Automotive Technology 6th Edition
Chapter 74 TEMPERATURE SENSORS
Opening Your Class

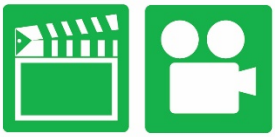
KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Technology 6th text provides complete coverage of automotive components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and ASEEducation (NATEF) and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Case Studies, Videos, Animations, and ASEEducation (NATEF) Task Sheets.
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. Describe the purpose and function of engine coolant temperature sensors. 2. Describe how to inspect and test temperature sensors. 3. Diagnose emissions and drivability problems resulting from malfunctions in the intake air temperature control systems. 4. Discuss how automatic fluid temperature sensor valves can affect transmission operation. 5. This chapter will help prepare for Engine Repair (A8) ASE certification test content area "E" (Computerized Engine Controls Diagnosis and Repair).
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: Lesson plan is based on 6th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

DOWNLOAD Chapter 74 Chapter Images: From

http://www.jameshalderman.com/automotive_principles.html

NOTE: You can use Chapter Images or possibly Power Point files:

ICONS	Chapter 74 Temperature Sensors
	**1. SLIDE 1 Chapter 74 Temperature Sensors** **2. SLIDE 2 EXPLAIN FIGURE 74-1** A typical engine coolant temperature (ECT) sensor. **3. SLIDE 3 EXPLAIN FIGURE 74-2** A typical ECT sensor temperature versus voltage curve.
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED** **http://www.jameshalderman.com/automotive_principles.html** **DOWNLOAD** **Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF**
	**Videos**
	**DISCUSS CASE STUDY:**
	**DEMONSTRATION: Show the students how to locate coolant temperature sensors using an electronic component locator in the ONLINE SERVICE INFORMATION**
	**4. SLIDE 4 EXPLAIN Figure 74-3** A typical two-step ECT circuit showing that when the coolant temperature is low, the PCM applies a 5-volt reference voltage to the ECT sensor through a higher resistance compared to when the temperature is higher. **5. SLIDE 5 EXPLAIN Figure 74-4** transition between steps usually occurs at a temperature that would not interfere with cold engine starts or the cooling fan operation. In this example, the transition occurs when the sensor voltage is about 1 volt and rises to about 3.6 volts
	**DISCUSSION: Have the students talk about sensors with a negative temperature coefficient (NTC). How is an NTC sensor different from most other components?**

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	**DEMONSTRATION: Show the students how to use a hydrometer and/or refractometer to analyze coolant mixture.**
	**DISCUSSION: Have the students discuss the difference between a hydrometer & refractometer. Which tester would they prefer to use? Why?**
	**DEMONSTRATION: Show students how to properly pressure-test a cooling system, to determine cooling system condition.**
	**DISCUSSION: Have the students talk about ECT operation. How can incorrect coolant level, incorrect coolant mixture, and/or incorrect system pressure cause inaccurate ECT operation?**
	6. **SLIDE 6 EXPLAIN Figure 74-5** Measuring resistance of the ECT sensor. The resistance measurement can then be compared with specifications
	**Show ANIMATION: Test Engine Coolant Temperature ECT Sensor (View) (Download)**
	7. **SLIDE 7 EXPLAIN Figure 74-6** When the voltage drop reaches approximately 1.20 volts, the PCM turns on a transistor. The transistor connects a 1-k Ω resistor in parallel with the 10-k Ω resistor. Total circuit resistance now drops to around 909 ohms. This function allows the PCM to have full binary control at cold temperatures up to approximately 122° F, and a second full binary control at temperatures greater than 122° F
	8. **SLIDE 8 EXPLAIN Figure 74-7** An ECT sensor being tested using a digital meter set to DC volts and record mode to capture the data shown. A chart showing the voltage decrease of the ECT sensor as the temperature increases from a cold start. The bumps at the bottom of the waveform represent temperature decreases when the thermostat opens and is controlling coolant temperature
	**DEMONSTRATION: Show how to use an ohmmeter FIGURE 74-5 to test engine coolant temperature sensors. Show how to use a voltmeter to check for proper ECT circuit operation. FIGURE 74-6 & 7**

