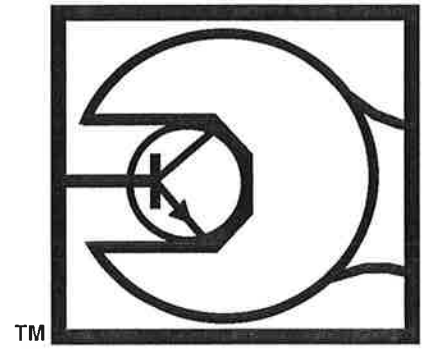
Synopsis

"The" 60-Lesson Vehicle Electronics Training Course



VEEJER ENTERPRISES INC.
Garland Texas, USA

Phone: **972-276-9642**
Web Site: **www.veejer.com**

Outline of "The" Vehicle Electronics (60 Lesson) Home-Study Course!
Lessons 1-12

About the Author
"The" (60 Lesson) Course is developed and written by Vince Fischelli, President of Veejer Enterprises. He graduated from his first electronics school in 1959 and has more than 60 years experience working in electronics. He began working in the automotive repair industry in 1968 after 10 years in military electronics. He is a graduate of seven electronics schools and the author of over 19 training manuals and numerous magazine articles covering vehicle electrical and electronics. He was the former manager of GM's ECM and Digital Dash Repair Center in Dallas, Texas, before starting Veejer Enterprises Inc., in 1985 to provide electrical and electronic circuit troubleshooting training to the vehicle service industry. He was the former Electronics Editor of IMPORT SERVICE MAGAZINE for 7 years and has presented over 250 electrical clinics and seminars and conducted more than 200 Hands-On Vehicle Electrical-Electronics Troubleshooting Workshops since 1987 to all segments of the vehicle service industry.

Lesson 1: ATOMIC STRUCTURE AND INTRO TO VEHICLE ELECTRICAL & ELECTRONIC SYSTEMS
Introduction to differences between vehicle electrical systems and electronic systems; introduction to the atom and elements; what is electricity; electrons; nucleus, protons and neutrons; The Law of Electrostatics; basic atoms; conductor and insulator atoms; direction of current flow; when an electrical circuit becomes an electronic circuit.

Lesson 2: ELECTRICAL CHARGES
The First Law of Charges; nature of negative and positive charges; potential difference; what happens when current flows; potential difference between unlike charges and similar charges; battery used to maintain charge, discharging a battery; Voltage; Units of Volts; relationship between battery and alternator.

Lesson 3: VOLTAGE & VOLTMETERS and CURRENT & AMMETERS
Definition of voltage; direct relationship of voltage and current; SLI battery voltage; Open Circuit Voltage measurement; Analog and digital voltmeters; voltmeter DC accuracy; basic principle of voltmeter operation; measuring open circuit voltage; DC current from a battery; ammeters measure current.

Lesson 4: RESISTANCE, PART 1
Definition of resistance, indirect relationship of current and resistance; the unit of resistance; expressing resistance; resistance in conductive material; resistance of wire; specific resistance; relative resistance values; specific resistance of materials; calculating resistance of wire; American Wire Gauge; specific resistance of solid-state material; resistor notation and symbol; fixed carbon resistors; how temperature affects resistance. Review Test 1-4, 28 Questions

Lesson 5: RESISTANCE, PART 2
The purpose of resistors; The Carbon Composition Resistor; Connecting resistors to circuit boards; definition of soldering; common problem mounting resistors and the dog-bone resistor; the schematic symbol of the resistor and resistance; evaluating resistors in terms of ohmic value, tolerance rating, temperature stability and power rating; resistor size in terms of physical size, wire wound resistors.

Lesson 6: RESISTANCE, PART 3
Resistor color code, labeling resistors on the circuit board, determine resistance from the color code, determine color code from the resistance, multiplier factor, tolerance factor, calculating tolerance values, practice exercise calculating tolerance, Meg ohms, k ohms, resistor circuits, the series circuit, the parallel circuit, the series parallel compound circuit, cold circuit analysis, practice exercise working with the resistor color code.

