# TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL

# CURRICULUM GUIDE

## Designed For:
## Engine and Transmission Remanufacturing

## Submitted to:

Interim Director, Proprietary School Certification
Missouri Department of Higher Education PO Box 469
Jefferson City, MO 65102-1469

**Developed 2016**

## ACKNOWLEDGMENTS

As creator of Tech Craftsman Career Building Trade School (TCCBTS) designed to develop and offer needed careers to advance graduate interns in a lifelong job. Also creator of Advance Technology Career University designed for advanced graduate interns to move on and earn AA and Bachelor Degrees.

While planning, developing, and writing this curriculum for automotive technology then the realization several more curriculum's need to be developed to fit all the other programs which are in the planning stage to be offered to fit several different fields for a wider variety to choose from.

I begged and borrowed many of different published curriculums to put together this plan to be turned into over to the Interim Director, Proprietary School Certification Missouri Department of Higher Education. It was explained to me once turned over to higher education, then at any time once, directors, master, engine and transmission technicians are hired, then this curriculum can be revised.

Realizing the final revised curriculum will require the coordinated efforts of many people involved in TCCBTS field of Automotive Technology. Automotive Technology will be the first program Tech Craftsman Career Building Trade School will offer on startup.

Appreciation is expressed to the many automotive technology experts who have worked in the automotive industry for decades, which now have years of experience and know what is lacking from instruction from community colleges or other automotive technology school which only instruct what's called, "Basic" knowledge. Those professionals who provided their assistance to the development of this document are greatly appreciated.

Tech Craftsman Career Building Trade School, has adopted Missouri NATEF Standards as the base document for instructional content in this curriculum. If for any revisions will be required in the future on this Automotive Technology Curriculum Guide it will be based on a Technical Committee set up by Tech Craftsman Career Building Trade School for review of the tasks in TCCBTS Instruction and a subsequent development of performance objectives by a writing team.

As President of TCCBTS, I reviewed several curricula's from different states, two such states as being Idaho and Florida. I adapted several parts from both states to fit Tech Craftsman Career Building Trade School, including the State of Missouri's needs and requirements.

James E. Grow, President/CEO

TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL

## INTRODUCTION

This Vocational Program Curriculum Project was designed for Tech Craftsman Career Building Trade School with a cooperative effort among automotive professional shop owners, car dealership shop managers, industry representatives, to develop competency based program standards for curriculum content.

The Automotive Technology Standards were developed utilizing documents the creator and developer of Tech Craftsman Career Building Trade School compiled from the State of Idaho, Florida, and several other sources, the VTECS modules, and the National Automotive Technicians Education Task Force (NATEF) task listing. This national research was directed in specific occupational areas. The content of this document is directed toward the occupational area of Automotive Technician - not toward a specific institution or level of instruction in the State of Missouri.

The benefits to students and institutions derived from the development of these curriculum standards should be considerable. Articulation of students from Tech Craftsman Career Building Trade School Proprietary School programs will be aided through a single set of curriculum standards. Local evaluation of programs and curricula can be accomplished using the NATEF Standards as an objective measure. Institutions will be able to utilize the curriculum standards in a flexible manner to assure that vocational programs meet the needs of local business and industry.

The Curriculum Guide is organized in the same manner as the NATEF Standards with eight instructional areas. Previous standards will be revised to be aligned with the NATEF groupings. Instructors will be able to use the NATEF Standards as the base for curriculum development at the local level, and follow that process with the State of Missouri's objectives as the instructional component for each group. The Competency Profiles will be revised to reflect the content of the NATEF tasks. Programs will also have the capability to scan the competencies with bar coding equipment as the profiles will have bar codes assigned to each task.

Each program is designed to contact and work with local car dealerships, private owned auto repair shops and Auto Manufacturers to establish a partnership with Tech Craftsman Career Building Trade School to incorporate not only any new technology into this curriculum but will review all suggested parts to be added by recommendations from partners. This curriculum guide format can be shared with all the mentioned partners to encourage them to participate in Tech Craftsman Career Building Trade School programs.

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## NATEF Task List: LEADERSHIP AND EMPLOYABILITY SKILLS

## Unit I

## LEADERSHIP AND EMPLOYABILITY SKILLS

**Section (A – I)**
**(1-01)**
Instructors will apply:

**PROPERLY INDENTIFY AND APPLY PRINCIPLES OF PARLIAMENTARY PROCEDURE**

PERFORMANCE OBJECTIVE: Given various case study scenarios, be able to demonstrate an ability to apply various parliamentary rules to conduct a business meeting that ensures that the will of the majority and rights of the minority are protected.

ENABLING OBJECTIVES:

1. Discuss the importance of parliamentary procedure and state the principles upon which it is based
2. Identify terminology used in parliamentary procedure, including types of motions used
3. Identify the 10 steps in running a meeting
4. Identify the reference source for parliamentary law

**Section (A – I)**
**(1-02)**
Instructors will apply:

**IDENTIFY AND USE PRINCIPLES OF PUBLIC SPEAKING**

PERFORMANCE OBJECTIVE: Given a topic of interest, demonstrate effective public speaking principles by giving a 10 minute speech on the topic of interest.

ENABLING OBJECTIVES:

1. Identify five strategies for dealing with speech nervousness
2. Identify effective active listening strategies
3. Identify four phases of the speech preparation process
4. Identify the parts (headings) of a speech
5. Prepare a speech outline
6. Identify four speech delivery methods
7. Identify the five purposes of public speaking

**Section (A – I)**
**(1-13)**
Instructors will apply:

**IDENTIFY INGREDIENTS OF GOOD LEADERSHIP**

PERFORMANCE OBJECTIVE: Given various case studies, demonstrate effective leadership principles by matching the most effective leadership style for the given situation.

ENABLING OBJECTIVES:

1. Identify four leadership styles
2. Identify five characteristics of a good leader
3. Describe four steps to becoming a good leader
4. Develop a leadership profile with classmates
5. Complete a leadership role

**Section (A – I)**
**(1-04)**
Instructors will apply:

**IDENTIFY EMPLOYMENT OPPORTUNITIES**

PERFORMANCE OBJECTIVE: Given the information resources of a library, obtain and compile the information needed to seek out job opportunities.

ENABLING OBJECTIVES:

1. Identify the requirements for a given job
2. Investigate educational opportunities
3. Investigate occupational opportunities
4. Locate resources for finding employment
5. Confer with prospective employers
6. Identify current job trends

**Section (A – I)**
**(1-13)**
Instructors will apply:

**DEVELOP AN EMPLOYMENT PLAN**

PERFORMANCE OBJECTIVE: Given appropriate assessment tools, develop an employment plan that matches individual capabilities and desires with a meaningful occupation.

ENABLING OBJECTIVES:

1. Match interests to employment area
2. Match aptitudes to employment area
3. Identify short term work goals
4. Match attitudes to job area
5. Match personality to job area
6. Match physical capabilities to job area
7. Identify career information from counseling sources

**Section (A – I)**
**(1-06)**
Instructors will apply:

**APPLY EMPLOYMENT SEEKING SKILLS**

PERFORMANCE OBJECTIVE: Given appropriate information, locate a job opportunity, prepare a resume; prepare for, and interview for the position; complete all required selection tests and application forms; and evaluate individual behavior.

ENABLING OBJECTIVES:

1. Locate a employment opportunities
2. Identify job requirements
3. Locate resources for finding employment
4. Prepare a resume
5. Prepare for a job interview
6. Complete a letter of application
7. Complete an interview follow-up letter
8. Complete application forms
9. Identify proper attire for a job interview

**Section (A – I)**
**(1-13)**
Instructors will apply:

**ACCEPT/REJECT EMPLOYMENT OFFER**

PERFORMANCE OBJECTIVE: Given a offer of employment, demonstrate proper etiquette for accepting and rejecting the job offer.

ENABLING OBJECTIVES:

1. Evaluate a job offer
2. Complete an acceptance letter
3. Evaluate a job rejection
4. Complete a rejection letter

**Section (A – I)**
**(1-08)**
Instructors will apply:

**COMMUNICATE PROPERLY ON THE JOB**

PERFORMANCE OBJECTIVE: Given the responsibilities of a new job, demonstrate a knowledge of proper work related communication skills/techniques.

ENABLING OBJECTIVES:

1. Communicate orally with others
2. Read and comprehend written communications
3. Use job-related terminology correctly
4. Develop active listening skills
5. Prepare written communications
6. Follow written directions
7. Demonstrate proper telephone etiquette
8. Interpret the use of body language

**Section (A – I)**
**(1-13)**
Instructors will apply:

**MAINTAIN PROFESSIONALISM ON THE JOB**

PERFORMANCE OBJECTIVE: Given a responsibility to perform the duties of a new job, with a new employer, demonstrate a knowledge of the actions and behaviors which will project a professional business-like image.

ENABLING OBJECTIVES:

1. Participate in employee orientation
2. Assess business image, products, and/or services
3. Identify positive work behavior
4. Identify company dress and appearance standards
5. Participate in company meetings
6. Identify work-related terminology
7. Identify how to treat people with respect

**Section (A – I)**
**(1-10)**
Instructors will apply:

**ADAPT AND COPE WITH CHANGE**

PERFORMANCE OBJECTIVE: Given the responsibility to perform the duties of a new job, with a new employer, demonstrate knowledge of how to adapt to change.

ENABLING OBJECTIVES:

1. Identify elements of job transition
2. Formulate a transition plan
3. Identify implementation procedures for a transition plan
4. Evaluate the transition plan
5. Demonstrate a willingness to participate in continuing education
6. Identify sources to keep up with technological advances
7. Exhibit an ability to handle stress
8. Recognize a need to change or quit a job
9. Write a letter of resignation

**Section (A – I)**
**(1-13)**
Instructors will apply:

**MAINTAIN INTERPERSONAL RELATIONS**

PERFORMANCE OBJECTIVE: Given the responsibility to perform the duties of a new job, with a new employer, demonstrate successful interpersonal relations with other employees.

ENABLING OBJECTIVES:

1. Value individual diversity
2. Show empathy, respect, and support for others
3. Respond to praise or criticism
4. Provide constructive praise or criticism
5. Channel and control emotional reactions
6. Resolve conflicts
7. Display a positive attitude
8. Identify and react to intimidation/harassment situations

**Section (A – I)**
**(1-12)**
Instructors will apply:

**DEMONSTRATE THE ABILITY TO WORK AS A TEAM MEMBER**

PERFORMANCE OBJECTIVE: Given the responsibility to successfully work as a team member, demonstrate effective team building and cooperation skills.

ENABLING OBJECTIVES:

1. Identify successful leadership styles used in team assignments
2. Match team member skills and group activity
3. Identify the four phases of team building
4. Work with team members
5. Evaluate outcomes of a team assignment

**Section (A – I)**
**(1-13)**
Instructors will apply:

**DEMONSTRATE PROPER WORK ETHICS AND BEHAVIOR**

PERFORMANCE OBJECTIVE: Given the responsibility of a new employee, in a new job, demonstrate knowledge of appropriate work ethic and behavior in the work place.

ENABLING OBJECTIVES:

1. Exhibit dependability
2. Demonstrate punctuality
3. Demonstrate the ability to set priorities
4. Practice cost effective work behaviors
5. Practice time management techniques
6. Exhibit pride in workmanship
7. Display initiative
8. Display assertiveness
9. Assume responsibility for decisions and actions
10. Demonstrate a willingness to learn
11. Apply principles of ethical reasoning

**Section (A – I)**
**(1-14)**
Instructors will apply:

**DEMONSTRATE THE ABILITY TO SOLVE PROBLEMS AND APPLY CRITICAL THINKING SHILLS**

PERFORMANCE OBJECTIVE: Given a problem situation, be able to apply sound problem- solving and decision-making techniques to come up with a reasonable solution.

ENABLING OBJECTIVES:

1. Identify the problem
2. Clarify purpose and goals
3. Identify solutions and their impacts
4. Employ reasoning skills
5. Evaluate options
6. Set priorities
7. Select and implement a solution
8. Evaluate results of solution
9. Organize workloads
10. Assess employer/employee responsibilities in problem solving/resolution

**Section (A – I)**
**(1-15)**
Instructors will apply:

**DEMONSTRATE TECHNOLOGICAL LITERACY**

PERFORMANCE OBJECTIVE: Given a job opportunity, be able to demonstrate technological literacy required for the job.

ENABLING OBJECTIVES:

1. Demonstrate basic keyboarding skills
2. Demonstrate basic computer literacy
3. Recognize the impact of technological changes on tasks and people
4. Demonstrate knowledge of sources and methods of keeping informed of new technological advances

**Section (A – I)**
**(1-16)**
Instructors will apply:

**APPLY WORK PLACE ECONOMIC PRINCIPLES**

PERFORMANCE OBJECTIVE: Demonstrate knowledge of the effects of personal economic issues on job performance.

ENABLING OBJECTIVES:

1. Identify terms associated with money management
2. Identify payroll deductions and their purposes
3. Identify various tax filing forms
4. Identify budgeting strategies
5. Identify money management strategies
6. Demonstrate an ability to balance a checkbook
7. Identify different types of checks
8. Describe the purpose of savings
9. Identify methods of establishing savings funds
10. Discuss the purpose of buying on credit
11. Discuss the pitfalls of buying on credit
12. Discuss methods to establish a credit line
13. Identify the purpose of insurance
14. Establish insurance needs
15. Identify the types of insurance
16. Discuss methods of establishing investment funds
17. Discuss the purpose of investing
18. Discuss various financial summary reports used to track financial stability
19. Discuss financial limits used to measure financial stability

## INVESTIGATE BUSINESS OWNERSHIP OPPORTUNITIES

PERFORMANCE OBJECTIVE: Given an opportunity to open a small business, determine the feasibility of opening the business and if going into business as an owner is appropriate.

ENABLING OBJECTIVES:

1. Conduct an initial feasibility study
2. Determine financial feasibility
3. Establish a legal structure
4. Analyze available time
5. Prepare a marketing plan.
6. Complete a financial plan.
7. Develop a production plan
8. Develop a personnel system
9. Obtain professional services
10. Develop a general management plan
11. Discuss the different types of business

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**

**Working with:**
**National Automotive Technicians Education Foundation**

**Instructional Set: Section A-UNIT II**

**NATEF Task List: SHOP AND SAFETY SKILLS**

## Unit II

## SHOP AND SAFETY SKILLS

**Section (A – II)**
**(2-01)**

Instructors will apply:

**APPLY SHOP SAFETY RULES AND PROCEDURES**

PERFORMANCE OBJECTIVE: Given examples of repair jobs and shop situations, apply shop safety rules and procedures by identifying safe and unsafe shop practices.

ENABLING OBJECTIVES:

1. Identify common hazards in the repair shop, including (a) improper use of tools, (b) unguarded machinery, (c) tripping and falling, (d) excessive exposure to exhaust gases, parts, cleaners, paints, and dust, (e) electrical hazards, and (f) improper lifting
2. Identify and explain warning signs posted in the shop area
3. Explain the importance of good housekeeping in the repair shop
4. Explain the importance of storing materials in a secure manner
5. Explain safety rules and procedures for operating hydraulic vehicle lifts, jacks and chains, including safety stands
6. Identify and explain potential hazards associated with handling and disposing of (a) asbestos, (b) carbon monoxide, (c) solvents, (d) paints and thinners, (e) dust, (f) noise, (g) hydrogen gas, and (h) catalysts
7. Explain safety rules and procedures for painting and refinishing
8. Explain safety rules and procedures for using compressed air equipment
9. Explain safety rules for welding, cutting, and brazing
10. Inspect the automotive repair shop for conformity with safety rules and procedures
11. Explain "Right to Know" Law
12. Explain Material Safety Data Sheets

**Section (A – II)**
**(2-04)**
Instructors will apply:

**APPLY PERSONAL SAFETY RULES PROCEDURES**

PERFORMANCE OBJECTIVE: Given examples of repair jobs and shop situations, apply personal safety rules and procedures by identifying safe and unsafe practices.

ENABLING OBJECTIVES:

1. Identify types of personal safety equipment and explain their applications
2. Identify types of repair work that require eye protection
3. Identify types of repair work that require hearing protection
4. Identify types of protective clothing and shoes and describe the conditions which require their use
5. Identify types of repair work that require respirators and shields
6. Explain regulations and procedures pertaining to sanitation in shop and rest room areas
7. Explain personal safety rules and procedures for welding and cutting
8. Explain the methods for cleaning and storing personal safety equipment

**Section (A – II)**
**(2-03)**
Instructors will apply:

**APPLY FIRE SAFETY RULES AND PROCEDURES**

PERFORMANCE OBJECTIVE: Given examples of types of fires, fire extinguishers, and shop situations, apply fire safety rules and procedures by identifying safe and unsafe practices.

ENABLING OBJECTIVES:

1. Identify and explain the applications for (a) foam, (b) carbon dioxide, (c) soda acid, (d) pump tank, (e) gas cartridge, (f) dry chemical, and (g) multipurpose dry chemical fire extinguisher
2. Describe the procedures for operating selected fire extinguisher
3. Identify the common causes of fire in automotive repair shops and common methods of avoiding or preventing fires
4. Inspect the repair shop for conformity with fire safety rules and procedures
5. Describe the shop's fire and emergency evacuation route(s)

**Section (A – II)**
**(2-04)**
Instructors will apply:

**APPLY ELECTRICAL SAFETY RULES AND PROCEDURES**

PERFORMANCE OBJECTIVE: Given a check list identifying electrical hazards and appropriate Safety manuals, apply electrical safety rules and procedures. Electrical equipment, exposed wire, frayed cords, and deteriorated insulation must be indicated in the checklist. Junction boxes, outlets, switches, breaker switches, must be identified as to their use.

ENABLING OBJECTIVES:

1. Explain the importance of labeling circuit breakers
2. Explain the importance of grounding electrical equipment
3. Explain the proper methods for using flexible extension cords and drop lights
4. Identify and explain the electrical hazards of and safety rules and procedures for welding, cutting, and brazing
5. Identify the approved location for all electrical equipment and power sources in the repair shop

**Section (A – II)**
**(2-05)**
Instructors will apply:

**APPLY RULES FOR HAZARDOUS WASTE DISPOSAL**

PERFORMANCE OBJECTIVE: Given examples of hazardous waste materials such as asbestos, oil, paints and thinners, and solvents, OSHA, EPA and other manuals and guidelines, explain the proper handling and disposal of such materials.

ENABLING OBJECTIVES:

1. Identify the hazardous waste materials found in a repair shop
2. Explain the proper procedures for disposing of asbestos, oil and oil based materials, paint and paint thinner, solvents, electrical insulating compounds
3. Conduct an inspection of the repair shop to detect the presence of hazardous wastes in accordance with OSHA and EPA guidelines

# TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL

## Working with:
## National Automotive Technicians Education Foundation

## Instructional Set: SECTION A-UNIT III

## NATEF Task List: TOOLS AND EQUIPMENT

## Unit III

## TOOLS AND EQUIPMENT

**Section (A – III)**
**(3-01)**
Instructors will apply:

**IDENTIFY, CHOOSE, USE, AND MAINTAIN HAND TOOLS, SUCH AS SCREWDRIVERS, SPECIAL APPLICATIONS PLIERS, HAMMERS, CHISELS, PUNCHES, PUNCHES, SPECIAL APPLICATIONS WRENCHES AND SOCKETS, FILES, HACK SAWS,BENCH VISES AND C CLAMPS**

PERFORMANCE OBJECTIVE: Given a set of hand tools and access to a tool room, perform an inventory, record any tools that are unsafe, broken or need repairs.

ENABLING OBJECTIVES:

1. Identify basic hand tools
2. Identify special tools used in engine repair
3. Identify tools used to service drive lines
4. Explain in writing the purpose of hand tools
5. Replace a hammer handle
6. Dress a grinding stone
7. Dress a screwdriver
8. Use a flat file
9. Sharpen a twist drill
10. Dress a brass drift
11. Put a new blade on a hack saw
12. Dress a punch or chisel
13. Use a torque wrench, bar and micrometer type
14. Explain four types of files
15. Use an adjustable wrench
16. Use a breaker bar
17. Identify special front end tools

**Section (A – III)**
**(3-06)**
Instructors will apply:

**DEMONSTRATE USE OF PRECISION MEASURING TOOLS**

PERFORMANCE OBJECTIVE: Given the proper measuring tool and a crankshaft, cylinder and flywheel, measure these units. Result should be within .0005 inch of industry specifications.

ENABLING OBJECTIVES:

1. Demonstrate how to hold a micrometer while measuring
2. Measure a crankshaft journal
3. Measure a cylinder for taper, out-of-round and diameter
4. Measure flywheel runout
5. Demonstrate the use of a slide caliper

**Section (A – III)**
**(3-03)**
Instructors will apply:

**APPLY BASIC WELDING SKILLS RELATED TO THE AUTOMOBILE INDUSTRY**

PERFORMANCE OBJECTIVE: Given flat metal and the proper welding equipment, apply basic welding skills, following electrical safety rules and acetylene welding rules using the welding manual as a guide for identifying proper welds.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures when welding
2. Demonstrate the ability to start, stop and restart a bead
3. Name the welding positions
4. List reasons for a poor weld
5. Describe the effects of raising and lowering the arc welding current
6. List types of electrodes
7. List rules for safe handling of oxygen and acetylene equipment
8. List causes of a backfire
9. Identify types of oxyacetylene flames
10. Demonstrate the ability to turn on, light, adjust flame and turn off the oxyacetylene equipment
11. Identify the parts of oxyacetylene welding equipment
12. Identify the types of welding goggles and shields

**Section (A – III)**
**(3-06)**
Instructors will apply:

**USE ANDMAINTAIN POWER TOOLS, SUCH ASDRILLS, BENCH GRINDERS, DRILL PRESSES, HYDRAULIC PRESSES, IMPACT WRENCHES, AIR CHISELS, PARTS WASHERS, HYDRAULIC JACKS AND VEHICLE HOISTS.**

PERFORMANCE OBJECTIVE: Given repair jobs that use power tools, follow all safety rules and manufacturer's directions.

ENABLING OBJECTIVES:

1. Describe safety rules for power equipment and tools
2. Demonstrate the ability to drill a hole using a drill press
3. Demonstrate the ability to cut metal with a power chisel
4. Raise a vehicle on a vehicle hoist
5. Raise a vehicle using a hydraulic jack, placing jack stands under the vehicle for safety
6. Demonstrate a safe method of washing parts
7. Demonstrate removing a bearing from a shaft using a hydraulic press

**Section (A – III)**
**(3-05)**
Instructors will apply:

**USE BASIC ELECTRICAL EQUIPMENT AND METERS**

PERFORMANCE OBJECTIVE: Given a vehicle, connect the electrical and electronic testers into the electrical system, following the instructions in the manufacturer's handbooks and charts of the electrical tester. Test the electrical system using specifications from the manufacturer's repair manual. Record information obtained.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when connecting and disconnecting the test equipment
2. Describe use of the electrical tester
3. Demonstrate proper connecting and disconnecting of the electrical test equipment
4. Describe the operation of an electrical analyzer
5. Demonstrate the use of an ohm meter
6. Demonstrate the use of a multimeter
7. Describe analog and digital test meters
8. Demonstrate the use of a test light

**Section (A – III)**
**(3-06)**
Instructors will apply:

**USE AND INSTALL FASTENERS, SUCH AS SCREWS AND BOLTS, KEY SCREW EXTRACTORS, HELICOIL INSERTS AND THREAD TAP AND DIES**

PERFORMANCE OBJECTIVE: Given a selection of fasteners, screw extractors, helicoils, tap/die set, basic instruction manual and tools, use fasteners to secure metals or components to vehicle. Follow manufacturer's specifications on fastener selection and installation.

ENABLING OBJECTIVES:

1. Demonstrate how to select the proper fasteners for a project
2. Demonstrate the use of a pitch gauge
3. Cut external threads using a die
4. Cut internal threads using a tap
5. Describe the procedure for removing broken bolts
6. Describe the procedure for removing broken taps
7. Explain five types of nuts
8. Demonstrate the use of pop rivet pliers
9. Identify a taper tap
10. Identify a bottoming tap
11. Explain both the customary and metric thread specifications of bolts
12. Explain how a helicoil is used to repair damaged threads
13. Explain bolt classifications

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**

**Working with:**
**National Automotive Technicians Education Foundation**

**Instructional Set: Section A-UNIT IV**

**NATEF Task List: BASIC AUTOMOTIVE TECHNOLOGY SKILLS**

## Unit IV

## BASIC AUTOMOTIVE TECHNOLOGY SKILLS

**Section (A – IV)**
**(4-01)**
Instructors will apply:

**APPLY BASIC MATH SKILLS**

PERFORMANCE OBJECTIVE: Given a basic math problem, find the correct solution.

ENABLING OBJECTIVES:

1. Add using whole numbers
2. Multiply using whole numbers
3. Subtract using whole numbers
4. Divide using whole numbers
5. Change a fraction to a decimal
6. Change a decimal to a fraction
7. Add fractions
8. Divide fractions
9. Multiply fractions
10. Subtract using fractions
11. Add decimal numbers
12. Subtract decimal numbers
13. Multiply decimal numbers
14. Divide using decimal numbers
15. Explain percent
16. Explain angles
17. Demonstrate the ability to use a standard torque wrench

**Section (A – IV)**
**(4-02)**
Instructors will apply:

**APPLY METRIC MATH SKILLS**

PERFORMANCE OBJECTIVE: Given a metric problem and using a math manual, work the problem to its correct solution.

ENABLING OBJECTIVES:

1. Explain the metric system of measurement
2. Define: (a) meter; (b) centimeter; (c) millimeter; and (d) kilometer
3. Explain the Celsius temperature scale
4. Add, subtract, multiply and divide using metric units
5. Demonstrate the ability to read a metric torque wrench

**Section (A – IV)**
**(4-08)**

Instructors will apply:

**SERVICE VEHICLE WITH PROPER AUTOMOTIVE LUBRICANTS**

PERFORMANCE OBJECTIVE: Given a vehicle and access to service manuals, tools and equipment, service the vehicle with the proper lubricants. Follow manufacturer's specifications in selecting the lubricants.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while servicing vehicle
2. Explain grading of oils
3. Explain properties of grease
4. Change engine oil
5. Change oil filter, being careful to select the proper filter
6. Demonstrate a chassis grease job
7. Explain oil service classifications
8. Explain viscosity numbers
9. Demonstrate how to use special lubrication tools
10. Explain how to service the transmission and transaxle
11. Explain how to service the differential
12. Explain how to service the transfer assembly

**Section (A – IV)**
**(4-08)**

Instructors will apply:

**DEMONSTRATE THE USE OF SHOP MANUALS AND TUNE UP CHARTS**

PERFORMANCE OBJECTIVE: Given an automotive repair work order showing repair problems and access to shop manuals, a computerized database, or CD ROM system, locate the information needed and record it on the work order.

ENABLING OBJECTIVES:

1. Demonstrate the ability to cross reference from one repair manual to another
2. Explain how to select manuals to locate information needed
3. Demonstrate locating flat rate time
4. Demonstrate locating part's cost
5. Demonstrate locating major repair sections
6. Locate repair procedure from a computerized database or CD ROM system
7. Demonstrate the ability to use a manufacturer's repair manual
8. Explain how to use a tune-up chart
9. Demonstrate how to locate a tune-up chart
10. Explain the location of tune-up decals
11. Demonstrate the ability to locate and use a wiring diagram
12. Explain how to locate and use an electrical diagram
13. Explain how to locate the vacuum section
14. Explain how to locate the emission section

**Section (A – IV)**
**(4-05)**

Instructors will apply:

**DEMONSTRATE A KNOWLEDGE OF AUTOMOTIVE TUBING TYPES AND SIZES**

PERFORMANCE OBJECTIVE: Given a variety of sizes and types of automotive tubing, correctly identify them.

