HELP

Automotive Service Technology

A4 Suspension and Steering

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, January 2000

ISBN 1-57837-243-7

HELP

Course Syllabus

A4 SUSPENSION AND STEERING

A Secondary-Level Course for Students Interested in Careers Related to Automotive Suspension and Steering Systems

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

HELP

I. Course Title

A4 Suspension and Steering

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 automotive suspension/steering systems and 4-wheel suspension alignment. This course builds on the essential concepts of geometry, gear reduction, hydraulics laws, and characteristics of liquids and how they apply to the operation and diagnosis of power steering and suspension systems. Steering column operation and diagnosis including supplemental restraint system service will be included. The course will cover the fundamentals of short/long-arm, and strut suspensions, including: caster, camber, thrust angle, toe-in, steering axis inclination (SAI), included angle, toe-out on turns (turning angle/radius), and how they apply to steering, suspension, and 4-wheel alignment. The following wheel balance terms will be specifically explained: static balance, dynamic balance, tramping, and radial force variation. Students will learn strategy-based diagnostic routines, in order to interpret and verify customer concerns and proper operation, and to perform tests and inspection to determine the causes and make corrections related to suspension/steering/wheel systems and alignment. These areas include steering columns, power steering, wheels/tires, short/long-arm/strut suspensions, and 4-wheel alignment. Through the inspection, testing, or measurement of component processes, students will learn to apply this knowledge to determine needed repairs and correctly repair a vehicle. Courseware will also include specific instructions for the worksite mentor trainer. **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 that is fundamental to steering/suspension/wheel systems and four-wheel alignment in the automotive industry. Skill mastery will depend on performance of the listed technical competencies used as criterion references. In this course, the student will apply the theories of mechanics and physics that are learned in the corequisite course in physics, and will build on the introductory work in technology systems and service technology learned in the prerequisite courses. The content of this course is intended to develop the student's understanding of complex steering, suspension, and wheel-alignment systems through the contextual learning principles of transferring, relating, application, cooperation, and experience.

V. Course Objectives

The 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.**

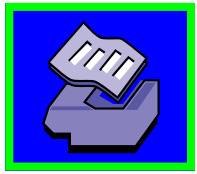
VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

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 suspension and steering systems and align and/or balance all four wheels 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.

HELP

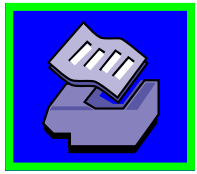


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

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	Professional help in projects, consulting with mentors, and internships can show examples of this skill.	**ICS 007 Chemical and Physical Properties** Identify and measure physical and chemical properties of matter, including various spectra, carrying out standardized tests and observations and using standard chemical references and/or databases where appropriate to obtain data on properties of test materials. Make connections between certain physical properties and states of matter. Make connections between molecular structure and chemical properties such as oxidizing and reducing properties and acidity and alkalinity. Use chemical and physical properties to purify reaction products and other compounds. **Technical Competencies** ♦ Define the characteristics of liquids.	**ICS assessment instrument** **Structured observation** **Work journal entry**

HELP

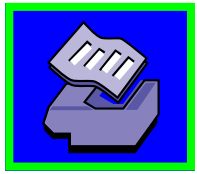


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

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 an automotive microprocessor used in electronic suspension control. ♦ Describe the types of automotive computer input and output signals used in electronic suspension systems.	**ICS assessment instrument** **Cognitive mapping** **ASE-style paper-and-pencil test**

HELP



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 and 3	Professional help in projects, consulting with mentors, and internships can show examples of this skill.	**ICS 101 Basic Physics** Identify and interpret the meaning of basic physics concepts of mechanics, forces, thermodynamics, heat, electricity, magnetism, optics, wave motion, acoustics, and atomic and nuclear physics. Apply these concepts in technology. **Technical Competencies** ♦ Explain the terms friction, force, inertia, lever, gear ratios, momentum, reduction, overdrive, speed, work, torque, and power and how these science terms apply to automotive steering and suspension systems. ♦ Identify the basic characteristics of the automobile tire and explain the three basic types of passenger tire construction. ♦ Identify and explain the types of tire ratings to include tire size ratings and spare tires. ♦ Explain the operation of air-adjustable shocks	**ICS assessment instrument** **ASE-style paper-and-pencil test**

HELP

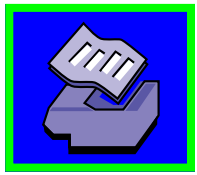
VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

