Automotive Service Technology

A6 Electrical/Electronic

AUTOMOTIVE Youth Educational Systems YES®

ORD

Published by:

CORD Communications, Inc.
P.O. Box 21206
Waco, Texas 76702-1206
(254) 776-1822
(800) 231-3015

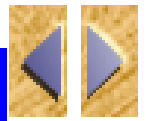
for

Automotive Youth Educational Systems
2701 Troy Center Drive
Suite 450
Troy, Michigan 48084
248-273-1200
www.ayes.org

Printed in the United States of America

July 1999
February 2000

ISBN 1-57837-241-0



Course Syllabus

A6 ELECTRICAL/ELECTRONIC

A Secondary-Level Course for Students Interested in Careers Related to Automotive Electricity and Electronics

This course links occupational and academic pedagogy and is built on* Integrated Curriculum Standards*, which incorporate state and national academic, occupational, and employability standards.

CONTENTS

I. Course Title

A6 Automotive Electrical/Electronic Systems

II. Course Duration

One to two years (1-2 Carnegie units) depending on the allowable school time blocks

III. Course Description

A specific technical course designed to teach the principles of electricity and electronics and apply them to automotive systems. This course builds on the essential concepts and measurement of electrical parameters, such as voltage, current, resistance, power, magnetism, electromagnetism, and magnetic induction that the student has learned in earlier physics courses. Students will learn the concept of Ohm's law in both application and mathematical theory. Detailed topics include the use of a digital multimeter (DMM) for the analysis of series, parallel, and series-parallel circuits. Specific automotive systems covered include batteries, charging and starting systems, lighting, gauges, accessories, electronics, automotive computers and solid-state devices, and communication systems. Students will learn how to apply electrical/electronic principles to repair car and truck electrical systems using a scientific process-of-elimination diagnostic strategy. Courseware will include specific instructions for the worksite mentor trainer. The student will apply all of this knowledge to accurately diagnose and service cars and trucks with electrical/electronic systems. **Prerequisite: Technology Systems, Fundamentals of Service Technology. Corequisite: Contextual Physics.**

IV. Course Instructional Philosophy, Purpose, and Methodology

This course will focus on student mastery of selected basic principles and the use of equipment fundamental to electricity and electronics in the automotive industry. Skill mastery will depend on performance of the listed technical competencies used as a criterion reference. In this course, the student will apply the theories of electricity and electronics that are learned in the corequisite course in physics and will build on the introductory work in physics learned in the prerequisite courses. The content of this course is intended to develop the student's understanding of complex automotive electrical and electronic systems through the contextual learning principles of transferring, relating, application, cooperation, and experience.

V. Course Objectives

The broad based objectives for this course are as follows:

1. **The student will master specified academic and technical content.**
2. **The student will practice effective communication skills.**
3. **The student will develop abilities to solve problems and think skillfully.**
4. **The student will practice skills required for working within a system.**
5. **The student will learn to manage resources and information.**
6. **The student will practice skills required for being a responsible person.**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Upon completion of this course, students are expected to have gained the knowledge, skills, and attitudes necessary to diagnose, repair and/or service car and truck electrical/electronic systems to original equipment manufacturer's specifications. These expectations are defined in terms of integrated academic, employability, and occupational standards represented by Integrated Curriculum Standards (ICS) plus detailed technical competencies.

Technical competencies specify the technical knowledge and skills that are required to diagnose, repair, and service electrical/electronic automotive systems. ICSs incorporate the national academic, employability, and occupational standards that should be considered in this course. With use of the ICSs, integration of academic and technical content can be accomplished. The ICSs introduce topics that go beyond the technical content and address expectations for students to develop a variety of complex skills. Additional information about the ICSs can be obtained from the *Curriculum Integrator* materials. See Section XI for the reference information.

Some connections to job sheets and ideas for application are given as examples of repairs and tasks performed in the various technology areas. Students will see the connections among the ideas for application, job sheets, worksite mentored activities, and various competencies and standards listed, because all activities are task/competency based and tied to the ICSs. Information provided in this syllabus is not only for instructor use, but can also provide value to the students and should be provided to them.