ENABLING OBJECTIVES:

1. Define the term "I.D."
2. Define the term "O.D."
3. Demonstrate knowledge of steel tubing
4. Demonstrate knowledge of flex gas tubing
5. Demonstrate knowledge of evaporative hoses
6. Demonstrate correct use of tubing connectors and fasteners
7. Demonstrate knowledge of vacuum hose
8. Explain where each type automotive tubing should be used

**Section (A – IV)**
**(4-08)**

Instructors will apply:

**DEMONSTRATE SKILL IN ELECTRICAL SOLDERING**

PERFORMANCE OBJECTIVE: Given pieces of wire and proper tools, properly join the wires together by soldering.

ENABLING OBJECTIVES:

1. Explain the results of too little heat
2. Explain the results of too much heat
3. Demonstrate knowledge of types of solder: (a) acid core; (b) rosin core; and (c) solid solder
4. Explain the use of soldering paste
5. Explain and demonstrate proper insulation removal
6. Explain and demonstrate proper joining before soldering
7. Explain and demonstrate proper covering after soldering: (a) electrical tape; and (b) heat shrink tubing

**Section (A – IV)**
**(4-07)**

Instructors will apply:

**DEFINE ELECTRICAL TERMS**

PERFORMANCE OBJECTIVE: Given proper manuals and test equipment, explain magnetism, electrical current, Ohm's law, and electronic theory.

ENABLING OBJECTIVES:

1. Explain: (a) magnetism; (b) electrical current flow; (c) Ohm's law; and (d) electronic theory
2. Explain what happens when an electrical current is applied to a magnet
3. Explain what E.I.R. means
4. Explain the difference between voltage, current, and resistance

**Section (A – IV)**
**(4-08)**

Instructors will apply:

**APPLY THE RULES OF SERIES CIRCUITS**

PERFORMANCE OBJECTIVE: Given a breadboard, electrical wire, resistors, and proper test equipment, build a series circuit and explain the series circuit laws.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working on live electrical circuits
2. Explain why a closed loop of wire does not necessarily make a circuit
3. State the series circuit laws
4. State total voltage drop in a series circuit
5. State the current flow in the circuit
6. State the total resistance in the circuit

**Section (A – IV)**
**(4-09)**

Instructors will apply:

**APPLY THE RULES OF PARALLEL CIRCUITS**

PERFORMANCE OBJECTIVE: Given a bread board, battery wire, resistors and proper test equipment, build a parallel circuit and explain parallel circuit laws.

ENABLING OBJECTIVES:

1. State the parallel circuit laws
2. Explain the difference between series and parallel circuits
3. Explain what happens to current when resistance is added to a parallel circuit
4. Explain what happens to voltage
5. Explain why combined resistance in a parallel circuit is less than the smallest resistor

**Section (A – IV)**
**(4-10)**

Instructors will apply:

**APPLY THE RULES OF SERIES PARALLEL CIRCUITS**

PERFORMANCE OBJECTIVE: Given a bread board, proper manuals and test equipment, build a series parallel circuit and explain series parallel circuitry.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working on live electrical circuits
2. Explain the differences in series, parallel and series parallel circuits
3. Explain what happens as resistance is added to the circuit
4. Explain what happens when voltage is added to a series parallel circuit
5. Explain where a series parallel circuit would be used in an automobile circuit

**Section (A – IV)**
**(4-18)**

Instructors will apply:

**DEFINE STEERING GEOMETRY AND SUSPENSION GEOMETRY**

PERFORMANCE OBJECTIVE: Given proper textbooks and repair manuals, explain the following: steering angles, toe in, and four wheel steering.

ENABLING OBJECTIVES:

1. Explain caster angle
2. Explain camber angle
3. Explain toe in
4. Explain toe in and toe out on turns
5. Explain king pin inclination
6. Explain four wheel steering
7. Explain four wheel alignments

**Section (A – IV)**
**(4-12)**

Instructors will apply:

**EXPLAIN THE FUNCTION OF STEERING AND SUSPENSION SYSTEM COMPONENTS**

PERFORMANCE OBJECTIVE: Given proper textbook and repair manuals, explain the functions of the following steering and suspension components.

ENABLING OBJECTIVES:

1. Explain the function of coil springs, leaf springs, and torsion bars
2. Explain the terms: twin "I" beams and Quadralinks
3. Explain the function of suspension bushings
4. Explain the function of shock absorbers
5. Explain the function of tie rod ends
6. Explain the function of ball joints and spindle bolts
7. Describe the difference between MacPherson struts and control arm suspension
8. Describe the difference between Pitman arms and control arms
9. Explain four wheel steering

**Section (A – IV)**
**(4-18)**

Instructors will apply:

**EXPLAIN AND DESCRIBE THE COMPONENTS OF MANUAL AND POWER STEERING**

PERFORMANCE OBJECTIVE: Given proper textbooks and repair manuals, explain the function of steering systems.

ENABLING OBJECTIVES:

1. Explain the function of a manual steering gear
2. Explain the operation of power steering gears
3. Explain the difference between integral and linkage type power steering
4. Explain the operation of rack and pinion gears
5. Explain the function of a power steering pump
6. Explain problems that are caused by power steering fluid leakage

**Section (A – IV)**
**(4-14)**

Instructors will apply:

**DESCRIBE DRUM BRAKE OPERATION**

PERFORMANCE OBJECTIVE: Given proper textbook and repair manual, explain the following Brake components and brake problems.

ENABLING OBJECTIVES:

1. Describe the operation of drum brakes
2. Describe the operation of automatic brake adjusters
3. Describe brake problems that can cause brake pull
4. Describe brake problems that can cause brake chatter
5. Describe brake problems that cause brake pedal pulsations
6. Describe the cause of brake fade
7. Explain the necessity for checking brake linings
8. Explain the function of brake boosters

**Section (A – IV)**
**(4-18)**

Instructors will apply:

**DESCRIBE DISC BRAKE OPERATION**

PERFORMANCE OBJECTIVE: Given proper textbook and repair manuals, explain the operation of disc brakes.

ENABLING OBJECTIVES:

1. Describe the function of a disc brake caliper assembly
2. Explain the causes of brake pull
3. Explain the possible causes of brake pedal pulsations
4. Explain the operation of anti-skid brake systems
5. Explain the causes of low brake pedal

**Section (A – IV)**
**(4-16)**

Instructors will apply:

**DESCRIBE OPERATION OF BRAKE SYSTEM VALVES**

PERFORMANCE OBJECTIVE: Given proper textbook, repair manuals, and factory handouts, explain brake system valves.

ENABLING OBJECTIVES:

1. Explain the function of pressure differential valve
2. Explain the function of the proportioning valve
3. Explain the function of the brake warning light
4. Explain the function of the brake metering valve

**Section (A – IV)**
**(4-17)**

Instructors will apply:

**EXPLAIN PROPER BRAKE PEDAL HEIGHT**

PERFORMANCE OBJECTIVE: Given proper textbook and repair manual, explain brake pedal height.

ENABLING OBJECTIVES:

1. Explain hydraulic principles as they apply to a hydraulic brake system
2. Explain the effect loose brake shoe adjustment has on pedal height
3. Explain how air in hydraulic fluid line affects pedal height
4. Explain the effect master cylinder push rod adjustments will have on brake pedal height
5. Explain the effect worn brake pedal bushings and connecting pins have on brake pedal height
6. Explain the effect that heat has on brake fluid

**Section (A – IV)**
**(4-18)**

Instructors will apply:

**DEMONSTRATE A KNOWLEDGE OF BASIC AUTOMOTIVE ENGINE COOLING SYSTEMS**

PERFORMANCE OBJECTIVE: Given proper study materials and information, pass a test covering automotive engine cooling systems.

ENABLING OBJECTIVES:

1. Explain the operation of a radiator
2. Explain the operation of an engine water jacket
3. Explain the operation of a thermostat
4. Explain the operation of a water pump
5. Explain the operation of a radiator cooling fan
6. Explain the operation of hoses and belts

**Section (A – IV)**
**(4-19)**

Instructors will apply:

**DEMONSTRATE A KNOWLEDGE OF AUTOMOTIVE HEATING AND AIR CONDITIONING SYSTEMS**

PERFORMANCE OBJECTIVE: Given proper study materials and information, pass a test covering automotive heating and air conditioning systems.

ENABLING OBJECTIVES:

1. Explain operation of heater hoses
2. Explain operation of water control valves
3. Explain operation of heater cores
4. Explain operation of electrical, vacuum and mechanical heater controls
5. Explain operation of heater ducting
6. Explain operation of air conditioning compressor
7. Explain operation of condenser
8. Explain operation of receiver-dryers and accumulators
9. Explain operation of flow control devices (exp valves, exp tubes)
10. Explain operation of evaporators
11. Explain operation of evaporator control devices, EPR
12. Explain operation of electrical controls, switches, wiring
13. Explain operation of vacuum controls, switches, hoses
14. Explain operation of high pressure and suction hoses
15. Explain temperature-pressure relationships of Freon 12
16. Explain safety precautions when handling Freon 12
17. Explain operation of compressor lubrication systems

**Section (A – IV)**
**(4-20)**

Instructors will apply:

**DEMONSTRATE KNOWLEDGE OF DIFFERENT WIRE SIZES AND DIFFERENT TERMINAL ENDS**

PERFORMANCE OBJECTIVE: Demonstrate knowledge of different wiring sizes and different terminal ends by passing a written examination.

ENABLING OBJECTIVES:

1. Demonstrate knowledge of AWG wire sizes
2. Demonstrate knowledge of metric wire sizes
3. Explain amperage characteristics of different sized wires
4. Explain the differences among various wire terminals
5. Explain different wire material

**Section (A – IV)**
**(4-21)**

Instructors will apply:

**DEMONSTRATE A KNOWLEDGE OF AUTOMOTIVE IGNITION AND FUEL SYSTEMS**

PERFORMANCE OBJECTIVE: Given a vehicle, textbook, repair manual, films, videos and slides, take a test that measures understanding of the ignition and fuel systems.

ENABLING OBJECTIVES:

1. List the components of an ignition system
2. List the components of a fuel system
3. Explain the operation of the ignition system
4. Explain the operation of the fuel system

**Section (A – IV)**
**(4-22)**

Instructors will apply:

**DESCRIBE REAR AXLE OPERATION**

PERFORMANCE OBJECTIVE: Given proper textbooks and repair manuals, explain the operation of the rear axle.

ENABLING OBJECTIVES:

1. Explain differential operation
2. Explain limited slip mechanism
3. Define floating, 3/4 floating and semi-floating axles

**Section (A – IV)**
**(4-23)**
Instructors will apply:

**DESCRIBE DRIVE SHAFT OPERATION**

PERFORMANCE OBJECTIVE: Given proper service manuals and textbooks, explain drive shaft operation and inspection.

ENABLING OBJECTIVES:

1. Explain the working angle
2. Identify worn U joints
3. Identify slip joint
4. Explain single joint
5. Explain constant velocity joint
6. Explain yoke and phase alignment

**Section (A – IV)**
**(4-24)**
Instructors will apply:

**DESCRIBE AUTOMATIC -TRANSMISSION AND TRANSAXLE OPERATION**

PERFORMANCE OBJECTIVE: Given proper service manual and textbooks, explain automatic transmission power flow operation.

ENABLING OBJECTIVES:

1. Explain torque converter function
2. Identify gears in the planetary gear system
3. Explain power flow
4. Explain the hydraulic system
5. Explain the operation of the transaxle transmission
6. Explain how automatic transmission fluid cools and lubricates

**Section (A – IV)**
**(4-25)**
Instructors will apply:

**DESCRIBE CLUTCH OPERATION**

PERFORMANCE OBJECTIVE: Given the proper textbooks and service manuals, explain the operation of a clutch.

ENABLING OBJECTIVES:

1. Identify the major parts of the clutch
2. Explain the wearing areas of the clutch
3. Explain engagement and disengagement
4. Explain power flow

**Section (A – IV)**
**(4-26)**

Instructors will apply:

**DESCRIBE CLUTCH RELEASE LINKAGE MECHANISMS**

PERFORMANCE OBJECTIVE: Given the proper textbooks and manuals, identify the different types of clutch linkage.

ENABLING OBJECTIVES:

1. Identify mechanical linkage
2. Identify cable linkage
3. Identify hydraulic linkage

**Section (A – IV)**
**(4-27)**

Instructors will apply:

**DESCRIBE MANUAL TRANSMISSION AND TRANSAZLE OPERATIONS**

PERFORMANCE OBJECTIVE: Given transmission textbook and service manuals, explain the operation of a manual transmission.

ENABLING OBJECTIVES:

1. Explain torque multiplication
2. Explain power flow in all gears
3. Explain synchronizer operation
4. Identify the different systems of shift mechanisms
5. Explain the difference in a transaxle power flow and calculating gear ratio

**Section (A – IV)**
**(4-28)**

Instructors will apply:

**DESCRIBE 4 x 4 TRANSFER CASE SYSTEMS**

PERFORMANCE OBJECTIVE: Given transfer case manuals and textbooks, identify the differences in transfer cases.

ENABLING OBJECTIVES:

1. Identify part time transfer cases
2. Identify full time transfer cases
3. Identify locking hubs
4. Explain adjustments on shifting linkage

**Section (A – IV)**
**(4-29)**
Instructors will apply:

**DEMONSTRATE KNOWLEDGE OF THE INTERNAL COMBUSTION ENGINE, BOTH DIESEL AND GASOLINE**

PERFORMANCE OBJECTIVE: Given equipment, components, and any charts needed, explain the operations of diesel and gasoline internal combustion engines.

ENABLING OBJECTIVES:

1. Explain the operation of the lubrication system
2. Explain the operation of the timing gear system
3. Explain the operation of the valves
4. Explain the operation of the piston assembly
5. Explain the difference in the construction and operation of a diesel engine and a gasoline engine

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**

## Working with:
## National Automotive Technicians Education Foundation

## Instructional Set: Section B-Unit I

## NATEF Task List: Engine Repair

## Unit I

## ENGINE REPAIR

**For every task in Engine Repair, the following safety requirement must be strictly enforced as a number one priority**: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage and disposal of chemicals in accordance with local, state and federal safety and environmental regulations.

### A. General Engine Diagnosis; Removal and Reinstallation

1. Interpret and verify complaint; determine needed repairs.
2. Inspect engine assembly for fuel, oil coolant, and other leaks; determine needed repairs.
3. Listen to engine noises; determine needed repairs.
4. Diagnose the cause of excessive oil consumption, unusual engine exhaust color, odor, and sound; determine needed repairs.
5. Perform engine vacuum tests; determine needed repairs.
6. Perform cylinder power balance tests; determine needed repairs.
7. Perform cylinder compression tests; determine needed repairs.
8. Perform cylinder leakage tests; determine needed repairs.
9. Remove engine (front-wheel drive); prepare for disassembly.
10. Reinstall engine (front-wheel drive).
11. Remove engine (rear-wheel drive); prepare for disassembly.
12. Reinstall engine (rear wheel drive).

### B. Cylinder Head and Valve Train Diagnosis and Repair

1. Remove Cylinder head (s); inspect cylinder head(s) for cracks; gasket Surface areas for warpage and leakage; check passage condition.

2. Install cylinder heads and gaskets; tighten according to manufacturer's specifications and procedures.

3. Inspect and test valve springs for squareness, pressure, and free height comparison; replace as needed.

4. Inspect valve spring retainers, locks, and valve grooves.

5. Replace valve stem seals.

6. Inspect valve guides for wear; check valve guide height and stem-to-guide clearance; recondition; or replace as needed.

7. Inspect valves; resurface or replace.

8. Inspect valve seats; resurface or replace.

9. Check valve face-to-seat contact and valve seat concentricity (runout); service seats and valves as needed.

10. Check valve spring assembled height and valve stem height; service valve and spring assemblies as needed.

11. Inspect pushrods, rocker arms, rocker arm pivots, and shafts for wear, bending, cracks, looseness, and blocked oil passages (orifices); repair or replace.

12. Inspect hydraulic or mechanical lifters; replace as needed.

13. Adjust valves (mechanical or hydraulic lifters).

14. Inspect and replace camshaft drives (including gear wear and backlash, sprocket and chain wear, overhead cam drive sprockets, drive belts, belt tension, and tensioners).

15. Inspect camshaft for runout; measure journals and lobes for wear.

16. Inspect and measure camshaft bearings for wear, damage, out-of-round, and alignment; determine needed repairs.

17. Verify camshaft(s) timing according to manufacturer's specifications and procedure.

**C. Engine Block Diagnosis and Repair**

1. Inspect and replace pans, covers, gaskets, and seals.

2. Inspect engine block for cracks, passage condition, core and gallery plug condition, and surface warpage; determine needed repairs.

3. Inspect internal and external threads; repair as needed.

4. Remove cylinder wall ridges.

5. Inspect and measure cylinder walls for damage and wear; determine needed repairs.

6. Deglaze and clean cylinder walls.

7. Inspect and measure camshaft bearings for wear, damage, out-of-round, and alignment; determine needed repairs.

8. Inspect crankshaft for surface cracks and journal damager; check oil passage condition; measure journal; determine needed repairs.

9. Inspect and measure main and connecting rod bearings for damage, clearance, and end play; determine needed repairs (includes the proper selections of bearings).

10. Identify piston and bearing wear patterns that indicate connecting rod alignment and main bearing bore problems; inspect rod alignment and bearing bore condition.

11. Inspect, measure, service or replace pistons.

12. Inspect, measure, and install piston rings.

13. Inspect, repair or replace crankshaft vibration damper (harmonic balancer).

14. Inspect flywheel or flexplate and ring gear for cracks and wear; measure runout; determine needed repairs.

15. Inspect, remove, and replace crankshaft pilot bearing or bushing (as applicable).

16. Reassemble engine components using correct gaskets and sealants.

17. Inspect auxiliary shaft(s) (balance, intermediate, idler, counterbalance or silencer); inspect shaft(s) and support bearings for damage and wear; determine needed repairs; reinstall and time.

18. Prime engine lubrication system.

**D. Lubrication and Cooling Systems Diagnosis and Repair**

1. Perform oil pressure tests; determine needed repairs.

2. Inspect oil pump gears or rotors, housing, pressure relief devices, and pump drive; replace as needed.

3. Perform cooling system tests (pressure, combustion leakage, and temperature); determine needed repairs

4. Inspect, replace, and adjust drive belts and pulleys.

5. Inspect and replace engine cooling and heater system hoses.

6. Inspect, test, and replace thermostat and housing.

7. Inspect coolant; drain, flush, and refill cooling system with recommended coolant and bleed air as required.

8. Inspect, test, remove, and replace water pump.

9. Inspect and test radiator, pressure cap, and coolant recovery system; remove and replace radiator.

10. Clean, inspect, and test fans (electrical or mechanical), fan clutch, fan shroud, and air dams.

11. Inspect and test electrical fan control system and circuits.

12. Inspect auxiliary oil coolers; replace as needed

13. Inspect, test, and replace oil temperature and pressure switches and sensors.

14. Perform oil and filter change.

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**
**Instructional Set**

**Section (B – I)**
**(1-01)**
Instructors and Interns will apply:

**DEMONSTRATE AND APPLY SAFERY RULES AND PROCEDURES**

PERFORMANCE OBJECTIVE: Given examples of repair jobs and shop situations, apply shop safety rules and procedures by identifying safe and unsafe shop practices.
ENABLING OBJECTIVES:

1. Identify common hazards in the repair shop including:
   a. improper use of tools
   b. unguarded machinery
   c. tripping and falling
   d. excessive exposure to exhaust gases, parts cleaners, paints, and dust
   e. electrical hazards
   f. improper lifting
2. Identify and explain warning signs posted in shop area
3. Explain the importance of good housekeeping in the shop
4. Explain the importance of storing materials in a safe and secure manner
5. Explain the potential hazards associated with:
   a. asbestos
   b. paints and thinners
   c. carbon monoxide
   d. solvents
   e. dusts
   f. noise
   g. hydrogen gas
6. Explain safety rules and procedures for using compressed air equipment
7. Explain the safety rules for welding, cutting, and brazing
8. Conduct an inspection of the shop for conformity with safety rules and procedures

**Section (B – I)**
**(1-02)**
Instructors and Interns will apply:

**DEMONSTRATE KNOWLEDGE OF SHOP REPAIR ORDER WRITING, CUSTOMER COMPLAINTS, AND REPAIR VERFICATIONS OR ALSO DESCRIBED AS (WORK ORDERS)**

PERFORMANCE OBJECTIVE: Given a typical shop repair order and repair complaint, write all needed information. Inspect and verify complaint; determine needed repair.

ENABLING OBJECTIVES:

1. Gain all information needed to fill out work order
2. Discuss customer complaint of vehicle operation
3. Interpret and verify complaint using automotive repair knowledge and skills
4. Determine needed repairs
5. Discuss needed repairs with customer to obtain permission to perform needed repairs

**Section (B – I)**
**(1-03)**
Instructors and Interns will apply:

**PERFORM RUNNING COMPRESSION TESTS**

PERFORMANCE OBJECTIVE: Given an engine at normal operating temperatures, test equipment, and service manual, perform a cylinder balance test. A cylinder-to-cylinder deviation exceeding manufacturer's specification must be detected.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when operating test equipment on a running engine
2. Define cylinder power balance
3. Explain the operation of the balance tester
4. Define R.P.M.'s for specific engine balance test
5. Explain the reason for R.P.M. variance or drop
6. Perform engine vacuum test and explain relationship and affect to cylinder balance test

**Section (B – I)**
**(1-04)**
Instructors and Interns will apply:

**PERFORM CYLINDER COMPRESSION TESTS**

PERFORMANCE OBJECTIVE: Provided an engine at normal operating temperatures, tools, gauges, and service manual, perform wet and dry cylinder compression tests. Cylinder pressure variation must test within manufacturer's specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when testing an operating engine
2. Describe steps in preparing an engine for a cylinder compression test
3. Describe how to install gauge and take reading
4. Explain "wet" and "dry" test and the importance of each
5. Explain all deviations found during test

**Section (B – I)**
**(1-05)**
Instructors and Interns will apply:

**PERFORM CYLINDER LEAKAGE TESTS**

PERFORMANCE OBJECTIVE: Given an engine at normal operating temperature, tools, equipment, and service manual, perform a cylinder leakage test following the manufacturer's recommended procedures. Leakage in excess of manufacturer's specifications must be noted and explained.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain method to prepare engine for cylinder leakage test
3. Identify parts of cylinder leakage tester
4. Demonstrate use of cylinder leakage tester
5. Record and compute differences in pressure leakage of cylinder
6. Describe deviations from specifications and explain causes

**Section (B – I)**
**(1-06)**
Instructors and Interns will apply:

**CLEAN ENGINES**

PERFORMANCE OBJECTIVE: Given an automobile with a dirty engine, necessary tools and equipment, clean the outer surface of deposits with no damage to related components.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures and precautions
2. Demonstrate equipment operation and material control
3. Describe care of related engine equipment
4. Explain drying of distributor and wiring if a problem develops from moisture
5. Demonstrate care of painted surfaces

**Section (B – I)**
**(1-07)**
Instructors and Interns will apply:

**DETRMINE SOURCE(S) OF OIL LOSS**

PERFORMANCE OBJECTIVE: Given an engine at operating temperature, examine the engine for oil leaks. All seals and gaskets must be securely fitted with no misalignment. No signs of oil should be around the gaskets or seals.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Identify the most likely areas on an engine that develop oil leaks
3. Identify oil leaks that make other areas appear to be leaking oil
4. Distinguish between oil seepage leaks and pressure leakage
5. Describe the function of gaskets, gasket sealers and oil seals
6. Demonstrate proper oil seal installation

**Section (B – I)**
**(1-08)**

Instructors and Interns will apply:

**DETERMINE SOURCE(S) OF COOLANT LOSS**

PERFORMANCE OBJECTIVE: Given a liquid cooled engine, test the engine cooling system with a pressure tester. Note any pressure deviation from the specified pressure ranges.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when external pressure is applied to cooling systems
2. Identify parts of engine cooling system
3. Describe pressure test on cooling system
4. Describe method to pressurize and check radiator caps
5. Demonstrate a pressure test on the cooling system and inspect for leaks

**Section (B – I)**
**(1-09)**

Instructors and Interns will apply:

**DETERMINE SOURCE(S) OF EXCESSIVE NOISE**

PERFORMANCE OBJECTIVE: Given an engine at normal operating temperature, tools, equipment and service manual, perform an operational test and determine area of noise source.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures while working on and around fan belts and gears
2. Describe types of noises that could be heard
3. Describe what can cause these noises
4. Identify major parts of the engine that can be damaged because of noise malfunctions
5. Perform noise inspection and determine why the noise is present

**Section (B – I)**
**(1-10)**
Instructors and Interns will apply:

**DETERMINE CAUSE(S) OF OVER HEATING**

PERFORMANCE OBJECTIVE: Given an engine with a liquid cooling system, visually inspect the cooling system for leaks. Radiator fins must be free of foreign matter, the pressure cap relief valve must not discharge pressure lower than permitted on the cap, the hoses must be securely connected, hoses must not restrict flow of liquid, the fan turning freely, and all drive belts must be properly adjusted.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working with cooling system components
2. Describe detection technique where coolant track is inspected after area dries
3. Inspect radiator fins for foreign matter and system for leaks
4. Inspect hoses, fan, water pumps, belts, and core plugs for any defects
5. Demonstrate repair of any leak or correction of other defects
6. Demonstrate drive belt adjustment with gauge or by hand method
7. Demonstrate inspection for internal radiator blockage

**Section (B – I)**
**(1-11)**
Instructors and Interns will apply:

**CHECK THE ENGINE OIL PRESSURE**

PERFORMANCE OBJECTIVE: Given an engine, service manual, proper tools, and test equipment, test the oil pump pressure. Any deviation from manufacturer's specification must be noted.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Identify connection where oil pressure can be checked closest to the pump
3. Identify oil pump pressure gauge and describe method of operation
4. Inspect oil pressure pump for restrictions or wear, where practical
5. Demonstrate method of obtaining oil pump pressure, record any reading below or above specifications
6. Inspect, test and replace as needed - oil temperature and pressure switches and sensors

**Section (B – I)**
**(1-12)**
Instructors and Interns will apply:

**REMOVE AND REPLACE MOTOR MOUNTS**

PERFORMANCE OBJECTIVE: Given an automobile in need of engine mounts, tools, equipment and service manual, remove and replace engine mounts according to manufacturer's procedures.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures
2. Explain the function of engine mounts
3. Demonstrate removal of broken engine mounts (engine will be properly raised)
4. Demonstrate replacement of new mount

**Section (B – I)**
**(1-13)**
Instructors and Interns will apply:

**REMOVE AND REPLACE CORE PLUGS**

PERFORMANCE OBJECTIVE: Given an engine block and cylinder head, necessary tools and proper equipment, remove and replace core plugs. No leaks should occur.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain the function of freeze plugs
3. Demonstrate method of removal from cylinder head and engine block
4. Explain the need to clean the water jacket and remove rust from plug holes
5. Demonstrate replacement of new plugs of correct size
6. Inspect for leaks

**Section (B – I)**
**(1-14)**
Instructors and Interns will apply:

**INSPECT AND MEASURE FLYWHEEL RUNOUT**

PERFORMANCE OBJECTIVE: Given a flywheel, service manual, necessary tools, and a dial indicator, measure flywheel run out for serviceability.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe how a dial indicator is used to measure runout
3. Demonstrate the testing procedure of flywheel runout
4. Inspect condition of flywheel surface and starter ring gear

**Section (B – I)**
**(1-15)**
Instructors and Interns will apply:

**REMOVE AND REPLACE FLYWHEEL**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, remove and replace the flywheel. Bolt torque will coincide with manufacturer's specifications and locking tabs must be correctly secured.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures when working under a raised vehicle
2. Demonstrate removal of a flywheel and related parts
3. Inspect the flywheel for clutch surface wear and starter ring gear damage
4. Demonstrate replacement of a flywheel, torquing of bolts, and locking procedure of bolts

**Section (B – I)**
**(1-16)**
Instructors and Interns will apply:

**REMOVE AND REPLACE FLYWHEEL RING GEAR**

PERFORMANCE OBJECTIVE: Given a flywheel, service manual, and necessary tools, remove and replace the flywheel ring gear.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain methods of removing the old ring
3. Demonstrate how to replace flywheel ring gear
4. Inspect installed ring gear for alignment

**Section (B – I)**
**(1-17)**
Instructors and Interns will apply:

**REMOVE AND REPLACE ENGINE ASSEMBIES**

PERFORMANCE OBJECTIVE: Given a vehicle in need of engine removal, service manual, tools and hoist equipment, remove and replace engine according to manufacturer's procedures. No damage will be incurred to accessory hardware and equipment.