Lesson 7: RESISTANCE, PART 4
Calculating resistance in series circuits, total resistance in series, total resistance in parallel, three ways to calculate total resistance in parallel, total resistance in compound circuits.

Lesson 8: ANALOG AND DIGITAL OHMMETERS
Introduction to ohmmeters, how an ohmmeter works, the ohmmeter scale, analog ohmmeter ranges, calibrating analog ohmmeters, digital ohmmeters, differences in analog and digital ohmmeters, ohmmeter test voltage polarity and amplitude, F.E.T. analog ohmmeter characteristics. Review Test 5-8, 33 Questions

Lesson 9: TROUBLESHOOTING WITH OHMMETERS
Selecting the type ohmmeter, measuring resistor circuits, small battery symbol for a test battery, connecting the ohmmeter test leads, tracing ohmmeter test current, indicating the resistance value, reversing ohmmeter test leads, analyzing analog ohmmeter readings, when resistance is lower than normal, definition of a "short," definition of an "open" or high resistance, using an ohmmeter to check continuity, checking resistance in parallel circuits.

Lesson 10: WORKING WITH RESISTANCE IN VEHICLE CIRCUITS
Working with resistance, incandescent lamp resistance, two factors to know about lamps, incandescent lamp "cold" resistance, incandescent lamp "hot" resistance, determining lamp hot resistance, resistance from friction, switch contact resistance, summarizing ohmmeters.

Lesson 11: VEHICLE CIRCUIT PRINCIPLES
"The Voltage Side of the Circuit"
Building the basic circuit, Modes of vehicle voltage source operation. Basic Vehicle Equivalent Circuit, System voltage in the BVEC, Current flow in the BVEC, Battery current, how current flows inside the battery, Current flow with the alternator on-line, BVEC circuit resistance, major points to remember.

Lesson 12: The Ground Side of the Circuit
The BVEC without grounds, Ground, Ground in a vehicle, Ground symbols on schematic diagrams, Negative ground systems, Ground side resistance, Positive ground systems, Polarity of the load, Ground circuit resistance, ground circuit voltage, Voltage above and below ground, Pop Quiz: The Proper Way To Measure Circuit Voltage. Test 9-12, 13 Questions.

Outline of "The" Vehicle Electronics (60 Lesson) Home Study Course!
Lessons 13-24

Lesson 13: INTRODUCTION TO OHM'S LAW, THE METRIC SYSTEM & POWER MEASUREMENT
Introduction; Ohm's Law in basic form; Metric system of measurement; Ohm's Law used throughout electronics; Ohm's Law defined; Ohm's Law Pie; Metric Units of Voltage Measurement; practice with Ohm's Law for voltage; a common mistake using Ohm's Law; Use Ohm's Law to calculate current; Metric units of current measurement, convert amps to milliAmps or milliAmps to amps; practice with Ohm's Law for current; use Ohm's Law to calculate resistance; practice with Ohm's law for resistance; Ohm's Law applies to the total circuit; power in electrical circuits; metric units of power measurement; practice with the power formula; answers to practice exercises.

Lesson 14: SERIES CIRCUIT ANALYSIS
Using Ohm's Law; updating the BVEC; total circuit values; voltage source variations; two basic configurations; current in a series circuit; voltage in a series circuit; detrimental effects of R_{VS} and R_{GS}; working with current and voltage in series; answers to practice problems.

Lesson 15: VOLTAGE DROP MEASUREMENTS
Introduction to voltage drops; what do you mean by a voltage drop? Good and bad voltage drops; the math of voltage drops; what makes voltage drops appear? normal voltage drops; small resistance makes big voltage drops; two limitations of ohmmeters.

Lesson 16: APPLIED VOLTAGE DROPS
Typical voltage drop readings; voltage drops in wiring; voltage drops in connections; voltage drops in battery cables; voltage drops in battery posts; voltage drops in ground circuits; proper grounding of a DMM; two primary vehicle ground Vds; Vd of voltage and ground side of a circuit; voltage drops; alternator and battery; voltage drops; battery & starter motor. Review Test: Lessons 13-16, 33 Questions.