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Professional help during projects can show the application of this skill.	**ICS 004 Chemical Bonding and the Structure of Matter** Use the periodic table to learn about and predict the properties of elements based on their atomic structure and bonding characteristics. Correlate the position of elements in the table to the following: 1) their atomic structure, 2) the way they bond to one another and to other elements based on their atomic structure, and 3) the way these bonding characteristics affect their properties. Use chemical handbooks, databases, and other resources to verify the properties of elements, compounds, and mixtures as determined by the periodic table and, where appropriate, further correlate these properties with their occurrence in cycles, such as the carbon cycle and the nitrogen cycle, and the benefits and hazards associated with them. **Technical Competencies** ◆ Define atomic structure and electron movement. ◆ Explain atomic theory in relation to battery operation using like and unlike charges. This analogy gives relevance to the abstract concept of attraction/repulsion or like and unlike charges. This understanding is necessary for semiconductors later in the program. ◆ Use an electroscope experiment to demonstrate electron movement and like and unlike charges.	**ICS assessment instrument** **On-demand demonstration**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Videotapes and two-way audio/video provide safe ways to observe the correct handling of chemicals.	**ICS 005 Chemical Reactions** Identify, describe, and perform basic types of chemical reactions: synthesis, redox, addition, displacement, and decomposition. Investigate selected processes that occur in these contexts. Analyze the processes in order to classify the types of reactions involved. Perform, monitor, and describe the basic types of reactions in the laboratory using appropriate equipment and giving attention to all safety and health factors in these reactions. Analyze reactions from both the "real-world" and the laboratory viewpoints. Identify reactants and products and the stoichiometric relationship between them in the balancing of equations. In all the above activities, use appropriate chemical nomenclature to name substances and describe reactions. **Technical Competencies** ◆ Describe the chemical, thermodynamic, and chemical kinetic characteristics of materials that can undergo oxidation/reduction reactions.	**ICS assessment instrument** **On-demand demonstration** **Structured observation**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Projects 2, 3, and 6	This topic can be reinforced and applied in many worksite settings.	**ICS 044 Basic Electrical Concepts** Identify and demonstrate a working knowledge of basic electrical concepts including but not limited to Ohm's law, resistance, voltage, and current. Describe and illustrate how these concepts apply to series, parallel, and series-parallel circuits. **Technical Competencies** ◆ Define atomic structure and electron movement. ◆ Define the term valence and its meaning to electricity. ◆ Use an electroscope experiment to demonstrate electron movement and like and unlike charges. ◆ Define electricity and identify automotive sources of electricity. ◆ Define voltage, current, resistance, voltage drop, and conductance.	**ICS assessment instrument** **Simulation** **On-demand demonstration** **Structured observation**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Project 4	Worksite learning plans should incorporate this topic. Students can use worksite situations as foundations for projects.	**ICS 086 DC Circuits** Identify and interpret the meaning of principles and operations of DC circuits and components. Apply logical and systematic approaches to analyze, design, fabricate, test, troubleshoot, and repair DC circuits, observing rules and techniques of accepted industry workmanship and safety standards including electrostatic discharge (ESD) safety. **Technical Competencies** ◆ Differentiate the cause and effect relationship in Ohm's law between voltage, current, resistance, and voltage drop; then, using this law's formulas, solve problems practically and mathematically. ◆ Solve for current in a complex series-parallel circuit using algebraic simultaneous equations. ◆ Define the two theories of current flow (conventional and electron) and explain which one the automotive industry uses and why. ◆ Explain the terms conductor, insulator, and semiconductor, and differentiate between their functions. ◆ Define electrical power and its Ohm's law relationship. (Power is the rate at which a device performs work.) ◆ Explain the difference between DC and AC current.	**ICS assessment instrument** **Work journal entry** **On-demand demonstration**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Project 4	Worksite learning plans should incorporate this topic. Students can use worksite situations as foundations for projects.	**ICS 086 Technical Competencies continued** ◆ Explain the function of a digital multimeter (DMM) and use it to measure voltage, voltage drop, current, resistances, and continuity in sample automotive electrical circuits. **NATEF Work Skill A6/A3, 4, 5, P1.** ◆ Differentiate between a short and a ground **NATEF Work Skill A6/A7, P1.** ◆ Identify the characteristics of series, parallel, and series-parallel circuits. Construct series, parallel, and series-parallel circuits, then assess and solve circuit problems both electrically and mathematically on those circuits. ◆ Using a DMM, jumper wires, or test light, assess and diagnose the different types of circuit faults including shorts, grounds, opens, resistance, and parasitic battery drain, and assess and diagnose their effects on automotive electrical circuits **NATEF Work Skill A6/A6, (P2), A7, (P1).** ◆ Identify an ESD symbol and explain its use.	**ICS assessment instrument** **Work journal entry** **On-demand demonstration**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Worksite learning plans should incorporate this topic. Students can use worksite situations as foundations for projects.	**ICS 087 AC Circuits** Identify and interpret the meaning of principles and operations of AC circuits and components. Apply logical and systematic approaches to analyze, design, fabricate, test, troubleshoot, and repair AC circuits, observing rules and techniques of accepted industry workmanship and safety standards including electrostatic discharge (ESD) safety. **Technical Competencies** ◆ Define capacitance and describe the function of a capacitor in an automotive electrical circuit. ◆ Differentiate between AC and DC electricity and use a DMM to measure voltage at different points in a circuit. ◆ Identify and explain the use of an ESD symbol. ◆ Diagnose electrical faults in circuits containing electromagnetic devices (solenoids, relays, starters, alternators, etc.) and/or capacitors. ◆ Demonstrate an understanding of proper safety techniques for all types of circuits and components (DC circuits, AC circuits, analog circuits, digital circuits, discrete solid-state circuits, microprocessors)	**ICS assessment instrument** **Work journal entry** **On-demand demonstration** **Structured observation**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Worksite learning plans should incorporate this topic. Students can use worksite situations as foundations for projects.	**ICS 088 Solid-State Devices** Identify and interpret principles and operations of solid-state devices. Apply logical and systematic approaches to analyze, design or service, fabricate/repair, test, troubleshoot, and service/repair solid-state circuits (i.e., control modules, diodes, transistors, thyristors, sensors), observing rules and techniques of accepted industry workmanship and safety standards including electrostatic discharge (ESD) safety. **Technical Competencies** ◆ Identify the basic types and construction of solid-state devices used in automotive electronic circuits. ◆ Explain the terms conductor, insulator, and semiconductor, and differentiate between their functions. ◆ Explain the use and function of diodes and transistors in an automotive circuit. ◆ Assess and diagnose electrical faults in circuits containing semiconductor devices. These items include the following: warning devices, driver information systems, electronic instrument clusters, sensors, sending units, connectors, and wires of electronic instrument circuits. Repair as needed. ◆ Identify the different types of sensors used by automotive computers.	**ICS assessment instrument** **Work journal entry** **On-demand demonstration** **Structured observation**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Worksite learning plans should incorporate this topic. Students can use worksite situations as foundations for projects.	**ICS 089 Analog Circuits** Identify and interpret principles and operations of analog devices, circuits, and systems. Apply logical and systematic approaches to analyze, design or service, fabricate/repair, test, troubleshoot, and service/repair analog circuits and systems, observing rules and techniques of accepted industry workmanship and safety standards including electrostatic discharge (ESD) safety. **Technical Competencies** ◆ Identify the different types of sensors used by automotive computers and differentiate between those that are analog and those that are digital. ◆ Assess and diagnose electrical faults in circuits containing analog-type semiconductor devices. These items include the following: warning devices, driver information systems, electronic instrument clusters, sensors, sending units, connectors, and wires of electronic instrument circuits. Repair as needed.	**ICS assessment instrument** **Work journal entry** **On-demand demonstration** **Structured observation**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Worksite learning plans should incorporate this topic. Students can use worksite situations as foundations for projects.	**ICS 090 Digital Circuits** Identify and interpret principles and operations of digital logic devices, circuits, and systems. Apply logical and systematic approaches to analyze, design or service, fabricate/repair, test, troubleshoot, and service/repair digital circuits and systems, observing rules and techniques of accepted industry workmanship and safety standards including electrostatic discharge (ESD) safety. **Technical Competencies** ◆ Describe the types of automotive computer digital input and output signals ◆ Identify the different types of digital sensors used by automotive computers. ◆ Explain the use and function of diodes and transistors in an automotive circuit. ◆ Assess and diagnose electrical faults in circuits containing digital semiconductor devices. These items include the following: warning devices, driver information systems, electronic instrument clusters, sensors, sending units, connectors, and wires of electronic instrument circuits. Repair as needed.	**ICS assessment instrument** **Cognitive mapping** **ASE-style paper-and-pencil test**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Worksite learning plans should incorporate this topic. Students can use worksite situations as foundations for projects.	**ICS 091 Microprocessor Systems and Interfaces** Identify and interpret principles and operations of microprocessors and external devices. Apply logical and systematic approaches to analyze, design or service, fabricate/repair, test, troubleshoot, and service/repair microprocessor circuits, observing rules and techniques of accepted industry workmanship and safety standards including electrostatic discharge (ESD) safety. **Technical Competencies** ◆ Describe the function and basic operation of a microprocessor and identify the different types of computers that use processors. ◆ Describe the uses of scan tools and Personal Computers in communicating with automotive computers (PCM/ECM) ◆ Using the OEM service manual and ESI, assess and diagnose electrical faults in circuits containing semiconductor devices. These items include the following: warning devices, driver information systems, electronic instrument clusters, sensors, sending units, connectors, and wires of electronic instrument circuits. Repair as needed **NATEF Work Skill A6/F2, 4, (P3), F3, (P1).** ◆ Diagnose radio static and weak, intermittent, or no radio reception and program electronic radios and clocks **NATEF Work Skill A6/H6, P3.**	**ICS assessment instrument** **Cognitive mapping** **ASE-style paper-and-pencil test**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