ENABLING OBJECTIVES:

1. Demonstrate all safety precautions and procedures
2. Demonstrate operation of hoist or other protection
3. Describe protective procedures that can be followed to guard the automobile and accessories in the engine compartment from damage
4. Demonstrate removal of engine
5. Inspect related accessory components and perform repair and maintenance
6. Demonstrate replacement of engine and perform repair and maintenance
7. Demonstrate operational test (check oil, coolant, and wiring)

**Section (B – I)**
**(1-18)**
Instructors and Interns will apply:

**REMOVE AND REPLACE OIL PANS**

PERFORMANCE OBJECTIVE: Given a vehicle with a damaged pan, necessary tools, equipment and service manual, remove pan and replace pan. Oil pan must not leak when replaced.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures while working under vehicle
2. Demonstrate proper jacking and supporting of vehicle
3. Discuss handling of fluids
4. Describe procedures of getting proper clearance between pan and frame to remove pan
5. Demonstrate cleaning pan area before reinstalling pan
6. Demonstrate pan removal from engine with engine out of vehicle
7. Explain precautions of installation of new pan gasket when putting pan on engine

**Section (B – I)**
**(1-19)**
Instructors and Interns will apply:

**REMOVE AND REPLACE OIL PUMPS**

PERFORMANCE OBJECTIVE: Given automobile engine needing an oil pump, a replacement oil pump, necessary tools, and proper service manual, remove and replace pump according to manufacturer's procedures. The pump must operate after installation at manufacturer's performance level without malfunction.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain working procedure of oil pump and bypass valve
3. Describe the function of the by-pass valve
4. Demonstrate measurement of gear or rotor of pump for excessive wear
5. Demonstrate operational test for specification pressure
6. Prime oil pump prior to installation

**Section (B – I)**
**(1-20)**
Instructors and Interns will apply:

**CLEAN CYLINDER BLOCKS, OIL PASSAGES, AND PISTIONS**

PERFORMANCE OBJECTIVE: Given a disassembled engine, access to proper cleaning equipment and tools, clean engine parts. All parts needing maintenance and repair must be identified. Any cracked or broken parts must be replaced. Each part must meet specifications set by the manufacturer.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures
2. Explain proper handling order of mixed parts
3. Describe cleaning of mating (machined) surfaces
4. Demonstrate precision measuring of surfaced parts of engine
5. Demonstrate cleaning of piston ring grooves
6. Demonstrate measuring wear in ring grooves

**Section (B – I)**
**(1-21)**
Instructors and Interns will apply:

**INSPECT BLOCKS FOR WARPAGE**

PERFORMANCE OBJECTIVE: Given an automobile engine block, with necessary tools and equipment, inspect the machined surfaces for warpage. Any warpage in excess of manufacturer's specifications must be corrected by proper machining.
ENABLING OBJECTIVES:

1. Demonstrate safety procedures
2. Explain machine surface inspection
3. Explain need for appropriate machining
4. Describe surface defects
5. Inspect engine block, making sure it meets manufacturer's specifications
6. Explain care of straight edge

**Section (B – I)**
**(1-22)**
Instructors and Interns will apply:

**MEASURE AND INSPECT ENGINE COMPONENTS FOR PROPER TOLERANCES**

PERFORMANCE OBJECTIVE: Given engine parts (block, crankshaft, pistons), necessary tools, special measuring instruments, and service manual, measure all engine parts for wear.
ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain use of micrometers
3. Demonstrate measuring techniques while using inside and outside micrometers (any deviation from manufacturer's specification must be noted)
4. Inspect all parts subject to reuse for wear
5. Describe parts found not to meet specifications

**Section (B – I)**
**(1-23)**
Instructors and Interns will apply:

**REMOVE AND REPLACE CRANKSHAFTS, MAINS, AND ROD BEARINGS**

PERFORMANCE OBJECTIVE: Given an engine block prepared for assembly, necessary tools, equipment, and service manual, replace the main bearings, oil seals, and crankshaft according to the manufacturer's procedure. All main bearings' caps will be installed as numbered in indicated position, properly torqued to manufacturer's specification.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures
2. Describe torque procedure for main bearings
3. Explain "line" bored
4. Demonstrate bearing fitting and proper main bearing positioning with oil seals in place
5. Demonstrate proper procedure to examine crankshaft end play
6. Explain use of plastigauge for checking clearance
7. Explain care of crank when removing and replacing rods
8. Explain why rods and mains are position marked when disassembled

**Section (B – I)**
**(1-24)**
Instructors and Interns will apply:

**REMOVE AND REPLACE CAMSHAFTS**

PERFORMANCE OBJECTIVE: Given an automobile engine, service manual, necessary tools and equipment, remove and replace the camshaft according to manufacturer's specifications. Inspect camshaft lobes for wear in excess of manufacturer's specification.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions relating to proper timing
2. Explain function of camshaft
3. Demonstrate procedure for determining wear and inspecting lifters
4. Demonstrate removal and replacement of camshaft

**Section (B – I)**
**(1-25)**
Instructors and Interns will apply:

**REMOVE AND REPLACE CAMSHAFTS BEARINGS**

PERFORMANCE OBJECTIVE: Given an automobile engine needing camshaft bearings, service manual, necessary tools and equipment, remove and replace camshaft bearings according to manufacturer's specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain camshaft function and need for proper bearing fit and placement
3. Demonstrate replacement of camshaft bearings, using care in placement of oil holes.
4. Replace camshaft gear and timing chain and related parts
5. Demonstrate operational test and inspect for external leakage
6. Inspect auxiliary shafts and support bearings and replace as needed.

**Section (B – I)**
**(1-26)**
Instructors and Interns will apply:

**REMOVE AND REPLACE PISTONS AND RINGS**

PERFORMANCE OBJECTIVE: Given an engine, service manual, tools and special equipment, remove and replace rings, pistons, rods and bearings according to manufacturer's specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures for installation of each component
2. Demonstrate use of ring compressor and explain ring protection
3. Demonstrate torque of rod bearing caps
4. Explain reason for lubricating parts prior to installation
5. Demonstrate procedures for protecting crankshaft when installing pistons
6. Inspect and measure piston ring side clearance and end gap
7. Install piston rings on pistons to manufacturer’s specifications

**Section (B – I)**
**(1-27)**
Instructors and Interns will apply:

**REMOVE RIDGES AND DEGLAZE CYLINDER WALLS**

PERFORMANCE OBJECTIVE: Given an automotive engine block needing the upper ring-ridge removed and/or cylinder walls deglazed, necessary tools and service manual, remove the cylinder bore upper ring-ridge according to specific ridge reaming tool operation procedures.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures
2. Demonstrate ridge reamer's placement in cylinder
3. Describe removal of cylinder ring ridge
4. Demonstrate removal of ridge from cylinder
5. Explain reason for removal before pistons are removed
6. Explain what may happen to piston and new rings if ridge is not removed properly
7. Explain reason for deglazing cylinder walls
8. Demonstrate deglazing procedure
9. Demonstrate safety practices of deglazing cylinder walls
10. Demonstrate cleaning of cylinder walls after deglazing

**Section (B – I)**
**(1-28)**
Instructors and Interns will apply:

**REMOVE AND REPLACE FRONT AND REAR OIL SEALS**

PERFORMANCE OBJECTIVE: Given a vehicle with defective oil seal(s), necessary tools, equipment and service manual, remove and replace oil seals.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures while working on and under vehicle
2. Describe proper jacking and supporting of vehicle
3. Discuss handling of fluids
4. Describe and demonstrate procedures of getting proper clearance between pan and frame to remove pan
5. Describe and demonstrate procedures to remove and replace rear main seal
6. Describe and demonstrate procedures to remove and replace front main seal

**Section (B – I)**
**(1-29)**
Instructors and Interns will apply:

**REMOVE AND REPLACE INTAKE AND EXHAUST MANIFOLD**

PERFORMANCE OBJECTIVE: Given a vehicle with an intake manifold problem, service manual, necessary tools and equipment, inspect intake manifold for warpage or cracks. Attachments and intake manifold must be torqued according to manufacturer's specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures
2. Explain function of intake manifold
3. Describe function of intake manifold heat passage
4. Demonstrate removal of intake manifold and old gasket material
5. Inspect for leaks, warpage, cracks
6. Demonstrate replacement of intake manifold and related parts
7. Demonstrate operational test

**Section (B – I)**
**(1-30)**
Instructors and Interns will apply:

**REMOVE, CLEAN, INSPECT AND REPLACE CYLINDER HEADS; INSPECT HEADS FOR CRACKS AND WARPAGE**

PERFORMANCE OBJECTIVE: Given a vehicle with cylinder head malfunctions, service manual, necessary tools and equipment, remove and replace cylinder heads in accordance with manufacturer's procedure. All attaching hardware must be torqued and head gasket and manifolds must not leak.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures
2. Explain head bolt torque sequence
3. Demonstrate use of torque wrench
4. Demonstrate removal of cylinder head and related components
5. Inspect cylinder head for warpage, cracks, burned valves, or other damage
6. Describe valve sealing, valve grinding, head milling or other related repairs
7. Identify intake and exhaust ports and explain their functions
8. Inspect water jacket
9. Describe front to rear head gasket coolant passage holes
10. Demonstrate replacement of head gasket, cylinder heads, intake, and exhaust manifold
11. Demonstrate tightening sequence of cylinder head and manifold bolts
12. Demonstrate operational test of engine (recheck cooling system liquid after thermostat opens)

**Section (B – I)**
**(1-31)**
Instructors and Interns will apply:

**TEST AND REPLACE HYDRAULIC LIFTERS**

PERFORMANCE OBJECTIVE: Given an engine with defective hydraulic lifter, necessary tools, equipment and service manual, test and replace hydraulic lifters.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures while working on engine
2. Discuss handling of fluids
3. Diagnose malfunction of lifter
4. Repair and replace defective lifter and associated parts
5. Performance test engine after work is completed

**Section (B – I)**
**(1-32)**
Instructors and Interns will apply:

**PRESSURE TEST HYDRAULIC LIFTERS**

PERFORMANCE OBJECTIVE: Given a disassembled engine, hydraulic lifter, necessary tools and equipment, pressure test hydraulic lifter.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures
2. Discuss handling of fluids under pressure
3. Diagnose malfunction of lifter
4. Perform pressure bleed down test
5. Describe corrective action if lifter defective

**Section (B – I)**
**(1-33)**
Instructors and Interns will apply:

**REFACE VALVES AND SEATS**

PERFORMANCE OBJECTIVE: Given an automobile engine needing a valve job, and necessary tools and equipment, perform a valve job in accordance with manufacturer's specifications. Resurfaced valves will perform without leaks, binds or noise.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions.
2. Explain reason for valve seals
3. Demonstrate valve seat and valve face resurfacing
4. Describe valve spring tension and installed height
5. Explain valve seat and valve face lap (mating)
6. Explain valve guide clearance and reaming (replace as necessary)
7. Explain valve stem height adjustment
8. Explain valve seat replacement
9. Check valve seat runout

**Section (B – I)**
**(1-34)**
Instructors and Interns will apply:

**CHECK VALVE GUIDE LIFTES FOR WEAR**

PERFORMANCE OBJECTIVE: Given a vehicle with valve lifter problem(s), necessary tools, equipment and service manual, test valve lifters for bleed down, and adjust to manufacturer's specification.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain bleed down process
3. Demonstrate adjustment procedures (where possible)
4. Demonstrate bleed down test of valve lifters
5. Explain problems of weak, badly worn or damaged lifters
6. Demonstrate replacement of defective valve lifters
7. Inspect valve guides for wear, check valve guide height and stem-to-guide recondition or replace as needed.

**Section (B – I)**
**(1-35)**
Instructors and Interns will apply:

**REMOVE AND REPLACE TIMING CHAIN AND GEARS**

PERFORMANCE OBJECTIVES: Given any automobile engine, service manual, necessary tools and equipment, remove and replace harmonic balancer, timing chain cover, timing gears and chain. Timing must be set according to manufacturer's specifications and cover will not leak. Harmonic balancer must be inspected for wear and slippage.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain timing marks on balancer, cover and gears
3. Explain procedure for proper positioning of timing marks
4. Demonstrate engine timing in accordance with manufacturer's specifications
5. Inspect related parts (harmonic balancer, key, shaft, etc.) for excessive wear and slippage
6. Replace parts and test for operation and leaks
7. Explain use of auxiliary drive shafts (i.e. balance shafts, idler shafts, counter balance or silencer shafts)
8. Demonstrate timing of auxiliary shafts according to manufacturer’s specifications

**Section (B – I)**
**(1-36)**
Instructors and Interns will apply:

**REMOVE AND REPLACE TIMING BELT**

PERFORMANCE OBJECTIVE: Given an automobile with timing belt, service manual, tools and equipment, remove and replace timing belt. Set timing and tension according to manufacturer's specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain how to avoid damage to valves
3. Explain timing marks
4. Explain procedure for setting timing marks' belt direction before replacing belt
5. Demonstrate method of setting belt tension
6. Demonstrate use of timing light or test operational timing setting

**Section (B – I)**
**(1-37)**
Instructors and Interns will apply:

**TEST VALVE SPRINGS**

PERFORMANCE OBJECTIVE: Given a set of valve springs, necessary tools, equipment and service manual, inspect and test valve springs.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures while working with tester
2. Discuss handling of springs under pressure
3. Test springs and describes malfunction problems of springs
4. Inspect valve spring retainers, locks and valve grooves for wear; replace as needed
5. Set valve spring installed height

**Section (B – I)**
**(1-38)**
Instructors and Interns will apply:

**ADJUST VALVE LIFTERS**

PERFORMANCE OBJECTIVE: Given an automobile engine with mechanical valve lifters, tools, equipment and service manual, adjust the exhaust and intake valve lash according to manufacturer's specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Adjust intake exhaust and valve lash using flat feeler gauge of correct thickness according to manufacturer's specifications
3. Explain the necessity for valve lash variation between the intake and exhaust valves
4. Explain "noise" made by mechanical valve lifters
5. Explain various methods of adjusting valve lash

**Section (B – I)**
**(1-39)**
Instructors and Interns will apply:

**REPLACE ROCKER ARM ASSEMBLIES, INSPECT WEAR AND LUBRICATION**

PERFORMANCE OBJECTIVE: Given a vehicle with rocker arm problem, service manual, and necessary tools, remove valve cover and inspect rocker arms for proper lubrication and wear, and replace rocker arm assembly, if necessary.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when operating an engine with valve cover removed
2. Explain rocker arm lubricating system
3. Describe valve rocker arm function
4. Inspect valve rocker arm assemblies (or independent rockers) for lubrication
5. Describe any rocker arm problem (lubrication, wear, broken or adjustment)

**Section (B – I)**
**(1-40)**
Instructors and Interns will apply:

**CHANGE OIL AND OIL FILTERS WITH PRPPER APPLICATION**

PERFORMANCE OBJECTIVE: Given a vehicle in need of oil and filter change, service manual, tools, supplies, hoist or jack, change oil and filter.

ENABLING OBJECTIVES:

1. Demonstrate all safety precautions and procedures
2. Demonstrate operation of hoist or raising device
3. Describe protective procedures for auto finish
4. Demonstrate removal of oil filter
5. Demonstrate proper installation of oil filter
6. Demonstrate proper removal of drain plug
7. Demonstrate proper replacement of drain plug
8. Describe proper oil type for application

**Section (B – I)**
**(1-41)**
Instructors and Interns will apply:

**REMOVE AND REPLACE RADIATORS**

PERFORMANCE OBJECTIVE: Given a vehicle with defective radiator and access to appropriate tools, equipment and service manual, remove and replace radiator. The radiator and its connecting components must not leak.

ENABLING OBJECTIVES:

1. Explain purpose of radiator
2. Demonstrate safety procedures (hot pressure)
3. Explain radiator construction and liquid flow direction
4. Demonstrate care in handling radiator to avoid damage
5. Inspect for leaks
6. Remove and replace radiator
7. Inspect auxiliary oil coolers, engine, and transmission coolers; replace as needed

**Section (B – I)**
**(1-42)**
Instructors and Interns will apply:

**CHECK RADIATOR COOLANT LEVEL**

PERFORMANCE OBJECTIVE: Given a vehicle with a liquid cooled engine, perform a radiator coolant level check.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working on engine cooling systems
2. Describe how to check coolant level
3. Check coolant level

**Section (B – I)**
**(1-43)**
Instructors and Interns will apply:

**TEST AND REPLACE OR RECYCLE COOLANT**

PERFORMANCE OBJECTIVE: Given a liquid-cooled engine at operating temperature, tools and equipment drain and replace the engine coolant, test the coolant freezing point and specific gravity. The reading must be within +/- 5 degrees of established reading. Test PH readings and recycle.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain boiling and freezing point of water and antifreeze mix
3. Demonstrate use of hydrometer or refractometer for antifreeze solution
4. Explain hazards of freezing coolant in an engine
5. Inspect system for leaks
6. Explain types of testers: freeze protection and PH readings
7. Explain types of coolants
8. Test the coolant for freeze protection and PH readings
9. Explain how to safely drain the cooling system
10. Explain correct mixture of water and antifreeze for proper protection
11. Recover and recycle old antifreeze or install new antifreeze
12. Tell how to properly dispose of old antifreeze

**Section (B – I)**
**(1-44)**
Instructors and Interns will apply:

**PRESSURE –TEST COOLING SYSTEM**

PERFORMANCE OBJECTIVE: Given a liquid-cooled engine and a radiator pressure tester pump, pressure-test the cooling system. Any pressure drop in the system will be noted. System must hold pressure within manufacturer's specifications with no leaks.
ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain operation of pressure tester
3. Explain pressure drop problems
4. Inspect system for signs of leakage
5. Pressure-test the system

**Section (B – I)**
**(1-45)**
Instructors and Interns will apply:

**TEST RADIATOR CAPS**

PERFORMANCE OBJECTIVE: Given a vehicle with a liquid cooled engine which is pressurized, a radiator cap and a radiator cap tester, test cap for proper operation.
ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe how the radiator cap controls the sealed system and explain the purpose for pressurizing the system
3. Test the radiator cap

**Section (B – I)**
**(1-46)**
Instructors and Interns will apply:

**INSPECT, REMOVE AND REPLACE RADIATOR AND HEATER HOSES**

PERFORMANCE OBJECTIVE: Given an automobile that is operational, visually inspect and physically examine heater and radiator hoses, and replace them if necessary. All cracked, soft or worn hoses and leaks must be detected.
ENABLING OBJECTIVES:

1. Demonstrate safety precautions while working with a cooling system
2. Explain heater and radiator hose functions
3. Describe preformed hoses and flexible hoses
4. Inspect hoses for faulty conditions, cracks, and soft hard or worn spots
5. Inspect all hose clamps and tighten
6. Remove and replace all hoses found to be defective

**Section (B – I)**
**(1-47)**
Instructors and Interns will apply:

**REMOVE, TEST AND REPLACE THERMOSTATS**

PERFORMANCE OBJECTIVE: Given an automobile that is operational but has thermostat problems and the necessary tools, test and replace thermostat. There must be no leaks, and the coolant level must be at the correct point at normal operating temperature.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain purpose of thermostat
3. Determine location of thermostat
4. Explain how to test thermostat
5. Demonstrate removal of thermostat and clean gasket surfaces
6. Test and replace thermostat gasket
7. Demonstrate proper tightening procedure of housing bolts

**Section (B – I)**
**(1-48)**
Instructors and Interns will apply:

**FLUSH COOLING SYSTEM**

PERFORMANCE OBJECTIVE: Given a liquid-cooled engine in operating condition and the necessary tools and equipment, clean and flush cooling system. After using proper procedures for cleaning and flushing the system, all connections must be leak proof and coolant must be at correct level at operating temperature. System must be rechecked after thermostat opens.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain the effect of the cooling system on the life of the engine
3. Identify types of antifreeze
4. Demonstrate safety rules when operating flush equipment
5. Inspect system for leaks
6. Inspect coolant level again after thermostat has opened
7. Explain reason for reverse flush of engine cooling system
8. Flush the cooling system

**Section (B – I)**
**(1-49)**
Instructors and Interns will apply:

**REMOVE AND REPLACE WATER PUMPS**

PERFORMANCE OBJECTIVE: Given a liquid-cooled engine, necessary tools, equipment and service manual, remove and replace water pump. The pump should function as specified without leaks or noise at normal operating temperature.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain how to use belt tension gauge
3. Explain how the cooling system works
4. Explain how to use pressure tester
5. Explain how to check water pump for end play and roughness in bearings and leakage
6. Demonstrate removal of all old gasket material from mating surfaces
7. Remove and replace water pump
8. Torque water pump bolts according to manufacturer's specifications

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**

**Working with:**
**National Automotive Technicians Education Foundation**

**Section B**
**Unit II**
**NATEF Task List: Automatic Transmission & Transaxle**

## Unit II
## AUTOMATIC TRANSMISSION AND TRANSAXLE

**For every task in Automatic Transmission and Transaxle, the following safety requirement must be strictly enforced as a number one priority:** Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage and disposal of chemicals in accordance with local, state and federal safety and environmental regulations.

### A. General Transmission and Transaxle Diagnosis

1. Interpret and verify driver's complaint, verify proper engine operation; determine needed repairs.
2. Diagnose unusual fluid usage, level, and condition problems, determine needed repairs.
3. Perform pressure tests; determine needed repairs.
4. Perform stall tests; determine needed repairs.
5. Perform lock-up converter system tests, determine needed repairs.
6. Diagnose electronic, mechanical, and vacuum control systems; determine needed repairs.
7. Diagnose noise and vibration problems; determine needed repairs.

### B. Transmission and Transaxle Maintenance and Adjustment

1. Inspect, adjust or replace manual shift valve and throttle (TV) linkages or cables and check gear select indicator (as applicable).
2. Service transmission; perform visual inspection; replace fluids and filters.

### C. In-Vehicle Transmission and Transaxle Repair

1. Inspect, adjust or replace (as applicable) vacuum modulator; inspect and repair or replace lines and hoses.
2. Inspect, repair, and replace governor assembly.
3. Inspect and replace external seals and gaskets.
4. Inspect extension housing; replace bushing and seals.
5. Inspect, leak test, flush, and replace cooler, lines, and fittings.
6. Inspect and replace speedometer drive gear (vehicle speed sensor), driven gear, and retainers.
7. Inspect, measure, clean, and replace valve body (includes surfaces and bores, springs, valves, sleeves, retainers, brackets, check-balls, screens, spacers, and gaskets); check/adjust valve body bolt torque.

8. Inspect servo bore, piston, seals, pin, springs, and retainers; repair or replace as needed.
9. Inspect accumulator bore, piston, seals, spring, and retainer; repair or replace as needed.
10. Inspect, test, adjust, repair or replace transmission related electrical and electronic components (includes computers, solenoids, sensor, relays, switches and harnesses).
11. Inspect, replace, and align power train mounts.
12. Inspect and replace parking pawl, shaft, spring, and retainer.

**D. Off-Vehicle Transmission and Transaxle Repair Remove, Disassembly, and Reinstallation**

1. Remove and reinstall transmission and torque converter (rear-wheel drive).
2. Remove and reinstall transaxle and torque converter assembly.
3. Disassemble, clean, and inspect transmission/trans axle.
4. Assemble transmission/transaxle.

**Oil Pump and Converter**

1. Inspect converter flex plate, attaching parts, pilot and pump drive, and seal areas.
2. Measure torque converter end play and check for interference; check stator clutch.
3. Inspect, measure, and replace oil pump housings, shafts, vanes, rotors, gears, valves, seals, and bushings.
4. Check torque converter and transmission cooling system for contamination

**Gear Train, Shafts, Bushings and Case**

1. Check end play or preload; determine needed service.
2. Inspect, measure, and replace thrust washers and bearings.
3. Inspect oil delivery seal rings, ring grooves, and sealing surface areas.
4. Inspect bushings; replace as needed.
5. Inspect and measure planetary gear assembly (includes sun, ring gear, thrust washers, planetary gears, and carrier assembly; replace as needed.
6. Inspect cases, bores, passages, bushings, vents and mating surfaces, replace as needed.
7. Inspect transaxle drive, link chains, sprockets, gears, bearings, and bushings; replace as needed.
8. Inspect, measure, repair, adjust or replace transaxle final drive components.

9. Inspect and reinstall parking pawl, shaft, spring, and retainer; replace as needed.

**Friction and Reaction Units**

1. Inspect clutch drum, piston, check-balls, springs, retainers, seals, and fiction and pressure plates; replace as needed.
2. Measure clutch pack clearance; adjust as needed.
3. Air test operation of clutch and servo assemblies.
4. Inspect roller and sprag clutch, races, rollers, sprags, springs, cages, and retainers, replace as needed.
5. Inspect bands and drums; replace as needed.

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**

**NATEF TASK LIST: INSTRUCTIONAL SET**

**Section (B – II)**
**(2-01)**
Instructors and Interns will apply:

**DEMONSTRATE AND APPLY SAFETY RULES AND PROCEDURES**

PERFORMANCE OBJECTIVE: Given examples of automatic transmission repair situations, apply shop safety rules and procedures by identifying safe and unsafe shop practices.

ENABLING OBJECTIVES:

1. Explain the importance of disconnecting the battery
2. Demonstrate safety procedures in using a hydraulic press
3. Demonstrate safety precautions when working under a raised vehicle
4. Demonstrate safety precautions when using transmission jacks

**Section (B – II)**
**(2-02)**
Instructors and Interns will apply:

**CHECK AUTOMOTIC TRANSMISSION FLUID LEVEL**

PERFORMANCE OBJECTIVE: Given an operating automobile and service manual, check and service the transmission fluid level. The fluid should be at the correct level and should be checked with the vehicle at operating temperature and in the proper gear.