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	**Projects 1 and 2**	Professional help in projects, consulting with mentors, and internships can show examples of this skill.	**ICS 102 Mechanics and Forces** Identify and interpret the meaning of the relevant units of mechanical forces. Apply the laws of motion and conservation of energy, the types of forces, and the concepts of levers and torque, angular momentum, and gravitational forces. **Technical Competencies** ♦ Explain Newton's concepts of mass, force, and acceleration, and his three laws of motion relating them, and apply them to automotive steering and suspension systems. ♦ Identify the fundamental laws of hydraulics and conclude how they apply to the operation of a power steering pump and non-rack and rack and pinion power steering gears. ♦ Identify the components of the integral non-rack and pinion and rack and pinion power steering gears and explain system operation. ♦ Explain the function of springs and Hooke's law. ♦ Define the terms: static balance, dynamic balance, tramping, and radial force variation. ♦ Identify the different types of wheel bearings and explain their operation. ♦ Identify the components of a typical electronically controlled automotive suspension and/or steering system and explain system operation.	**ICS assessment instrument** **ASE-style paper-and-pencil test**

Table of Contents

HELP

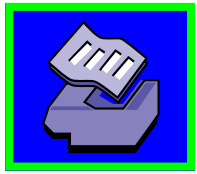


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

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
Language Arts	**Projects 3 and 6**	Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	**ICS 155 Steering and Suspension Systems** Identify and interpret the operation of steering and suspension. Diagnose and repair malfunctions in the steering column, power rack/non-rack-and-pinion steering gear, and long- and short-arm and strut suspension. **Technical Competencies** ♦ Identify terms and definitions associated with steering and suspension systems. ♦ Disable supplemental restraint systems (SRS) in accordance with manufacturer's procedures. **NATEF A4/A1, P1** ♦ Flush, fill, and bleed power steering system. **NATEF A4/A13, P2** ♦ Remove, inspect, replace, and adjust power steering pump belt. **NATEF A4/A15, P1** ♦ Remove, inspect, and replace power steering pump, pump mounts, pump seals, pulley, and gaskets. **NATEF A4/A16** ♦ Remove and replace power rack and pinion and non-rack and pinion steering gear; inspect and replace mounting bushings and brackets (includes vehicles equipped with air bags and/or other steering wheel mounted controls and components). **ASE Task A4/A2/10, 11** ♦ Disassemble, inspect, repair, adjust, and rebuild power rack/non-rack-and-pinion steering gears. **NATEF A4/A7, A9.**	**ICS assessment instrument** **On-demand demonstration**

HELP

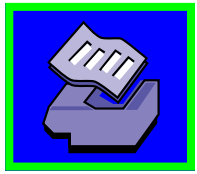


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

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 155 Technical Competencies continued ♦ Explain shock absorber operation and ratios. ♦ Explain the operation of short/long-arm and strut front suspension systems and distinguish between the two systems. ♦ Differentiate between a compression-loaded and a tension-loaded ball joint. ♦ Identify and explain the basic characteristics of leaf, control arm, and strut-type rear suspension systems. ♦ Remove and reinstall front suspension springs, control arms, shock absorbers, torsion bars, ball joints, struts, bushings, and related components and—through measurement, service, replacement, or adjustment—complete the repair. **NATEF A4/B1/3 to 11** ♦ Remove and reinstall rear-suspension shock absorbers, springs, control arms, struts, bushings, and related components and—through measurement, service, replacement, or adjustment—complete the repair. **NATEF A4/B2/1 to 4** ♦ Remove, inspect, and service or replace front and rear wheel bearings. **NATEF A4/B3/2, P1**	

HELP

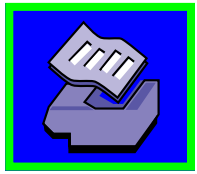


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

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, 4, and 5**	Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	**ICS 156 Wheel Alignment, Wheels, and Tires** Identify and interpret wheel alignment and the operation of wheels and tires. Diagnose and repair malfunctions in wheel alignment, wheels, and tires. **Technical Competencies** ♦ Differentiate between dynamic and static wheel balance. ♦ Identify the terms: caster, camber, thrust angle, and toe-in (turning radius) and relate them to wheels, steering, and tires. ♦ Explain steering axis inclination. ♦ Explain the terms included angle, turning radius, and toe-out on turns, and relate them to steering geometry. ♦ Explain the difference between a 2-wheel and a 4-wheel alignment. ♦ Diagnose vehicle wander, drift, pull, hard steering, bump steer, memory steer, torque steer, steering return, tire wear patterns, wheel/tire vibration, shimmy, and noise problems. **NATEF Task A4/C1, P1** ♦ Perform prealignment inspection; perform necessary action. **NATEF Task A4/C2, P1** ♦ Measure vehicle-riding height; determine needed repairs. **NATEF Task A4/C3, P1**	**ICS assessment instrument** **On-demand demonstration**