			ICS 091 Technical Competencies continued ◆ Describe the types of automotive computer input and output signals. ◆ Diagnose incorrect operation of cruise-control systems; repair as needed **NATEF Work Skill A6/H4, P3.** ◆ Identify supplemental restraint system (SRS) components on vehicle and follow manufacturer's safety procedures to prevent accidental deployment **NATEF Work Skill A6/H5, P2.** ◆ Diagnose supplemental restraint system (SRS) problems; repair as needed **NATEF Work Skill A6/H5, P2.**	
		This topic can be reinforced and applied in many worksite settings. Worksite learning plans should incorporate this topic.	**ICS 093 Soldering** Identify and interpret principles and practices of electronic connections including soldering/desoldering and solderless connections, observing rules and techniques of accepted industry workmanship and safety standards including electrostatic discharge (ESD) safety. **Technical Competencies** ◆ Repair automotive wiring harnesses and connectors following OEM procedures. **NATEF Work Skill A6/A11, P1.** ◆ Demonstrate an understanding of and comply with relevant OSHA safety standards. ◆ Perform standard soldering and desoldering techniques **NATEF Work Skill A6/A12, P1.**	**ICS assessment instrument** **On-demand demonstration** **Structured observation** **ASE-style paper-and-pencil test**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Science	**Project 1**	This topic can be reinforced and applied in many worksite settings. Worksite learning plans should incorporate this topic.	**ICS 104 Electricity and Magnetism** Identify and interpret the meaning of the basic units and principles of electricity and magnetism and their interrelationship and application. **Technical Competencies** ◆ Define magnetism, electromagnetism, electromagnetic induction, and magnemotive force. ◆ Compare the units of magnetism to electricity: magnetic force to current, field density to voltage, and reluctance to resistance. ◆ Explain the use and operation of automotive circuit components that use electromagnetic induction and magnetism, including: alternators, motors, starters, relays, solenoids, etc. ◆ Define capacitance and describe the function of a capacitor in an electrical circuit.	**ICS assessment instrument** **On-demand demonstration** **ASE-style paper-and-pencil test**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Math	**Projects 3 and 6, 7**	Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	**ICS 160 Battery Starting and Charging Systems** Identify and interpret the operation of battery starting and charging systems. Diagnose and repair malfunctions in battery starting and charging systems. **Technical Competencies** ◆ Identify the purpose of the battery. ◆ Describe battery operation and capacity. ◆ Identify battery ratings and safety procedures. ◆ Perform battery state-of-charge tests; determine needed service **NATEF Work Skill A6/B1, P1**. ◆ Diagnose and locate battery parasitic loads **NATEF Work Skill A6/A8, P1.** ◆ Perform battery capacity (load, high-rate discharge) test; determine needed service **NATEF Work Skill A6/B2, P1.** ◆ Explain battery ratings, cold cranking amps (CCA), reserve capacity (RC) ratings, and how the number of plates and cells affects CCA and RC ratings **NATEF Work Skill A6/B2, P1.** ◆ Restore electronic computer memory functions **NATEF Work Skill A6/B3, P2.** ◆ Perform ECM draw test **NATEF Work Skill A6/A7, P1.** ◆ Inspect, clean, fill, and replace battery **NATEF Work Skill A6/B4, P2.**	**ICS assessment instrument** **On-demand demonstration**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Math	**Projects 3 and 6**	Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	**ICS 160 Technical Competencies Continued** ◆ Perform slow/fast battery charge **NATEF Work Skill A6/B5, P2**. ◆ Inspect and clean battery cables, connectors, clamps, and hold-downs; repair or replace as needed **NATEF Work Skill A6/B6, P1.** ◆ Perform voltage drops on the battery cables and connectors **NATEF Work Skill A6/C2, P1.** ◆ Identify and explain starting system principles. ◆ Describe starting system switch function and operation. ◆ Explain electric motor operation. ◆ Identify starter component function including gear ratios. ◆ Perform starter current draw and circuit voltage drop test; determine needed repairs **NATEF Work Skill A6/C1, P1.** ◆ Inspect and test starter relays and solenoids **NATEF Work Skill A6/C3, P2.** ◆ Remove and replace/reinstall starter **NATEF Work Skill A6/C4, P2.** ◆ Differentiate between electrical and engine mechanical problems that cause a slow crank or no crank condition. ◆ Diagnose electrical faults in circuits containing electromagnetic devices (starters, alternators, etc.) and/or capacitors **NATEF Work Skill A6/H1, P2.**	**ICS assessment instrument** **On-demand demonstration**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Math	**Projects 3 and 6, 7**	Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	**ICS 160 Technical Competencies Continued** ◆ Identify charging system principles. ◆ Inspect, test, and repair or replace switches, connectors, and wires of starter control circuits **NATEF Work Skill A6/C6, P2**. ◆ Disassemble, clean, inspect, and test starter components; replace as needed; then perform starter bench tests; determine necessary action. **NATEF Work Skill A6/C7, P3** ◆ Explain charging system function and operation. ◆ Identify generator components and explain their operation. ◆ Perform charging system output test; determine necessary action. **NATEF Work Skill A6/D1, P1.** ◆ Diagnose charging system problems that cause undercharge, no-charge, or overcharge conditions and perform needed repairs, such as, drive belt adjustment or alternator component testing and replacement **NATEF Work Skill A6/D2, P1.** ◆ Perform charging circuit voltage drop tests; determine necessary action. **NATEF Work Skill A6/D7, P1.**	**ICS assessment instrument** **On-demand demonstration**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Project 6	Job shadowing, part-time employment, and intern-ships can give firsthand experience with this skill.	**ICS 161 Electrical Components, Gauges, and Warning Devices** Diagnose and repair malfunctions in electrical components, gauges, and warning devices. **Technical Competencies** ◆ Inspect and test fusible links, circuit breakers, and fuses; replace as needed. **NATEF Work Skill A6/A9, P1.** ◆ Inspect and test switches, connectors, relays, and wires of electrical/electronic circuits; repair or replace as needed **NATEF Work Skill A6/A10, P1.** ◆ Inspect and test gauges, warning devices, driver information systems, circuit voltage regulators, gauges, sending units, connectors, wires, and printed circuit boards of gauge circuits; repair or replace as needed **NATEF Work Skills A6/F1, (P2) F2, (P3) F3, (P1) F4 (P3).** ◆ Use a diagnostic strategy thought process along with OEM service manual fault statements and electronic service information to reduce the list of possible causes of faults in an electrical circuit and to diagnose and locate those electrical circuit faults **NATEF Work Skill A6/A1, P1.** ◆ Inspect, replace, and aim headlights and bulbs and diagnose all lighting circuits; repair or replace as needed **NATEF Work Skill A6/E1, E2, P2.**	**ICS assessment instrument** **On-demand demonstration**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 1: The student will master specified academic and technical content.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Project 6	Job shadowing, part-time employment, and intern-ships can give firsthand experience with this skill.	**ICS 161 Technical Competencies Continued** ◆ Diagnose intermittent, high, low, or no gauge readings **NATEF Work Skill A6/F1.** ◆ Diagnose the following: incorrect horn operation, incorrect wiper operation, wiper speed control and park problems, incorrect windshield washer operation, incorrect operation of motor-driven accessory circuits; incorrect heated glass operation, incorrect electric door and hatch/trunk lock operation; repair as needed **NATEF Work Skill A6/G1-G3, H1-H3.**	**ICS assessment instrument** **On-demand demonstration**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 2: The student will practice effective communication skills.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Language Arts	**Project 4**	This topic can be reinforced and applied in many worksite settings. Job shadowing with the service manager, warranty clerk, parts manager, and the finance/ insurance staff provides important examples of this skill.	**ICS 018 Communication** Determine content of communication based on purpose and audience. Select and interpret appropriate references. Identify the appropriate format for communication. Convey information to audience according to accepted practices. **Technical Competencies** ◆ Using strategy-based diagnostic routines, interpret and verify the customer's concern and determine needed repairs. ◆ Interpret and communicate information – select and analyze information and communicate the results to others using oral, written, graphic, pictorial, or multimedia methods. ◆ Use computers to acquire, organize, analyze, and communicate information.	**ICS assessment instrument** **Simulations** **Videotaping**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 2: The student will practice effective communication skills.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Math	**Project 6**	Four hours of job shadowing with the service manager provides experience for this skill.	**ICS 032 Customer Relations** Exhibit an awareness of the importance of good customer relations to a business. Communicate with customers to identify their needs and expectations. Identify and/or obtain additional resources to resolve customer problems and satisfy their needs. Differentiate between consumer rights and business responsibilities. Recognize the relationship between public relations and marketing. **Technical Competencies** ◆ Using strategy-based diagnostic routines, interpret and verify the customer's concern and determine needed repairs. ◆ Document customer complaints and provide customer service. ◆ Interact with management, fellow technicians, and customers.	