ENABLING OBJECTIVES:

1. Explain procedures for checking fluid level
2. Demonstrate safety in servicing transmissions while the engine is operating
3. Demonstrate proper procedure for checking automatic transmission fluid level
4. Inspect for leaks

**Section (B – II)**
**(2-07)**

Instructors and Interns will apply:

**PERFORMANCE TEST AUTOMATIC TRANSMISSIONS**

PERFORMANCE OBJECTIVE: Given an operating vehicle equipped with automatic transmission, service manual and proper tools, perform operational test on automatic transmission.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when performing operational tests
2. Explain how the manufacturer's manual and charts can be used most effectively
3. Define manifold vacuum
4. Locate the pressure gauge test connections
5. Demonstrate operational test

**Section (B – II)**
**(2-04)**

Instructors and Interns will apply:

**DIAGNOSE MALFUNCTIONS OF AUTOMATIC TRANSMISSIONS**

PERFORMANCE OBJECTIVE: Given an automatic transmission with known malfunctions, service manual and tools, diagnose malfunctions.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain the use of the troubleshooting section of the manual
3. Explain causes of problems such as fluid leaks, fluid condition, slipping, lockup and shifting problems
4. Explain malfunctions as diagnosed and explain how they may be corrected

**Section (B – II)**
**(2-10)**
Instructors and Interns will apply:

**DIAGMOSE, REPAIR AND REPLACE TRANSAXLES**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, repair, replace, and rebuild a transaxle assembly. When complete the unit should not leak fluid, excessive noise should not be present when operating, and all bolts must be secured.

ENABLING OBJECTIVES:

1. Distinguish between a split case unit and a one piece unit
2. Demonstrate safety precautions when working on each type unit
3. Demonstrate removal, disassembly and inspection of all parts for wear and/or damage
4. Demonstrate reassembly and installation on vehicle
5. Demonstrate operational test of vehicle
6. Demonstrate inspection and repair procedures on transaxle drive, link chains, sprockets, gears, bearings and bushings
7. Inspect final drive components and repair to manufacturer's specifications

**Section (B – II)**
**(2-06)**
Instructors and Interns will apply:

**PRESSURE TEST TRANSMISSION IN VEHICLE**

PERFORMANCE OBJECTIVE: Given an operating vehicle equipped with automatic transmission, proper manual, necessary tools and gauges, perform pressure tests in the different gear ranges.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working on a raised vehicle
2. Explain the different types of pressures (line, modulator, defects, etc.) in a transmission and the purposes of each
3. Demonstrate gauge hook up and gauge read out of the different gear ranges

**Section (B – II)**
**(2-07)**

Instructors and Interns will apply:

**STALL TEST TRANSMISSIONS IN VEHICLES**

PERFORMANCE OBJECTIVE: Given a vehicle with an automatic transmission, service manuals and equipment, stall test a transmission.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when performing stall test
2. Demonstrate stall test procedure for vehicle on which test is performed
3. Explain the results of the test and how they relate to transmission condition

**Section (B – II)**
**(2-08)**

Instructors and Interns will apply:

**CHANGE TRANSMISSION OIL FILTER**

PERFORMANCE OBJECTIVE: Given an automatic transmission, service manual and tools, remove and replace or service the transmission filter. All bolts must be torqued and the gaskets and filter must be correctly installed.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working under a raised vehicle
2. Explain the difference between a filter that can be serviced or cleaned and one that must be replaced
3. Describe proper procedures for draining transmission fluids
4. Demonstrate removal of oil pan, filter and old gasket material
5. Demonstrate replacement of filter, oil pan and fluid (check fluid level)

**Section (B – II)**
**(2-09)**

Instructors and Interns will apply:

**ADJUST LINKAGE FROM THE ENGINE**

PERFORMANCE OBJECTIVE: Given a vehicle with an automatic transmission, service manual and proper tools, adjust the manual throttle valve kick-down at the engine or at the transmission.

ENABLING OBJECTIVES:

1. Demonstrate proper adjustment procedures
2. Explain location of adjustments

**Section (B – II)**
**(2-10)**
Instructors and Interns will apply:

**ADJUST SHIFT LINKAGE**

PERFORMANCE OBJECTIVE: Given a vehicle with an automatic transmission, service manual and proper tools, adjust the shift linkage. When adjustments are completed, appropriate gears should be able to be selected, the quadrant indicator must be positioned correctly and locking devices must be secured.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while working under a raised vehicle
2. Explain differences between rod linkage and cable linkage and column and floor linkage
3. Define quadrant indicator
4. Demonstrate adjustment of external linkage and quadrant indicator position

**Section (B – II)**
**(2-11)**
Instructors and Interns will apply:

**TEST ELECTRICAL AND COMPUTER CONTROLS OF AN AUTOMATIC TRANSMISSION AND CLUTCH CONVERTER**

PERFORMANCE OBJECTIVE: Given an automatic transmission computer control with code indicating an electrical problem, service manual, multimeter (volt, amps/ohm), test relays or solenoids relating to the electrical trouble code.

ENABLING OBJECTIVES:

1. Demonstrate the proper use of the multimeter
2. Compare a bad solenoid to a good one by explanation
3. Perform lock-up converter system test; determine needed repairs
4. Demonstrate the proper removal and replacement procedures for transmission control computers, relays, and wire harnesses

**Section (B – II)**
**(2-18)**
Instructors and Interns will apply:

**ADJUST NEUTRAL SAFETY SWITCHES**

PERFORMANCE OBJECTIVE: Given a vehicle with an automatic transmission, service manual and necessary tools, adjust the neutral safety switch as needed. When adjustments are completed the engine should crank when the gear selector is in park or neutral but fail to crank in any other gear.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain how the neutral safety switch controls engine cranking and why it is n Necessary
3. Describe adjustment procedure
4. Demonstrate proper neutral safety switch operation when adjustments are made

**Section (B – II)**
**(2-13)**
Instructors and Interns will apply:

**REMOVE AND REPLACE EXTERNAL GASKETS AND SEALS**

PERFORMANCE OBJECTIVE: Given a vehicle with an automatic transmission, tools and service manual, replace external gaskets and seals.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Demonstrate removal and replacement of external gaskets and seals

**Section (B – II)**
**(2-14)**
Instructors and Interns will apply:

**TEST VACUUM SHIFT MODULATORS**

PERFORMANCE OBJECTIVE: Given an automatic transmission, service manual, tools and vacuum gauge, test the vacuum modulator.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain the function of the vacuum modulator
3. Demonstrate use of a vacuum gauge
4. Identify vacuum modulator and test instrument
5. Demonstrate modulator test procedure

**Section (B – II)**
**(2-18)**
Instructors and Interns will apply:

**ADJUST BANDS**

PERFORMANCE OBJECTIVE: Given an automatic transmission, service manual and proper tools, make band adjustments (external and/or internal). Band must be adjusted within specifications and lock nuts torqued.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe special tools for different band adjustments
3. Distinguish between adjustable and nonadjustable bands
4. Demonstrate proper band adjustments (external or internal)

**Section (B – II)**
**(2-16)**
Instructors and Interns will apply:

**SERVICE GOVERNORS**

PERFORMANCE OBJECTIVE: Given an automatic transmission, service manual and tools, remove, service, and replace transmission governor.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working on automatic transmission
2. Explain governor operation
3. Demonstrate removal and replacement or service of governor

**Section (B – II)**
**(2-17)**
Instructors and Interns will apply:

**SERVICE VALVE BODIES**

PERFORMANCE OBJECTIVE: Given an automatic transmission, service manual and proper tools, service valve body. All gaskets must be installed and valve body torqued to specifications.

ENABLING OBJECTIVES:

1. Explain the importance of precisely handling delicate valves and springs
2. Identify each valve and explain its function
3. Demonstrate safety precautions when working on automatic transmissions
4. Demonstrate removal and replacement of valve body and related parts
5. Demonstrate torquing procedures and explain why torque of valve body is critical

**Section (B – II)**
**(2-18)**
Instructors and Interns will apply:

**REBUILD TRANSMISSION ASSEMBLIES**

PERFORMANCE OBJECTIVE: Given a rebuildable automatic transmission in an operating vehicle, service manual, tools and replacement parts, rebuild the automatic transmission. The transmission must shift correctly, must not leak, and all hoses, lines, clamps and mounts must be properly secured.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Demonstrate how to safely raise the vehicle and remove the transmission
3. Demonstrate complete disassembly of the transmission and drain or flush converter
4. Inspect all assembly parts for excessive wear and damage and discard any parts not serviceable (very close inspection must be made of pumps)
5. Describe how to rebuild or service a clutch pack, servo, valve body and governor
6. Demonstrate reassembly of all parts and assemblies
7. Explain how to adjust bands and reinstall transmission unit
8. Demonstrate fluid replacement and operational test and the plug fluid leak inspection

**Section (B – II)**
**(2-19)**
Instructors and Interns will apply:

**PRESSURE FLUSH CONVERTER ASSEMBLIES**

PERFORMANCE OBJECTIVE: Given a torque converter, converter flusher machine, and service manual, installs adapters to clean and flush converter.

ENABLING OBJECTIVES:

1. Explain proper amount of time needed to flush converter
2. Demonstrate installation of adapters
3. Check torque converter for contamination and follow service procedures

**Section (B – II)**
**(2-20)**
Instructors and Interns will apply:

**PRESSURE FLUSH TRANSMISSION COOLER ASSEMBLIES AND CHECK LIQUID FLOW**

PERFORMANCE OBJECTIVE: Given a car with an automatic transmission, service manual and proper tools, pressure flush cooler. No leaks should be visible, lines must be tightly secured and not rub or touch other parts at potential wear points.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain how transmission cooling systems operate
3. Inspect oil lines, oil line connections and cooling unit for leaks, cracks, wear or restrictions
4. Demonstrate repairs to correct malfunctions or to avoid future malfunctions
5. Check transmission cooling system for contamination and follow service procedures

**Section (B – II)**
**(2-21)**
Instructors and Interns will apply:

**REMOVE AND REPLACE EXTENSION HOUSING AND BUSHINGS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, remove and replace the extension housing and bushing. The bushing position must be correct.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while working on a raised vehicle
2. Explain the purpose of the extension housing and bushing
3. Identify special tools necessary to replace bushing properly
4. Demonstrate removal and replacement of extension housing and bushing

## REMOVE AND REPLACE POWER TRAIN MOUNT(S)

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and proper tools, remove and replace the power train mount(s). When completed the mount must be secure and properly aligned. Safety will be observed in the process.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working under a raised vehicle
2. Explain hazards that exist in the process of raising the transmission during this task
3. Demonstrate removal and replacement of power train mounts
4. Inspect for security and condition of surrounding components

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**
**Instructional Set:**

**Working with:**
**National Automotive Technicians Education Foundation**

**Unit III**

**Section B**

**NATEF Task List: Manual Drive Train and Axles**

## Unit III
## MANUAL DRIVE TRAIN AND AXLES

**For every task in Manual Drive Train and Axles, the following safety requirement must be strictly enforced as a number one priority:** Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage and disposal of chemicals in accordance with local, state, and federal safety and environmental regulations.

### A. Clutch Diagnosis and Repair

1. Diagnose clutch noise, linking, slippage, pulsation, and chatter problems; determine needed repairs.
2. Inspect, adjust or replace clutch pedal linkage, cables, automatic adjuster mechanisms, brackets, bushings, pivots, and springs.
3. Inspect, adjust, repair or replace hydraulic clutch slave and master cylinders, lines, and hoses.
4. Inspect, adjust or replace release (throw-out) bearing, lever, and pivot.
5. Inspect and replace clutch pressure plate assembly and clutch disc.
6. Inspect, remove or replace crankshaft pilot bearing or bushing (as applicable).
7. Inspect, repair, and service or replace flywheel and ring gear.
8. Inspect engine block, clutch (bell) housing, and transmission case mating surfaces; determine needed repairs.
9. Measure flywheel-to-block run out and crankshaft end play; determine needed repairs.
10. Measure clutch (bell) housing bore-to-crankshaft runout and face squareness; determine needed service.

### B. Transmission Diagnosis and Repair

1. Diagnose transmission noise, hard shifting, jumping out of gear, and fluid leakage problems; determine needed repairs.
2. Inspect, adjust, and replace transmission shift linkages, brackets, bushings, cables, pivots, and levers.
3. Inspect, replace, and align power train mounts.
4. Inspect and replace transmission gaskets, seals, and sealants; inspect sealing surfaces.
5. Remove and reinstall transmission.
6. Disassemble, clean, and reassemble transmission components.
7. Inspect, adjust, and reinstall transmission shift cover, forks, grommets, levers, shafts, sleeves, detent mechanisms, interlocks, and springs.
8. Inspect and reinstall input (clutch) shaft and bearings.

9. Inspect and reinstall main shaft, gears, thrust washers, bearings and retainers.
10. Inspect and reinstall synchronizer hub, sleeve, keys (inserts), springs, and blocking rings.
11. Inspect and reinstall counter (cluster) gear, shaft, bearings thrust washers, and retainers; check end play; adjust as needed.
12. Inspect and reinstall reverse idler gear, shaft, bearings, thrust washers, and retainers; check end play; adjust as needed.
13. Inspect and replace speedometer drive gear, driven gear, vehicle speed sensor (VSS), and retainers.
14. Inspect, repair, and replace extension housing and transmission case mating surfaces, bores, bushings, and vents.
15. Inspect lubrication devices (oil pump or slingers).

**C. Transaxle Diagnosis and Repair**

1. Diagnose transaxle noise, hard shifting, jumping out of gear, and fluid leakage problems; determine needed repairs.
2. Inspect, adjust, and reinstall transaxle shift linkages, brackets, bushings, cables, pivots, and levers.
3. Inspect and reinstall power train mounts.
4. Remove and reinstall transaxle.
5. Inspect and replace transaxle gaskets, seals, and sealants; inspect sealing surfaces.
6. Remove and replace transaxle final drive.
7. Disassemble and clean transaxle final drive.
8. Inspect, adjust, and reinstall transaxle shift cover, forks, levers, grommets, shafts, sleeves, detent mechanism, interlocks, and springs.
9. Inspect and reinstall input (clutch) shaft and bearings.
10. Inspect and reinstall output shaft, gears, thrust washers, bearings, and retainers.
11. Measure end play or preload (shim or spacer selection procedure) on transaxle shafts; adjust as needed.
12. Inspect and reinstall synchronizer hub, sleeve, keys (inserts), springs, and blocking rings.
13. Inspect and reinstall reverse idler gear, shaft, bearings, thrust washers, and retainers.
14. Inspect transaxle case, mating surfaces, bores, bushings, and vents.
15. Inspect and reinstall speedometer drive gear, driven gear, vehicle speed sensors (VSS), and retainers.
16. Diagnose differential assembly noise and vibration problems; determine needed repairs.

17. Remove, inspect, measure, adjust, and reinstall differential pinion gears (spiders), shaft, side gears, side bearings, thrust washers, and case assembly.
18. Inspect lubrication devices (oil pump or slingers).

**D. Drive and Half Shaft Universal and Constant-Velocity (CV) Joint Diagnosis and Repair.**

1. Diagnose constant-velocity (CV) joint noise and vibration problems; determine needed repairs.
2. Diagnose universal joint noise and vibration problems; determine needed repairs.
3. Diagnose front wheel drive (FWD) front wheel bearing noise and vibration problems; determine needed repairs.
4. Inspect, service, and replace shaft, yokes, boots, and universal/CV joints.
5. Inspect, service, and replace shaft center support bearings.
6. Check and correct shaft balance; measure shaft run out; measure and adjust driveline angles.

**E. Rear Axle Diagnosis and Repair Ring and Pinion Gears and Differential Case Assembly**

1. Diagnose noise and vibration problems; determine needed repairs.
2. Diagnose fluid leakage problems; determine needed repairs.
3. Inspect and replace companion flange and pinion seal; measure companion flange run out.
4. Inspect ring gear and measure runout; determine needed repairs.
5. Remove and inspect drive pinion gear, spacers, sleeves, and bearings.
6. Measure and adjust drive pinion depth.
7. Measure and adjust drive pinion bearing preload.
8. Measure and adjust side bearing preload and ring and pinion gear total backlash and backlash variation on a differential carrier assembly (threaded cup and shim types).
9. Check ring and pinion tooth contact patterns; adjustments as needed.
10. Disassemble, inspect, measure, and adjust or replace differential pinion gears (spiders), shaft, side gears, side bearings, thrust washers, and case.
11. Reassemble and reinstall differential case assembly; measure run out; determine needed repairs.

**Limited Slip Differential**

1. Diagnose noise, slippage, and chatter problems; determine needed repairs.
2. Inspect and flush differential housing; refill with correct lubricant.
3. Inspect and reinstall clutch (cone or plate) components.
4. Measure rotating torque; determine needed repairs.

**Axle Shaft**

1. Diagnose rear axle shafts, bearings, and seals for noise, vibration, and fluid leakage problems; determine needed repairs.
2. Inspect and replace rear axle shaft wheel studs.
3. Remove and replace rear axle shafts.
4. Inspect and replace rear axle shaft seals, bearings, and retainers.
5. Measure rear axle flange run out and shaft end play; determine needed repairs.

**F. Four-wheel Drive/All-wheel Drive Component Diagnosis and Repair**

1. Diagnose noise, vibration, and unusual steering problems; determine needed repairs.
2. Inspect, adjust, and repair shifting controls (mechanical, electrical, and vacuum), bushings, mounts, levers, and brackets.
3. Remove and reinstall transfer case.
4. Disassemble, service, and reassemble transfer case and components.
5. Inspect, service, and replace front-wheel bearings and locking hubs.
6. Check drive assembly seals and vents; check lube level.
7. Inspect viscous coupling assembly.

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**

**NATEF TASK INSTRUCTIONAL SET**

**Section (B – III)**
**(3-01)**
Instructors and Interns will apply:

**DEMONSTRATE AND APPLY SAFETY RULES AND PROCEDURES**

PERFORMANCE OBJECTIVE: Given examples of manual transmission repair situations, apply shop safety rules and procedures by identifying safe and unsafe shop practices.

ENABLING OBJECTIVES:

1. Explain the importance of disconnecting the battery
2. Demonstrate safety procedures when using a hydraulic press
3. Demonstrate safety precautions when working under a raised vehicle
4. Demonstrate safety precautions when using transmission jacks
5. Explain the importance of keeping the floor free of transmission fluids

**Section (B – III)**
**(3-02)**
Instructors and Interns will apply:

**DIAGNOSE DRIVELINE PROBLEMS, HALF SHAFT, AND CV JOINTS PROBLEMS**

PERFORMANCE OBJECTIVE: Given a vehicle and necessary manuals and tools, perform an operational test and inspect the drive line(s), half shafts, and CV joints. The following minimum items should be checked: drive shaft, universal joints, CV joints, wheel bearings, support bearings, rear end supports, hangers and springs, transmission mount, and lug nuts.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while working under a raised vehicle
2. Explain how a vehicle's "handling reactions" feel when it has drive line slack or loose motion
3. Identify: drive shaft, universal joints, support bearings, rear end supports, transmission mount, lug nuts, half shafts and CV joints
4. Demonstrate a complete drive line inspection
5. Describe discrepancies found and repairs needed

**Section (B – III)**
**(3-08)**

Instructors and Interns will apply:

**CHECK AND CORRECT SHAFT BALANCE; MEASURE SHAFT RUNOUT; MEASURE AND ADJUST DRIVELING ANGLES**

PERFORMANCE OBJECTIVE: Given a vehicle and necessary manuals and tools, check and correct shaft balance, run out and angle. When completed, shaft should be free of vibration.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while working under a raised vehicle
2. Demonstrate shaft balance procedures
3. Measure shaft run out
4. Measure and adjust driveline angles

**Section (B – III)**
**(3-04)**

Instructors and Interns will apply:

**DIAGNOSE AND PERFORMANCE TEST MANUAL TRANSMISSION/TRANAXLE PROBLEMS**

PERFORMANCE OBJECTIVE: Given a vehicle with a manual transmission/transaxle and service manuals, perform operational test of a manual transmission.

ENABLING OBJECTIVES:

1. Explain power flow of transmission/transaxle gears
2. Explain the purpose of all parts within a manual transmission/transaxle
3. Demonstrate safety precautions
4. Demonstrate operational test to check gear positions for operation, noise or malfunction

**Section (B – III)**
**(3-08)**

**DIAGNOSE AND PREFORMANCE TEST MANUAL TRANSMISSION/TRANSAXLE PROBLEMS**

PERFORMANCE OBJECTIVE: Given vehicles with limited slip and open type differentials and service manuals, perform operational test of drive axle/differential.
ENABLING OBJECTIVES:

1. Explain power flow of drive axle/differential
2. Explain purpose of all parts within a drive axle/differential
3. Demonstrate operational test to check for noise, vibration, slippage, chatter, and leakage

**Section (B – III)**
**(3-06)**
Instructors and Interns will apply:

**INSPECT AND SERVICE DRIVE SHAFTS, UJOINTS AND CENTER BEARINGS**

PERFORMANCE OBJECTIVE: Given a drive shaft and proper tools, inspect drive shaft for wear and damage and perform service procedures.
ENABLING OBJECTIVES:

1. Inspect/service bearing support
2. Inspect/service joints for wear
3. Inspect/service bearing for noise
4. Inspect/service yoke for phase

**Section (B – III)**
**(3-07)**
Instructors and Interns will apply:

**LUBRICATE UNIVERSAL JOINT**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual, necessary tools and grease gun, lubricate universal joint. There should be a sufficient amount of the appropriate grease properly applied without excessive grease remaining on the joint.
ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working under a raised vehicle
2. Identify the special tool required to grease universal joints that have close clearances
3. Demonstrate proper lubrication procedures for serviceable universal joints
4. Inspect all joints for excessive wear and/or loose or missing locks

**Section (B – III)**
**(3-08)**

Instructors and Interns will apply:

**CHECK THE FLUID LEVEL IN A MANUAL TRANSMISSION**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and tools, lubricate the manual transmission. Fluid level, filler plug tightness and type of lubricant must be correct.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working under a raised vehicle
2. Explain what fluid (by weight) should be used in the transmission of a specific vehicle
3. Identify the lubricating point and check fluid level

**Section (B – III)**
**(3-09)**

Instructors and Interns will apply:

**FLUSH AND CHECK THE FLUID LEVEL IN A DIFFERENTIAL**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and tools, flush and check the fluid level in a differential. Fluid level must be correct.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working under a raised vehicle
2. Explain what fluid (by viscosity) should be used in the differential of a specific vehicle
3. Demonstrate proper flushing procedure
4. Identify the lubricating point and check fluid level

**Section (B – III)**
**(3-10)**

Instructors and Interns will apply:

**REMOVE AND REPLACE POWER TRAIN MOUNT(S)**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and proper tools, remove and replace the power train mount(s). When completed the mount must be secure and properly aligned. Safety will be observed in the process.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working under a raised vehicle
2. Explain hazards that exist in the process of raising the transmission during this task
3. Demonstrate removal and replacement of power train mounts
4. Inspect for security and condition of surrounding components

**Section (B – III)**
**(3-11)**
Instructors and Interns will apply:

**ADJUST SHIFT LINKAGE**

PERFORMANCE OBJECTIVE: Given a vehicle with a manual transmission, service manual and proper tools, adjust the external shift linkage. When adjustments are completed, the shifter should operate smoothly, appropriate gears should be able to be selected and all nuts and fasteners should be installed correctly.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain how a manual transmission shift is accomplished
3. Identify adjustment points
4. Demonstrate proper shift pattern for specific vehicle when adjustments are made

**Section (B – III)**
**(3-12)**
Instructors and Interns will apply:

**ADJUST CLUTCHES**

PERFORMANCE OBJECTIVE: Given a vehicle with manual clutch, service manual and necessary tools, adjust the clutch as needed. The free travel will be compared to the manufacturer's specifications, all nuts and fasteners must be correctly installed and the return spring must work properly.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain the purpose of clutch free travel
3. Describe adjustment procedure
4. Demonstrate properly adjusted clutch action in relation to transmission shift
5. Identify adjusting mechanism of hydraulic clutch
6. Identify clutch master cylinder and slave cylinder
7. Inspect fluid level of system and correct if low

**Section (B – III)**
**(3-13)**

Instructors and Interns will apply:

**REMOVE AND REPLACE EXTENSION HOUSING SEALS AND BUSHINGS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, remove and replace the extension housing seals and bushings. The bushing position and seal installation must be correct.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while working on a raised vehicle
2. Explain the purpose of the extension housing seals and bushings
3. Identify special tools necessary to replace bushings and seals properly
4. Demonstrate removal and replacement of bushings and seals

**Section (B – III)**
**(3-14)**

Instructors and Interns will apply:

**REMOVE, REPLACE AND REBUILD MANUAL TRANSMISSION**

PERFORMANCE OBJECTIVE: Given a transmission, service manual and tools, rebuild a manual transmission. All bolts will be torqued, no leakage will be present and the transmission must operate smoothly. All needle bearings and thrust washers must be correctly installed.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions and remove transmission
2. Explain power flow of the manual transmission in all gears
3. Demonstrate how to use grease to hold needle bearings in position during assembly
4. Demonstrate disassembly of manual transmission
5. Inspect gears and related parts for wear and damage
6. Demonstrate reassembly of gears and examine operation
7. Reinstall transmission

**Section (B – III)**
**(3-15)**
Instructors and Interns will apply:

**DIAGNOSE AND REPAIR CLUTCH**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, remove and replace all clutch components, including release bearing, linkage and pilot bearing. All nuts and bolts must be torqued or secured and the clutch should engage and disengage smoothly.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working under a raised vehicle
2. Describe how a clutch operates
3. Explain the purpose of free travel in a clutch
4. Demonstrate removal of clutch assembly and related components
5. Identify the throw-out bearing and the pilot bushing; explain the function of each
6. Inspect all clutch assembly parts for wear and damage
7. Demonstrate lubrication, assembly and adjustments of clutch parts and related components
8. Demonstrate operational test
9. Diagnose noise, linking, slipping, pulsation, and chatter problems
10. Inspect engine block, bellhousing, and transmission case mating surfaces
11. Measure flywheel-to-block run out and crankshaft end play
12. Measure bellhousing bore-to-crankshaft runout and face squareness

**Section (B – III)**
**(3-16)**
Instructors and Interns will apply:

**REBUILD CLUTCH MASTER AND SLAVE CYLINDERS**

PERFORMANCE OBJECTIVE: Given required vehicle, manual and necessary tools, remove, replace or rebuild the slave or master cylinder. The cylinder should be bled, have no leaks and all nuts, bolts and bleeder screws secure.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when handling hydraulic fluid
2. Explain how to bleed a hydraulic clutch
3. Demonstrate removal and disassembly of the specific unit
4. Inspect all parts and replace all worn or damaged parts
5. Demonstrate reassembly and installation of specific unit
6. Demonstrate bleeding of hydraulic system and test for proper operation

**Section (B – III)**
**(3-29)**

Instructors and Interns will apply:

**REMOVE AND REPLACE UNIVERSAL JOINTS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools and parts, remove and replace the universal joints.

ENABLING OBJECTIVES:

1. Inspect U joint cross for wear
2. Inspect U joint caps for damage
3. Demonstrate the proper installation of grease zerk
4. Demonstrate the proper seating of the all snap rings
5. Demonstrate proper lubrication

**Section (B – III)**
**(3-18)**

Instructors and Interns will apply:

**REMOVE AND REPLACE SPEEDOMETER GEARS, VEHICLE SPEED SENSOR (VSS) AND SERVICE SPEEDOMETER CABLES**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual, necessary tools and lubricant, remove, replace, and lubricate speedometer cable and driver gear. The cable must move freely and be free of sharp bends.

ENABLING OBJECTIVES:

1. Explain the differences between the operation of speedometers that work off the front wheel versus the drive shaft or output shaft
2. Demonstrate safety precautions
3. Identify speedometer cable and gear location
4. Demonstrate removal of cable and gear assembly and inspect for damage
5. Demonstrate lubrication (using proper lubricating materials) and replace assembly
6. Demonstrate operational test

**Section (B – III)**
**(3-29)**
**(3-19)**
Instructors and Interns will apply:

**REMOVE AND REPLACE AXLE, AXLE BEARINGS, SEALS AND STUDS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and proper tools, remove and replace an axle bearing and seal. When completed the axle bearing and its retainer must be recessed on in the proper position. All nuts and bolts must be properly torqued.