HELP

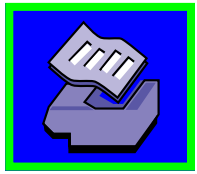


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

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, 4, and 5**	Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	**ICS 156 Technical Competencies continued** ♦ Check and adjust front and rear wheel camber; determine needed repairs. **NATEF Task A4/C4, P1** ♦ Evaluate and adjust caster; determine needed repairs. **NATEF Task A4/C5, P1** ♦ Evaluate and adjust front and rear wheel toe; center the steering wheel. **NATEF Task A4/C6, P1** ♦ Center steering wheel **NATEF Task A4/C7, P1** ♦ Evaluate toe-out-on-turns (turning radius); determine needed repairs. **NATEF Task A4/C8, P1** ♦ Evaluate SAI (steering axis inclination) and included angle; determine needed repairs. **NATEF Task A4/C9, P2** ♦ Evaluate and adjust rear wheel toe. **NATEF Task A4/C10, P2** ♦ Evaluate rear wheel thrust angle; determine needed repairs. **NATEF Task A4/C11, P2** ♦ Assess the front wheel setback; determine needed repairs. **NATEF Task A4/C12, P2** ♦ Check front cradle (subframe) alignment; determine needed repairs. **NATEF Task A4/C13, P2**	**ICS assessment instrument** **On-demand demonstration**

HELP

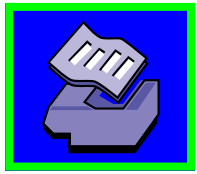


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

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, 4, and 5**	Job shadowing, part-time employment, and internships can give firsthand experience with this skill.	**ICS 156 Technical Competencies continued** ♦ Explain automotive wheel rim design ♦ Diagnose tire wear problems; determine necessary action. **NATEF Task A4/D1, P1** ♦ Inspect tires; check and adjust air pressure. **NATEF Task A4/D2, P1** ♦ Diagnose wheel/tire vibration, shimmy, and noise; determine necessary action. **NATEF Task A4/D3, P2** ♦ Rotate tires according to manufacturer's recommendations. **NATEF Task A4/D4, P1** ♦ Measure wheel, tire, axle, and hub runout; determine needed repairs. **NATEF Task A4/D5, P2** ♦ Diagnose tire pull (lead) problem; determine necessary action. **NATEF Task A4/D6, P1** ♦ Balance wheel and tire assembly (static and dynamic). **NATEF Task A4/D7, P1** ♦ Dismount, inspect, repair, and remount tire on wheel. **NATEF Task A4/D8, P2** ♦ Reinstall wheels and torque lug nuts. **NATEF Task A4/D9, P1**	**ICS assessment instrument** **On-demand demonstration**

HELP

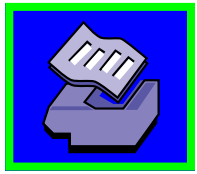


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

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 6	Field trips, mentors, and professionals in the field can give examples of the importance of this skill. Interviews give firsthand experience for improving this skill. Job shadowing with dealership department managers and personnel gives examples for this skill.	**ICS 027 Listening** Develop and practice active listening skills including identification of speaker's major points, focusing on speaker's message rather than listener's response, discriminating between fact and opinion, and verifying interpretation of message. Use appropriate note-taking techniques and overcome communication barriers by treating the speaker with courtesy and respect. Seek clarity of reception of communication by responding to verbal messages and other cues such as body language by rephrasing statements and asking questions. **Technical Competencies** ♦ Interpret and verify driver's concern regarding proper power steering operation; determine needed repairs. ♦ Interpret and verify driver's concern regarding front and rear suspension operation; determine needed repairs. ♦ Interpret and verify driver's concern regarding vehicle four-wheel alignment and vehicle vibrations; determine needed repairs.	**ICS assessment instrument** **Scenarios and simulations** **Videotaping**

HELP

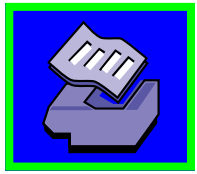


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

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, and 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 service manual and bulletin information; determine if available information is adequate to proceed with effective diagnosis. ♦ Read and interpret original equipment manufacturer (OEM) service manual/bulletin specifications, diagnostic flow diagrams, and component schematics.	**ICS assessment instrument** **On-demand demonstration** **Conferencing**