**ICS assessment instrument** **Simulation** **Checklist** **ASE-style paper-and-pencil test**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 2: The student will practice effective communication skills.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Project 2	Using blueprints and diagrams in projects gives students firsthand experience with them.	**ICS 049 Blueprints and Diagrams** Demonstrate the proper procedures for reading and interpreting blueprints and diagrams in production or service technology. Obtain representative drawings and identify dimensions, symbols, types of lines, views, and scale. Understand the logic of algebraic or service/repair procedures and geometric concepts as they relate to blueprint reading. Understand the importance of working with established industry tolerances. **Technical Competencies** ◆ Determine appropriate diagnostic procedures based on available vehicle data and service information; determine if available information is adequate to proceed with effective diagnosis. ◆ Read and interpret blueprints, logic diagnostic charts, flow diagrams, schematics, and three-dimensional objects in order to recognize problems and to work toward their solution. ◆ Demonstrate an understanding of the interpretation and creation of electronic schematics, technical drawings, and flow diagrams. ◆ Use steps of logic and analysis to identify relevant details to correctly interpret diagnostic charts and diagrams. ◆ Identify and use different dimension methodologies and general symbols.	**ICS assessment instrument** **On-demand demonstration** **Conferencing**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Math	**Project 3**	This topic can be reinforced and applied in many worksite settings. Job shadowing with the service manager, warranty clerk, parts manager, and finance/ insurance staff gives important examples of this skill.	**ICS 037 Basic Math** Apply basic mathematical operations (addition, subtraction, multiplication, and division) using whole numbers, integers, fractions, mixed numbers, decimals, percentages, ratios, and proportions to solve problems. Demonstrate a basic knowledge of making estimations. Use appropriate technology to solve math-related problems. Convert word problems to mathematical expressions. **Technical Competencies** ◆ Differentiate the cause-and-effect relationship in Ohm's law between voltage, current, resistance, and voltage drop; then, using this law's formulas, determine the values mathematically. ◆ Solve for current in a complex series-parallel circuit using algebraic simultaneous equations. ◆ Identify the characteristics of series, parallel, and series-parallel circuits. Construct series, parallel, and series-parallel circuits, then assess and solve circuit problems both electrically and mathematically on those circuits.	**ICS assessment instrument** **Graphic organizer**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		This topic can be reinforced and applied in many worksite settings. Worksite learning plans could incorporate this topic.	**ICS 038 Math for Science** Express, read, and write numbers in scientific notation and/or standard notation. Perform and apply basic mathematical operations, including both continuous and discrete mathematical operations. Recognize and calculate levels of significance in numbers. Use appropriate technology to solve mathematical problems and judge reasonableness of results. Construct and/or interpret graphs, charts, tables, and scales to assist in solving mathematical problems or to illustrate findings. **Technical Competencies** ◆ Acquire and evaluate Information – identify a need for data, obtain the data from existing sources or create them, and evaluate their relevance and accuracy, ◆ Express, read, and write numbers in scientific notation and enter the values into a calculator and solve problems involving scientific notation. ◆ Demonstrate the ability to use a simple electronic calculator to solve mathematical problems and judge the reasonableness of their results.	**ICS assessment instrument** **Graphic organizer**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Projects 2, 4, and 6	These concepts are used in many worksite activities. Job shadowing with the service technician can provide examples of this skill.	**ICS 040 Graphs/Charts for Technical Information** Identify and interpret appropriate resources, data sources, and technology to create, represent, and present technical information in common graphs and charts. **Technical Competencies** ◆ Determine appropriate diagnostic procedures based on available vehicle data and service information; determine if available information is adequate to proceed with effective diagnosis.	**ICS assessment instrument** **Cognitive mapping**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Projects 3 and 4	Worksite reports should include relevant math applications.	**ICS 042 Math Formulas** Apply combinations of algebra, geometry, trigonometry, and statistics techniques to use in formulas to solve for simple and complex equations and inequalities and to analyze data. Use graphic organizers and technology when appropriate. **Technical Competencies** ◆ Differentiate the cause-and-effect relationship in Ohm's law between voltage, current, resistance, and voltage drop; then, using this law's formulas, determine the values mathematically. ◆ Identify the characteristics of series, parallel, and series-parallel circuits. Construct series, parallel, and series-parallel circuits, then assess and solve circuit problems both electrically and mathematically on those circuits.	**ICS assessment instrument** **Graphic organizer**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Math	**Projects 3 and 4**	Have students look for problem-solving and documen-tation pro-cesses at the worksite during field trips, job shadowing, part-time employment, and internships.	**ICS 045 Problem Solving and Decision Making** Demonstrate ability to use problem-solving and decision-making processes and to apply these processes to personal and business situations. Identify root causes. Understand the factors that influence solving problems and making decisions and use this understanding in formulating and implementing action plans. Monitor action plans and make adjustments as needed. **Technical Competencies** ◆ Use a diagnostic strategy thought process along with OEM service manual fault statements and electronic service information to reduce the list of possible causes of faults in an electrical circuit and to diagnose and repair those electrical circuit faults. ◆ Recognize that a problem exists (i.e., there is a discrepancy between what is and what should or could be); identify possible reasons for the discrepancy; devise and implement a plan of action to resolve it; evaluate and monitor progress; and revise plan as indicated by findings. ◆ Specify goals and constraints, generate alternatives, consider risks, and evaluate and choose best alternative.	**ICS assessment instrument** **Cognitive mapping** **Work journal entry**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Math	**Project 3**	Professional help with projects through mentors or Internet mentoring can provide guidance with this skill.	**ICS 061 Units of Measurement** Choose the appropriate types of measurement for a particular production process. Demonstrate general and precision measurement techniques and calculations. **Technical Competencies** ◆ Explain the function of a digital multimeter (DMM) and use it to measure voltage, voltage drop, current, resistances, and continuity in sample automotive electrical circuits. ◆ Compare the units of magnetism to electricity: magnetic force to current, field density to voltage, and reluctance to resistance. ◆ Demonstrate proper general electrical measurement techniques.	**ICS assessment instrument** **Structured observation**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Math	**Project 3**	Professional help with projects through mentors or Internet mentoring can provide guidance with this skill.	**ICS 062 Measurement Tools** Choose the appropriate specialized measurement tool, instrument, and/or test equipment to make measurements required by production processes. Use measuring tools, instruments, and test equipment, applying industry standards for precision, accuracy, and tolerance. Recognize the effects of measurement errors on calculations. **Technical Competencies** ◆ Explain the function of a digital multimeter (DMM) and use it to measure voltage, voltage drop, current, resistances, and continuity in sample automotive electrical circuits. **NATEF Work Skill A6/A3, P1.** ◆ Interpret digital multimeter (DMM) readings. ◆ Using a DMM, jumper wires, or high-impedance test light, assess and diagnose the different types of circuit faults including shorts, grounds, opens, resistance, and parasitic battery drain, and their effects on automotive electrical circuits. ◆ Describe the uses of the scan tools in communicating with computers. ◆ Explain the use of oscilloscopes in the understanding and diagnosis of automotive electronic circuits. ◆ Diagnose automotive electronic circuits using oscilloscopes.	**ICS assessment instrument** **Structured observation** **Annotated notes**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		This skill is applicable in all worksite settings.	**ICS 078 Scientific Method** Use the scientific method to solve problems in the laboratory or in the field. Maintain proper documentation of problems, references, and procedures. Follow procedures for gathering and analysis of data. Formulate hypotheses and conduct testing. Support conclusions with evidence. **Technical Competencies** ◆ Use a diagnostic strategy thought process along with OEM service manual fault statements and electronic service information to reduce the list of possible causes of faults in an electrical circuit and to diagnose and repair those electrical circuit faults. ◆ Using strategy-based diagnostic routines, interpret and verify complaint; determine needed repairs.	**ICS assessment instrument** **Checklist** **Annotated notes** **On-demand demonstration**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Math	**Project 3**	Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	**ICS 166 Inspection** Inspect the general condition of tools, equipment, systems, and inventory. Follow an inspection process. Respond to warning conditions indicated. **Technical Competencies** ◆ Inspect, clean, fill, and replace battery; inspect and clean battery cables, connectors, clamps, and hold-downs; repair or replace as needed. **NATEF Work Skill A6/B6, P1** ◆ Inspect and test fusible links, circuit breakers, fuses, switches, connectors, relays, wires, gauges, warning devices, driver information systems, starter relays and solenoids, gauge circuit voltage regulators, gauges, sending units, and printed circuit boards of gauge circuits; repair or replace as needed. **NATEF Work Skill A6/A9, A10, (P1) C3, C6, (P2) F2, F4, (P3).** ◆ Inspect, replace, and aim headlights and bulbs; repair or replace as needed. **NATEF Work Skill A6/E2, P2.** ◆ Inspect and adjust generator (alternator) drive belts; replace as needed. **NATEF Work Skill A6/D3, P1.** ◆ Inspect and test voltage regulator/regulating circuit; perform necessary action. **NATEF Work Skill A6/D4, P1.