Lesson 17: VOLTAGE AND CURRENT IN PARALLEL CIRCUITS
Introduction to parallel circuits; The Parallel Circuit; Review of the laws of series circuits; Introduction to Voltage and Current In Parallel; The Law of Voltage in Parallel; Using the Law of Voltage in Parallel; The Law of Current in Parallel; Using the Law of Current in Parallel; Tracing Current in a Parallel Circuit; Measuring Key Off Drain; Kirchhoff's Laws; Applying Kirchhoff's Current Law; Applying Kirchhoff's Voltage Law; Analyzing Circuit Loops; R_{VS} and R_{GS} in Parallel Circuits; Jump Starting Creates a Parallel Circuit.

Lesson 18: COMPOUND CIRCUIT ANALYSIS & INTRO. TO TROUBLESHOOTING
Introduction; The Series Circuit; The Parallel Circuit; Cold Circuit Analysis; Practice Exercises Using Figure 3; The Compound Circuit; Practice Exercise Using Figure 4; Electronic Troubleshooting By Definition: How To Begin Troubleshooting; Two Techniques of Voltage Measurement; Techniques of Current Measurement; Techniques of Resistance Measurements.

Lesson 19: BATTERY PRINCIPLES, Part 1 of 2 Parts
Why test batteries?; what is V.E.T. battery troubleshooting?; battery construction; battery voltage; battery operation; specific gravity; surface charge; specific gravity vs. OCV; adding water to batteries; charging batteries; how to tell when battery is fully charged; storing batteries on concrete; battery chemistry; two battery specifications are important; when a V.E.T. installs a new battery; misc. battery safety tips.

Lesson 20: TESTING BATTERIES, Part 2 of 2 Parts
Overview of battery testing; test equipment for battery testing; crank test the battery in the vehicle; BATTERY TEST FOR DISCHARGE; determine remaining battery service life; BATTERY TEST FOR CHARGE and common ways SLI batteries fail. Supplement 20-1 Vehicle Battery Standard Test Procedure for VETs. Review Test 17-20, 39 Questions

Lesson 21: ALTERNATORS AND CHARGING SYSTEMS, PART 1 of 2
Introduction to Alternators; The Alternator or Charging System; The Charging Voltage; The Charging Current; The Voltage Regulator; Regulating the Charging Voltage; Rotor and Stator Windings; AC Inside the Alternator; AC Changed to DC; Regulating Charging Current.

Lesson 22: ALTERNATORS AND CHARGING SYSTEM TROUBLESHOOTING, PART 2 of 2
The Diode Trio; The Electronic Feedback Principle; Alternator Specifications; Vds in the Charging System; When Vd_{VS} and Vd_{GS} are Slightly Too High; Alternator Noise; AM/FM Radio Detects Alternator Noise; Battery Should Be Fully Charged When Installed; Testing the Charging System; Charging System Characteristics; Testing the Charging Voltage; Voltage Test for Undercharge; Voltage Test for Overcharge; Testing the Charging Current; Final Item About Charging Systems; New Horizons with Alternator.

Lesson 23: LOAD CIRCUIT CONTROL
The Vehicle's Voltage Source; BVEC Series Lamp Circuit; Load Control; The Texas-Two-Step-; Switch-to-Voltage Control; V_c with Switch-to-Voltage Control; Switch-to-Ground Control; V_c with Switch-to-Ground Control; Dynamic Load Resistance; In-Rush Current, Switch Control in Parallel Circuits; Fail-Safe.

Lesson 24: BASIC CIRCUIT FAULT ANALYSIS
What Goes Wrong in a Circuit?; The Texas-Two-Step- Effect of $Vd_{(LOAD)}$ on the Circuit; Six Common Circuit Problems; Circuit Problem #1; Definition of an Open Circuit; Circuit Problem #2; Definition of a Vd; What Happens When the Load is Disconnected?; Circuit Problem #3; Circuit Problem #4; Circuit Problem #5; Circuit Problem #6. Test 21-24, 24 Questions

Outline of "The" Vehicle Electronics (60 Lesson) Home-Study Course!
Lessons 25-36

Lesson 25: TROUBLESHOOTING SHORT CIRCUITS
Introduction to short circuits; What is a Short?; BVEC Circuit; Testing total resistance; Evaluating CUT R_T; Shorted Load; Low resistance Load; Voltage side short to ground; Short to ground, CUT OK; Sample readings on vehicles.