ENABLING OBJECTIVES:

1. Inspect axle bearing and related parts when removed from vehicle
2. Measure axle flange runout and shaft endplay
3. Demonstrate safety precautions when working on a raised vehicle
4. Demonstrate how to safely use a hydraulic press to remove and replace an axle bearing and wheel studs
5. Demonstrate seal installation
6. Install axle
7. Demonstrate operational test when repairs are completed

**Section (B – III)**
**(3-20)**
Instructors and Interns will apply:

**OVERAHUL INTEGRAL DIFFERENTIALS**

PERFORMANCE OBJECTIVE: Given a differential, service manual and necessary tools, rebuild the assembly. When completed the tolerances must be within manufacturer's specifications and all nuts and bolts secure.

ENABLING OBJECTIVES:

1. Discuss how to adjust the differential using shims for carrier adjustment
2. Demonstrate safety precautions
3. Identify special tools and equipment
4. Demonstrate removal of components and inspect for wear, damage, or runout
5. Demonstrate reassembly and adjustments of gear teeth, back lash and bearing preload
6. Demonstrate operational test

**Section (B – III)**
**(3-29)**

Instructors and Interns will apply:

**REMOVE, REPLACE AND OVERHAUL REMOVABLE DIFFERENTIALS**

PERFORMANCE OBJECTIVE: Given a differential, service manual and necessary tools, rebuild the assembly. When completed the tolerances must be within manufacturer's specifications and all nuts and bolts secure.

ENABLING OBJECTIVES:

1. Discuss how to adjust carrier bearings using adjusting nuts
2. Demonstrate safety precautions
3. Identify special tools and equipment
4. Demonstrate removal of components and inspect for wear, damage or runout
5. Demonstrate reassembly and adjustments of gear teeth, back lash and bearing preload
6. Demonstrate operational test

**Section (B – III)**
**(3-22)**

Instructors and Interns will apply:

**OVERAHUL LIMITED SLIP DIFFERENTIALS**

PERFORMANCE OBJECTIVE: Given a limited slip differential, service manual and necessary tools, overhaul the assembly. When completed the tolerances must be within manufacturer's specifications, the assembly must transmit driving torque as required and all nuts and bolts must be secure.

ENABLING OBJECTIVES:

1. Demonstrate all overhaul procedures that are common to all differentials, whether they are limited slip or not
2. Discuss different ways manufacturers use to load the clutches in limited slip units
3. Demonstrate disassembly and inspection of all parts for wear and/or damage
4. Demonstrate reassembly
5. Demonstrate safety precautions

**Section (B – III)**

**(3-23)**

Instructors and Interns will apply:

**REMOVE, REPLACE, AND OVERHAUL TRANSAZLE ASSEMBIIES**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, rebuild a transaxle assembly. When completed the unit should not leak fluid, excessive noise should not be present when operating and all bolts must be secured.

ENABLING OBJECTIVES:

1. Distinguish between a split-case unit and a one piece unit
2. Demonstrate safety precautions when working on each type unit
3. Demonstrate removal of transaxle from vehicle
4. Demonstrate disassembly and inspection of all parts for wear and/or damage
5. Demonstrate reassembly and installation on vehicle
6. Demonstrate operational test of vehicle

**Section (B – III)**

**(3-24)**

Instructors and Interns will apply:

**ADJUST TRANSAZLE SHIFTING CONTROLS**

PERFORMANCE OBJECTIVE: Given a vehicle with a manual transaxle, service manual and proper tools, adjust the external shift linkage. When adjustments are completed, the shifter should operate smoothly, appropriate gears should be able to be selected and all nuts and bolts must be installed correctly.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain how a manual transaxle shift is accomplished
3. Identify adjustment points
4. Demonstrate proper shift pattern for specific vehicle when adjustments are made

**Section (B – III)**
**(3-29)**

Instructors and Interns will apply:

**INSPECT, REMOVE, REPLACE AND LUBRICATE FRONT-DRIVE AXLE FLEXIBLE JOINTS**

PERFORMANCE OBJECTIVE: Given a front wheel drive vehicle, service manual, necessary tools and lubricant, remove, replace and lubricate the front flex joints. There should be a sufficient amount of grease on the joints and any boots, if used, must be secure and not twisted. All retaining bolts, clips, snap-rings and clamps must be secure.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working under a raised vehicle
2. Inspect all joints for excessive wear
3. Identify the various types of joints and boots
4. Demonstrate removal and replacement procedures for flex joints
5. Demonstrate proper lubrication procedures

**Section (B – III)**
**(3-26)**

Instructors and Interns will apply:

**INSPECT, REMOVEAND REPLACE CONSTANT VELOCITY UNIVERSAL JOINTS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, remove and replace a constant velocity U joint. All clips, snap-rings, and nuts and bolts must be secure.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working under a raised vehicle
2. Explain why a constant velocity joint is used and how it functions
3. Demonstrate removal and replacement of the joint
4. U-joints should be properly planed and phased

**Section (B – III)**
**(3-27)**
Instructors and Interns will apply:

**REMOVE, REPLACE, SERVICE OR REPAIR TRANSFER CASE AND SHIFTING CONTROLS**

PERFORMANCE OBJECTIVE: Given a four wheel drive vehicle, service manual and necessary tools, repair a transfer case and/or the vacuum control. When completed the unit should not leak, produce excessive noise when operating, should shift smoothly and transfer torque as required. All nuts and bolts should be secure.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working under a raised vehicle
2. Explain various types of transfer cases and methods of transmitting torque
3. Explain various ways that shifting is controlled
4. Perform removal, disassembly and inspection of transfer cases; determine needed repair/service
5. Remove, inspect, and replace chain
6. Remove, inspect, and replace all gears
7. Remove, inspect, and replace all bearings
8. Install transfer case and fill with correct lubricant
9. Inspect and adjust shifting linkage (mechanical, electrical, vacuum)
10. Demonstrate an operational test of 4-wheel drive repairs (road test)

**Section (B – III)**
**(3-28)**
Instructors and Interns will apply:

**DIAGNOSE WHEEL/TIRE VIBRATIONS, SHIMMING AND TRAMP**

PERFORMANCE OBJECTIVE: Given a vehicle with a vibration complaint and proper service manuals, troubleshoot the vehicle and make proper recommendation for repair.

ENABLING OBJECTIVES:

1. Diagnose wheel balance
2. Discuss types of tires
3. Discuss types of rims
4. Explain and demonstrate static balance
5. Explain and demonstrate dynamic balance

**Section (B – III)**
**(3-29)**

Instructors and Interns will apply:

**DIAGNOSE STEERING PROBLEMS**

PERFORMANCE OBJECTIVE: Given a vehicle with steering problems, proper service manual, and using information from customer complaint and a test drive, if possible, recommend the proper repair for the vehicle.

ENABLING OBJECTIVES:

1. Check tie-rod ends
2. Check idler arms
3. Check power steering gears including rack and pinion
4. Check manual steering gears including rack and pinion
5. Check drag links

**Section (B – III)**
**(3-30)**

Instructors and Interns will apply:

**SERVICE FRONT WHEEL BEARINGS, GREASE SEALS, AND LOCKING HUBS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, grease, seal, inspect and service the wheel bearing and seal.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while removing a wheel from a raised vehicle
2. Explain what will happen if the wheel bearing is over tightened or under tightened
3. Demonstrate proper removal, cleaning and grease packing of wheel bearings
4. Demonstrate replacement of bearings and seal
5. Demonstrate bearing adjustment and spindle nut locking procedure of hub
6. Demonstrate proper replacement of dust cap

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**
**Instructional Set:**

**Working with:**
**National Automotive Technicians Education Foundation**

**Section B**
**Unit IV**

**NATEF Task List: STEERING SUSPENSION & WHEEL SERVICE**

## Unit IV
## STEERING SUSPENSION AND WHEEL SERVICE

**For every task in Suspension and Steering, the following safety requirement must be strictly enforced as a number one priority:** Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage and disposal of chemicals in accordance with local, state, and federal safety and environmental regulations.

### A. Steering Systems Diagnosis and Repair

1. Disable supplemental restraint systems (SRS) in accordance with manufacturer's procedures.
2. Diagnose steering column noises, looseness, and binding problems (including tilt mechanisms); determine needed repairs.
3. Diagnose power non-rack and pinion steering gear binding, uneven turning effort, looseness, hard steering, and fluid leakage problems; determine needed repairs.
4. Diagnose power rack and pinion steering gear vibration, looseness, and hard steering problems; determine needed repairs.
5. Inspect and replace steering shaft universal-joint(s), flexible coupling(s), collapsible column, lock cylinder mechanism, and steering wheel.
6. Adjust manual or power non-rack and pinion worm bearing preload and sector lash.
7. Remove and replace manual or power rack and pinion steering gear; inspect mounting bushings and brackets.
8. Disassemble, inspect, repair, and reassemble rack and pinion steering gear.
9. Adjust manual or power rack and pinion steering gear.
10. Inspect and replace manual or power rack and pinion steering gear inner tie rod ends (sockets) and bellows boots.
11. Inspect manual and power steering fluid levels and condition.
12. Flush, fill, and bleed power steering system.
13. Diagnose power steering fluid leakage; determine needed repairs.
14. Inspect, replace, and adjust power steering pump belt.
15. Remove, inspect, and replace power steering pump, pump mounts, pump seals, and gaskets.
16. Remove, inspect, and replace power steering pump pulley; check alignment.

17. Perform power steering system pressure test; determine needed repairs.
18. Inspect and replace power steering hoses and fittings.
19. Inspect and replace pitman arm, relay (centerlink/intermediate) rod, idler arm and mountings, and steering linkage damper.
20. Inspect, replace, and adjust tie rod ends (sockets), tie rod sleeves, and clamps.
21. Diagnose, inspect, adjust, repair or replace components of electronically-controlled steering systems.
22. Diagnose, inspect, repair or replace components of variable-assist steering systems.

**B. Suspension Systems Diagnosis and Repair Front Suspensions**

1. Diagnose short and long arm suspension system noises, body sway, and uneven riding height problems; determine needed repairs.
2. Diagnose MacPherson strut suspension system noises, body sway, and uneven riding height problems; determine needed repairs.
3. Remove, inspect, and replace upper and lower control arms, bushings, shafts, and rebound bumpers.
4. Remove, inspect, replace, and adjust strut (compression/tension) rods and bushings.
5. Remove, inspect, and replace upper and lower ball joints on short and long arm suspension systems.
6. Remove, inspect, and replace steering knuckle assemblies.
7. Remove, inspect, and replace short and long arm suspension system coil springs and spring insulators.
8. Remove, inspect, replace, and adjust suspension system torsion bars; inspect mounts.
9. Remove, inspect, and replace stabilizer bar bushings, brackets, and links.
10. Remove, inspect, and replace ball joints on MacPherson strut suspension systems.
11. Remove, inspect, and replace MacPherson strut cartridge or assembly, strut coil spring, and insulators, and upper strut bearing mount.
12. Lubricate suspension and steering systems.

**Rear Suspensions**

1. Remove, inspect, and replace coil springs and spring insulators.
2. Remove, inspect, and replace transverse links, control arms, bushings, and mounts.
3. Remove, inspect, and replace leaf springs, leaf spring insulators (silencers), shackles, brackets, bushings, and mounts.

4 Remove, inspect, and replace MacPherson strut cartridge or assembly, strut coil spring, and insulators (silencers).

**Miscellaneous Service**

1. Inspect, remove, and replace shock absorbers.
2 Remove, inspect, and service or replace front and rear wheel bearings.
3 Diagnose, inspect, adjust, repair, or replace components of electronically-controlled suspension systems.

**C. Wheel Alignment Diagnosis, Adjustment and Repair**

1. Diagnose vehicle wander, drift, pull, hard steering, bump steer, memory steer, torque steer, and steering return problems; determine needed repairs.
2. Measure vehicle riding height; determine needed repairs.
3. Check and adjust front and rear wheel camber; determine needed repairs.
4. Check and adjust caster; determine needed repairs.
5. Check and adjust front wheel toe; adjust as needed.
6. Center steering wheel.
7. Check toe-out-on-turns (turning radius); determine needed repairs.
8. Check SAI (steering axis inclination) and included angle; determine needed repairs.
9. Check and adjust rear wheel toe.
10. Check rear wheel thrust angle; determine needed repairs.
11. Check for front wheel setback; determine needed repairs.
12. Check front cradle (sub-frame) alignment; determine needed repairs.

**D. Wheel and Tire Diagnosis and Repair**

1. Diagnose tire wear patterns; determine needed repairs.
2. Inspect tires; check and adjust air pressure.
3. Diagnose wheel/tire vibration, shimmy, and noise problems; determine needed repairs.
4. Rotate tires according to manufacturer's recommendations.
5. Measure wheel, tire, axle, and hub runout; determine needed repairs.
6. Diagnose tire pull (lead) problem; determine corrective actions.
7. Balance wheel and tire assembly (static and dynamic).
8. Dismount, inspect, repair, and remount tire on wheel.
9. Reinstall wheel; torque lug nuts.

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**
**INSTRUCTIONAL SET**

**Section (B – IV)**
**(4-01)**
Instructors and Interns will apply:

**DEMONSTRATE AND APPLY SAFETY RULES AND PROCEDURES**

PERFORMANCE OBJECTIVE: Given a vehicle needing service on steering, suspension and/or wheels demonstrate and apply proper safety rules and procedures.

ENABLING OBJECTIVES:

1. Demonstrate the proper wearing of safety glasses
2. Discuss reasons for not wearing ring, watches and jewelry when working on a vehicle
3. Apply proper jacking and lift precautions
4. Demonstrate safety precautions when working under a raised vehicle

**Section (B – IV)**
**(4-02)**
Instructors and Interns will apply:

**DIAGNOSE ABNORMAL TIRE WEAR PROBLEMS**

PERFORMANCE OBJECTIVE: Given a tire and wheel assembly and proper tools, inspect the assembly for serviceability.

ENABLING OBJECTIVES:

1. Check air pressure
2. Check for irregular wear
3. Check for physical damage (cuts, etc.)
4. Check for radial and lateral run-out

**Section (B – IV)**
**(4-18)**

Instructors and Interns will apply:

**DIAGNOSE SUSPENSION PROBLEMS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, inspect the suspension system components. All parts worn beyond manufacturer's specifications must be detected.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Identify the different types of suspension systems
3. Demonstrate the proper procedure to inspect the suspension system
4. Describe shock absorber function
5. Identify steering linkage parts
6. Identify defective front and rear suspension assemblies

**Section (B – IV)**
**(4-04)**

Instructors and Interns will apply:

**DIAGNOSE WHEEL/TIRE VIBRATIONS, SHIMMY AND TRAMP**

PERFORMANCE OBJECTIVE: Given a vehicle with a vibration complaint and proper service manuals, troubleshoot the vehicle and make proper recommendation for repair.

ENABLING OBJECTIVES:

1. Diagnose wheel balance
2. Discuss types of tires
3. Discuss types of rims
4. Explain and demonstrate static balance
5. Explain and demonstrate dynamic balance

**Section (B – IV)**
**(4-18)**

Instructors and Interns will apply:

**DIAGNOSE STEERING PROBLEMS**

PERFORMANCE OBJECTIVE: Given a vehicle with steering problems, proper service manual, and using information from customer complaint and a test drive, if possible, recommend the proper repair for the vehicle.

ENABLING OBJECTIVES:

1. Check tie-rod ends
2. Check idler arms
3. Check power steering gears including rack and pinion
4. Check manual steering gears including rack and pinion
5. Check drag links

**Section (B – IV)**
**(4-06)**

Instructors and Interns will apply:

**LUBRICATE SUSPENSION, STEERING GEAR AND LINKAGE**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and proper tools, lubricate suspension points.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while raising a vehicle on a hoist
2. Describe "greased" joints versus "non-greasable" joints
3. Inspect and clean all fittings to be lubricated
4. Explain use of a lubricating chart for a specific vehicle
5. Demonstrate the lubricating equipment

**Section (B – IV)**
**(4-07)**

Instructors and Interns will apply:

**CHECK MANUAL STEERING GEAR FLUID LEVEL**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and required tools, lubricate manual steering gear box. Proper level will be checked.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain why different gear boxes operate most effectively with varying weights of greases and/or oils
3. Explain how grease or oil level may be determined
4. Demonstrate proper gear box lubricating method
5. Inspect gear box for safe operation

**Section (B – IV)**
**(4-18)**

Instructors and Interns will apply:

**INSPECT, ADJUST AND REPAIR STEERING SYSTEMS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, inspect, and adjust or repair the steering gear and linkage. Any parts that are worn beyond limits will be replaced.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working under a raised vehicle
2. Explain the importance, safety wise, of inspecting the steering gear and linkage
3. Demonstrate methods of testing parts for excessive wear
4. Identify steering parts to be inspected for wear
5. Describe an excessively worn part
6. Inspect steering shaft flex coupler

**Section (B – IV)**
**(4-09)**

Instructors and Interns will apply:

**INSPECT AND REPAIR SYSPENSION SYSTEMS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, inspect the suspension system components. All parts worn beyond manufacturer's specifications must be detected and replace as needed.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Identify the different types of suspension systems
3. Demonstrate the proper procedure to inspect the suspension system
4. Describe shock absorber function
5. Identify steering linkage parts
6. Inspect and repair front and rear suspension components

**Section (B – IV)**
**(4-18)**

Instructors and Interns will apply:

**INSPECT AND TEST SHOCK ABSORBERS AND AUTO LEVELING SYSTEMS**

PERFORMANCE OBJECTIVE: Given a vehicle, proper service manuals and proper tools, test the shocks and the leveling system to the manufacturer's specifications.

ENABLING OBJECTIVES:

1. Describe single action shocks
2. Describe dual action shocks
3. Describe leveling system operation

**Section (B – IV)**
**(4-11)**

Instructors and Interns will apply:

**CHECK POWER STEERING FLUID LEVEL**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, service power steering fluid level. All fluid levels less than operating level must be detected and filled to proper level.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe the differences among several types of fluids on the market that could be used in the steering system
3. Identify power steering major parts
4. Describe method used to determine fluid level and fill to proper level
5. Inspect for power steering fluid leaks and any loose steering parts

**Section (B – IV)**
**(4-12)**

Instructors and Interns will apply:

**REPLACE POWER STEERING DRIVE BELTS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and tools, remove and replace steering belt(s). Upon completion belt tension must be correct, belt must be properly aligned and adjusting bolts secured.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working on steering components
2. Describe how belts are sized according to length, design and width
3. Identify belt to be removed and bolts used to release belt tension
4. Demonstrate removal and replacement of selected belt
5. Demonstrate proper gauge tension on replaced belt (or hand method)
6. Demonstrate operational test

**Section (B – IV)**
**(4-18)**

Instructors and Interns will apply:

**IDENTIFY TIRES BY TYPES AND SIZES**

PERFORMANCE OBJECTIVE: Given several tires, properly identify them by type and size.

ENABLING OBJECTIVES:

1. Identify bias tires
2. Identify radial tires
3. Identify belted tires
4. Define aspect ratio
5. Discuss combination of belted, bias and radial tires
6. Diagnose tire pull; determine corrective action

**Section (B – IV)**
**(4-14)**

Instructors and Interns will apply:

**REPAIRE TIRES**

PERFORMANCE OBJECTIVE: Given a tire that needs repair, repair the tire by properly dismounting, placing a patch on the inside and remounting the tire.

ENABLING OBJECTIVES:

1. Repair tubeless tires using cold and hot patches
2. Repair tube type tires using cold and hot patches or boots

**Section (B – IV)**
**(4-15)**

Instructors and Interns will apply:

**ROTATE WHEELS AND TIRES AND TORQUE LIG NUTS TO SPECIFICATIONS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and proper tools, rotate the tires. When finished, the lug nuts will be torqued to specifications and tires will be positioned considering the types of tires on the vehicle.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when vehicle is raised and wheels are removed
2. Demonstrate how to properly raise a vehicle to rotate the tires
3. Demonstrate proper handling of tire and hub caps and lug nuts while removed from the vehicle
4. Explain need to check tire and wheel balance at this time
5. Demonstrate proper rotation of tires (bias ply or radial ply)

**Section (B – IV)**
**(4-18)**

Instructors and Interns will apply:

**BALANCE TIRES BY COMPUTER, BUBBLE, OR SPIN**

PERFORMANCE OBJECTIVE: Given a wheel and tire assembly, wheel balancer, proper tools and wheel weights, balance the assembly.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Define the terms "static" and "dynamic" balancing
3. Demonstrate locating position for wheel weights according to the type of balance
4. Explain why a certain size weight was used
5. Explain varying methods of attaching wheel weights based on wheel construction
6. Demonstrate balancer available

**Section (B – IV)**
**(4-17)**

Instructors and Interns will apply:

**SERVICE FRONT WHEEL BEARINGS, GREASE SEALS, AND LOCKING HUBS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, grease, seal, inspect, and service the wheel bearing and seal.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while removing a wheel from a raised vehicle
2. Explain what will happen if the wheel bearing is over tightened or under tightened
3. Demonstrate proper removal, cleaning and grease packing of wheel bearings
4. Demonstrate replacement of bearings and seal
5. Demonstrate bearing adjustment and spindle nut locking procedure of hub
6. Demonstrate proper replacement of dust cap

**Section (B – IV)**
**(4-18)**

Instructors and Interns will apply:

**REMOVE AND REPLACE FRONT AND REAR WHEEL BEARINGS**

PERFORMANCE OBJECTIVE: Given a vehicle with defective front or rear wheel bearings, replace the bearings using the proper tools and service manuals, to manufacturer's specifications.

ENABLING OBJECTIVES:

1. Discuss types of grease
2. Demonstrate proper bearing adjustment
3. Torque lugs to proper specifications

**Section (B – IV)**
**(4-19)**

Instructors and Interns will apply:

**REMOVE AND REPLACE SPINDLES AND BALL JOINTS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and proper tools, remove and replace the steering spindle and ball joints.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working on a raised vehicle
2. Discuss the importance of not straightening or heating a bent steering spindle
3. Describe special tools needed to remove a spindle held by ball joints
4. Demonstrate removal of spindle
5. Inspect all related parts (hub, bearings, backing plate, brake parts, etc.)
6. Demonstrate replacement of all related parts
7. Demonstrate removal of ball joints

**Section (B – IV)**
**(4-28)**

Instructors and Interns will apply:

**REMOVE AND REPLACE SHOCK ABSORBERS AND MOUNTS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and tools, remove and replace shock absorbers.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working under a raised vehicle
2. Explain the difference among standard, heavy duty and special purpose shock absorbers
3. Describe two purposes of shock absorbers
4. Demonstrate torque of shock absorber rubber grommets
5. Demonstrate test for operation and noise of shock absorbers

**Section (B – IV)**
**(4-21)**

Instructors and Interns will apply:

**MEASURE AND ADJUST TORSION BAR HEIGHT**

PERFORMANCE OBJECTIVE: Given a vehicle with torsion bar suspension and proper service manual, measure and adjust height.

ENABLING OBJECTIVES:

1. Follow proper safety procedures
2. Measure vehicle height to determine needed adjustments
3. Describe where to make adjustment, if not to specifications
4. Make adjustment

**Section (B – IV)**
**(4-22)**

Instructors and Interns will apply:

**REMOVE AND REPLACE TORSION BARS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, remove and replace the torsion bar(s). When completed proper bolt torque will be checked as well as equal curb height being adjusted.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working under a raised vehicle
2. Explain how the curb height can be adjusted on most torsion bar equipped vehicles
3. Demonstrate removal and replacement of torsion bar and curb height adjustment procedure

**Section (B – IV)**
**(4-28)**

Instructors and Interns will apply:

**REMOVE AND REPLACE COIL SPRINGS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and required tools, remove and replace the coil spring(s). When completed the springs must be properly seated.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures when working under a raised vehicle
2. Demonstrate the use of a spring compressor
3. Describe special tools needed to release ball joint connection
4. Demonstrate replacing and seating of replacement coil spring

**Section (B – IV)**
**(4-24)**

Instructors and Interns will apply:

**REMOVE AND REPLACE CONTROL -ARMS AND BUSHINGS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, remove and replace control arms and bushings.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when removing major suspension components
2. Describe several dangerous aspects of removing and replacing a control arm

**Section (B – IV)**
**(4-25)**

Instructors and Interns will apply:

**REMOVE AND REPLACE STEERING LINKAGE COMPONENTS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and proper tools, remove and replace steering linkage components.

ENABLING OBJECTIVES:

1. Check tie rod
2. Check center link (drag link)
3. Check Pitman arm
4. Check idler arm
5. Check steering knuckle
6. Check steering sector
7. Check damper
8. Remove defective or damaged steering components
9. Replace and make proper adjustments to steering components

**Section (B – IV)**
**(4-28)**

Instructors and Interns will apply:

**REMOVE AND REPLACE MCPHERSON STRUT ASSEMBLY**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and proper tools, remove and replace the MacPherson strut assembly. All attachment hardware must be torqued to specifications, ride height must be correct and wheels must turn to their extremes without binding.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working on a raised vehicle
2. Identify several cars that are MacPherson strut equipped and discuss the differences of such cars
3. Explain special tools used for safe operation
4. Identify a MacPherson strut assembly and explain its construction
5. Demonstrate removal of strut assembly and control of the coil spring
6. Demonstrate replacement of strut assembly and all related parts

**Section (B – IV)**
**(4-27)**

Instructors and Interns will apply:

**REBUILD A MACPHERSON STRUT**

PERFORMANCE OBJECTIVE: Given a vehicle, service annual and proper tools, rebuild a MacPherson strut. Upon completion the strut must not bind, there should be no leaks, and all snap rings and rubber boots should be secured.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain the advantages and/or disadvantages of a MacPherson strut as compared to other front end designs
3. Inspect unit to be disassembled for external damage
4. Demonstrate disassembly of strut and inspection of internal parts
5. Demonstrate assembly, installation and testing for operation of strut assembly

**Section (B – IV)**
**(4-28)**

Instructors and Interns will apply:

**REMOVE AND REPLACE REAR SUSPENSION PARTS, INCLUDING INDEPENDENT SUSPENSION**

PERFORMANCE OBJECTIVE: Given a vehicle with a problem in the rear suspension, determine the type of suspension, make a visual check and check for wear according to manufacturer's specifications.