**	**ICS assessment instrument** **ASE-style paper-and-pencil test** **On-demand demonstration** **Simulations** **Structured observation** **Work journal entry**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Math	**Project 3**	Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	**ICS 166 Technical Competencies Continued** • Remove, inspect, and install generator (alternator). **NATEF Work Skill A6/D5, P2.** • Disassemble generator (alternator), clean, inspect, and test components; determine necessary action. **NATEF Work Skill A6/D6, P3.**	**ICS assessment instrument** **ASE-style paper-and-pencil test** **On-demand demonstration** **Simulations** **Structured observation** **Work journal entry**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	**ICS 167 Diagnosis** Research the system breakdown using technical information to determine diagnostic procedures. Follow strategy-based diagnostic routines. Generate solutions to problems and determine needed repairs while recognizing when assistance is needed. Document the diagnostic procedures and results. **Technical Competencies** ◆ Using strategy-based diagnostic routines, interpret and verify complaint; determine needed repairs. ◆ Diagnose electrical faults in circuits containing electromagnetic devices (starters, alternators, etc.) and/or capacitors. ◆ Diagnose charging system problems that cause undercharge, no-charge, or overcharge conditions and perform needed repairs, such as drive-belt adjustment or alternator component testing and replacement; determine necessary action. **NATEF Work Skill A6/D2, P1.** ◆ Use a diagnostic thought process (scientific process of elimination) and fault statements to reduce the list of possible causes of a fault in an electrical circuit. ◆ Diagnose intermittent, high, low, or no gauge readings; determine necessary action. **NATEF Work Skill A6/F1, P2** ◆ Diagnose incorrect horn operation; perform necessary action. **NATEF Work Skill A6/G1, P3**	**ICS assessment instrument** **ASE-style paper-and-pencil test** **On-demand demonstration** **Simulations** **Structured observation** **Work journal entry**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 3: The student will develop abilities to solve problems and think skillfully.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	**ICS 167 Technical competencies continued** ◆ Diagnose incorrect wiper and washer operation; diagnose wiper speed control, washer, and park problems; perform necessary action. **NATEF Work Skill A6/G2, P3.** ◆ Diagnose incorrect operation of motor-driven accessory circuits, incorrect heated glass operation, incorrect electric door and hatch/trunk lock operation; determine necessary action. **NATEF Work Skill A6/H1, P2.** ◆ Diagnose incorrect operation of cruise-control systems; repair as needed. **NATEF Work Skill A6/H4, P3.** ◆ Assess and diagnose electrical faults in circuits containing semiconductor devices. These items include the following: warning devices, driver information systems, electronic instrument clusters, sensors, sending units, connectors, and wires of electronic instrument circuits. Repair as needed. ◆ Diagnose radio static and weak, intermittent, or no radio reception; determine necessary action. **NATEF Work Skill A6/H6, P3.** ◆ Diagnose incorrect operation of cruise-control systems; repair as needed. **NATEF Work Skill A6/H4, P3.** ◆ Diagnose supplemental restraint system (SRS) problems; determine necessary action. **NATEF Work Skill A6/H5, P3.**	**ICS assessment instrument** **ASE-style paper-and-pencil test** **On-demand demonstration** **Simulations** **Structured observation** **Work journal entry**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 4: The student will practice skills required for working within a system.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Math	**Project 3**	Students identify appropriate regulations affecting the worksite. Job shadowing with the warranty clerk gives examples of this skill.	**ICS 002 Regulations** Demonstrate the ability to locate, apply, and take part in dialogue concerning the impact of government regulations and business/industry procedures on the performance of particular job functions and services. Differentiate among federal, state, and local regulations; the various agencies involved in government oversight; and local business and industry procedures and services. Recognize the process and impact of regulations on the management of resources and delivery of services. **Technical Competencies** ◆ Identify supplemental restraint system (SRS) components on vehicle and follow manufacturer's safety procedures to prevent accidental deployment. ◆ Be familiar with "right to know" legislation. ◆ Apply federal, state, and local regulations when storing and disposing of chemical materials and waste and know where to find current information about implementing these regulations. ◆ Follow regulations of the U.S. Occupational Safety and Health Administration (OSHA).	**ICS assessment instrument and checklist** **ASE-style paper-and-pencil test** **Work journal entry**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 4: The student will practice skills required for working within a system.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Language Arts	**Project 3 and 5**	Worksite learning provides a powerful reinforce-ment of safety issues. Job shadowing with a service technician should always emphasize this skill.	**ICS 034 Safety** Identify safety requirements and recognize safety signs and symbols. Apply appropriate information to respond, use safety equipment correctly, and take appropriate actions. Implement safety programs and document results. **Technical Competencies** ◆ Practice recommended precautions when handling static-sensitive devices. ◆ Use appropriate safety procedures and guidelines. ◆ Use protective equipment. ◆ Maintain, understand and follow material safety data sheets (MSDS). ◆ Maintain safety equipment. ◆ Recognize safety symbols/signs. ◆ Demonstrate an understanding of and comply with relevant OSHA safety standards.	**ICS assessment instrument** **Extended paper and pencil test** **Checklist** **Structured observation** **Project portfolio**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 4: The student will practice skills required for working within a system.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Project 5	This skill can be reinforced with worksite experiences. Job shadowing with the parts manager provides examples of this skill.	**ICS 079 Teamwork** Participate as an effective member of a team by contributing to the group effort of accomplishing goals. Identify and employ the appropriate role within the group. Use effective communication, interpersonal skills, and learning techniques while working with others of diverse backgrounds. Participate in group decision-making processes incorporating the appropriate role within the group. Evaluate the team's efforts. **Technical Competencies** ◆ Participate as an effective member of a dealership business or work team by contributing to the team efforts of repairing vehicles correctly and reducing repair cycle time. ◆ Demonstrate understanding of the role of a professional automotive technician and other dealership personnel and how the effective communication processes and individuals contribute to the whole organization.	**ICS assessment instrument** **Conferencing** **Project-based learning** **Simulations**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 4: The student will practice skills required for working within a system.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Projects 4, 5, and 6	Research and analyze policies found in the worksite that relate to nondiscrimi-nation. Job shadowing with the parts manager provides evidence of the need for this skill.	**ICS G20 Appreciation of Diversity** Recognize differences associated with diversity in racial, ethnic, regional, educational, social, and age issues. Implement interpersonal skills involved in working with and for others of diverse backgrounds.	**ICS assessment instrument** **Conferencing** **Structured observation**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 5: The student will learn to manage resources and information.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Math	**Projects 5 and 6**	This topic can be reinforced and applied in many worksite settings. Job shadowing with the warranty clerk and service technicians gives examples of this skill.	**ICS 009 Reference Materials** From a wide range of resources, obtain materials appropriate to a given problem, topic, or situation. Collect and organize information from the materials for use in communication. **Technical Competencies** ◆ Apply and explain the use of the OEM service manual and electronic service information as information resources in locating electrical and electronic faults. ◆ Apply the service manual and ESI as diagnostic aids in locating electrical circuit faults. ◆ Locate, understand, and interpret written information in prose and documents – including manuals, graphs, and schedules – to perform tasks; learn from text by determining the main idea or essential message. ◆ Identify relevant details, facts, and specifications; infer or locate the meaning of unknown or technical vocabulary; and judge the accuracy and appropriateness. ◆ Collect and organize information from library resources, reference books, and electronic databases.	**ICS assessment instrument** **Scenarios and simulations** **On-demand demonstration** **Structured observation**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective 5: The student will learn to manage resources and information.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Projects 4 and 6	Mentors and job shadow-ing with other dealership managers and personnel as well as with the service technician can provide guidance for this skill.	**ICS G05 Sources, Types, and Uses of Career Information** Identify, locate, and evaluate sources of career information. Demonstrate use of these sources of information regarding career exploration and development.	**ICS assessment instrument** **Graphic organizer** **On-demand demonstration**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 6: The student will practice skills required for being a responsible person.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
		This topic can be reinforced and applied in many worksite settings.	**ICS 012 General Housekeeping** Implement general housekeeping practices to maintain a neat and orderly work area while recognizing the connection to successful job performance. **Technical Competencies** ◆ Keep work area free from clutter. ◆ Maintain organized and neat workplace. ◆ Clean work area according to shop standard and be familiar with a variety of cleanup and emergency response procedures.	**ICS assessment instrument** **Structured observation**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 6: The student will practice skills required for being a responsible person.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
Math	**Projects 2 and 5**	Interviewing can provide practice for this skill. Mentors and job shadowing with various dealership managers and personnel can give examples of the importance of this skill.	**ICS G01 Self-Expression** Demonstrate skills of self-expression appropriate to the situation. Identify styles of self-expression and tailor them to the situation.	**ICS assessment instrument** **On-demand demonstration** **Simulation** **Structured observation**

VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Obj 6: The student will practice skills required for being a responsible person.

Ideas for Application	Projects/Labs (Job Sheets)	Worksite Options	Standards and Competencies	Assessment Strategy Options
	Project 3	Field trips and job shadowing in various dealership departments can help a student decide to enter or not to enter a profession.	**ICS G09 Role of Awareness of Abilities and Skills in Career Development** Demonstrate an understanding of personal abilities and skills with an awareness of the impact on career development of achievement in academic and occupational skills. Discuss the impact of abilities and skills on colleagues and clients.	**ICS assessment instrument** **Work journal entry** **Graphic organizer**

VII. Active Learning—Ideas for Application

SCIENCE

The coil of an electrical solenoid valve has a resistance of 179 ohms and is energized by the battery/alternator system of a car. The coil has an inductance of 150 millihenries. The solenoid valve is energized and the current through the coil has reached the level predicted by Ohm's law. If an electronic switch turns the current off so that it decreases linearly to zero in 1.5 milliseconds, what are the magnitude and sign of the voltage induced in the solenoid coil?

MATH

Victoria must determine if a battery should be replaced. She takes a specific gravity reading of each cell. The readings are as follows: cell 1, 1.145; cell 2, 1.182; cell 3, 1.131; cell 4, 1.131; cell 5, 1.158; cell 6 1.173. Her service manual states that a battery must be replaced if there is a range of 0.050 (50 points) in the specific gravity readings of the cells.

A. What is the lowest specific gravity reading of the cells?

B. What is the highest specific gravity reading of the cells?

C. What is the range of the specific gravity readings of the cells?

D. Should Victoria replace the battery?

E. How can Victoria explain the need for a new battery to a customer?

Answer:

1.131

1.182

0.051

Yes

Answers will vary.

Math Alternate

Open-circuit voltage test (sealed batteries)

Mary must determine if a battery should be replaced or recharged first on a battery with no fill caps or built-in hydrometer. Using a digital multimeter (DMM) set on DC volts, she performs a "Open-circuit voltage test," by checking the voltage across the positive and negative battery terminals. A battery cell at 80°F in good condition on the open-circuit tests at 2.1 volts per cell at 100% charge. The results of this test can indicate a battery's state of charge. If the state of charge is 75% or more, the battery is considered charged. Mary's service manual states that the battery must pass the *state-of-charge* or *open-circuit voltage test* before a *capacity test*, which provides a realistic determination for battery replacement. If the battery shows less than 12.2 volts, it should be recharged before the *capacity test*. Mary measures 11.8 volts on the *open-circuit voltage test.*

A. What voltage reading indicates a 100% charge?

B. What does Mary's reading indicate?

C. What reading indicates a 75% charge?

D. Should Mary recharge or replace the battery?

E. How can Mary explain the need for a new battery to a customer?

Open-Circuit Voltage	State of Charge
12.6 or greater	100%
12.4 to 12.6 volts	70-100%
12.2 to 12.4 volts	50-75%
11.7 to 12.0 volts	0-25%
11.7 or less	0%

Answer:

A. 12.6 or greater

B. A 0 to 25% charge

C. 12.4 volts

D. Recharge the battery first

E. Answers will vary.

LANGUAGE ARTS

Safety issues are abundant in the electrical/electronic course taken by students studying automotive service technology. Lead students in a discussion of what they would consider some common safety precautions the average "driver" would recognize. Compare these responses to what the experts in the automotive technology have to say. Ask students to write comparative narratives that clearly explain the differences. They could conclude with recommendations for improving "driver awareness" of safety issues.

VIII. Active Learning—Projects/Labs (Job Sheets)

1. (**SCIENCE**) The learner teams will construct project board circuits with a mechanical switches, ignition coils, and spark plugs to demonstrate voltage generated by the collapse of the magnetic field in a inductor as used in ignition systems. Use a similar circuit with a resistive load to demonstrate a similar, but possibly damaging, "inductive kick" when turning off the current through the coil of a solenoid or relay.

2. (**SCIENCE " PWM Signals and Pressure Control"**) The learner teams will construct RC filter circuits to demodulate pulse-width modulated pressure command signals and correlate commands from the scan tools with the demodulated PWM signals, and will perform physical measurement of pressure on a Hydramatic transmission. **(Project Provided.)**

3. (MATH) Students will show understanding of a specific-gravity reading on a battery, how it is measured—including variation in temperature—and how it is related to determining if a battery should

be replaced. Students will measure the specific gravity of the cells of several batteries and determine whether the batteries should be replaced.

4. **(MATH "Wire Size ÷ Wire Length = Illumination")** In a team, the learner will diagnose problems in a circuit, and make recommendations to correct a circuit problem to understand and explain the relationship between the length and gauge of wiring. **(Project provided.)**
5. **(LANGUAGE ARTS)** In teams of three or four, students will prepare presentations that illustrate the specific safety precautions that apply to automobiles with computers on board. They will research service manuals and specification sheets from auto parts. Allow time for them to collect vignettes of experiences from various worksite locations where failure to comply with these safety precautions resulted in hazards in the workplace. Encourage students to find a variety of ways to present their findings that will capture their classmates' attention and interest, as well as make the point that it is critical to follow appropriate safety precautions.
6. **(LANGUAGE ARTS "Making Connections")**The learner will demonstrate an understanding of scientific and mathematical principles in the implementation of electrical and electronic applications by constructing analogies to define or illustrate significant concepts. **(Project provided.)**
7. **(INTEGRATED "Control of Alternator Output Voltage")** Learner teams will remove the regulators from alternators, add external leads from the rotor coil brush terminals, and build manual field control circuits on their project boards. They will investigate how field current affects output voltage and the interaction between battery voltage, alternator voltage, and alternator current**. (Project provided.)**

IX. Active Learning—Worksite Options

This course can be strongly supported by worksite learning activities. Both the technical competencies and the integrated standards offer numerous opportunities for worksite application. The objectives for the worksite activities should incorporate the objectives for this course wherever possible. Students and employers should be oriented to these objectives, and the students should be required to report back in terms of the objectives. Worksite learning involves a partnership between local companies and the local school for students to work, or at least to observe, in a short-term situation. Some

suggested worksite experiences follow. These experiences are presented in order of increasing activity and involvement on the part of the student.

1. **Field trips**
   Field trips are a useful teaching aid only when they are carefully planned and orchestrated. All logistical and scheduling criteria should be shared with the administration and/or management of the site to be visited. The visitation site should be appropriate to demonstrate a working environment that can be definitive for students in specific career paths. AYES automotive dealers are encouraged to initiate and conduct field trips from the local elementary or middle schools to their dealerships. An AYES awareness package provides all of the details.