Lesson 26: CAPACITORS, Part 1 of 2
Overview of electronic components; Introduction to capacitors; Capacitors in DC versus AC circuits; Charging capacitors with DC; Polarity of capacitor charge; Quantity of capacitor charge; Size of capacitor plates affects charge; Characteristics of dielectric materials.

Lesson 27: CAPACITORS PART 2 of 2
The charged capacitor; Dielectric leakage; A capacitor holds a charge; How a capacitor discharges, Capacitor action in a live circuit; S1 closed, S2 closed; Capacitors react to increased source voltage; Capacitors react to decreased source voltage; Turning circuit OFF with capacitors; Capacitor values; Formula for capacitance; Capacitors and time; RC time constants; Time constants while charging; Time constants while charging; Types of capacitors; Electrolytic capacitors; Capacitors mounted on circuit boards.

Lesson 28: INDUCTORS AND INDUCTANCE, Part 1 of 3
Review of an electrostatic field; What is an inductor; Inductors compared to capacitors; Current through a wire; Use care with an inductive current clamp; Properties of magnets; Dynamics of a coil; Coil symbols; Inductor designations; Effect of Inductor at circuit power-up; When a coil is not present; When coil is present; Effect of inductor at max current; Effect of inductor as source voltage varies; Effect of inductor at circuit power down; Electronics circuits need surge protection; Inductance measured in Henries. REVIEW TEST 25-28, 18 Questions

Lesson 29: INDUCTORS, PART 2 of 3
Inductors in circuits; Inductive characteristics; Inductance and current; Inductance and resistance; Inductance and core material; Inductance and number of turns; Troubleshooting Intermittent Coils; Inductor Time Constants; Coil Discharging and Time Constants.

Lesson 30: INDUCTORS, PART 3 of 3
The good and the bad about inductors; energizing a coil; Battery voltage decreases while cranking; De-energizing a coil; Surge current path; How a coil dumps stored electrical energy so fast; Protecting solid-state computer circuits (from voltage spikes).

Lesson 31: CAPACITORS & INDUCTORS WORKING TOGETHER
Capacitors and inductors work together; Reviewing capacitors; Reviewing inductors; Radio noise filtering; Radio noise filter theory; Coil filters current variations; Capacitor filters voltage variations; Ignition circuit; When the points are OPEN; When the points are CLOSED; When the points are OPENED; What is a transformer?; Firing the plug; Quieting switch pop.

Lesson 32: COIL CIRCUITS, PART 1 of 2
Where we are up to now. when a coil is a load in a circuit; Coil load reaction to circuit current; Coil load resistance readings; Reviewing ohmmeters; Measuring coil resistance; Measuring coil circuit current; Measuring coil circuit voltages. REVIEW TEST 29-32, 25 Questions

Lesson 33: COIL CIRCUITS, PART 2, TROUBLESHOOTING SOLENOID CIRCUITS
Overview; Measuring coil circuit Vds; Controlling a coil as the load; Switch-to-ground control; TTS readings with S-G-C; Try the TTS on an A/C Clutch on a car; Six basic coil circuit failures; Coil circuit failure #1; Troubleshooting coil problem #1; Coil circuit failure #2; Troubleshooting coil problem #2; When load is disconnected from circuit; Coil circuit failure #3; Troubleshooting coil problem #3; Coil circuit failure #4; Troubleshooting failure #4; When load is disconnected from circuit; Coil circuit failure #5; Troubleshooting failure #5; Coil circuit failure #6; Troubleshooting failure #6; Coils and ballast resistors.