HELP

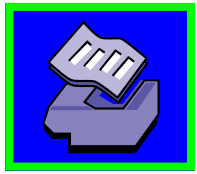


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective. 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 2, 3, and 4**	Worksite reports should include relevant math applications.	**ICS 042 Mathematics 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** ♦ Choose appropriately from a variety of mathematical techniques and use quantitative data to construct logical explanations to diagnose concerns and correct steering and suspension problems related to steering/suspension geometry and alignment; express mathematical ideas and concepts orally and in writing.	**ICS assessment instrument** **Graphic organizer**

HELP

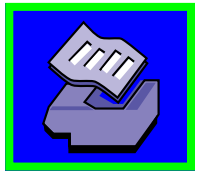


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective. 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
	Project 6	Have students look for problem-solving and documen-tation processes 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 symptom fault statements and electronic service information to reduce the list of possible causes of a customer concern in steering/suspension/alignment/balance areas and to diagnose and repair those problems. ♦ Recognize that a problem exists; i.e., there is a discrepancy between original equipment manufacturer's definition of normal operation and what is measured and observed. 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.	**ICS assessment instrument** **Cognitive mapping** **Work journal entry**

HELP

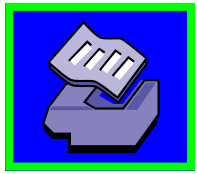


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective. 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**	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** ♦ Choose the appropriate types of measurement to measure vehicle-riding height; determine needed repairs. ♦ Choose the appropriate types of measurement to measure wheel, tire, axle, and hub runout; determine needed repairs. ♦ Choose the appropriate types of measurement to measure caster, camber, wheel toe, SAI, and turning radius (toe-out on turns, Ackerman angle); determine needed repairs.	**ICS assessment instrument** **Structured observation**

HELP



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

Course Objective. 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	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** ♦ Choose the appropriate measurement tools to measure power rack and non-rack steering gear endplay, turning torque, and bearing pre-load during service and reassembly; determine needed repairs. ♦ Choose the appropriate type of measurement tool to measure vehicle-riding height and suspension component wear; determine needed repairs. ♦ Use a dial indicator to measure wheel, tire, axle, and hub runout; determine needed repairs. ♦ Use computerized and manual four-wheel alignment equipment to measure caster, camber, wheel toe, SAI, and turning radius (toe-out on turns, Ackerman angle); determine needed adjustments or repairs.	**ICS assessment instrument** **Structured observation** **Annotated notes**

HELP

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

Course Objective. 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
	Project 2	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** ♦ Using strategy-based diagnostic routines, interpret and verify customer concerns regarding the proper operation of suspension and steering systems and perform tests and inspection to determine the causes and correct the problems. ♦ Interpret and verify driver's complaint, verify proper steering/suspension/alignment/balance concerns and operation; determine needed repairs or service.	**ICS assessment instrument** **Checklist** **Annotated notes** **On-demand demonstration**

HELP

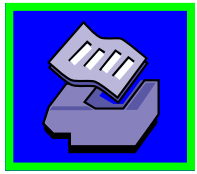
VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective. 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 166 Inspection** Inspect the general condition of tools, equipment, systems, and inventory. Follow an inspection process. Respond to warning conditions indicated. **Technical Competencies** ♦ Inspect and replace steering shaft U-joint(s), flexible coupling(s), collapsible columns, steering wheels (includes steering wheels with air bags and/or other steering wheel mounted controls and components). **NATEF Task A4/A6, P2** ♦ Remove and replace steering wheel, center/time supplemental restraint system (SRS) coil in accordance with original equipment manufacturer's (OEM) procedures. **NATEF Task A4/A2, P1** ♦ Inspect and replace power steering hoses and fittings. **NATEF TASK A4/A18, P2** ♦ Inspect power steering fluid levels and condition. ♦ Inspect, replace, and adjust power steering pump belt. **NATEF TASK A4/A15, P1** ♦ Remove, inspect, and replace power steering pump, pump mounts, pump seals, pulley, hoses, lines, and gaskets/seals. **NATEF TASK A4/A17, P3** ♦ Perform prealignment inspection; determine necessary action. **NATEF Task A4/C2, P1** ♦ ♦	**ICS assessment instrument** **ASE-style paper-and-pencil test** **On-demand demonstration** **Simulations** **Structured observation** **Work journal entry**

