

TRN 120 Basic Transportation Electricity

COURSE DESCRIPTION:

Prerequisites: None

Corequisites: None

This course covers basic electrical theory, wiring diagrams, test equipment, and diagnosis, repair and replacement of batteries, starters, and alternators. Topics include Ohm's Law, circuit construction, wiring diagrams, circuit testing, and basic troubleshooting. Upon completion, students should be able to properly use wiring diagrams, diagnose, test, and repair basic wiring, battery, starting, charging, and electrical concerns. Course Hours per Week: Class, 4. Lab, 3. Semester Hours Credit, 5.

STUDENT LEARNING OUTCOMES:

After completing the course requirements, the student will be able to:

(State-wide outcomes)

- a. Demonstrate work place safety related to transportation electrical systems.
- b. Interpret and apply wiring diagram information on a transportation vehicle electrical system.
- c. Demonstrate the proper use of electrical diagnostic test equipment.
- d. Use Ohm's law to calculate the value of any of the following given the values of the remaining variables: Voltage (V), Resistance (R), Amperage (A)
- e. Given a transportation vehicle with a fault in the battery, starting, and charging system, students will be able to perform successful diagnosis and repairs.
- f. Demonstrate the ability to obtain appropriate service information on electrical circuit construction.

(Local outcomes)

- g. Explain the basic principles of direct current electricity, magnetism, inductance, and capacitance.
- h. Identify circuit types and circuit symbols.
- i. Identify and use circuit test equipment.
- j. Use schematics and perform circuit testing.
- k. Diagnose and repair various automotive electrical systems.

OUTLINE OF INSTRUCTION:

- I. Class orientation
 - A. Procedures and policies
 - B. Required materials and supplies
 - C. Automotive lab safety

- II. Types of Circuits (Understand Voltage, Amperage, and Resistance Relationships in Each)
 - A. Series
 - B. Parallel
 - C. Series-parallel

- III. Circuit Devices/Symbols
 - A. Fuses
 - B. Circuit Breakers
 - C. Fusible Links
 - D. Relays
 - E. Switches
 - F. Solenoids
 - G. Diodes (Include Zener-Type and LEDs)
 - H. Transistors (NPN and PNP)
 - I. Motors
 - J. Lamps
 - K. Resistors
 - L. Ground
 - M. Battery
 - N. Connections (Male and Female)

- IV. Circuit Test Equipment and Hook-Up (Know How to Read the Different Scales on Meters)
 - A. Voltmeter
 - B. Ammeter
 - C. Ohmmeter
 - D. 12-Volt Test Light and Logic Probe
 - E. Self-Powered Test Light
 - F. Short Detectors (Buzzers and Circuit Breakers)
 - G. Jumper Wires
 - H. High Impedance DVOM

- V. Circuit Testing (You Will Be Asked to Use Schematics in Locating Diagnosis Test Points)
 - A. Shorted Circuit
 - B. Open Circuit
 - C. Grounded Circuit
 - D. Intermittent Circuit Problems
 - E. Voltage
 - F. Truth Table Interpretation

- VI. Lighting Systems (Understand the Typical Operation for Each Circuit)

- A. Headlight Circuit
 - 1) High beam lamps
 - 2) Low beam lamps
 - 3) Dimmer switch
 - 4) Switch rheostat
 - 5) Wiring
 - 6) Test, aim, and replace headlights
- B. Stop Lamp Circuit
 - 1) Adjust Stop light switch
 - 2) Test stop light Portion of turn signal switch
- C. Directional Signal Circuit
 - 1) Flasher types
 - 2) Switch replacement
 - 3) Flashing speed
- D. Hazard Warning Lights
- E. Tail Lamp Circuit
- F. Back-Up Lamp Circuit
- G. Instrument Panel Displays and Interior Lights
 - 1) Printed circuit boards/connectors/wires
- H. Problem/Diagnosis
 - 1) Intermittent, dim, or no headlight operation
 - 2) No dash light brightness control
 - 3) No flash on one or both sides
 - 4) No hazard flasher lights
 - 5) Brighter than normal lights
 - 6) No back-up lights
 - 7) No tail lamps
 - 8) No stop lamps