2. **Interviewing**
   Interviewing is a powerful tool for allowing students to establish contact with the workplace. Initially, students should be prompted with appropriate questions. They should then be encouraged to script their questions and to work with classmates and the teacher for validation. Further, students might work on a variety of possible scenarios for answers to their initial questions and their considered responses and further questions. Some interviewing can be done during field trips to appropriate worksites.

3. **Professional help during the development of a project**
   During field trips or in the interviewing process described above, students may have made valuable contacts in the workplace. If so, these contacts might be cultivated and called upon to act in the role of informal consultants for student projects. These consultants can help during the inception, development, and implementation phases of student projects. Students should be briefed on telephone etiquette and the need to respect the consultants' time constraints. Interviewing skills developed earlier in the worksite learning sequence should be emphasized here.

4. **Internet mentoring (E-mail)**
   Another interesting method of linking with informal consultants who can help students in problem solving and project planning and implementation is Internet mentoring. Again, students should be briefed on how to ask questions succinctly and on the importance of using correct grammar and E-mail etiquette. They should give the consultants plenty of time to respond to their questions.

5. **Videotapes of dangerous or sterile environments and/or two-way audio and video**
   The hazards inherent in the occupations at some worksites make it unreasonably dangerous for students to take field trips to the worksites to observe technicians and practitioners or to interview them. An alternate method for

introducing students to these worksites is through the use of videotapes of the worksites. After this initial, passive introduction, students can be brought more into real-time communication with technicians and practitioners through the use of two-way audio and video communication. For example, it is prohibitively dangerous for students wanting to study nuclear technology to visit a power plant's containment unit. Through the use of two-way audio and video communication, however, these students can "see" the containment area and conduct interviews with prospective mentors and occupational consultants.

6. **Shadowing**
Career shadowing can be a very effective tool for introducing students to the general parameters of activity involved with specific occupations. Care must be taken in choosing both the worksite and the worker to be shadowed. Students should be briefed so that they understand that the experience gained during the shadowing process may not include exposure to every aspect of a particular job. Shadowing must be as active as it is passive. The worker to be shadowed should be ready for questions and be ready to explain the general parameters of the job. The shadowing student should be prepared to be attentive and inquisitive and should realize that he or she is also being observed. The AYES initiative requires career shadowing prior to internship.

7. **Part-time employment**
Students should not be allowed to participate in part-time employment arrangements until they have acquired skills that apply to the workplace, even if only marginally. It is understood that part-time employment will be at the job-entry level. It is, however, incumbent upon the educational institution sponsoring a student for part-time employment to ensure that prospective part-time student workers possess those prerequisite skills specified in the Student Development Plan and AYES Work Journal.

8. **Mentoring**
Mentors and students to be mentored should be carefully selected and matched. All mentors and interns are required to attend the AYES Mentor Training Course prior to beginning the internship. This course covers in detail the attitudinal, employability, and interpersonal issues in the workplace. Each technical course will contain mentor training units that detail the process of teaching the technical competencies at the worksite. A mentor should be patient, willing to teach, and knowledgeable of the job. The mentor should be organized, should have a work ethic that is worthy of being imitated, and should have no agenda that exceeds the scope of the job and the student he or she is mentoring. Students to be mentored should be made aware that they represent not only the school where they

are enrolled, but themselves and their families as well. Students must also realize that the mentor has agreed to take on the added responsibility of mentoring and should be treated with respect.

9. **Internships**
Internships are usually associated with short-term, but full-time, exploratory employment. This temporary full-time status generally allows the student greater opportunities to observe and internalize the complex of activities within a firm and specifically to observe more closely and actually perform the duties associated with a specific job. It can even include the student's becoming involved in, and contributing to, an ongoing project. Students launched into internships should have fairly advanced prerequisite job skills and should have been well trained in job-retention techniques. AYES summer internships are paid.

X. Assessment Strategy Options and Instruments

Numerous strategies are available to assess student learning. The use of multiple strategies is encouraged to provide measures of complex skills and varying student strengths and learning styles. Following are suggested strategies.

Annotated notes
Students can annotate the notes taken from classroom discussions, lectures, readings, or their own research. Reflection is the key with this type of assessment. You should look for (1) new insights that are generated as a result of the previously taken notes, (2) ideas that are extensions of previously expressed ideas, and/or (3) comments and questions stemming from previously stated ideas. The thinking represented should be more in the higher-level categories of application, synthesis, and evaluation than a simple restatement or summary.

Case studies, scenarios, and simulations
Case studies, scenarios, and simulations are used to assess a student's ability to analyze events and individuals in light of established criteria. Using this type of situation-specific format, students will be able to reveal their ability to synthesize evidence to support generalizations based on individual cases. Students can choose a variety of formats for presentation of case studies, scenarios, and simulations—videotaping, role playing, written or oral presentations, plays, debates, movements, songs, poetry, and so on.

Charts for information gathering
As information is gathered for projects or individual assignments, students can create matrices or charts to organize the

data. Assessment of a chart or matrix should be based on its appropriateness and design and the accuracy and thoroughness of the data collected. Charts and matrices can be included in portfolios.

Checklist

A checklist is used when specific tasks or functions can be predetermined. Sources of checklists include teacher-made lists based on content and/or processes of knowledge, skill, or attitudes; student-made lists as the initial step in the completion of a project; and employer-made lists that reflect expectations for performance in a specific occupational area. Each item in the checklist should have a single focus. This will allow each element of a task to be isolated and "checked off."

Cognitive mapping

Like graphic organizers, cognitive mapping is a visual representation of relationships among ideas. Cognitive mapping does not have a specific format. The map is generated by the student as a picture of the way he or she sees the ideas fitting together. Common shapes, lines, colors, symbols, and so on can be employed, but the map itself is idiosyncratic. You will still be able to use general evaluation guidelines such as accuracy, thoroughness, and appropriateness, but determining the final outcome of the evaluation requires greater latitude. Using a cognitive map for conferences will reveal a great deal about a student's understanding as well as help the student to clarify his or her thoughts in preparation for the conference.

Conferencing

Collecting information about students' understanding of knowledge, skills, and attitudes on a one-on-one basis is typically referred to a "conferencing." This is more than a "talk." The student should bring a portfolio, a visual representation, or some other piece of work to the conference to support the topic of the conference.

ASE-style criterion-referenced multiple-choice paper-and-pencil tests

Criterion-referenced multiple-choice tests focus on specific technical competencies to determine whether a student has the necessary skills to do a particular task. These tasks pertain to the required knowledge, skills, and actions for meeting automotive industry standards. The tests measure the knowledge and skills the technician must have for performing under certain conditions against the standard of determining needed repair. Criterion-referenced tests measure mastery or lack of mastery. These tasks demonstrate the way the student or employee receives data and solves problems in real life instead of asking him or her to recite memorized answers. The data built in to the questions are based on real work experiences. For example, a question may give a gauge reading and describe visual clues and then ask, "What do you do next?" Six types of questions are asked. They are standard multiple-choice questions, "except" questions, technician A/technician B questions, questions using illustrations, "most likely" questions, and "least likely" questions. In addition, you can ask students to "draw out their thinking" in visual representations using cognitive maps or graphic organizers. Another variation on

extended response is to ask students to formulate the questions for a given piece of information. Students choose the most appropriate answer. This process will reveal a great deal about the students' levels of knowledge and skills.

Graphic organizer
Visual representations are considered graphic organizers when they are formatted into a shape that reveals the flow of ideas, the connection among ideas, and the application of ideas. You can use graphic organizers to assess a student's level of understanding by examining the accuracy, thoroughness, and appropriateness of the graphic to represent a given concept, skill, or process. This assessment tool is especially powerful as a nonverbal mechanism for making inferences about what students know.