Table of Contents

HELP

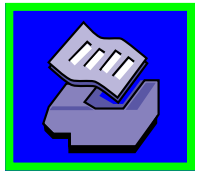


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective. 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 166 Technical Competencies continued** ♦ Disassemble, inspect, repair, and reassemble rack-and-pinion and non-rack power steering gear; determine needed repair. **NATEF TASK A4/A18, P2** ♦ Inspect and replace manual or power rack-and-pinion steering gear inner tie rod ends (sockets) and bellows boots. **NATEF TASK A4/A11, P2** ♦ Inspect and replace pitman arm, relay (centerlink/intermediate) rod, tie rod ends, idler arm and mountings, and steering linkage damper. **NATEF TASK A4/A19, P3** ♦ Inspect, replace, and adjust tie rod ends (Sockets), tie rod sleeves, and clamps. **NATEF TASK A4/A20, P2** ♦ Remove and inspect and/or replace all front suspension components, bushings, brackets, links on short/long-arm, torsion arm, and MacPherson strut suspension systems; determine needed repair or service. **NATEF A4/B1/ 3 to 11** ♦ Remove and inspect and/or replace all rear suspension components, springs, bushings, brackets, links on leaf, control arm, and MacPherson strut suspension systems; determine needed repair or service. **NATEF A4/B2/ 1 to 4** ♦ Inspect, remove, and replace shock absorbers. **A4/B3/1, P1** ♦ Perform power steering system pressure and flow tests; determine needed repairs (**ASE Work Skill A4/A2/8**).	**ICS assessment instrument** **ASE-style paper-and-pencil test** **On-demand demonstration** **Simulations** **Structured observation** **Work journal entry**

HELP



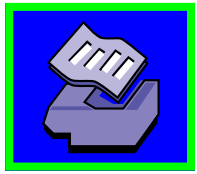
VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective. 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 a 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** ♦ Diagnose power non-rack-and-pinion, and power rack-and-pinion steering gear, noises, binding, uneven turning effort, looseness, hard steering, and vibration; determine needed repairs. **NATEF TASK A4/A4, A5** ♦ Diagnose power steering fluid leakage; determine necessary action. **NATEF TASK A4/A14, P2** ♦ Diagnose steering column noises, looseness, and binding concerns (including tilt mechanisms); determine necessary action. **NATEF TASK A4/A3, P3** ♦ Diagnose the causes of long- and short-arm and strut suspension concerns; determine needed service and make corrections using the correct tool (s) and OEM procedures. **NATEF TASK A4/B1/1, 2, P1** ♦ Diagnose the causes of rear suspension concerns; determine needed service and make corrections using the correct tool(s) and OEM procedures. **NATEF TASK A4/B2/1-4, P1**	**ICS assessment instrument** **ASE-style paper-and-pencil test** **On-demand demonstration** **Simulations** **Structured observation** **Work journal entry**

Table of Contents

HELP

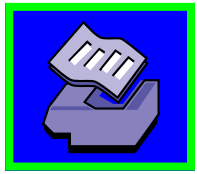


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective. 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, inspect, and adjust, repair or replace components of electronically controlled steering systems; determine necessary action. **NATEF Task A4/A21**	**ICS assessment instrument** **ASE-style paper-and-pencil test** **On-demand demonstration** **Simulations** **Structured observation** **Work journal entry**

HELP

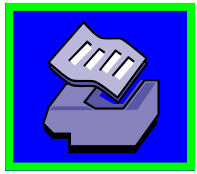


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective. 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
	Project 6	Field trips and job shadowing with dealership department managers and personnel can help students develop this skill.	**ICS G07 Relation of Personal Interest to Career Choices** Discover personal interests in relationship to academic and vocational/technical skills and educational and occupational information. Apply this information to career choices within the context of the global economy.	

HELP

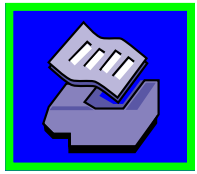


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective. 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
		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** ♦ Disable supplemental restraint systems (SRS) in accordance with original equipment manufacturer's (OEM) procedures. **NATEF Task A4/A1, P1** ♦ 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. ♦ Explain the purposes of the U.S. Occupational Safety and Health Act.	**ICS assessment instrument and checklist** **ASE-style paper-and-pencil test** **Work journal entry**

HELP

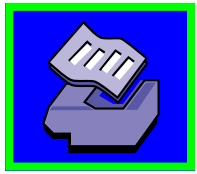


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective. 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 4	Worksite learning provides a powerful reinforce-ment of safety issues. Job shadowing with a service technician should always emphasize safety.	**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** ♦ Identify the location of first aid supplies. ♦ 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**