Lesson 34: PRINCIPLES OF DC MOTORS
Lesson overview; DC motor component parts; Current in DC motor operation; DC motor operational characteristics; What is CEMF? DC motor symbols; DC motor configurations; Starter motor circuit; Interpreting starter motor circuits; Low voltage - yet normal current?

Lesson 35: TROUBLESHOOTING DC MOTORS
Lesson overview; When a DC motor is the load in a circuit; DC motor reaction to circuit current; DC motor winding resistance; Check DC motor for shorts to housing; Measuring DC motor load current; Calculating DC motor resistance when ON; Measuring DC motor circuit voltages; Measuring DC motor voltage drops; DC motor ballast resistors; DC blower motor circuit; Troubleshooting a blower motor problem.

Lesson 36: DC MOTOR CIRCUIT COMMON FAILURE MODES, PART 1 of 2
Lesson overview; Controlling a DC motor; Switch-to-voltage DC motor Control; TTS readings with S-V-C; TTS readings with S-G-C; Perform TTS on a DC blower motor circuit; DC motor circuit failures; DC motor circuit failure #1; DC motor circuit failure #2; DC motor circuit failure #3; DC motor circuit failure #4. REVIEW TEST 33-36, 19 Questions.

Outline of "The" Vehicle Electronics (60 Lesson) Home-Study Course
Lessons 37-48

Lesson 37: DC MOTOR CIRCUIT COMMON FAILURE MODES, PART 2 of 2
DC motor circuit failure #5; DC motor circuit failure #6; DC motor is shorted; Voltage side of circuit shorted to ground; DC motor winding shorted to housing; DC motor controlling excessive load; Benefits of DC motor load testing; When 2 problems exist at the same time.

Lesson 38: RELAY CIRCUITS, PART 1 of 4
Lesson introduction; The purpose of relays; Common relay terminal description; A coil polarity problem; Relay spike suppression resistor; Introduction to troubleshooting relays, BVEC relay circuit.

Lesson 39: RELAY CIRCUITS, PART 2 of 4
Lesson introduction; Relay DC circuit operation; Relay terminology; CCA or relay's primary circuit; CCA of relay's secondary circuit; A system for troubleshooting relays; Troubleshooting relay primary circuit; troubleshooting relay secondary circuit; Relay coil reaction to primary circuit; Importance of relay winding resistance; Check coil resistance Ä digital ohmmeter; Reviewing analog ohmmeters; Check coil resistance; analog ohmmeter.

Lesson 40: RELAY CIRCUITS, PART 3 of 4
Checking diodes with diode test; Will diode test always check a diode?; Relays with spike suppression resistors; measuring relay coil current; measuring relay circuit voltage drops; Vds of the primary circuit; Vds of the secondary circuit; Checking relay contact Vd.
REVIEW TEST 37-40, 13 Questions

Lesson 41: RELAY CIRCUITS, PART 4 of 4
Finishing up relay circuits; Switch-to-Voltage relay control; Switch-to-Ground relay control; Relay circuit failures; Relay circuit failure #1; Relay circuit failure #2; Relay circuit failure #3; Relay circuit failure #4; Relay circuit failure #5; Relay circuit failure #6; Troubleshooting a shorted load; relay winding resistance readings.

Lesson 42: INTRODUCTION TO SEMICONDUCTOR PRINCIPLES
It's about time we got this far; Electric current in circuits; What does a VET need to know; The history of solid state electronics; It's time for atoms, again; Covalent bonding; Doping semiconductor material, Adding impurities; Creating N-type material, Creating P-type material; Holes in P-type material.

Lesson 43: SEMICONDUCTOR PRINCIPLES
Lesson introduction; Electrons and Holes; Creating a PN junction diode; Semiconductor diode terminology; Forward bias turns diode ON; Diode schematic symbol forward bias; Leakage current in PN junctions; Diode schematic symbol reversed biased; Introduction to graphs; Diode forward and reverse bias graph; Lesson summary.

