
 - a. Components
 - (1) Alternator: 65 Amp
 - (2) Electric Window Grid
 - (3) Control Switch/Timer Relay Assembly
 - (4) Fusible Link
 - (5) Relay Circuit Fuse
 - b. Operation
 - (1) Grid
 - (2) Control Switch/Timer Relay Module

 - 2. Diagnosis and Service
 - a. System Test Procedures
 - (1) System Checks
 - (2) Rear Glass Grid Line Test
 - (3) Control Switch/Timer Relay Module Test
 - b. Repair Procedures (Grid Lines, Terminals and Pigtails)
 - (1) Mopar Repair Kit #4267992

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LAB ACTIVITY C-10: Heated Rear Window System Checks

III. V. COURSE REVIEW/FINAL EXAM

Evaluation

50% Direct Evaluation of Shopwork
40% Five Quizzes, Midterm/Final Exams
10% Class Participation