HELP

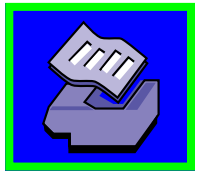


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective. 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 3, 4, and 5	This skill can be reinforced with worksite experiences. Job shadow-ing 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 fixing vehicles right the first time 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**

HELP

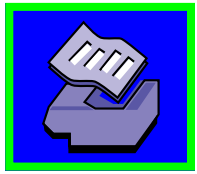


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective. 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 3 and 4	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**

HELP

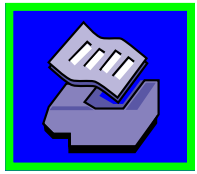


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

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
	Project 2	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 original equipment manufacturer (OEM) service manual and electronic service information as an information resource in locating steering, suspension, and alignment information and symptom diagnosis. ◆ Apply the OEM service manual and ESI as diagnostic aids in locating answers to steering, suspension, vibration, and alignment concerns. ◆ 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**

HELP

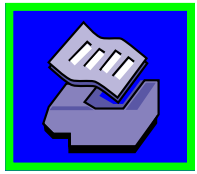


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

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
		Mentors and job shadow-ing with dealership department managers and personnel will help students with this skill.	**ICS G10 Information and Skills Required in Career Planning** Identify elements of career planning. Apply knowledge of self, educational opportunities, and occupations to develop a career plan. Develop a portfolio to support the career plan.	**ICS assessment instrument** **Checklist** **Conferencing**

HELP

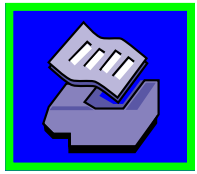


VI. Integrated Curriculum Standards and Technical Competencies Addressed in This Course

Course Objective. 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 work place. ◆ Clean work area according to shop standard and be familiar with a variety of cleanup and emergency response procedures.	**ICS assessment instrument** **Structured observation**
	Project 4	Job shadowing with the dealership department managers and personnel will give students valuable information in this area.	**ICS G13 Consequences of Career Choice** Recognize potential impact of career choice on family and personal life. Consider factors that affect goals, self-esteem, lifestyle, and the family as balance in lifestyle is sought and as short- and long-term consequences are examined in light of individual and family developmental stages.	**ICS assessment instrument** **Conferencing** **Graphic organizer** **Cognitive mapping**

HELP



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

Course Objective. 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
	Projects 2, 3, and 5	Students should analyze and practice in worksite. Job shadow-ing with dealership department managers and personnel will show examples of this skill.	**ICS G19 Intrapersonal and Interpersonal Management Skills** Negotiate work and personal demands in a way that promotes effective time- and stress-management techniques. Using intrapersonal and interpersonal skills, demonstrate techniques in conflict prevention and conflict resolution.	**ICS assessment instrument** **Simulations**

VII. Active Learning—Ideas for Application

Science

A semitrailer suspension has four "air springs" to support the load. The effective diameter of the air springs is 12 inches. How much air pressure is required to support a load of 35,000 pounds?

Math

Manuel is doing a four-wheel alignment on a customer's vehicle. During the alignment, Manuel has made the following toe measurements.

Tire	Distance from centerline of vehicle to		Calculated tire toe
	centerline of the tire at the front of the tire (A)	centerline of the tire at the rear of the tire (B)	A – B
Right front	71.3079 cm	71.8921 cm	
Left front	71.8413 cm	71.3587 cm	
Right rear	71.9048 cm	71.2952 cm	
Left rear	71.4984 cm	71.7016 cm	

A. Complete the table by calculating the toe on each tire. Express answers in mm.

B. Calculate the total toe on the front end by finding the sum of the right front toe and left front toe.

C. Calculate the total toe on the rear end by finding the sum of the right rear toe and left rear toe.

Answers:

A.

Tire	Distance from centerline of vehicle to		Calculated tire toe
	centerline of the tire at the front of the tire (A)	centerline of the tire at the rear of the tire (B)	A – B
Right front	71.3079 cm	71.8921 cm	–5.842 mm
Left front	71.8413 cm	71.3587 cm	4.826 mm
Right rear	71.9048 cm	71.2952 cm	6.096 mm
Left rear	71.4984 cm	71.7016 cm	–2.032 mm

B. Total toe on front end = –5.842 mm + 4.826 mm

Total toe on front end = –l.016 mm

C. Total toe on rear end = 6.096 mm + (–2.032 mm)

Total toe on rear end = 4.064 mm

Language Arts

Ask students to write a letter of complaint to the dealership about a malfunction in the steering mechanism of a car they own. Encourage students to work in teams to create a scenario that sets the stage for the letter and identifies the audience. Arrange for the letters to be read by persons who represent the kind of audience they have identified.

