Automotive Technology 5th Edition

Chapter 48 ELECTRONIC FUNDAMENTALS

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class provides complete coverage of the components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and NATEF and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Real World Fixes, Videos, Animations, and NATEF Task Sheet references.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time, which translates into more money.
State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending this session or class.	Explain learning objectives to students as listed below: 1. Discuss how semiconductors and diodes work. 2. Discuss the different uses of diodes. 3. Explain transistors, field-effect transistors, phototransistors, integrated circuits, transistor gates, and operational amplifiers. 4. Discuss the electronic components failure causes, how to test diodes and transistors, how to avoid electrostatic discharge, and converters and inverters.
Establish the Mood or Climate	Provide a ***WELCOME**,* Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

NOTE: This lesson plan is based on the 5th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

LINK CHP 48: ATE5 Chapter Images

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1. **TITLE SLIDE 1 ELECTRONIC FUNDAMENTALS**
2. **SLIDE 2 EXPLAIN Figure 48-1** N-type material. Silicon (Si) doped with a material (phosphorus) with 5 electrons in outer orbit results in extra free electron.

Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/

WEB SITE IS CONSTANTLY UPDATED

Videos

DISCUSSION: DISCUSS difference between electricity & electronics

3. **SLIDE 3 EXPLAIN Figure 48-2** P-type material. Silicon (Si) doped with a material, such as boron (B), with three electrons in the outer orbit results in a hole capable of attracting an electron.
4. **SLIDE 4 EXPLAIN Figure 48-3** Unlike charges attract and the current carriers (electrons and holes) move toward the junction.
5. **SLIDE 5 EXPLAIN Figure 48-4** A diode is a component with P-type and N-type materials together. The negative electrode is called the cathode and the positive electrode is called the anode.
6. **SLIDE 6 EXPLAIN Figure 48-5** Diode connected to a battery with correct polarity (battery positive to P type and battery negative to N-type). Current flows through the diode. This condition is called forward bias.
7. **SLIDE 7 EXPLAIN Figure 48-6** Diode connected with reversed polarity. No current flows across the junction between the P-type and N-type materials. This connection is called reverse bias.
8. **SLIDE 8 EXPLAIN Figure 48-7** Diode symbol and electrode names. The stripe on one end of a diode represents the cathode end of the diode.

DEMONSTRATION: Demonstrate to students on a Project Board to show how a DIODE Works & How it is tested

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9. **SLIDE 9 EXPLAIN Figure 48-8** Zener diode blocks current flow until a certain voltage is reached, then it permits current to flow.

10. **SLIDE 10 EXPLAIN Figure 48-9a** Notice that when the coil is being energized, the diode is reverse biased and the current is blocked from passing through the diode. The current flows through the coil in the normal direction.
11. **SLIDE 11 EXPLAIN Figure 48-9b** When the switch is opened, the magnetic field surrounding the coil collapses, producing a high-voltage surge in the reverse polarity of the applied voltage. This voltage surge forward biases the diode, and the surge is dissipated harmlessly back through the windings of the coil.
12. **SLIDE 12 EXPLAIN Figure 48-10** A diode connected to both terminals of the air conditioning compressor clutch used to reduce the high-voltage spike that results when a coil (compressor clutch coil) is de-energized.
13. **SLIDE 13 EXPLAIN Figure 48-11** Spike protection diodes are commonly used in computer-controlled circuits to prevent damaging high-voltage surges that occur any time current flowing through a coil is stopped.
14. **SLIDE 14 EXPLAIN Figure 48-12 Zener diode** is commonly used inside automotive computers to protect delicate electronic circuits from high-voltage spikes. A 35 volt Zener diode will conduct any voltage spike higher than 35 voltage resulting from the discharge of the fuel injector coil safely to ground through a current-limiting resistor in series with the Zener diode.
15. **SLIDE 15 EXPLAIN Figure 48-13** despiking resistor is used in many automotive applications to help prevent harmful high-voltage surges from being created when magnetic field surrounding a coil collapses when coil circuit is opened.

DEMONSTRATION DIODES: Show students examples of Zener and LED Diodes. Ask them to look for visible differences between these diodes and the diodes you would find in an Alternator.

Hold a DISCUSSION on DIODES on the visible differences between these diodes and the diodes you would find in an Alternator.