ENABLING OBJECTIVES:

1. Follow safety procedures
2. Describe leaf type suspension
3. Describe coil type suspension
4. Describe independent suspension
5. Describe strut type independent suspension
6. Demonstrate disassembly of suspension parts
7. Demonstrate assembly and installation of suspension parts

**Section (B – IV)**
**(4-29)**

Instructors and Interns will apply:

**REMOVE AND REPLACE MAST JACKET OF STEERING ASSEMBLY**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, remove and replace mast jacket. The mast jacket should be tight, in proper alignment and gear selector operational.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Identify the mast jacket and explain its purpose
3. Demonstrate removal of all related parts
4. Demonstrate removal and replacement of mast jacket
5. Demonstrate operational test of mast jacket and all related parts

**Section (B – IV)**
**(4-01)**
Instructors and Interns will apply:

**REPAIR STEERING COLUMN**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, repair the tilt or telescopic steering column. This will include replacing small parts kit, bearing and locking assembly.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working inside a vehicle
2. Identify tilt and/or telescopic steering column of the specific vehicle
3. Explain how each type operates
4. Demonstrate removal of related parts to expose the assembly to be repaired
5. Identify the needed repair and demonstrate removal and replacement of parts
6. Demonstrate operational test of repaired unit and related parts

**Section (B – IV)**
**(4-31)**
Instructors and Interns will apply:

**REMOVE AND REPLACE STEERING WHEEL**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and tools, remove and replace the steering wheel. The steering wheel should be aligned, bolt tightened, horn connected, and there should not be any damage done to steering wheel cover.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working inside a vehicle
2. Demonstrate use of a steering wheel puller
3. Identify thread and bolt size on a specific vehicle so the appropriate puller can be used
4. Demonstrate proper removal and replacement of steering wheel and related parts

**Section (B – IV)**
**(4-32)**

Instructors and Interns will apply:

**REMOVE AND REPLACE COMPONENTS AND/OR CONTROLS IN POWER STEERING SYSTEM**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and proper tools, remove and replace hydraulic components in power steering system. Items to be included are steering gear, hose(s) and line(s), steering cylinder, control valve and pump. When completed there should be no leaks, all attaching bolts should be secured, and all lines and hoses routed properly.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions for working on hydraulic power steering components
2. Test pressure in power steering systems
3. Identify all power steering units and explain functions
4. Demonstrate removal and replacement of components selected for removal
5. Inspect for leakage and loose, worn or damaged parts
6. Flush, fill and bleed system
7. Diagnose variable-assist steering system
8. Diagnose, inspect, and adjust electronically-controlled steering systems

**Section (B – IV)**
**(4-33)**

Instructors and Interns will apply:

**CHECK TWO WHEEL AND FOUR WHEEL ALIGNMENTS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual, necessary tools and equipment, align wheels. The toe, caster, and camber should meet manufacturer's specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while working under a vehicle
2. Define toe, caster, and camber
3. Identify adjustment points of the front end for toe, caster and camber setting
4. Describe tools and equipment necessary to align automobile front end
5. Demonstrate front end alignment procedure
6. Measure riding height; adjust as needed
7. Inspect tires; check and adjust pressure
8. Check wheel, tire, and hub runout

**Section (B – IV)**
**(4-34)**
Instructors and Interns will apply:

## ALIGN REAR AXLE

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, align rear axle. Vehicle readings must be within manufacturer's specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working under a vehicle
2. Identify several cars that have an adjustable rear axle
3. Locate rear axle adjustment points
4. Demonstrate use of the equipment necessary to align the vehicle's rear axle

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**
**Instructional Set:**

**Working with:**
**National Automotive Technicians Education Foundation**

**Section B**
**Unit V**

**NATEF Task List: AUTOMOTIVE BRAKE SERVICE**

## Unit V

## AUTOMOTIVE BRAKE SERVICE

For every task in Brakes, the following safety requirement must be strictly enforced as a number one priority: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage and disposal of chemicals in accordance with local, state, and federal safety and environmental regulations.

A Hydraulic System Diagnosis and Repair

1. Measure and adjust pedal pushrod length and pedal height.
2. Check master cylinder for internal and external leaks and proper operation; determine needed repairs.
3. Remove, bench bleed, and replace master cylinder.
4. Diagnose poor stopping, pulling or dragging caused by problems in the hydraulic system; determine needed repairs.
5. Inspect brake lines and fillings for leaks, dents, kinks, rust, cracks or wear; tighten loose fittings and supports.
6. Inspect flexible brake hoses for leaks, kinks, cracks, bulging or wear; tighten loose fittings and supports.
7. Fabricate and install brake lines (double flare and ISO types); replace hoses, fittings, and supports as needed.
8. Select, handle, store, and install brake fluids to proper level.
9. Inspect, test, and replace metering (hold-off) proportioning (balance), pressure differential, and combination valves.
10. Inspect, test, replace, and adjust height (load) sensing proportioning valve.
11. Inspect, test, and replace components of brake warning light system.
12. Bleed (manual, pressure, vacuum or surge) brake system; flush hydraulic system.

**B. Drum Brake Diagnosis and Repair**

1. Diagnose poor stopping, noise, pulling, grabbing, dragging or pedal pulsation problems; determine needed repairs.
2. Remove, clean (using proper safety procedures), inspect, and measure brake drums; service or replace as needed.
3. Mount brake drum on lathe; machine braking surface.
4. Remove, clean, and inspect brake shoes, springs, pins, clips, levers, adjusters/self-adjusters, other related brake hardware, and backing support plates; lubricate and reassemble.

5. Remove and reinstall wheel cylinders.

6. Pre-adjust brake shoes and parking brake before installing brake drums or drum/hub assemblies and wheel bearings.

7. Reinstall wheel, torque lug nuts, and make final checks and adjustments.

**C. Disc Brake Diagnosis and Repair**

1. Diagnose poor stopping, noise, pulling, grabbing, dragging or pedal pulsation caused problems; determine needed repairs.

2. Remove caliper assembly from mountings; clean and inspect for leaks and damage to caliper housing.

3. Clean and inspect caliper mounting and slides for wear and damage.

4. Remove, clean, and inspect pads and remaining hardware; determine needed service.

5. Dissemble and clean caliper assembly; inspect parts for wear, rust scoring, and damage; replace seal, boot, and damaged or worn parts.

6. Reassemble, lubricate, and reinstall caliper, pads, and related hardware.

7. Clean, inspect, and measure rotor with a dial indicator and a micrometer; follow manufacturer's recommendations in determining need to machine or replace.

8. Refinish rotor according to manufacturer's recommendations.

9. Adjust calipers with integrated parking brake system.

10. Full master cylinder with recommended fluid and seat pads; inspect caliper for leaks.

11. Reinstall wheel, torque lug nuts, and make final checks and adjustments.

12. Remove and replace rotor.

**D. Power Assist Units Diagnosis and Repair**

1. Test pedal free travel with and without engine running; check power assist operation.

2. Check vacuum supply (manifold or auxiliary pump) to vacuum-type power booster.

3. Inspect the vacuum-type power booster unit for vacuum leaks; inspect the check valve for proper operation; repair or replace parts as needed.

**E. Miscellaneous (Wheel Bearings, Parking Brakes, Electrical, Etc.) Diagnosis and Repair**

1. Diagnose wheel bearing noises, wheel shimmy, and vibration problems; determine needed repairs.

2. Remove, clean, inspect, repack, and reinstall wheel bearings and replace seals; reinstall hub and adjust wheel bearings.

3. Check parking brake cables and components for wear, rusting, binding, and corrosion; clean, lubricate, and replace as needed.

4. Check parking brake operation; adjust as needed.

5. Check operation of parking brake indicator light system.

6. Check operation of brake stop light system; adjust and service as needed.

7. Replace wheel bearing and race.

**F. Anti-lock Brake System**

1. Inspect, test, and service anti-lock brake system (ABS) hydraulic, electrical, and mechanical components.

2. Diagnose poor stopping, wheel lock-up, abnormal pedal feel or pulsation, and noise problems caused by the anti-lock brake system (ABS); determine needed repairs.

3. Observe anti-lock brake system (ABS) warning light(s) at startup; determine if further diagnosis is needed.

4. Diagnose anti-lock brake system (ABS) electronic control (s) and components using self-diagnosis and/or recommended test equipment; determine needed repairs.

5. Depressurize high pressure components of the anti-lock brake system (ABS) following manufacturer's recommended safety procedures.

6. Fill the anti-lock brake system (ABS) master cylinder with recommended fluid following manufacturer's procedures; inspect system for leaks.

7. Bleed the anti-lock brake system's (ABS) front and rear hydraulic circuits following manufacturer's procedures.

8. Perform a fluid pressure (hydraulic boost) diagnosis on the high pressure anti-lock system (ABS); determine needed repairs.

9. Remove and install anti-lock brake system (ABS) electrical/electronic/ hydraulic components following manufacturer's procedures and specifications.

10. Service, test, and adjust anti-lock brake system (ABS) speed sensors following manufacturer's recommended procedures.

11. Diagnose anti-lock brake system (ABS) braking problems caused by vehicle modifications (tire size, curb height, final drive ratio, etc.).

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**
**INSTRUCTIONAL SET**

**Section (B – V)**
**(5-01)**
Instructors and Interns will apply:

**DEMONSTRATE AND APPLY SAFETY RULES AND PROCEDURES**

PERFORMANCE OBJECTIVE: Given proper equipment and repair manuals, demonstrate safety while repairing brake systems.

ENABLING OBJECTIVES:

1. Demonstrate safety while hoisting a vehicle using proper lift points and jack stands, if appropriate
2. Demonstrate safety while removing brake dust that may contain asbestos
3. Demonstrate safety while removing and replacing brake parts
4. Demonstrate safety regarding any brake fluid spillage
5. Demonstrate safety after brake work is completed by testing brakes before the vehicle is driven
6. Demonstrate safety during road test

**Section (B – V)**
**(5-02)**
Instructors and Interns will apply:

**DIAGNOSE BRAKE SYSTEM PROBLEMS**

PERFORMANCE OBJECTIVE: Given a vehicle with brake problems, diagnose the brake system by evaluation of the customer's description of the problem, visual inspection and a road test, if the vehicle can be safely driven.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures
2. Demonstrate visual inspection of external components and leaks
3. Demonstrate diagnostic procedure for concealed problems or internal leaks
4. Demonstrate diagnostic procedures for poor stopping, break noise, pulling, grabbing, dragging, and pedal pulsation problems

**Section (B – V)**
**(5-03)**
Instructors and Interns will apply:

**DIAGNOSE PRESSURE DIFFERENTIAL VALVE MALFUNCTIONS**

PERFORMANCE OBJECTIVE: Given proper equipment and repair manuals, diagnose a brake problem caused by a malfunctioning pressure differential valve.
ENABLING OBJECTIVES:

1. Demonstrate safety while hoisting vehicle and by using jack stands, if appropriate
2. Demonstrate safety if there is brake fluid spillage
3. Test pressure differential valve according to repair manual
4. Repair or replace pressure differential valve according to repair manual
5. Test brakes for proper pedal height and fluid leakage before vehicle is driven
6. Road test vehicle for proper brake operation
7. Repair or replace brake warning light components

**Section (B – V)**
**(5-04)**
Instructors and Interns will apply:

**DIAGNOSE PROPORTIONING VALVE MALFUNCTIONS**

PERFORMANCE OBJECTIVE: Given proper tools, equipment and repair manuals, diagnose a brake problem caused by a malfunctioning proportioning valve.

ENABLING OBJECTIVES:

1. Demonstrate safety while hoisting vehicle and by using jack stands, if appropriate
2. Demonstrate safety is there is a brake fluid spillage
3. Test a proportioning valve according to instructions in proper repair manual
4. Repair or replace proportioning valve according to directions in repair manual
5. Test brakes for proper operation and fluid leakage before vehicle is driven
6. Road test vehicle for proper brake operation

**Section (B – V)**
**(5-05)**
Instructors and Interns will apply:

**DIAGNOSE BRAKE METERING VALVE MALFUNCTIONS**

PERFORMANCE OBJECTIVE: Given proper equipment and repair manuals, diagnose a brake problem caused by a malfunctioning brake metering valve.

ENABLING OBJECTIVES:

1. Demonstrate safety while hoisting vehicle and by the use of jack stands, if appropriate
2. Demonstrate safety if there is a brake fluid spill
3. Test brake metering valve according to instructions in repair manual
4. Repair or replace metering valve according to instructions in repair manual
5. Test brakes for proper operation and fluid leakage before vehicle is driven
6. Road test vehicle for proper brake operation

**Section (B – V)**
**(5-06)**
Instructors and Interns will apply:

**PERFORM OPERATIONAL INSPECTIONS**

PERFORMANCE OBJECTIVE: Given a vehicle needing an operational brake test, proper service manual and access to necessary tools and equipment, perform an operational brake test. Record malfunctions for brake warning light operation, brake pedal reserve, brake pedal action, vehicle's braking behavior and braking noises.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while testing a vehicle with possible brake problems
2. Define pedal reserve
3. Describe vehicle braking behavior
4. Demonstrate vehicle braking action during an emergency stop
5. Check the operation of brake stop light system; adjust, repair, or replace as needed
6. Test pedal free play with and without engine running

**Section (B – V)**
**(5-07)**

Instructors and Interns will apply:

**INSPECT BRAKE AND WHEEL ASSEMBLIES AND PERFORM PROPER CLEANING PROCEDURES**

PERFORMANCE OBJECTIVE: Given a vehicle needing a visual brake inspection, proper service manual and access to necessary tools and equipment, perform a visual inspection of all system components. Record findings for master cylinder reservoir fluid level, leaks, brake hose condition, brake lining condition and thickness, brake drum diameter and condition, brake rotor thickness, run out and parallelism, and brake pad thickness.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures while removing wheels, etc. for inspection
2. Demonstrate how to read micrometers (brake drum type and outside micrometers on rotors)
3. Identify specifications for vehicle in question in proper shop manual
4. Define rotor run out and parallelism
5. Inspect all brake lines and flexible hoses
6. Demonstrate removal of wheels, etc. for visual lining inspection
7. Demonstrate proper cleaning procedures
8. Discuss danger of materials

**Section (B – V)**
**(5-08)**
Instructors and Interns will apply:

**REMOVE AND REPLACE CALIPERS AND ROTORS, FRONT AND REAR**

PERFORMANCE OBJECTIVE: Given a vehicle with disc brakes on front and/or rear, replace the calipers and rotors to manufacturer's specifications, torquing wheel nuts to proper torque.

ENABLING OBJECTIVES:

1. Use proper safety procedures
2. Bleed the system
3. Properly fill master cylinder
4. Demonstrate use of proper tools
5. Demonstrate proper lifting and supporting procedures
6. Inspect pads for wear
7. Inspect rotor for wear or warpage
8. Adjust disc brakes
9. Inspect caliper for corrosion and leakage
10. Demonstrate use of dial indicator
11. Clean and inspect caliper mountings and slides for wear and damage; repair to specifications
12. Adjust calipers with integrated parking brake system

**Section (B – V)**
**(5-09)**
Instructors and Interns will apply:

**REFINISH ROTORS, ON OR OFF CAR, AND TORQUE LUG NUTS TO SPECIFICATIONS**

PERFORMANCE OBJECTIVE: Given a set of brake rotors needing machining, proper service manual and access to tools, equipment and materials, machine rotors. Machine rotors to the tolerance allowed by the manufacturer, with surfaces parallel, no run out and a non-directional, smooth surface finish.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures when using a disc brake lathe
2. Demonstrate the proper use of a disc brake lathe
3. Describe the use of a special micrometer for measuring rotors
4. Demonstrate procedures for doing the task on a vehicle, if equipment is available

**Section (B – V)**
**(5-10)**
Instructors and Interns will apply:

**CLEAN, INSPECT AND REBUILD CALIPERS**

PERFORMANCE OBJECTIVE: Given a vehicle with a defective disc brake caliper, proper service manual and access to necessary tools and equipment, repair disc brake caliper. The caliper bore will be properly serviced, the piston seal and piston and dust seal properly installed and the machined surfaces of caliper properly serviced.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working on a hydraulic brake system
2. Demonstrate use of special caliper tools
3. Demonstrate use of bore or cylinder hone
4. Explain caution and careful inspection necessary in rebuilding a caliper cylinder
5. Demonstrate proper procedure in rebuilding caliper cylinder
6. Explain need for the cylinder dust boot

**Section (B – V)**
**(5-11)**
Instructors and Interns will apply:

**REFINISH BRAKE DRUMS AND TORQUE LUG NUTS TO SPECIFICATIONS**

PERFORMANCE OBJECTIVE: Given a set of brake drums needing machining, service manual and access to necessary tools, equipment and materials, machine drums. The drums will be machined to a tolerance allowed by the manufacturer's specifications and D.O.T. regulations, and the surface will be smooth across the width.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when using a brake drum lathe
2. Demonstrate the proper use of a brake drum lathe
3. Demonstrate the use of a brake drum micrometer
4. Explain when proper cut on brake drum surface has been made

**Section (B – V)**
**(5-12)**
Instructors and Interns will apply:

**REPLACE DRUMS BRAKE SHOES WITH PROPER MATERIALS**

PERFORMANCE OBJECTIVE: Given a vehicle with worn brake shoes, service manual and access to necessary tools and equipment, replace brake shoes. Worn shoes will be removed, backing plate platforms will be serviced, replacement shoes and shoe return springs will be positioned correctly and self-adjusting mechanisms will be correctly positioned and serviced. Front wheel bearings must be lubricated and adjusted to torque specifications.

ENABLING OBJECTIVES:

1. Demonstrate the use of special brake tools
2. Demonstrate safety precautions on the work being done and while working on a brake system
3. Explain need to rebuild wheel and master cylinder
4. Explain how self-adjuster works
5. Demonstrate operation of brakes immediately after brake shoes are replaced
6. Demonstrate precautions necessary in driving the vehicle immediately after brake shoe replacement
7. Demonstrate handling of wheels and hub caps during the brake repair job
8. Pre-adjust brake shoes and parking brake before reassembly

**Section (B – V)**
**(5-13)**
Instructors and Interns will apply:

**SERVICE AND/OR REPLACE BRAKE PADS**

PERFORMANCE OBJECTIVE: Given a vehicle with worn disc brake pads, proper service Manual, and access to necessary tools and equipment, service and/or replace pads. Worn pads will be removed, caliper support will be properly serviced, the pads will be properly located and the anti-rattle springs will be properly positioned.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while working around a raised and supported vehicle
2. Explain proper service needs for the specific vehicle
3. Demonstrate the proper lubricating of wheel bearings, seal inspection and bearing adjustment while caliper is off for pad replacement
4. Demonstrate brake pad removal and safe placement of caliper
5. Inspect and measure wear of rotor with a micrometer
6. Demonstrate replacement of pads and caliper
7. Clean and inspect retaining hardware
8. Adjust calipers with integrated parking brake system

**Section (B – V)**
**(5-14)**
Instructors and Interns will apply:

**ADJUST BRAKE SHOES**

PERFORMANCE OBJECTIVE: Given a vehicle with non-self adjusting brakes, proper service manual and access to necessary tools and equipment, adjust the brakes. Each wheel must be free of drag, and the vehicle will not pull to either side when brakes are applied.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working with a brake system
2. Explain correct direction to move adjuster
3. Demonstrate properly adjusted drum brake system
4. Explain importance of type, size and air pressure of tires on vehicle performance and handling

**Section (B – V)**
**(5-15)**
Instructors and Interns will apply:

**ADJUST PARKING BRAKES**

PERFORMANCE OBJECTIVE: Given a vehicle needing parking brake adjustment, proper service manual, proper tools and proper lifting and supporting equipment, adjust the parking brake to manufacturer's specifications.

ENABLING OBJECTIVES:

1. Demonstrate proper safety precautions
2. Demonstrate proper lifting and supporting procedures
3. Use proper tools
4. Test for drag when completed

**Section (B – V)**
**(5-16)**
Instructors and Interns will apply:

**REBUILD OR REPLACE WHEEL CYLINDER**

PERFORMANCE OBJECTIVE: Given a vehicle with a defective wheel cylinder, proper service manual and access to necessary tools and equipment, repair or replace wheel cylinder. Standard brake system will operate properly with firm pedal and no fluid leaks.

ENABLING OBJECTIVES:

1. Explain the methods used to determine cylinder condition
2. Describe the safety procedures used to repair a cylinder
3. Explain how new parts are to be installed into cylinder
4. Demonstrate the use of brake cylinder hone to prepare cylinder for new parts
5. Install cylinder repair parts
6. Demonstrate the use of brake bleeding tools

**Section (B – V)**
**(5-17)**
Instructors and Interns will apply:

**BLEED HYDRAULIC BRAKES**

PERFORMANCE OBJECTIVE: Given a vehicle needing the brakes bled, proper service manual and access to necessary tools and equipment, bleed the brakes within twice the time allowed by the flat rate manual. All air from line will be removed and the pedal will be firm.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working with hydraulic brake fluid
2. Demonstrate proper use of bleeder tools and equipment
3. Explain brake pedal action when all air has been removed from the system
4. Describe bleeding procedure for removal of air from brake system
5. Check master cylinder fluid level

**Section (B – V)**
**(5-18)**
Instructors and Interns will apply:

**FREE UP OR REPLACE PARKING BRAKE CABLES AND LINKAGE**

PERFORMANCE OBJECTIVE: Given a vehicle needing brake attention, proper service manual and access to necessary tools and equipment, replace or free up parking linkage. The linkage must be properly routed, secured and positioned and the vehicle will not roll with the parking brake applied.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain how parking brakes operate
3. Explain how to free up binding cables
4. Demonstrate parking brake cable adjustment
5. Check operation of parking brake indicator system

**Section (B – V)**
**(5-19)**
Instructors and Interns will apply:

**REMOVE AND REPLACE/OVERAHUL MASTER CYLINDER**

PERFORMANCE OBJECTIVE: Given a vehicle with a defective master cylinder, proper service manual and necessary tools, remove, rebuild, then replace master cylinder. Master cylinder must be rebuilt and installed according to manufacturer's procedures. All attaching hardware must be torqued to specifications, pedal must be firm and line connections must not leak.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working with a hydraulic brake system
2. Explain the method used to determine master cylinder condition
3. Demonstrate the use of special tools
4. Describe the need to hone the cylinder
5. Describe cleaning all parts and valves
6. Explain how new parts are installed, function of lock screw (if used) and snap rings
7. Explain the differences in master cylinders
8. Demonstrate bench bleeding a master cylinder
9. Measure and adjust rod length and check pedal height

**Section (B – V)**
**(5-20)**
Instructors and Interns will apply:

**FLUSH BRAKE SYSTEMS**

PERFORMANCE OBJECTIVE: Given a vehicle with contaminated brake fluid and access to necessary tools and ample brake fluid, flush the brake system at each wheel until no air or contamination exists in the fluid.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures while working with a brake hydraulic system
2. Describe proper jacking and supporting of vehicle
3. Discuss handling of fluid (keeping out of eyes and off any painted surface)
4. Explain brake fluid grades or types
5. Demonstrate brake flushing at each wheel

**Section (B – V)**
**(5-21)**
Instructors and Interns will apply:

**TEST AND REPLACE VACUUM BRAKE POWER UNIT**

PERFORMANCE OBJECTIVE: Given a vehicle with a defective brake power unit, proper service manual and access to necessary tools and equipment, test and replace vacuum brake power unit. Demonstrate that all vacuum connections are properly routed and connected and that brake pedal behavior reflects proper operation, with no vacuum or fluid leaks.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe vacuum effect on unit
3. Remove and replace power lubricant
4. Demonstrate operation of power brake unit

**Section (B – V)**
**(5-22)**
Instructors and Interns will apply:

**TEST AND REPLACE HYDRO-BOOSTER**

PERFORMANCE OBJECTIVE: Given a vehicle with a defective hydraulic brake booster unit, proper service manual and access to necessary tools and equipment, test and replace hydro- booster. Demonstrate that hydraulic lines are properly routed and connected and that brake pedal behavior reflects proper operation with no hydraulic or brake fluid leaks.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe power steering pump pressure on the brake system
3. Remove and replace hydro-boost unit
4. Demonstrate proper operation of the hydro-boost unit

**Section (B – V)**
**(5-23)**
Instructors and Interns will apply:

**TEST BRAKE ANTI-LOCK SYSTEM**

PERFORMANCE OBJECTIVE: Given a vehicle needing the anti-lock system tested, road check the vehicle to determine the problem. No wheel will lock (skid) when brakes are firmly applied or otherwise deviate from manufacturer's specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when road checking a vehicle with known brake defect
2. Identify which wheel has problems or other system defects
3. Explain the need for proper road check driving procedures
5. Describe possible malfunctions which would cause the ABS warning light to illuminate
6. Interpret vehicle self-diagnostics system signals and test equipment readouts to diagnose brake problems
7. Perform a fluid pressure diagnosis on the high pressure ABS
8. Service, test, and adjust ABS speed sensors following manufacturers recommended practices
9. Diagnose ABS braking problems caused by vehicle modifications (tire size, final drive ratio, etc.)

**Section (B – V)**
**(5-24)**
Instructors and Interns will apply:

**REMOVE AND REPLACE ANTI-LOCK SYSTEM COMPONENTS**

PERFORMANCE OBJECTIVE: Given a vehicle with a defective anti-lock system, proper service manual and access to necessary tools and equipment, repair or replace the component. Components must be installed according to manufacturer's recommendation. All wheels must function properly under firm pedal pressure without lockup (skid).

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working on a brake system and depressurizing high pressure components
2. Identify the component location and function
3. Explain the function of anti-lock system
4. Remove and replace faulty components
5. Demonstrate proper function of anti-lock brake system
6. Fill system with proper fluid and bleed as per manufacturer's recommendations

**Section (B – V)**
**(5-25)**
Instructors and Interns will apply:

**FABRICATE AND INSTALL BRAKE LINES AND HOSES**

PERFORMANCE OBJECTIVE: Given a vehicle with a damaged brake line, proper tools and equipment, repair or replace the brake line and hose.

ENABLING OBJECTIVES:

1. Inspect brake lines and hoses for leaks, dents, kinks, cracks, bulging, or wear; tighten loose fittings or supports
2. Fabricate and install brake lines (double flare and I.S.O. types)
3. Replace hoses, fittings, and supports as needed

**Section (B – V)**
**(5-26)**
Instructors and Interns will apply:

**DIAGNOSE WHEEL/TIRE VIBRATIONS, SHIMMY AND TRAMP**

PERFORMANCE OBJECTIVE: Given a vehicle with a vibration complaint and proper service manuals, troubleshoot the vehicle and make proper recommendation for repair.

ENABLING OBJECTIVES:

1. Diagnose wheel balance
2. Discuss types of tires
3. Discuss types of rims
4. Explain and demonstrate static balance
5. Explain and demonstrate dynamic balance

**Section (B – V)**
**(5-27)**
Instructors and Interns will apply:

**SERVICE FRONT WHEEL BEARINGS, GREASE SEALS, AND LOCKING HUBS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, grease, seal, inspect and service the wheel bearing and seal.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while removing a wheel from a raised vehicle
2. Explain what will happen if the wheel bearing is over tightened or under tightened
3. Demonstrate proper removal, cleaning and grease packing of wheel bearings
4. Demonstrate replacement of bearings and seal
5. Demonstrate bearing adjustment and spindle nut locking procedure of hub
6. Demonstrate proper replacement of dust cap

**Section (B – V)**
**(5-28)**
Instructors and Interns will apply:

**REMOVE AND REPLACE FRONT AND REAR WHEEL BEARINGS**

PERFORMANCE OBJECTIVE: Given a vehicle with defective front or rear wheel bearings, replace the bearings using the proper tools and service manuals, to manufacturer's specifications.

ENABLING OBJECTIVES:

1. Discuss types of grease
2. Demonstrate proper bearing adjustment
3. Torque lugs to proper specifications

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**
**Instructional Set:**

**Working with:**
**National Automotive Technicians Education Foundation**

**Section B**
**Unit VI**
**NATEF Task List: ELECTRICAL/ELECTRONIC SYSTEM**

## Unit VI
## ELECTRICAL/ELECTRONIC SYSTEMS

**For every task on Electrical/ Electronic Systems, the following safety requirement must be strictly enforced as a number one priority:** Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage and disposal of chemicals in accordance with local, state, and federal safety and environmental regulations.