VIII. ACTIVE LEARNING—PROJECTS/LABS (JOB SHEETS)

1. (**SCIENCE)** The learner teams will add enough loads to the trunk of a vehicle equipped with automatic level control to actuate the system. Measure the increase in air pressure supplied to the shock absorber to support the additional load. Next, the student estimates the cross-sectional area of the cylinder to which the air is applied.
2. **(SCIENCE: "Yaw Rate and Lateral Acceleration")** Learner teams will calculate radius of a turn, yaw rate, and centripetal acceleration from knowledge of steering angle, wheelbase, and speed. Teams will interpret the outputs of yaw-rate sensors and lateral accelerometers in a test vehicle**. (PROJECT PROVIDED.)**
3. **(MATH:)** As a team have students demonstrate knowledge of the relationship between caster angles and steering control. Activities may include mathematics in caster and effects on steering; caster differences in power and manual steering; identification of different suspensions systems and location of steering pivots in each; measuring caster angle and adjusting to manufacturer's tolerances; adjusting caster angles out of tolerance and driving vehicle to see how steering feel is affected.
4. **(MATH: "Squeal from a Bad Toe")** Learner will work in a team to develop an understanding of the meaning of turning angle through discoveries made in determining the turning radius of a wheel **(PROJECT PROVIDED).**
5. **(LANGUAGE ARTS)** Check with your local dealership to collect examples of worn tires for this project. Have students form teams to inspect the tires for kind of wear. Have students sketch the appearance of the tires and label each as to the type and possible cause of wear. Example wear patterns are: bald spots, wear on one side, cracked treads, rapid wear in the center or at the shoulders, and scalloped wear. Take time to let the class review one another's work and guide a discussion on the role of good tires in the overall functioning of the automobile.

6. **(LANGUAGE ARTS " Why Test?)** The learner will demonstrate ability to explain to a customer the reasoning behind testing and changing electronic sensors in the suspension system by creating a scenario to establish the context for the procedure, documenting in writing the procedure itself, conducting appropriate research to obtain and install parts used in the procedure, and summarizing reflections on his or her learning throughout the procedure **(PROJECT PROVIDED).**

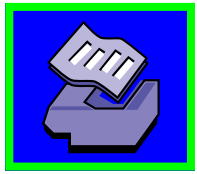
7. **(INTEGRATED "What Went Wrong?")** The learner teams will examine data from wheel-position sensors on test car to make a determination of the cause of a suspension failure that resulted in loss of control of the car during a high-speed turn **(PROJECT PROVIDED).**

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



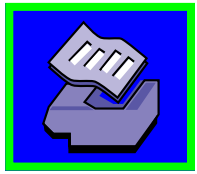
scenarios for answers to their initial questions and their considered responses and further questions. Some interviewing can be done during field trips to appropriate worksites.

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.

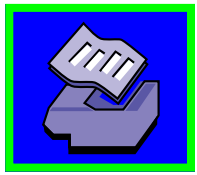
Charts for information gathering
As information is gathered for projects or individual assignments, students can create matrices or charts to organize the data. Assessment of a chart or matrix should be based on its appropriateness and design and the accuracy and thoroughness of the data collected. Charts 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.

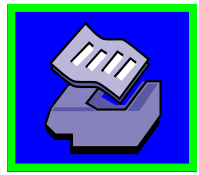


Graphic organizer
Visual representations are considered graphic organizers when they are formatted into a shape that reveals the flow of ideas, the connection among ideas, and the application of ideas. You can use graphic organizers to assess a student's level of understanding by examining the accuracy, 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.