AYES Work Journal
Students will use work journals to keep records of their learning experiences using the AYES technical competencies (NATEF task list). Journal entries can serve as accountability pieces. Every repair that an intern works on requires he or she to fill out a **"Work Journal Diagnostic Report."** This report states customer complaint, the cause, and the correction. Once a week, the intern selects one diagnostic report and fills out an **"Applied Education Summary"** that details the technical competencies (NATEF tasks) involved and how they connect to foundation skills—such as reading, writing and math—and employability skills—such as time use or teamwork. The work journal also provides a **"Time-on-Task Tracking Sheet"** to check the repetitiveness of the technical competencies. Work journals allow students to reflect on the meaning of their learning and the attitudes connected to the experiences. Work journal entries can be checked as having been made—yes or no. They reflect the work of the intern in school and at the worksite. AYES students are required to answer specific questions, write specific amounts, and use these specific forms.

Narrative writing
Translating factual information into a narrative format requires students to shift their thinking from comprehension to application. Look for evidence in the narratives that students have internalized the knowledge, skills, or attitudes by being able to represent the information in real-world situations.

On-demand demonstration
When performance of a hands-on skill or solution of a real-life problem is assessed, an on-demand demonstration can to be used to determine level of accuracy, flexibility in application of skill, recognition of appropriate choice of skill for a specific task, and so on. Criteria should be identified prior to the learning experience and then applied during the assessment phase of the demonstration. Students should be prepared to complete this type of assessment with little, if any, prior notification, i.e., "on-demand." Students should be encouraged to keep records of hands-on performances that illustrate habits of mind and levels of knowledge and skills.

Portfolio
A portfolio is a collection of pieces of evidence of a student's knowledge, skills, and attitudes. Used to showcase the student's best work or work in progress, the portfolio serves as a record of progress over time. The content is selected by the student in collaboration with the teacher. The portfolio becomes the centerpiece for review conferences with experts in the field, parents, administrators, other teachers, and even peers. The most effective use of the portfolio is for students to take it to the workplace to showcase competencies and employability skills to employers. Evidence of learning can take various forms such as journals, charts for information gathering, visual representations, narrative writing, photographs, and videotapes.

Project-based learning
Project-based learning provides a hands-on demonstration of knowledge, skills, and attitudes that reveals a student's ability to plan, organize, and create a product or an event. Examples of criteria are timeliness of completion, demonstration of skills needed to complete the experience, documentation of processes used in project development, presence of evidence to support conclusions, relevance and thoroughness of presentation, accuracy of content and processes used, and level of performance as a team member in the completion of the project-based learning experience. Tools used to collect data for evaluation could be computer programs, checklists of the development process from initial to final steps, annotated notes, and conferencing.

Rubrics
A rubric is an expandable scoring guide that specifies the criteria for performance along a continuum. The rubrics provided for the Integrated Curriculum Standards (ICS) from the *Curriculum Integrator* are set along a four-point scale. The key indicators for each component of the ICS are specified with frequency of occurrence and quality of performance or product varying along the scale from 4 through 1. The rubric is distributed to or constructed by the students at the beginning of the course. The purpose is to make the target of learning clear by revealing the critical features of mastery-level performance

from the beginning. Students can learn to monitor and adjust their own levels of performance based on the rubric rather than passively depending on the teacher to "give a grade."

Structured observation
Observation of events, groups, and individuals that focuses on the salient traits of the skill or attitude being displayed is one of the most powerful assessment strategies. When observation is "structured," the key behaviors or attitudes to be observed are predetermined with a focus on "observable" behaviors. Using a scale of frequency of occurrence such as *often–sometimes–seldom–not yet* allows you to collect evidence of student performance in an objective, systematic manner. This information can then be shared in conferencing with students and/or parents. Videotaping can be used to complete the picture of observed behaviors. View the videotape with the student, allowing the student to "unpack" his or her thinking during the taped event.

Videotaping and photography
Composition of the videotape or photograph should reveal what a student considers representative of the knowledge, skill, or attitude. By inference, then, you are able to draw tentative conclusions about his or her level of understanding and ability to appropriately apply the learning. This type of assessment can become a vital piece of the portfolio or a conferencing experience.

XI. Suggested Textbooks/References

A6 Electrical/Electronic Systems, CD-ROM, Interactive Computer Based Training, DVP/CDX 1-888-873-2239

Chrysler Electrical/Electronics I and II, Daimler-Chrysler AG

Curriculum Integrator, CORD Communications, Waco, Texas, 1998

Fundamentals of Electric and Electronic Circuits, Mandl, Prentice Hall

Fundamentals of Electronics, Russell Meade, Delmar Publishing

GM Specialized Electronics Training (18001.02-3), GM Corporation/Raytheon

Today's Technician Automotive Electricity and Electronics, 2nd Edition, Hollembeak, Delmar Publishing

Electrical/Electronics Systems Specialist, Oklahoma Curriculum Instructional Materials Center (CIMC)

Toyota Basic Electrical/Electronics, Toyota Motor Sales, Inc.

XII. Outline of Course Content

I. Basic Electricity, DC and AC Circuits

1. Electrical Fundamentals
   a) Basic electrical concepts
   b) Chemical bonding
2. Conductors and Insulators
3. Characteristics of Electricity (Current, Voltage, Resistance)
   a) Units of measurement
   b) Measurement tools
4. Introduction to the Digital Multimeter (DMM)
5. The Complete Electrical Circuit
6. Using the DMM
7. Ohm's Law
   a) Basic mathematics and formulas
   b) Mathematics for science
8. Series and Parallel Circuits
9. Circuit Protection and Circuit Faults

II. Electromagnetic Devices—Electrical/Magnetic Components

1. Magnetism and Electromagnetism
2. Electromagnetic Load Devices
3. Magnetic (Electromagnetic) Induction

III. General Electrical Diagnosis

1. Reading Electrical Schematics and Wiring Diagrams
    a) Blueprints and diagrams
    b) Reference materials
2. Diagnostic Strategy
    a) Diagnosis
    b) Graphs and charts for technical information
    c) Reference materials
    d) Shop safety
    e) General housekeeping
3. Test Equipment and Special Tools
    a) High-impedance test light
    b) Jumper wires/noid light
    c) Digital multimeter (DMM)
    d) Scan tool
4. Horn and Wiper/Washer Diagnosis and Repair

IV. Battery Diagnosis and Service

1. Battery Operation
2. Battery Service
3. Battery Diagnosis

V. Charging System Diagnosis and Service

1. Charging System Operation
2. Charging System Diagnosis
3. Charging System Service

VI. Starting System

1. Starting System Operation
2. Starting System Diagnosis
3. Starter Service

VII. Automotive Wiring and Wire Service—Wiring Service

1. Inspection of Wiring
    a) Soldering
    b) Chemical Reactions

VIII. Lighting Systems Diagnosis and Repair

1. Operation
    a) Headlights
    b) Headlight Switching Circuits
    c) Taillight Circuits
    d) Interior Lights
2. Lighting Systems Diagnosis

IX. Lighting System Diagnosis

1. Switches and Sending Units
2. Warning Lights
3. Gauges
4. Speedometers
5. Tachometer
6. Electronic Instrument Panel
7. Troubleshooting

X. Miscellaneous Systems Diagnosis and Repair

1. Accessories Diagnosis and Repair

XI. Working with Others/Mentor Module I

1. Workplace Interpersonal Skills
    a) Teamwork
    b) Management of Self-Expression
    c) Customer Relations

2. Work Journal
    a) Problem Solving And Decision Making
    b) Teaching Techniques
    c) Task Lists
    d) Career Information and Development

XII. Automotive Electronics

1. Solid-State-Devices
2. Diodes and Transistors
3. Microprocessors
4. Input Devices
5. Output Devices

XIII. Body Computer Systems

1. Cruise Control Systems
2. Supplemental Restraint Systems (SRS)
3. Radios and Entertainment Systems

XIV. Module Communication

1. Module Communication
2. Data Link Connector
    a) Scan Tools
3. Cellular Phone Systems

XV. Unit Fifteen Diagnosis And Testing

1. Diagnostic Thought Process
2. Testing Process
3. Oscilloscopes