VII. Accessory Systems

- A. Basic Theory of Operation for Each Component/Circuit
- B. Basic Troubleshooting Procedures (including Printed Circuits)
 - 1) Oil sending unit
 - 2) Fuel gauge and tank sending unit
 - 3) Temperature warning)
 - 4) Horns
 - 5) Constant voltage regulator for dash instruments charge test)
 - 6) Buzzer/relays/timers
 - 7) Air bags
 - 8) Wiper/washer circuit
 - 9) Power side window
 - 10) Power tailgate
 - 11) Power seat circuit
 - 12) Electric door locks

- 13) Defogger switches, grid, and blower motors
 - 14) Radio Power
 - 15) Radio speaker and antenna (trim procedure)
 - 16) Cruise control cables, regulator, servo, and hoses
 - 17) Clock circuit
 - 18) Cigar lighter circuit
 - 19) Sunroof and convertible top circuits
 - 20) Keyless lock/unlock circuits
 - 21) Anti-theft circuits
 - 22) Electric door lock
 - 23) Miles-to-empty fuel circuit
- C. Problem/Diagnosis
- 1) Slow, intermittent, or no power window operation
 - 2) Radio static
 - 3) Weak, intermittent, or no radio reception
 - 4) Unregulated. intermittent, or no cruise control
 - 5) Constant, intermittent, or no horn operation
 - 6) Wiper speed control and park problems (including pulsating type)
 - 7) No windshield washer operation
 - 8) High, low, or no gauge readings
 - 9) Constant warning buzzer operation
 - 10) Poor rear window defogger operation
 - 11) No power seat operation
 - 12) No power window operation
 - 13) Poor or no electric door lock operation
 - 14) No keyless lock/unlock device operation
 - 15) No electric sunroof or convertible top
 - 16) Poor heated mirror operation
 - 17) No clock operation

VIII. Battery

- A. Safety Procedures
- B. Open Flame and Explosion Hazard
- C. Removal and Installation Procedure
- D. Basic Construction and Chemical Action)
- E. Sizes and Ratings tests (shorts, grounds, continuity)
- F. Testing/Service tests (shorts, grounds, (continuity)
 - 1) State of charge (built-in indicator)
 - 2) Cell voltage (light load test)
 - 3) 3.Capacity test
 - 4) Sulphation (3-minute charge test)
 - 5) Battery charging procedure (slow and fast)
 - 6) Clean/fill/replace
 - 7) Jump starting

- 8) Replace cables and clamps
 - 9) Constant battery drain (including computer draw)
 - G. Interpretation of Test Results
 - H. Problem/Diagnosis
 - 1) Corroded connections
 - 2) Leakage (dirt on battery top)
 - 3) No start complaints
 - 4) Slow cranking complaints
 - 5) Excessive water use
 - 6) Discharges overnight (heavy current drain)
 - 7) Damaged plates
 - I. Storage
 - 1) Dry charge
 - 2) Wet charge
 - 3) Putting into service procedure
- IX. Charging System
- A. Basic System Components/Purpose/Operation
 - 1) Diodes
 - 2) Rotor
 - 3) Stator
 - 4) Slip rings
 - 5) Load input to ECM (computer) circuitry
 - B. Circuit Operation
 - 1) Various system schematics
 - 2) Voltage regulation
 - 3) Current control.
 - 4) Light relay
 - 5) Field relay
 - 6) Ammeter circuit (instead of charge indicator light)
 - C. Test Equipment
 - 1) Voltmeter
 - 2) Ammeter
 - 3) Ohmmeter
 - 4) Quarter Q resistor/rheostat
 - 5) Knife switch
 - 6) Diode testers
 - 7) Lab scope
 - D. Test Hook-Up/Interpretation of Results
 - 1) Field circuit (current draw)
 - 2) Rotor tests (shorts, grounds, continuity)
 - 3) Stator tests (shorts, grounds, (continuity)
 - 4) Diode tests
 - 5) Output test