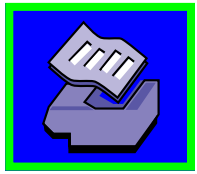
On-demand demonstration
When performance of a hands-on skill or solution of a real-life problem is assessed, an on-demand demonstration can to be used to determine level of accuracy, flexibility in application of skill, recognition of appropriate choice of skill for a specific task, and so on. Criteria 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

A4 Steering and Suspension Systems, CD-ROM, Interactive Computer Based Training, DVP/CDX 1-888-873-2239

Chrysler Steering and Suspension Systems, Daimler-Chrysler AG

Curriculum Integrator, CORD Communications, Waco, Texas, 1998

GM 4-Wheel Alignment (13001.00-2), GM Corporation/Raytheon

GM Steering Systems Service (13001.01-2), GM Corporation/Raytheon

GM Vibration Correction (13002.01-2), GM Corporation/Raytheon

Module 5 Steering and Suspension Systems, Instructional Materials Laboratory (IML), University of Missouri

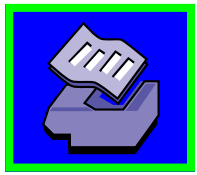
Today's Technician Automotive Steering and Suspension, 2nd Edition, Knowles, Delmar Publishing

Toyota Basic Steering and Suspension Systems, Toyota Motor Sales, Inc.

XII. Outline of Course Content

I. Steering System Design

1. Introduction to Steering Systems
   - A) Basic Physics
   - B) Mechanics and Forces
   - C) Steering and Suspension Systems
2. Power Non-Rack-and-Pinion Systems
   - A) Chemical and Physical Properties
   - B) Mathematical Formulas
   - C) Basic Physics



D) Mechanics and Forces

3. Power Rack-and-Pinion Systems

A) Chemical and Physical Properties

B) Mathematical Formulas

C) Basic Physics

D) Mechanics/Forces

II. Power Steering Diagnosis

1. Power Steering Service

2. Diagnosing Fluid Leaks

A) Power Steering Pump and Hose Service

3. Steering System Diagnosis

A) Pressure Testing Power Steering Systems

B) Measurement Tools

C) Scientific Method

D) Problem Solving and Decision Making

E) Inspection

F) Diagnosis

III. Inspecting and Replacing Steering Linkage Components

1. Steering Linkage Inspection Procedures

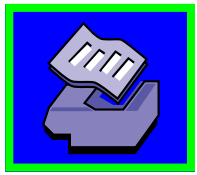
A) Inspection

IV. Non-Rack-and-Pinion (Integral) Power Steering Service

1. Integral Power Steering Gear Repair

A) Inspection

B) Blueprints and Diagrams



A) Safety
B) Listening
C) Inspection

3. Inspecting and Replacing Front Suspension Springs, Ball Joints, and Control Arms
   A) Safety
   B) Listening
   C) Inspection

IX. MacPherson Strut Suspension Service
   1. Inspection, diagnosis and repair of MacPherson Strut suspension components

X. Wheel Bearing/Spindle Inspection, Diagnosis, and Repair
   1. Wheel Bearing inspection, diagnosis, and repair

XI. Rear Suspension System Design and Operation
   1. Rear Suspension System Design
      A) Basic Physics
      B) Mechanics and Forces
   2. Rear Suspension System Diagnosis and Service

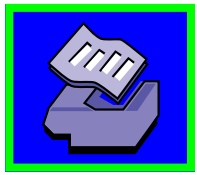
XII. Electronic Suspension Systems
   1. Design and Operation of Electronic Suspension Controls
      A) Microprocessor Systems
      B) Mechanics and Forces
   2. Diagnosing Electronic Suspension Controls
      A) Measurement Tools
      B) Inspection
      C) Diagnosis

HELP

XIII. Wheels and Tires
- 1. Tire and Wheel Design
  - A) Basic Physics
  - B) Mechanics and Forces
- 2. Tire Inspection, Rotation, and Service
  - A) Units of Measurement
  - B) Measurement Tools
  - C) Tire Mounting and Puncture Repair
- 3. Principles of Wheel Balance and Runout
  - A) Testing for and Correcting Wheel Assembly Runout and Imbalance
  - B) Units of Measurement
  - C) Measurement Tools

XIV. Four-Wheel Alignment and Steering/Suspension Diagnosis
- 1. Principles of Wheel Alignment
  - A) Basic Physics
  - B) Mechanics and Forces
- 2. Diagnosing Steering/Suspension and Wheel Alignment Concerns
- 3. Measuring and Correcting Wheel Alignment
  - A) Measurement Tools
  - B) Scientific Method
  - C) Problem Solving and Decision Making

XV. Dealer Mentor Training Unit
- 1. Workplace Interpersonal Skills
  - A) Teamwork



B) Listening

C) Relationship of Personal Interests

D) Information and Skills Required in Career Planning

E) Intrapersonal and Interpersonal Skills

F) Appreciation of Diversity

2. Work Journal

A) Task Lists

B) Consequences of Career Choice

C) Diversity in the Workplace