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	16. **SLIDE 16 EXPLAIN Figure 48-14** typical light-emitting diode (LED). This particular LED is designed with a built-in resistor so that 12 volts DC may be applied directly to the leads without an external resistor. Normally a 300 to 500 ohm, 0.5 watt resistor is required to be attached in series with the LED, to control current flow to about 0.020 A (20 mA) or damage to the P-N junction may occur.
	**Potentiometer (View) (Download)** **Relay (View) (Download)** **Transistors (View) (Download)**
	17. **SLIDE 17 EXPLAIN Figure 48-15** Typical photodiodes. They are usually built into a plastic housing so that the photodiode itself may not be visible. 18. **SLIDE 18 EXPLAIN Figure 48-16** Symbol for a photodiode. The arrows represent light striking the P-N junction of the photodiode.
	19. **SLIDE 19 EXPLAIN Figure 48-17** Either symbol may be used to represent a photoresistor. 20. **SLIDE 20 EXPLAIN Figure 48-18** Symbol and terminal identification of an SCR. 21. **SLIDE 21 EXPLAIN Figure 48-19** Wiring diagram for center high-mounted stoplight (CHMSL) using SCRs. 22. **SLIDE 22 EXPLAIN Figure 48-20** Symbols used to represent a thermistor.
	**DEMONSTRATION THERMISTOR: show students a thermistor and explain where it is commonly used. Use a heat source to test the thermistor, showing the resistance change. An ECT sensor will work.**
	23. **SLIDE 23 EXPLAIN Figure 48-21** Rectifier bridge contains 6 diodes; 3 on each side are mounted in an aluminum-finned unit to keep diode cool
	24. **SLIDE 24 EXPLAIN Figure 48-22** Basic transistor operation. A small current flowing through the base and emitter of the transistor turns on the transistor and permits a higher amperage current to flow from the collector and the emitter. 25. **SLIDE 25 EXPLAIN Figure 48-23** Basic transistor operation. A small current flowing through the base and emitter of the transistor turns on the transistor and permits a higher amperage current to flow from the collector and the emitter.

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DEMONSTRATION: Demonstrate to students on an Project Board to show how a TRANSISTOR Works & How it is tested

Hold a <u>DISCUSSION</u> on TRANSISTORS on the visible differences between Bipolar, Phototransistor, CMOS, FET, etc.

<u>DEMONSTRATION Transistors:</u> Show students examples of different transistors: Bipolar, Phototransistor, CMOS, FET, etc. Ask them to look for visible differences between these transistors.

26. **SLIDE 26 EXPLAIN FIGURE 48-24** The three terminals of a field-effect transistor (FET) are called the source, gate, and drain.
27. **SLIDE 27 EXPLAIN FIGURE 48-25** A Darlington pair consists of two transistors wired together, allowing for a very small current to control a larger current flow circuit.
28. **SLIDE 28 EXPLAIN FIGURE 48-26** Symbols for a phototransistor. (a) This symbol uses the line for the base; (b) this symbol does not.
29. **SLIDE 29 EXPLAIN Figure 48-27** A typical automotive computer with the case removed to show all of the various electronic devices and integrated circuits (ICs). The CPU is an example of a DIP chip and the large red and orange devices are ceramic capacitors.

<u>Potentiometer (View) (Download)</u>

<u>Relay (View) (Download)</u>

<u>Transistors (View) (Download)</u>

30. **SLIDE 30 EXPLAIN Figure 48-28** Typical transistor AND gate circuit using two transistors. The emitter is always the line with the arrow. Notice that both transistors must be turned on before there will be voltage present at the point labeled “signal out.”
31. **SLIDE 31 EXPLAIN Figure 48-29** Symbol for an operational amplifier (op-amp).
32. **SLIDE 32 EXPLAIN Figure 48-30** Schematic for a blinking LED theft deterrent.

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	33. **SLIDE 33 EXPLAIN Figure 48-31a** To check a diode, select "diode check" on a digital multimeter. The display will indicate the voltage drop (difference) between the meter leads. The meter itself applies a low-voltage signal (usually about 3 volts) and displays the difference on the display. (a) When the diode is forward biased, the meter should display a voltage between 0.500 and 0.700 V (500 to 700 mV). 34. **SLIDE 34 EXPLAIN Figure 48-31b** When the meter leads are reversed, the meter should read OL (over limit) because the diode is reverse biased and blocking current flow. 35. **SLIDE 35 EXPLAIN Figure 48-32** If the red (positive) lead of the ohmmeter (or a multimeter set to diode check) is touched to the center and the black (negative lead) touched to either end of the electrode, the meter should forward bias the P-N junction and indicate on the meter as low resistance. If the meter reads high resistance, reverse the meter leads, putting the black on the center lead and the red on either end lead. If the meter indicates low resistance, the transistor is a good PNP type. Check all P-N junctions in the same way.
	36. **SLIDE 36 EXPLAIN Figure 48-33** DC to DC converter is built into most powertrain control modules (PCM) and is used to supply 5 volt reference called V-ref to many sensors used to control internal combustion engine. 37. **SLIDE 37 EXPLAIN Figure 48-34** DC-DC converter is designed to convert 42 volts to 14 volts, to provide 14 V power to accessories on a hybrid electric vehicle operating with a 42 volt electrical system. 38. **SLIDE 38 EXPLAIN Figure 48-35** A typical circuit for an inverter designed to change direct current from a battery to alternating current for use by the electric motors used in a hybrid electric vehicle. 39. **SLIDE 39 EXPLAIN Figure 48-36** The switching (pulsing) MOSFETs create a waveform called a modified sine wave (solid lines) compared to a true sine wave (dotted lines).
	**Students complete ATE4 Task Sheet on Electronic Fundamentals from Page 144 of ATE4 Worktext**

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 	**HOMEWORK: SEARCH INTERNET: Have students use Internet to gather information on field-effect transistors, MOSFETS, & Darlington pairs.** Crossword Puzzle (Microsoft Word) (PDF) Word Search Puzzle (Microsoft Word) (PDF)