- 6) Voltage regulator setting
- 7) Insulated and ground circuit tests (voltage drop)
- E. Replace Component Parts
 - 1) Brushes/holders
 - 2) Bearings and end frames
 - 3) Diodes (including soldering techniques)
 - 4) Stator
 - 5) Rotor
 - 6) Capacitor
 - 7) Warning light/driver information circuit
 - 8) Rectifier bridge
 - 9) Integral regulator
 - 10) Electro-mechanical regulator
 - 11) Diode trio
- F. Problem/Diagnosis
 - 1) Loose belts
 - 2) Open rotor circuit
 - 3) Grounded rotor circuit
 - 4) Defective diode(s)
 - 5) Noises
 - (a) Bearings
 - (b) Belts
 - (c) Mounting
 - (d) Diode
 - 6) Undercharge conditions
 - 7) No-charge conditions
 - 8) Overcharge conditions
 - 9) Defective regulator
 - (a) "Full-field" procedure (include precautions)
 - (b) Fusible links/in-line fuses
 - (c) Light relay
 - (d) Integral regulators
- G. Alternator Rebuilding Procedures/Tools
- X. Starter (Cranking) System
 - A. Basic Function
 - B. Types and Basic Differences
 - 1) Moveable pole shoe
 - 2) Permanent magnet types
 - 3) Gear reduction types
 - C. Relays and Solenoids
 - D. Construction and Nomenclature of Parts
 - E. Starter Drives
 - 1) Bendix

- 2) Overrunning clutch
- 3) Inspect and replace
- F. Testing/Service
 - 1) Current draw using BST
 - 2) Field coil tests (shorts, grounds, continuity)
 - 3) Armature tests (shorts, grounds, continuity)
 - (a) Growler and test light
 - (b) Free-running bench test
 - 4) Insulated circuit voltmeter readings (drop)
 - 5) Ground circuit voltmeter readings (drop)
 - 6) Remote cranking
 - 7) Rebuilding procedures
 - (a) Turning commutator
 - (b) Don't wash starter drive in 3 solvent
 - (c) Torque test
 - (d) Replace components (include bushings and end frames)
 - 8) Inspecting control circuit wiring
- G. Problem/Diagnosis
 - 1) Dragging armature
 - 2) Defective starter drive
 - 3) Worn bushings
 - 4) Worn flywheel ring gear
 - 5) Starter alignment (shims)
 - 6) Noise when cranking
 - 7) High current draw
 - 8) Low current draw
 - 9) Thrown armature windings
 - 10) Will not crank
 - 11) Cranks slowly
 - 12) Burned commutator
 - 13) Worn brushes/holders
 - 14) Spins but will not engage
 - 15) Solenoid plunger vibrates back and forth

XI. Starter Circuit Controls (Understand Basic Operation)

- A. Relays
- B. Solenoids
- C. Neutral Safety Switches
- D. Resistor By-pass
- E. Ignition Switches (Including Removal and Replacement)
- F. Circuit Testing
 - 1) Voltage drop acceptable readings
 - 2) Solenoid/relay tests
 - 3) Supply circuit and control circuit

G. Problem/Diagnosis

- 1) "Chatter"
- 2) Ignition switch contact corrosion
- 3) Poor solenoid contact disc connection
- 4) Starter motor won't stop turning after ignition switch is placed in run position
- 5) Broken drive nose
- 6) Overheat failure

REQUIRED TEXTBOOKS AND MATERIALS:

Textbook to be determined by instructor.

Safety Glasses

Safety Footwear

Tools as listed in the 'Durham Technical Community College Tool List for Automotive Systems Technology Students Handout.'