### A. General Electrical System Diagnosis

1. Use wiring diagram during diagnosis of electrical circuit problems.
2. Check electrical circuits with a test light; determine needed repairs.
3. Check voltage and voltage drops in electrical/electronic circuits using a digital multimeter (DMM); determine needed repairs.
4. Check current flow in electrical/electronic circuits and components using an ammeter; determine needed repairs.
5. Check electrical circuits using jumper wires; determine needed repairs.
6. Find shorts, grounds, opens, and resistance problems in electrical/electronic circuits; determine needed repairs.
7. Measure and diagnose the cause(s) of abnormal key-off battery drain; determine needed repairs.
8. Inspect and test fusible links, circuit breakers, and fuses; replace as needed.
9. Inspect and test switches, connectors, relays, and wires of electrical/electronic circuits; repair or replace as needed.

### B. Battery Diagnosis and Service

1. Perform battery state-of-charge test; determine needed service.
2. Perform battery capacity (load, high-rate discharge) test; determine needed service.
3. Maintain or restore electronic memory functions.
4. Inspect, clean, fill, and replace battery.
5. Perform slow/fast battery charge.
6. Inspect and clean battery cables, connectors, clamps, and hold-downs; repair or replace as needed.
7. Start a vehicle using jumper cables and a battery or auxiliary power supply.

### C. Starting System Diagnosis and Repair

1. Perform starter current draw and circuit voltage drop test; determine needed repairs.

2. Inspect and test starter relays and solenoids; replace as needed.
3. Remove and replace/reinstall starter.
4. Perform starter bench tests; determine needed repairs.
5. Inspect, test, and repair or replace switches, connectors, and wires of starter control circuits.
6. Disassemble, clean, inspect, and test starter components; replace as needed.

**D. Charging System Diagnosis and Repair**

1. Diagnose charging system problems that cause an undercharge, a no-charge or an overcharge condition.
2. Inspect and adjust alternator drive belts; replace as needed.
3. Inspect and test voltage regulator; replace as needed.
4. Remove, inspect, and replace/reinstall alternator.
5. Disassemble, clean, inspect, and test alternator components; replace as needed.
6. Perform charging circuit voltage drop tests; determine needed repairs.

**E. Lighting Systems Diagnosis and Repair**

1. Diagnose brighter than normal, intermittent, dim or no light operation.
2. Inspect, replace, and aim headlights and bulbs.
3. Inspect and diagnose incorrect turn signal or hazard light operation; repair or replace as needed.

**F. Gauges, Warning Devices, and Driver Information Systems Diagnosis and Repair**

1. Diagnose intermittent, high, low or no gauge readings.
2. Test gauge circuit voltage regulators (limiters); replace as needed.
3. Inspect and test gauges and gauge sending units; replace as needed.
4. Inspect and test connectors, wires, and printed circuit boards of gauge circuits; repair or replace as needed.
5. Diagnose incorrect operation of warning devices and other driver information systems.
6. Diagnose intermittent, high low or no readings on electronic instrument clusters.
7. Inspect and test sensors, sending units, connectors, and wires of electronic I instrument circuits; repair or replace as needed.

**G. Horn and Wiper/Washer Diagnosis and Repair**

1. Diagnose incorrect horn operation; repair as needed.
2. Diagnose incorrect wiper operation; diagnose wiper speed control and park problems; repair as needed.
3. Diagnose incorrect windshield washer operation; repair as needed.

**H. Accessories Diagnosis and Repair**

1. Diagnose incorrect operation of motor driven accessory circuits; repair as needed.
2. Diagnose incorrect heated glass operation; repair as needed.
3. Diagnose incorrect electric door and hatch/trunk lock operation; repair as needed.
4. Diagnose incorrect operation of cruise control systems; repair as needed.
5. Diagnose supplemental restraint system (SRS) problems; repair as needed. **(Note: Follow manufacturer's safety procedures to prevent accidental deployment.)**
6. Diagnose radio static and weak, intermittent, or no radio reception.

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**
**INSTRUCTIONAL SET**

**Section (B-VI)**
**(6-01)**

Instructors and Interns will apply:

**DEMONSTRATE AND APPLY SAFETY RULES AND PROCEDURES**

**CAUTION:** *When working with electrical components, especially in the steering column and dash area of the automobile, be certain to check supplemental restraint system (SRS) repair/removal procedure.*

PERFORMANCE OBJECTIVE: Given examples of repair jobs and shop situations in electrical and electronic repair, apply shop safety rules and procedures by identifying safe and unsafe shop practices.

ENABLING OBJECTIVES:

1. Discuss reasons for not wearing rings, watches and jewelry when working on a vehicle.
2. State precautions to use when working with gasoline
3. State reasons for not wearing loose clothing, ties, and long hair
4. Apply fire safety rules
5. Apply electrical and electronic safety rules
6. Demonstrate proper use of anti-static devices & procedures when working with electronic components

**Section (B-VI)**
**(6-02)**

Instructors and Interns will apply:

**DIAGNOSE ELECTRICAL ENGINE MALFUNCTIONS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, perform an electrical test for an electrical malfunction.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when performing electrical tests
2. Explain test equipment hook-ups
3. Describe which test to perform for specific malfunction
4. Explain procedure for removal and replacement of malfunctioning component
5. Demonstrate the ability to put tools and equipment away in proper place after use

**Section (B-VI)**
**(6-07)**
Instructors and Interns will apply:

**PERFORM POWER CHECKS**

PERFORMANCE OBJECTIVE: Given a live fused or circuit breaker circuit, test for serviceability by using an amp meter, test light or volt meter.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while working on electrical units
2. Explain how an amp meter, test light or volt meter can be used to determine current flow
3. Explain care in handling electrical circuits and test equipment
4. Demonstrate proper knowledge of function switch and lead connections of a VOM

**Section (B-VI)**
**(6-04)**
Instructors and Interns will apply:

**MEASURE VOLTAGE DROP, CURRENT FLOW, CONTINUITY AND RESISTANCE IN A CIRCUIT OR COMPONENT**

PERFORMANCE OBJECTIVE: Given a vehicle, volt/amp tester and ohm meter, service manual and necessary tools, test electrical unit for amperage and voltage drop and continuity. Record readings and compare with specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when testing electrical circuits
2. Explain how many amps are being drawn by the unit
3. Explain the various voltage drops
4. Explain hookup and test operation for the unit
5. Describe results of the test
6. Explain parasitic drain

**Section (B-VI)**
**(6-07)**
Instructors and Interns will apply:

**(6-05)**
Instructors and Interns will apply:

**LOCATE AN OPEN CIRCUIT OR A SHORT CIRCUIT**

PERFORMANCE OBJECTIVE: Given a vehicle with a known ground, short, or open circuit, the proper tools and service manual, locate and repair the condition. The student should achieve accuracy, sped, and safety on the task.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures while working on an electrical circuit
2. Discuss how the whole wiring system of a vehicle can be broken down into individual electrical systems and the problem isolated to a particular system
3. Demonstrate use of test equipment
4. Identify the circuit and type of electrical failure
5. Demonstrate the type of repair necessary to correct problem
6. Demonstrate test for proper operation of repaired circuit

**Section (B-VI)**
**(6-06)**
Instructors and Interns will apply:

**ANALZYE CRANKING SYSTEM MALFUNCTIONS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual, proper tools and test equipment, analyze cranking malfunctions in the starting system.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe how a starting system operates
3. State the purpose of neutral starting switch
4. Test battery cables and connections
5. Test starter current draw
6. Explain the function of the starter solenoid
7. Inspect and test starter replays and solenoids; replace as needed

**Section (B-VI)**
**(6-07)**
Instructors and Interns will apply:

**ANALYZE CHARGING SYSTEM MALFUNCTIONS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual, volt amp tester, and necessary tools, test alternator for maximum output. When completed the recorded output should be compared to specifications. Safety precautions must be observed as the vehicle engine is running.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when using test equipment on an operating engine
2. Explain the different ways that manufacturers check maximum output of their alternators
3. Demonstrate use of and proper "hook-up" of alternator test equipment, analyze results and determine needed repair
4. Diagnose charging system malfunctions that cause an undercharge or no-charge condition
5. Diagnose charging system malfunctions that cause an overcharge condition

**Section (B-VI)**
**(6-08)**
Instructors and Interns will apply:

**SERVICE AND TEST BATTERIES**

PERFORMANCE OBJECTIVE: Given a vehicle with a battery, proper tools, test and cleaning equipment, diagnose faulty batteries, and perform indicated maintenance/repairs.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working with battery test equipment
2. Explain amperage draw versus voltage values
3. Demonstrate how to hook up a volt meter, ammeter and carbon pile
4. State sequence of removal of battery cables
5. Describe proper methods and chemicals to clean battery cables
6. Demonstrate use of protective coatings on connections
7. Discuss the advantages and/or disadvantages of side-mount battery
8. Describe proper charging procedures; slow and fast charge of conventional and maintenance free batteries
9. Perform battery capacity (load, high rate discharge) test; determine needed service
10. Perform battery capacity (load, high rate discharge) test; determine needed service
11. Perform battery 3-minute charge test; determine needed service/repair
12. Service batteries
13. Maintain or restore electronic memory functions
14. Start a vehicle using jumper cables and a battery or auxiliary power supply
15. Diagnose the cause of abnormal, key-off battery drain; determine needed repairs

**Section (B-VI)**
**(6-09**
Instructors and Interns will apply:

**REMOVE AND REPLACE LIGHT BULBS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, remove and replace a light bulb. When completed all terminals must be secure, wires routed correctly and bulb operate correctly.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Discuss examples of units and other components that must be removed in order to remove and replace the bulb
3. Demonstrate proper use of tools
4. Demonstrate proper use of service manual

**Section (B-VI)**
**(6-10)**
Instructors and Interns will apply:

**INSPECT, REMOVE AND REPLACE ALTERNATOR BELTS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual, and proper tools, inspect, remove, replace and adjust the alternator belt. Check belt condition for serviceability, tension, and bolts for tightness.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain the important of belt tightness on an alternator-equipped vehicle
3. Inspect drive belt for cracks and excessive wear
4. Demonstrate use of drive belt tension gauge "hand" method test

**Section (B-VI)**
**(6-11)**
Instructors and Interns will apply:

**TEST, REMOVE AND REPLACE FUSIBLE LINKS, FUSES AND CIRCUIT BREAKERS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual, proper tools and replacement parts, test, remove and replace a fusible link, fuse or circuit breaker. When finished, the unit will be securely fastened in place. Circuit should be in operational order when completed.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while working on electrical unit
2. Explain how an ammeter, volt meter or test light cab be used to determine current flow
3. Demonstrate proper use of ohm meter on unit being tested.
4. Define circuit breaker and its function
5. Inspect and test fusible links, fuses, circuit breakers; replace as needed

**Section (B-VI)**
**(6-12)**
Instructors and Interns will apply:

**REPLACE AND TEST STARTERS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual, necessary tools and parts, remove, repair or replace starter. When completed, all terminals must be secure, all bolts tightened and starter will operate to manufacturer's specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while working on electrical circuits
2. Explain the need for a starter draw test
3. Explain the need for a voltage drop test on the positive and negative side of the circuit
4. Explain the results of the tests
5. Inspect and test all parts for burning, wear and general condition
6. Demonstrate bench test for proper operation

**Section (B-VI)**
**(6-13)**
Instructors and Interns will apply:

**TEST AND OVERHAUL ALTERNATORS**

PERFORMANCE OBJECTIVE: Given an alternator, service manual and necessary tools and parts, test and overhaul an alternator. When completed all bolts must be tight, proper points lubricated and terminals secure. Alternator should perform to specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when servicing an alternator
2. Explain how brushes are loaded and installed in an alternator
3. Demonstrate being checks and lubrication
4. Demonstrate tests for positive and negative diodes
5. Demonstrate test for proper output of unit
6. Inspect and test voltage regulator
7. Remove and replace alternator

**Section (B-VI)**
**(6-14)**
Instructors and Interns will apply:

**REMOVE AND REPLACE REGULATOTRS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, remove and replace the voltage regulator. All bolts, screws and terminal connections must be secure. Check wires for proper positioning.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working on electrical circuits
2. Explain which systems have internal and which systems have external regulators and how the procedures for removing or replacing them differ
3. Identify external regulator
4. Demonstrate removal and replacement of external regulator and careful handling of electrical connections
5. Identify internal regulator type of alternator
6. Demonstrate removal and replacement of alternator and replacement of internal regulator

**Section (B-VI)**
**(6-15)**
Instructors and Interns will apply:

**INSPECT AND REPAIR LIGHTING SYSTEMS**

PERFORMANCE OBJECTIVE: Given a lighting system problem, service manual and necessary tools, diagnose the problem and make necessary repairs. Upon completion the system will operate correctly.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Demonstrate method of testing to be performed on a specific unit
3. Demonstrate removal and installation of components
4. Demonstrate use of wiring schematics
5. Demonstrate proper use of test equipment to include: test light, DVOM, short finder
6. Explain proper wire repair procedures
7. Diagnose brighter than normal, intermittent, dim, or no light operation
8. Inspect, replace, aim headlights, and bulbs

**Section (B-VI)**
**(6-16)**
Instructors and Interns will apply:

**DIAGNOSE, REPAIR OR REPLACE TURN SIGNAL AND STOP LIGHT SWITCHES**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, diagnose, remove and replace switch. When completed all terminals must be secure, wires routed correctly and correct wire on correct terminal. The switch must be securely mounted and adjusted as needed. **Note: If vehicle has supplemental restraint system (SRS), check required procedures**

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while working on an electrical circuit
2. Demonstrate use of DVOM
3. Demonstrate use of wiring schematics
4. Explain complete circuit of unit tested
5. Demonstrate test for proper operation

**Section (B-VI)**
**(6-17)**
Instructors and Interns will apply:

**TEST AND REPLACE ELECTRICAL SYSTEM SWITCHES**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, test and replace a switch. When completed switch must be mounted securely and adjusted as needed. Switch should control circuit as designed by manufacturer.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Demonstrate method of testing to be performed on circuit
3. Explain the importance of care to be taken with delicate switches and wiring
4. Explain the procedures for removal and replacement
5. Demonstrate the use of jumper wires in testing electrical circuits and switches

**Section (B-VI)**
**(6-18)**
Instructors and Interns will apply:

**DIAGNOSE, REPAIR OR REPLACE POWER WINDOW AND POWER SEAT SYSTEMS, INCLUDING MOTOR DRIVERN ACCESSORIES**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and proper tools, diagnose and repair power window and power seat circuits. When repair is completed all trim will have been installed correctly, and unit will function according to specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while testing or replacing electrical units
2. Identify the components and circuits
3. Demonstrate use of wiring schematics
4. Demonstrate use of proper test equipment
5. Demonstrate proper procedures of removal of trim panels and upholstery
6. Diagnose incorrect operation of motor driven accessory circuits; repair or replace as needed
7. Diagnose incorrect heated glass operation; repair or replace as needed
8. Diagnose incorrect electric door, hatch and trunk lock operation; repair or replace as needed
9. Diagnose incorrect operation of cruise control systems; repair or replace as needed

**Section (B-VI)**
**(6-19)**
Instructors and Interns will apply:

**DIAGNOSE, REPAIR OR REPLACE HORN SYSTEM**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, diagnose and repair horn system. Upon completion the horn will function properly.

**Note: If vehicle has supplemental restraint system (SRS), check required procedures**

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while testing
2. Explain complete circuit being tested
3. Demonstrate use of wiring schematics
4. Demonstrate knowledge of proper disassembly of horn control circuit
5. Demonstrate test for proper operation of repaired circuit

**Section (B-VI)**
**(6-20)**
Instructors and Interns will apply:

**DIAGNOSE, REPAIR OR REPLACE CLOCK SYSTEMS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, properly diagnose and repair clock circuit. Upon completion, system will be operational, properly aligned with no rattles.

ENABLING OBJECTIVES:

1. Explain diagnostic procedures
2. Demonstrate proper use of wiring schematics
3. Explain circuit being tested
4. Explain proper disassembly and reassembly of dash board and components

**Section (B-VI)**
**(6-21)**
Instructors and Interns will apply:

**DIAGNOSE, REPAIR OR REPLACE WARNING BUZZER**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, diagnose and repair or replace warning buzzer. When completed, buzzer will be properly secured and operational.

ENABLING OBJECTIVES:

1. Demonstrate proper use of shop manual and manufacturer's wiring schematics
2. Explain diagnostic procedures and repair procedures
3. Explain circuit operation
4. Demonstrate test of repaired circuit for proper operation

**Section (B-VI)**
**(6-22)**
Instructors and Interns will apply:

**TEST AND REPLACE INSTRUMENT PANEL UNITS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, test and replace instrument panel units. Upon completion, unit will be operational, with no rattles or scratches.

**Note: If vehicle has supplemental restraint system (SRS), check required procedures**

ENABLING OBJECTIVES:

1. Observe special procedures and test procedures for electrical safety
2. Demonstrate proper use of shop manual
3. Demonstrate proper use of test equipment
4. Explain operation of circuit being repaired
5. Diagnose intermittent, high, low or no gauge readings
6. Test gauge circuit voltage regulators (limiters)
7. Inspect and test gauges and sending units; replace as needed
8. Inspect and test connectors, wires, and printed circuit boards of gauge circuits; repair or replace as needed
9. Diagnose intermittent, high, low, or no gauge readings on electronic instrument clusters
10. Inspect and test sensors, sending units, connectors and wires of electronic instrument circuits; repair or replace as needed.

**Section (B-VI)**
**(6-23)**
Instructors and Interns will apply:

**SERVICE OR REPAIR WINDSHIELD WIPER/WASHER SYSTEM**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools and parts, properly service or repair the windshield wiper/washer system. When completed, system will operate as designed.

**Note: If vehicle has supplemental restraint system (SRS), check required procedures**

ENABLING OBJECTIVES:

1. Demonstrate proper filling procedures for windshield washer
2. Explain proper procedures for wiper blade replacement system
3. Demonstrate knowledge of windshield wiper/washer system
4. Demonstrate proper use of service manual
5. Explain diagnostic procedures
6. Demonstrate proper use of DVOM
7. Diagnose incorrect wiper operation including speed controls and park problems; repair or replace as needed
8. Diagnose incorrect windshield washer operation; repair or replace as needed

**Section (B-VI)**
**(6-24)**
Instructors and Interns will apply:

**TEST AND REPLACE ELECTRONIC CONTROL UNITS**

PERFORMANCE OBJECTIVE: Given a vehicle with an electronic control unit, service manual and necessary tools, test and replace electronic control unit. Upon completion of repair, system should operate correctly and set no diagnostic codes.

ENABLING OBJECTIVES:

1. Demonstrate proper use of shop manual
2. Explain system operation
3. Explain problem found and proper repair procedures
4. Demonstrate proper use of diagnostic equipment

**Section (B-VI)**
**(6-25)**
Instructors and Interns will apply:

**CHECK, REMOVE AND REPLACE RADIOS**

PERFORMANCE OBJECTIVE: Given a vehicle with a radio, service manual and necessary tools, check, remove, and replace radio. When completed, all connections must be tight, radio properly aligned, with no scratches or rattles and fully operational.

**Note: If vehicle has supplemental restraint system (SRS), check required procedures**

ENABLING OBJECTIVES:

1. Demonstrate proper use of manufacturer's service manual for removal procedures
2. Demonstrate use of wiring schematics
3. Demonstrate use of DVOM
4. Explain results of diagnosis for static, weak, intermittent, or no reception
5. Demonstrate test for proper operation of repaired circuit

**Section (B-VI)**
**(6-26)**
Instructors and Interns will apply:

**CHECK OR DISABLE SUPPLEMENTAL RESTRAINT SYSTEM (SRS) PROBLEMS**

PERFORMANCE OBJECTIVE: Given a vehicle with supplemental restraint system (SRS) manufacturer's instructions, or service manual and necessary tools, disable or test system.

ENABLING OBJECTIVES:

1. Disable supplemental restraints in accordance with manufacturer's instructions before attempting any repairs on instrument panel or steering column which could cause accidental deployment
2. Diagnose supplemental restraint system problems; repair as needed
3. Restore system to normal operation after disabling, diagnosing or repairing

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**
**Instructional Set:**

**Working with:**
**National Automotive Technicians Education Foundation**

**Section B**
**Unit VII**
**NATEF Task List: Heating and Air Conditioning**

## Unit VII
## HEATING AND AIR CONDITIONING

For every task in Heating and Air Conditioning, the following safety requirement must be strictly enforced as a number one priority: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage and disposal of chemicals in accordance with local, state, and federal safety and environmental regulations.

### A. A/C System Diagnosis and Repair

1. Diagnose unusual operating noises in the A/C system; determine needed repairs.
2. Conduct a performance test of the A/C system; determine needed repairs.
3. Leak test A/C system; determine needed repairs.
4. Inspect the condition of discharged oil.
5. Select oil type; measure and add oil to the A/C system as needed.

### B. Refrigeration System Component Diagnosis and Repair Compressor and Clutch

1. Diagnose A/C system problems that cause the protection devices (pressure, thermal, and PCM) to interrupt system operation; repair as needed.
2. Inspect A/C compressor drive belts; replace and adjust as needed.
3. Inspect, test, and replace A/C compressor clutch components or assembly.
4. Remove and replace A/C compressor and mountings.
5. Inspect and replace A/C compressor shaft seal assembly(s).

### Evaporator, Receiver/Drier, Condenser, Etc

1. Diagnose A/C system problems caused by too much moisture in the refrigerant; determine needed repairs.
2. Install A/C System filter.
3. Remove and inspect A/C system mufflers, houses, lines, fittings, O-rings, seals, and service valves; replace as needed.
4. Inspect A/C condenser for air flow restrictions; service as required.
5. Inspect receiver/drier or accumulator/drier; replace as needed.
6. Inspect and test expansion valve or orifice (expansion) tube; replace as needed.
7. Inspect evaporator housing water drain; repair as needed.

## C. Heating and Engine Cooling Systems Diagnosis and Repair

1. Diagnose temperature control problems in the heater/ventilation system; determine needed repairs.
2. Perform cooling system, cap, and recovery system tests (pressure, combustion leakage, and temperature); determine needed repairs.
3. Inspect engine cooling and heater system hoses and belts; replace as needed.
4. Inspect, test, and replace thermostat and housing.
5. Determine coolant condition; drain and recover.
6. Flush system and refill with recommended coolant; bleed system.
7. Clean, inspect, and test fan, fan clutch (electrical and mechanical), fan shroud, and air dams; replace as needed.
8. Inspect and test heater control valve(s); replace as needed.

## D. Electrical

1. Diagnose failures in the electrical controls of heating and A/C systems; determine needed repairs.
2. Inspect and test A/C-heater blower, motors, resistors, switches, relays, wiring, and protection devices; repair or replace as needed.
3. Test A/C compressor load cut-off systems; determine needed repairs.

### Vacuum/Mechanical

1. Diagnose failures in the vacuum and mechanical controls of the heating and A/C system; determine needed repairs.
2. Inspect and test A/C-heater control panel assembly; replace as needed.
3. Inspect and test A/C-heater control cables and linkages; adjust or replace as needed.
4. Inspect and test A/C-heater vacuum control switches, hoses, diaphragms (motors), vacuum reservoir, check valve, and restrictors; replace as needed.
5. Inspect and test A/C-heat ducts, doors, hoses, and outlets; replace as needed.

### Automatic and Semi-Automatic Temperature Controls

1 Check operation of automatic and semi-automatic heating, ventilation, and air-conditioning (HVAC) control systems; determine needed repairs.

**E. Refrigerant Recovery, Recycling, and Handling**

1. Verify correct operation and maintenance or refrigerant handling equipment.
2. Identify and recover A/C system refrigerant.
3. Recycle refrigerant.
4. Label and store refrigerant.
5. Test recycled refrigerant for non-condensable gases.
6. Evacuate and charge A/C system.

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**
**INSTRUCTIONAL SET**

**Section (B-VII)**
**(7-01)**

Instructors and Interns will apply:

**DEMONSTRATE AND APPLY SAFETY RULES AND PROCEDURES**

PERFORMANCE OBJECTIVE: Demonstrate ability to safely diagnose, test and repair engine cooling, air conditioning and heating systems.

ENABLING OBJECTIVES:

1. Demonstrate proper storage and use of Refrigerant 1 2
2. Describe steps for discharging, repairing, evacuating and charging air conditioning systems
3. Describe steps for diagnosing and repairing engine cooling systems and vehicle heating systems
4. Explain safety precautions necessary when diagnosing, servicing and repairing heating, air conditioning and engine cooling systems
5. Explain proper disposal of old antifreeze

**Section (B-VII)**
**(7-02)**

Instructors and Interns will apply:

**INSPECT, REMOVE AND REPLACE DRIVE BELT(S)**

PERFORMANCE OBJECTIVE: Given a vehicle and access to the appropriate service manual, tools and equipment, inspect, remove and replace the drive belt(s). All components will be tight, and the tension on drive belt(s) will be correct.

ENABLING OBJECTIVES:

1. Explain use of drive belt gauge
2. Demonstrate caution to be used in moving alternator or other belt-driven accessories
3. Explain mechanical operation of pulleys
4. Explain methods of tightening belts
5. Demonstrate safety precautions
6. Demonstrate "hand" test for drive belt tension (when no gauge is available)
7. Demonstrate inspecting, removing and replacing belt(s)

**Section (B-VII)**
**(7-03)**
Instructors and Interns will apply:

**REMOVE AND REPLACE RADIATORS**

PERFORMANCE OBJECTIVE: Given a vehicle with defective radiator and access to appropriate tools, equipment and service manual, remove and replace radiator. The radiator and its connecting components must not leak.