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	**DISCUSSION:** Have the students discuss how excessive resistance in ECT circuit would affect the computer control system. What effect would excessive resistance have on engine operation, fuel economy, and emissions?
	**DEMONSTRATION:** Show the students how to use a scan tool to retrieve ECT circuit voltage and coolant temperature.
	**Some older Toyotas will display a fixed value of 176 on scan tool if there is an ECT circuit malfunction.**
	**DISCUSSION:** Have the students discuss the significance of fixed ECT readings. What is indicated by a – 40° F reading on scan tool? What is indicated by a 248°F reading?
	9. **SLIDE 9** EXPLAIN **Figure 74-8** IAT sensor on this GM 3800 V-6 engine is in the air passage duct between the air cleaner housing and the throttle body.
	**EXPLAIN TECH TIP:** ***Quick and Easy ECT Test*** **To check that the wiring and the computer are functioning, regarding ECT sensor, connect a scan tool and look at ECT temperature display. STEP 1 Unplug connector from ECT sensor. Temperature displayed on scan tool should read about −40°C. NOTE: −40° Celsius is also −40° Fahrenheit. This is the point where both temperature scales meet. STEP 2 With the connector still removed from the ECT sensor, use a fused jumper lead and connect two terminals of the connector together. The scan tool should display about 285°F (140°C). This same test procedure works for IAT and most other temperature sensors.**
	**DISCUSSION:** Have the students discuss IAT operation. What impact does IAT sensor have on air-fuel mixture? FIGURE 74-8

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	**DEMONSTRATION:** Remove an IAT sensor from a vehicle. Hook up an ohmmeter to show how resistance changes when you hold sensor in your hand. Discuss how body heat may lead to incorrect diagnosis of sensor condition.
	**HANDS-ON TASK:** Have the students locate an IAT sensor on a vehicle and perform a visual inspection. FIGURE 74-8
	**EXPLAIN TECH TIP:** ***Poor Fuel Economy?*** Black Exhaust Smoke? Look at IAT. If intake air temperature sensor is defective, it may be signaling computer that intake air temperature is extremely cold, when in fact it is warm. In such a case, computer supplies a mixture that is much richer than normal. If a sensor is physically damaged or electrically open, computer often sets a diagnostic trouble code (DTC). This DTC is based on the fact that sensor temperature did not change for a certain amount of time, usually about nine minutes. If, however, wiring or sensor itself has excessive resistance, a DTC is not set and result is lower-than-normal fuel economy, and, in serious cases, black exhaust smoke from the tailpipe during acceleration.
	**DISCUSSION:** Have the students discuss how a short-to ground in the 5 V reference wire would affect IAT operation. What would be the effect on air-fuel mixture and emissions?
	**DISCUSS FREQUENTLY ASKED QUESTION:** ***What Exactly Is an NTC Sensor?*** A negative temperature coefficient (NTC) thermistor is a semiconductor whose resistance decreases as temperature increases. In other words, the sensor becomes more electrically conductive as temperature increases. Therefore, when a voltage is applied, typically 5 volts, the signal voltage is high when the sensor is cold because sensor has a high resistance and little current flows through to ground. • **SEE FIGURE**

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	74–9. However, when the temperature increases, the sensor becomes more electrically conductive and takes more of 5 volts to ground, resulting in a lower signal voltage as sensor warms.
	**10. SLIDE 10 EXPLAIN FIGURE 74–9** A typical temperature sensor circuit. **11. SLIDE 11 EXPLAIN FIGURE 74–10** Some engines are equipped with a cylinder head temperature (CHT) sensor which is used by the PCM along with the ECT, to determine the temperature of the engine.
	**DISCUSS CHART 74-1 Selected temperature sensor-related diagnostic trouble codes.**
	**HANDS-ON TASK: Have the students use a scan tool to retrieve ECT & IAT circuit voltage and temperature. How can this data be used to diagnose malfunctions?**
	**DISCUSSION: Discuss the different types of temperature sensors used on vehicles. Ask them to talk about different types of conditions sensors are exposed to. How does this affect design of sensors?**
	**DISCUSSION: discuss temperature sensor diagnostic trouble codes. Why will most computer control systems set a DTC for temperature sensor circuit only open or grounded?**
 	**ON-VEHICLE ASEEDUCATION TASK B6. Diagnose emissions or driveablility concerns without stored or active diagnostic trouble codes; determine needed action.**
 	**ON-VEHICLE ASEEDUCATION TASK E7. Interpret diagnostic trouble codes (DTCs) and scan tool data related to the emissions control systems; determine needed action.**