Lesson 44: TROUBLESHOOTING DIODES
Lesson introduction; Testing diodes; Setting Up analog ohmmeter; Testing diodes with analog ohmmeter; Applying reverse bias turns diode OFF; Applying forward bias turns diode ON; Ohmmeter power testing diodes; Abnormal ohmmeter readings of diodes; Testing diodes with DMM's diode test; A practical use of a diode; Diode ratings; How diodes fail; Light emitting diodes; Lesson summary. REVIEW TEST 41-44, 20 Questions

Lesson 45: TRANSISTORS, Part 1: The NPN TRANSISTOR
Lesson introduction; Basic transistors; The NPN transistor; Forward bias current in a NPN transistor; Collector current in a NPN transistor; Voltage and current in a NPN transistor; NPN transistor in a circuit; NPN transistor in a digital signal circuit; Testing the NPN transistor circuit; Transistor static test - analog ohmmeter; Transistor dynamic tests - digital voltmeter.

Lesson 46: TRANSISTOR, Part 2: The PNP TRANSISTOR
The PNP transistor; PNP bias arrangement; Collector current in a PNP transistor; Voltage and current in a PNP transistor; PNP transistor in a circuit; PNP transistor in a digital signal circuit; Phase shift in transistor circuits; Transistor amplification; Transistor static test - analog ohmmeter; Transistor dynamic tests - with DMM; PNP versus NPN.

Lesson 47: SEMICONDUCTORS IN VEHICLE ELECTRONICS
Lesson introduction; Zener diodes; Zener diode in a voltage regulation circuit; Why test a 5-volt reference circuit; How to test a 5-volt reference circuit; How a 5-volt reference circuit fails; What to do? Introduction to the PCM schematic; 5-volt reference voltage in a PCM.

Lesson 48: SPIKE VOLTAGE SUPPRESSION & INTRODUCTION TO LAB SCOPES
Lesson introduction; The spike suppression diode; spike suppression diode review; spike suppression diodes and driver; Spike suppression in injector circuits; Lab Scope Terminology; Basic injector wave form; Analyzing basic injector wave form; Spike suppression diode in relay circuits; Spike suppression resistors in relays. TEST 45-48, 15 Questions

Outline of "The" Vehicle Electronics (60 Lesson) Home-Study Course!
Lessons 49-60

Lesson 49: POLARITY SENSING DIODES & INTRO. TO VEHICLE COMPUTERS
Polarity sensing diodes; The polarity sensing diode; Polarity sensing diode in injector circuits; Polarity sensing diode in relay circuits; Analyzing TTS readings with polarity sensing diode; Schottky diode; Polarity sensing diode in computers; B+ supply to computers; The ground side of computers; Should a VET repair computers? The computer brain.

Lesson 50: DIGITAL ELECTRONICS, Part 1 of 4
Lesson introduction; Analog vs. digital electronics; Analog voltage; Measuring analog voltage; Using analog voltage to control a lamp; Digital voltage; Using a digital signal to

control a lamp; Measuring digital signals; Digital logic probes (DLP); Intro to DLPs; DLP features; DLP switch settings; DLP voltage thresholds; basic DC voltage checks with a DLP.

Lesson 51: DIGITAL ELECTRONICS, Part 2 of 4
Lesson introduction; Numbering systems; What is a logic circuit?; Logic formats and logic levels; The logic gate function; Logic gate symbol and truth table; Actual circuit of a logic gate; Troubleshooting a logic gate; Logic gate in a circuit; The NOT function; The NOT gate logic symbol and truth table; Actual circuit of a NOT gate; NOT gate in a circuit; Troubleshooting a NOT gate circuit; The AND function; The AND gate circuit.

Lesson 52: DIGITAL ELECTRONICS, Part 3 of 4
Lesson introduction; The NAND gate function; NAND gate logic symbol and truth table; Actual circuit of a NAND gate; Quad driver NAND gate operation; Troubleshooting a quad driver circuit; Common quad driver failures; Testing quad driver resistance; The OR function; The OR gate symbol and truth table; Actual circuit of an OR gate; OR gate in a circuit; Review Test 49-52, 14 Questions

Lesson 53: DIGITAL ELECTRONICS, Part 4 of 4
Lesson introduction; INTRO. to integrated circuits; Basic computer block diagram; The CPU; ROM, RAM, PROM memory; Analog to digital conversion; Input/output IC; Integrated circuit failures; Ground straps prevent ESD, The Thermal Curve concept; Artificially applying the thermal curve; Surface mount technology; Computer personality; Examples of computer personality.

Lesson 54: VOLTAGE DIVIDER CIRCUITS & CRITICAL VOLTAGE MEASUREMENT
Lesson introduction; Two resistor "fixed" voltage divider; Two resistor "dynamic" voltage divider; Three resistor "fixed" voltage divider; Current problems with voltage dividers; DMM loading problem with voltage dividers; Critical voltage analysis; Applying C_v analysis; Fat chance; When C_v is B+; When C_v is simply too high; When C_v is zero volt; When C_v is simply too low; How much can C_v reading deviate? When C_v test point reads zero volts; How to use C_v analysis.

Lesson 55: POSITION SENSOR CIRCUITS, Part 1 of 2
Introduction; The potentiometer principle; Potentiometer failures; Throttle position sensors; Adding voltage to the TP sensor circuit; Significance of analog sensor signal voltage; Troubleshooting the TP sensor circuit; Analyzing incorrect TP signal voltage; Sweeping a TP sensor; TP sensor diagnostic trouble codes.

Lesson 56: POSITION SENSORS, Part 2 of 2
Completing the TP sensor circuit; TP sensor noise filter circuit; Noise filter networks, The analog to digital converter; Labeling logic condition in logic diagrams; Reading analog data from the AD/C; Analog input circuit failures; TP signal drop-out problem; Actual TP problems and solutions; Scan tools; Examples of scan tool troubleshooting; Fuel level sensor; EGR feedback voltage; summarizing the last two lessons. TEST 53-56, 21 Questions

Lesson 57: SWITCH POSITION SENSING & INTRO. TO TEMPERATURE SENSING
Switch position sensors; Input/output IC inside the PCM; Troubleshooting switch-to-ground sensing; Troubleshooting 3rd gear switch; Switch to voltage position sensing; Processing A/C switch input; Troubleshooting switch-to-voltage sensing; Introduction to temperature measurement; Temperature sensing methods; Thermister temperature sensors; Principle of Thermister operation.

Lesson 58: ANALOG SENSOR TROUBLESHOOTING
Lesson introduction; Engine coolant sensor circuit; Basic ECT circuit; ECT circuit for OBDII, ECT strategy; DTC sensor graph; Sample ECT sensor graph; ECT sensor DTC graph analysis; Troubleshooting ECT circuit; Check ECT resistance or voltage: Two NTC temperature sensor applications; Overview of the SI system of measurement; Basic pressure measurement terminology.

Lesson 59: PRESSURE SENSING AND OXYGEN SENSORS
Lesson introduction; Manifold absolute pressure sensor; MAP technology yesterday and tomorrow; MAP operating strategy; Basic MAP sensor circuit; MAP sensor DTC graph; MAP sensor circuit troubleshooting; Introduction to oxygen sensors; Operating principle of oxygen sensor; Zro2 sensor circuit in OBDII; Zro2 sensor bias voltage; How to measure O2 bias voltage; Zro2 sensor response and driveability; Running lean but no lean DTC; Running rich but no rich DTC.

Lesson 60: "The Finale" TROUBLESHOOTING COMPUTER CONTROLLED ACTUATOR CIRCUITS
Welcome to Lesson 60; Switch to ground computer control basics; Switch to ground controlled solenoid circuit; When switch to ground reading is not normal; Resistance test a coil or solenoid; Current test a coil; Check the spike suppression diode; Injector drivers Ä pulsed coil operation; Coil control with pulse width modulation; Examples of switch to ground pulse width modulated control; Switch to voltage computer control basics; Switch to voltage computer controlled solenoid circuit; When switch to voltage C_v reading is not normal, Example of switch to voltage pulse width modulated control; Problems controlling DC motors; Load testing actuators; Computer control of relay circuits; Congratulations on completing 60 lessons.

Congratulations for completing "*The*" 60 Lesson Course