ENABLING OBJECTIVES:

1. Explain purpose of radiator
2. Demonstrate safety procedures (hot pressure)
3. Explain radiator construction and liquid flow direction
4. Demonstrate care in handling radiator to avoid damage
5. Inspect for leaks
6. Remove and replace radiator
7. Inspect auxiliary oil coolers, engine, and transmission coolers; replace as needed

**Section (B-VII)**
**(7-04)**
Instructors and Interns will apply:

**INSPECT AND PRESSURE-TEST AIR CONDITIONING SYSTEM**

PERFORMANCE OBJECTIVE: Given a vehicle with an air conditioning problem, necessary tools and equipment and service manual, inspect and pressure-test air conditioning system.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures
2. Explain inspection procedures
3. Explain pressure-test procedures
4. Inspect and pressure-test the system and record your findings
5. Use proper service manual and charts to diagnose problems in the system
6. Verify automatic and semi-automatic temperature control operation
7. Verify proper control of airflow through ducts and vents
8. Determine outlet air temperatures at air ducts and condensor
9. Verify proper evaporator housing water drain operation

**Section (B-VII)**
**(7-05)**
Instructors and Interns will apply:

**DISCHARGE, EVACUATE AND CHARGE A BASIC AIR CONDITIONING SYSTEM**

PERFORMANCE OBJECTIVE: Given an automobile with an air conditioning system, refrigerant, necessary tools and equipment, discharge, evacuate and charge an air conditioning system to the correct pressures with the proper air temperature coming out the in-car ducts.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain purpose of Refrigerant 12
3. Explain purpose of evacuating the system
4. Explain dehydration
5. Explain effects of moisture in the system
6. Explain temperature-pressure relationship charts
7. Demonstrate discharging, evacuating and recharging the system to manufacturer's specifications

**Section (B-VII)**
**(7-06)**
Instructors and Interns will apply:

**LEAK TEST BASIC AIR CONDITIONING SYSTEMS**

PERFORMANCE OBJECTIVE: Given an automobile air conditioning system, leak test the system. The system should not leak.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain purpose and methods of leak detection
3. Explain use of gauge and manifold
4. Demonstrate method of leak detection and repair, as necessary

**Section (B-VII)**
**(7-07)**
Instructors and Interns will apply:

**SERVICE AIR CONDITIONING ELECTRICAL CIRCUITS**

PERFORMANCE OBJECTIVE: Given an automobile with problems in the air conditioning electrical circuits, service manuals, necessary tools, meters and test equipment, service air conditioning electrical circuits.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Demonstrate use of a wiring schematic to trace circuits
3. Explain how the circuits function
4. Diagnose problems in the circuits
5. Service and repair problems in circuits
6. Inspect, test, and replace air conditioning compressor clutch components or assembly

**Section (B-VII)**
**(7-08)**
Instructors and Interns will apply:

**SERVICE AIR CONDITIONING VACUUM CIRCUITS**

PERFORMANCE OBJECTIVE: Given an automobile with problems in the air conditioning vacuum circuits, service manuals, necessary tools and equipment, service air conditioning vacuum circuits.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Demonstrate use of vacuum schematic to trace vacuum circuits
3. Explain how the vacuum circuits function
4. Diagnose problems in the vacuum circuits
5. Service and repair problems in the vacuum circuits

**Section (B-VII)**
**(7-09)**
Instructors and Interns will apply:

**REMOVE AND REPLACE COMPONENTS IN BASIC AIR CONDITIONING SYSTEMS**

PERFORMANCE OBJECTIVE: Given a vehicle with a basic air conditioning system, service manuals, tools and equipment, inspect, test, remove and replace components in a basic air conditioning system.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain purpose and functions of compressors
3. Explain purpose and functions of condensers
4. Explain purpose and functions of receiver-dryers and accumulators
5. Explain purpose and functions of expansion valves and orifice tubes
6. Explain purpose and function of evaporators
7. Explain purpose and function of evaporator pressure regulators
8. Explain purpose and function of connecting hoses
9. Explain how to remove and replace air conditioning components
10. Demonstrate how to correctly remove and replace air conditioning components

**Section (B-VII)**
**(7-10)**
Instructors and Interns will apply:

**REMOVE AND REPLACE ENGINE FAN CLUTCHES**

PERFORMANCE OBJECTIVE: Given a vehicle with a fan clutch, service manual, necessary tools and equipment, test, remove and replace the fan clutch.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe operation and function of fan clutches
3. Explain use of fan shroud and the horsepower advantage of fan clutches
4. Demonstrate removal and replacement procedures

**Section (B-VII)**
**(7-11)**
Instructors and Interns will apply:

**REMOVE AND REPLACE BLOWER MOTORS**

PERFORMANCE OBJECTIVE: Given a vehicle with a blower motor, service manuals, tools, equipment and materials, remove and replace the blower motor.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain operation of blower motor
3. Explain removal and replacement procedures
4. Remove and replace blower motor

**Section (B-VII)**
**(7-12)**
Instructors and Interns will apply:

**REMOVE AND REPLACE HEATER CORES, CONTROL UNITS AND CABLES**

PERFORMANCE OBJECTIVE: Given a vehicle with a heater, service manual, tools, equipment and materials, remove and replace heater core, heater and/or air conditioning control units and control cables.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain the function and operation of heater cores, control units and cables
3. Describe removal and replacement procedures
4. Demonstrate removal and replacement of heater core
5. Demonstrate how to properly adjust control units and cables

**Section (B-VII)**
**(7-13)**
Instructors and Interns will apply:

**REMOVE AND REPLACE COMPRESSOR SHAFTS SEALS**

PERFORMANCE OBJECTIVE: Given an air conditioning compressor, service manual, necessary tools, equipment and materials, remove and replace the compressor shaft seals.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain function and location of compressor shaft seals
3. Explain procedure for removal and replacement of compressor shaft seals
4. Demonstrate removal and replacement of compressor shaft seals

**Section (B-VII)**
**(7-14)**
Instructors and Interns will apply:

**SERVICE ELECTRIC ENGINE COOLING FAN AND CONTROLS**

PERFORMANCE OBJECTIVE: Given a vehicle with an electrical cooling fan, service manuals, necessary testers, tools, equipment and supplies, service the electric cooling fan system.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain function and operation of electrical cooling fans and circuitry
3. Trace cooling fan system circuitry on a wiring schematic
4. Explain procedures for testing and servicing electric cooling fans
5. Demonstrate testing and servicing electric cooling fans

**Section (B-VII)**
**(7-15)**
Instructors and Interns will apply:

**PERFORM PROPER HANDLING, RECOVERY AND RECYCLING OF REFRIGERANT**

PERFORMANCE OBJECTIVE: Given a vehicle in need of air conditioning refrigerant replacement, demonstrate proper handling, recovery, and recycling of refrigerant according to manufacturer's and EPA guidelines.

ENABLING OBJECTIVES:

1. Follow proper safety precautions for handling hazardous materials
2. Describe operation of refrigerant handling equipment
3. Describe and perform proper maintenance of recovery equipment as necessary

**Advanced Technology Career University**
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**Instructional Set:**

**Working with:**
**National Automotive Technicians Education Foundation**

**Section B**
**Unit VIII**
**NATEF Task List: ENGINE PERFORMANCE**

## Unit VIII
## ENGINE PERFORMANCE

**For every task in Engine Performance the following safety requirement must be strictly enforced as a number one priority:**

Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage and disposal of chemicals in accordance with local, state, and federal and environmental regulations.

### A. General Engine Diagnosis

1. Interpret and verify complaint; determine needed repairs.
2. Inspect engine assembly for fuel, oil, coolant, and other leaks; determine needed repairs.
3. Diagnose unusual engine noise or vibration problems; determine needed repairs.
4. Diagnose unusual exhaust color, odor, and sound; determine needed action.
5. Perform engine absolute (vacuum/boost) manifold pressure tests; determine needed repairs.
6. Perform cylinder power balance test; determine needed action.
7. Perform cylinder compression test; determine needed action.
8. Perform cylinder leakage test; determine needed action.
9. Diagnose engine mechanical, electrical, electronic, fuel, and ignition problems with and oscilloscope and engine diagnostic equipment; equipment; determine needed action.
10. Prepare 4 or 5 gas analyzer, inspect and prepare vehicle for test and obtain Exhaust readings; interpret readings and determine needed action.

### B. Computerized Engine Controls Diagnosis and Repair

1. Diagnose emissions or drive-ability problem resulting from failure computerized engine controls with no diagnostic trouble codes stored; determine needed repairs.
2. Retrieve and record stored diagnostic trouble codes.
3. Diagnose the causes of emissions or drive-ability problems resulting from failure of computerized engine controls with stored diagnostic trouble codes.
4. Inspect, test, adjust, and replace computerized engine control system sensors, powertrain control module (PCM), actuators, and circuits.
5. Obtain and interpret digital multimeter (DMM) readings.

6. Access and use electronic service information.
7. Locate and interpret vehicle and major component identification numbers (VIN, vehicle certification labels and calibration decals).
8. Inspect and test power and ground circuits and connections; service or replace as needed.
9. Practice recommended precautions when handling static sensitive devices.
10. Diagnose drive-ability and emissions problems resulting from failures of interrelated systems (cruise control, security alarms, torque controls, suspension controls, traction controls, torque management, A/C, automatic transmissions, and similar systems); determine needed repairs.

**C. Ignition System Diagnosis and Repair**

1. Diagnose no-starting, drive-ability, and emissions problems on vehicles with distributorless (electronic ignition) systems; determine needed repairs.
2. Diagnose no-starting, drive-ability, and emissions problems on vehicles with distributor ignition (DI) systems; determine needed repairs.
3. Inspect and test ignition primary circuit wiring and components; repair or replace as needed.
4. Inspect and test distributor; service as needed.
5. Inspect and test ignition system secondary circuit wiring and components; replace as needed.
6. Inspect and test ignition coil(s); replace as needed.
7. Check and adjust (where applicable) ignition system timing and timing advance/retard.
8. Inspect and test ignition wiring harness and connectors; replace as needed.
9. Inspect and test ignition system pick-up sensor or triggering devices; replace as needed.
10. Inspect and test ignition control module; replace as needed.

**D. Fuel, Air Induction, and Exhaust Systems Diagnosis and Repair**

1. Diagnose hot or cold no-starting, hard starting, poor drive-ability, incorrect idle speed, poor idle, flooding, hesitation, surging, engine misfire, power loss, stalling, poor mileage, dieseling, and emissions problems on vehicles with carburetor-type fuel systems; determine needed action.

2. Diagnose hot or cold no-starting, hard starting, poor drive-ability, incorrect idle speed, poor idle, flooding, hesitation, surging, engine misfire, power loss, stalling, poor mileage, dieseling, and emissions problems on vehicles with injection-type fuel systems; determine needed action.
3. Inspect fuel tank and fuel cap; inspect and replace fuel lines, fittings, and hoses.
4. Check fuel for contaminants and quality.
5. Inspect and test mechanical and electrical fuel pumps and pump control systems; replace as needed.
6. Replace fuel filters.
7. Inspect and test fuel pressure regulation system and components of injection type fuel systems; adjust or replace as needed.
8. Inspect and test cold enrichment system components; adjust or replace as needed.
9. Remove, clean, and reinstall throttle body; adjust related linkages.
10. Inspect and test fuel injectors; clean and replace.
11. Inspect throttle body mounting plates, air induction and filtration system, intake manifold, and gaskets; clean or replace as needed.
12. Check/adjust idle speed and fuel mixture where applicable
13. Remove, inspect, and test vacuum and electrical components and connections of fuel system; repair or replace as needed.
14. Inspect exhaust manifold, exhaust pipes, mufflers, resonators, tail pipes, and heat shields; repair or replace as needed.
15. Perform exhaust system back-pressure test; determine needed repairs.
16. Test the operation of turbocharger/supercharger systems; determine needed action.
17. Remove, clean, inspect, and repair or replace turbocharger/supercharger system components.
18. Identify the causes of turbocharger/supercharger failure; determine needed repairs.

**E. Emissions Control Systems Diagnosis and Repair**

**Positive Crankcase Ventilation**

1. Diagnose oil leaks emissions and drive-ability problems resulting from failure of the positive crankcase ventilation (PCV) system.
2. Inspect and test positive crankcase ventilation (PCV) filter/breather cap, valve, tubes, orifices, and hoses; service or replace as needed.

**Exhaust Gas Recirculation**

1 Diagnose emissions and drive-ability problems caused by failure of the exhaust gas recirculation (EGR) system.

2. Inspect and test valve, valve manifold, and exhaust passages of exhaust gas recirculation (EGR) systems; service or replace as needed.
3. Inspect and test vacuum/pressure controls, filters, and hoses of exhaust gas recirculation (EGR) systems; service or replace as needed.
4. Inspect and test electrical/electronic sensors, controls, and wiring of exhaust gas recirculation (EGR) systems; repair or replace as needed.

**Exhaust Gas Treatment**

1. Diagnose emissions and drive-ability problems resulting from failure of the secondary air injection and catalytic converter systems.
2. Inspect and test mechanical components of secondary air injection systems; service or replace as needed.
3. Inspect and test electrical/electronically-operated components and circuits of air injection systems; replace as needed.
4. Inspect and test components of catalytic converter systems; replace as needed.

**Intake Air Temperature Controls**

1. Diagnose emissions and drive-ability problems resulting from failure of the intake air temperature control systems.
2. Inspect and test components of intake air temperature control systems; replace as needed.

**Early Fuel Evaporation (Intake Manifold Temperature) Controls**

1. Diagnose emissions and drive-ability problems resulting from failure of early fuel evaporation control systems.
2. Inspect and test components of early fuel evaporation control systems; service or replace as needed.

**Evaporative Emissions Controls**

1. Diagnose emissions and drive-ability problems resulting from failure of evaporative emissions control system.
2. Inspect and test components and hoses of evaporative emissions control systems; replace as needed.

**Engine Related Service**

1. Adjust valves on engines with mechanical or hydraulic lifters.
2. Verify correct camshaft timing; determine needed action.
3. Verify engine operating temperature; determine needed action.
4. Perform cooling system pressure tests; check coolant condition; inspect and test radiator, pressure cap, coolant recovery tank, and hoses; service or replace as needed.
5. Inspect and test thermostat, by-pass, and housing; replace as needed.
6. Inspect and test mechanical/electrical fans, fan clutch, fan shroud/ducting, air dams, and fan control devices; service or replace as needed.

**TECH CRAFTSMAN CAREER BUILDING TRADE SCHOOL**
**INSTRUCTIONAL SET**

**Section (B-VIII)**
**(8-01)**

Instructors and Interns will apply:

**DEMONSTRATE AND APPLY SAFETY RULES AND PROCEDURES**

PERFORMANCE OBJECTIVE: Given examples of repair jobs and shop situations during engine performance service, apply shop safety rules and procedures by identifying safe and unsafe practices.

ENABLING OBJECTIVES:

1. Identify common hazards in the repair shop, including
   (a) Improper use of tools;
   (b) Unguarded machinery;
   (c) Tripping and falling;
   (d) Excessive exposure to exhaust gases, parts cleaners, paints and dust;
   (e) Electrical hazards;
   (f) Improper lifting
2. Identify and explain warning signs posted in the shop area
3. Explain the importance of good housekeeping in the repair shop
4. Explain the importance of storing materials in a secure manner
5. Identify and explain potential hazards associated with
   (a) Asbestos;
   (b) Carbon monoxide;
   (c) Solvents;
   (d) Paints and thinners;
   (e) Dusts;
   (f) Noise;
   (g) Hydrogen gas
6. Explain safety rules and procedures for using compressed air equipment
7. Explain safety rules for welding, cutting and brazing
8. Inspect the repair shop for conformity with safety rules and procedures

**Section (B-VIII)**
**(8-27)**

Instructors and Interns will apply:

**INTERPRET AND VERIFY OWNER'S COMPLAINT**

PERFORMANCE OBJECTIVE: Given a malfunctioning vehicle or customer complaint list, prepare a shop repair order and perform needed repairs.

ENABLING OBJECTIVES:

1. Gather all information needed to fill out work order
2. Verify or validate the customer's complaint by conducting an operational test of the component
3. Repair or replace malfunctioning components

**Section (B-VIII)**
**(8-03)**

Instructors and Interns will apply:

**ANALYZE ENGINE PERFORMANCE**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual, access to an engine analyzer and other test equipment, perform an engine performance test. Record any malfunction in the primary circuit, secondary circuit, computer control and sensors, fuel system, emission system and power balance.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working with test leads around the engine
2. Describe the function and operation of an engine analyzer
3. Demonstrate operation of an engine analyzer
4. Explain primary circuit
5. Explain secondary circuit
6. Describe and demonstrate emission test
7. Describe and demonstrate power balance test

**Section (B-VIII)**
**(8-27)**

Instructors and Interns will apply:

**PERFORM CYLINDER COMPRESSION TEST**

PERFORMANCE OBJECTIVE: Provided an engine at normal operating temperatures, tools, gauges and service manual, perform a cylinder compression test. Cylinder pressure variation must test within manufacturer's specifications. Perform wet and dry tests for significant deviations.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when testing an operating engine
2. Describe steps in preparing an engine for a cylinder compression test
3. Describe how to install gauge and take reading
4. Explain "wet" and "dry" test and the importance of each
5. Explain all deviations found during test

**Section (B-VIII)**
**(8-05)**

Instructors and Interns will apply:

**CHECK THE PERFORMANCE OF ENGINES EQUIPPED WITH ON-BOARD COMPUTES**

PERFORMANCE OBJECTIVE: Given a vehicle with an on-board computer, necessary test equipment, service or repair manual, diagnostic test manual and test codes, diagnose and/or repair computer controls.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe the function of the computer control
3. Determine location of the computer module
4. Explain and demonstrate use of test equipment
5. Explain and demonstrate factory test procedure
6. Demonstrate application of plug-in for computer control
7. Explain reason for test codes
8. Explain recommended precautions when handling static sensitive devices
9. Diagnose drive-ability and emissions problems resulting from failures of interrelated systems as indicated by error codes

**Section (B-VIII)**
**(8-27)**

Instructors and Interns will apply:

**INSPECT, REMOVE AND REPLACE POINTS AND CONDENSERS**

PERFORMANCE OBJECTIVE: Given a distributor (or vehicle) requiring point or condenser replacement, access to proper service manual and tools, remove and replace the points and condenser within manufacturer' specifications. All connections must be secure and positioned to avoid shortage in electrical circuit.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain dwell settings
3. Describe the condenser effect
4. Inspect points and condensers for defects in wear
5. Install points and condenser and adjust points

**Section (B-VIII)**
**(8-07)**

Instructors and Interns will apply:

**REMOVE AND REPLACE DISTRIBUTOR**

PERFORMANCE OBJECTIVE: Given a vehicle with distributor ignition problem, proper service manual, access to necessary tools, remove and replace distributor unit according to manufacturer's timing specifications within +/_ one degree. Tighten down bolt and insert all distributor secondary wires securely in the distributor cap.

ENABLING OBJECTIVES:

1. Explain function of distributor
2. Describe engine timing with distributor
3. Explain timing setting at 180 degrees out
4. Remove and test distributor
5. Install and adjust distributor

**Section (B-VIII)**
**(8-27)**

Instructors and Interns will apply:

**CHECK DISTRIBUTOR USING A DISTRIBUTOR TESTER**

PERFORMANCE OBJECTIVE: Given a vehicle with a timing problem, access to proper service manual, tools and electrical equipment, test initial timing and set distributor to manufacturer's specifications; test centrifugal advance with vacuum disconnected for smooth, even advance; test vacuum advance mechanism by attaching hose. Examine distributor for full curve, smooth, even operation to manufacturer's specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions for working on a live engine
2. Explain spark advance curve
3. Describe equipment hookup
4. Demonstrate use of specification manual

**Section (B-VIII)**
**(8-09)**

Instructors and Interns will apply:

**CHECK THE DISTRIBUTOR ADVANCE IN THE VEHICLE**

PERFORMANCE OBJECTIVE: Given a vehicle needing timing test, proper service manual and access to necessary tools and equipment, analyze the timing and advance mechanisms. Record any malfunction in the initial ignition timing setting, vacuum spark advance mechanism and centrifugal advance action.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while testing a "live" engine
2. Describe hookup of timing strobe light and/or magnetic pickup.
3. Explain initial ignition timing
4. Explain vacuum spark advance action
5. Explain centrifugal spark advance operation

**Section (B-VIII)**
**(8-27)**

Instructors and Interns will apply:

**OVERHAUL DISTRIBUTOR**

PERFORMANCE OBJECTIVE: Given a vehicle with a defective operating distributor, access to proper service manual, tools and equipment, disassemble and rebuild distributor to manufacturer's specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain operation of distributor
3. Describe initial timing settings
4. Disassemble and rebuild distributor

**Section (B-VIII)**
**(8-11)**

Instructors and Interns will apply:

**INSPECT AND TEST PRIMARY CIRCUITS**

PERFORMANCE OBJECTIVE: Given a vehicle with ignition wiring problem, access to necessary tools and equipment, test primary wire circuit to coil from battery for resistance on both circuits. Any deviation from manufacturer's specifications must be corrected.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe use of test equipment
3. Explain engine cranking current and engine running current variations
4. Demonstrate use of test equipment
5. Test primary and secondary circuits

**Section (B-VIII)**
**(8-12)**

Instructors and Interns will apply:

**REMOVE AND REPLACE COIL**

PERFORMANCE OBJECTIVE: Given a vehicle with defective coil, access to proper service manual and test equipment, test coil for deviation from manufacturer's specifications. Any variation from specifications is cause for replacement of unit.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain function of coil
3. Describe wiring procedure of coil
4. Demonstrate use of test equipment
5. Remove and replace coil

**Section (B-VIII)**
**(8-27)**

Instructors and Interns will apply:

**REMOVE AND REPLACE IGNITION SWITHCHES**

PERFORMANCE OBJECTIVE: Given a vehicle, necessary service manuals and tools, remove and replace an ignition switch. Care must be taken when installing the ignition switch so the switch locks the steering wheel and operates the ignition system.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions necessary to disconnect battery when working with electrical system
2. Explain operation of the ignition switch
3. Demonstrate removing and replacing the switch
4. Demonstrate operation of the ignition switch after installation

**Section (B-VIII)**
**(8-14)**

Instructors and Interns will apply:

**INSPECT, REMOVE AND REPLACE IGNITION WIRE, CAP AND ROTOR**

PERFORMANCE OBJECTIVE: Given a vehicle with defective spark plug wires, necessary service manuals and tools, replace each plug wire, routing wires according to manufacturer's specifications. Replacement wires must meet or exceed manufacturer's specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe engine firing order
3. Explain routing of plug wires
4. Demonstrate replacement of wires
5. Describe operation of the distributor cap and rotor
6. Demonstrate replacement of cap and rotor

**Section (B-VIII)**
**(8-27)**

Instructors and Interns will apply:

**REMOVE AND REPLACE SPARK PLUGS**

PERFORMANCE OBJECTIVE: Given a vehicle needing spark plugs, proper service manual, necessary tools and equipment, remove and replace spark plugs, set plug gap and torque plugs to manufacturer's specifications and replace wires securely.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe spark plug heat range and sizes
3. Explain spark plug gap settings (standard and electronic)
4. Demonstrate removal, gap setting and torque of spark plug

**Section (B-VIII)**
**(8-16)**

Instructors and Interns will apply:

**PERFORM CYLINDER LEAKAGE TEST**

PERFORMANCE OBJECTIVE: Given an engine at normal operating temperature, tools, equipment and service manual, perform a cylinder leakage test following the manufacturer's recommended procedures. Leakage in excess of manufacturer's specifications must be noted and explained.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain method to prepare engine for cylinder leakage test
3. Identify parts of cylinder leakage
4. Demonstrate use of cylinder leakage tester
5. Record and compute differences in pressure leakage of cylinder
6. Describe deviations from specifications and explain causes

**Section (B-VIII)**
**(8-27)**

Instructors and Interns will apply:

**SERVICE ELECTRONIC IGNITION SYSTEM**

PERFORMANCE OBJECTIVE: Given a vehicle(s), necessary service manuals and tools, test and service electronic ignition system. Student should be able to test and service all makes. Test all systems and follow all test codes. Care must be taken to use proper test equipment.

ENABLING OBJECTIVES:

1. Demonstrate proper safety procedures and use of correct testing equipment
2. Explain how the electronic ignition system works
3. Name the major components of the ignition system
4. Name the systems for Ford, GM, Chrysler and AMC
5. Define CCC, EEC, MCU, C_4, EMC, Hall Effect, C3l, SSI, TFI and HEI
6. Explain why computer controls are necessary
7. Describe common precautions and procedures for computer control service
8. Test and perform appropriate service on electronic ignition system

**Section (B-VIII)**
**(8-18)**

Instructors and Interns will apply:

**SERVICE OXYGEN FEEDBACK SYSTEM**

PERFORMANCE OBJECTIVE: Given a vehicle, necessary service manuals and tools, test and service an oxygen feedback system. Take care to use proper test equipment.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions and use proper test equipment
2. Describe feedback system
3. Locate and test sensors for feedback system
4. Explain closed and open loop
5. Explain limp home mode
6. Explain trouble codes

**Section (B-VIII)**
**(8-27)**

Instructors and Interns will apply:

**SERVICE AIR CLEANER**

PERFORMANCE OBJECTIVE: Given a vehicle, proper tools, shop manual and necessary filter elements, inspect, service or replace carburetor air cleaner. Inspect main filter element and the positive crankcase ventilation system filter (if used). Clean or replace filter(s). When service is completed, the air cleaner will limit induction noise, filter, and serve as a flame arrester.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain purpose and operation of the air cleaner canister and filters
3. Explain service procedure
4. Demonstrate a simple air filter element test

**Section (B-VIII)**
**(8-20)**

Instructors and Interns will apply:

**INSPECT, REMOVE AND REPLACE FUEL FILTERS**

PERFORMANCE OBJECTIVE: Given a vehicle, tubing wrenches, and inline filter, replace fuel filter. With the engine operating, the installed unit will not leak and will be positioned as recommended by the manufacturer.

ENABLING OBJECTIVES:

1. Demonstrate gasoline handling safety procedure
2. Explain installation procedure; include proper location for safe operation
3. Inspect all connections very carefully for fuel leaks
4. Check fuel for contaminants and quality
5. Remove and replace fuel filter

**Section (B-VIII)**
**(8-27)**

Instructors and Interns will apply:

**MEASURE FUEL FLOW AND PRESSURE**

PERFORMANCE OBJECTIVE: Given a vehicle, tools, equipment and service manual, measure fuel pump volume, pressure and vacuum. Check pressure and volume at specified time and RPM. Pressure, volume and vacuum will meet manufacturer's requirements.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working with automobile fuels
2. Explain test procedure of fuel system and safety rules
3. Explain fuel system operation and location
4. Demonstrate use of test equipment to determine fuel pressure

**Section (B-VIII)**
**(8-22)**

Instructors and Interns will apply:

**REMOVE AND REPLACE FUEL LINES**

PERFORMANCE OBJECTIVE: Given a vehicle and the necessary tools, repair or replace fuel lines and hoses. Lines and hoses will be free of restrictions, leaks or other defects. Remove stands and lower vehicle.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working under a raised vehicle and with fuels
2. Explain hose and line selection
3. Demonstrate line repair procedure for metal and flexible lines
4. Inspect all flexible lines for weather and heat cracks

**Section (B-VIII)**
**(8-27)**

Instructors and Interns will apply:

**REMOVE AND REPLACE FUEL PUMPS (MECHANICAL AND ELECTRICAL)**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual, necessary tools and parts, remove and replace the fuel pump. When completed, bolt tightening, gasket installation and proper line hookup and routing will be checked.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Discuss the advantages and disadvantages of mechanical versus electric fuel pumps
3. Explain the differences between a two-line and a three-line fuel pump
4. Describe fuel pump pressures, vacuums and "vapor lock"
5. Remove and replace fuel pump
6. Inspect connections carefully for fuel leaks

**Section (B-VIII)**
**(8-24)**

Instructors and Interns will apply:

**ADJUST IDLE SPEED**

PERFORMANCE OBJECTIVE: Given a vehicle, necessary service manuals and tools, adjust engine idle speed. When completed the proper curb idle, high idle and air fuel ratio should be within factory specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain function of idle adjustment
3. Explain anti-dieseling solenoid
4. Demonstrate test equipment and operation
5. Adjust idle speed to manufacturer's specifications

**Section (B-VIII)**
**(8-27)**

Instructors and Interns will apply:

**ADJUST IDLE MIXTURE (PROPANE)**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and proper tools, perform a propane enrichment carburetor adjustment. When complete the specifications will be compared to the actual test results.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain the advantage of setting a carburetor using the propane method
3. Adjust idle mixture to comply with manufacturer's specifications
4. Demonstrate exhaust emission test

**Section (B-VIII)**
**(8-26)**

Instructors and Interns will apply:

**CLEAN AND ADJUST CHOKE AND CHECK PROPER OPERATION OF ELECTRIC CHOKE**

PERFORMANCE OBJECTIVE: Given a vehicle, an approved cleaning fluid and access to the proper tools, inspect, clean and adjust choke unit. When completed, the choke should be clean, move or operate freely and at desired temperature ranges. The choke pull off should have been checked for operation as well as the choke "high" idle.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain choke operation
3. Explain method of adjusting different types of chokes
4. Demonstrate proper cold setting of a standard automatic choke assembly

**Section (B-VIII)**
**(8-27)**

Instructors and Interns will apply:

**CLEAN AND OVERHAUL CARBURETOR**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools and replacement parts, rebuild a carburetor. When completed the carburetor should have all screws, clamps and hoses secured. The carburetor should operate and be adjusted within manufacturer's specifications.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when using carburetor cleaners
2. Explain disassembly and assembly procedures (include testing and setting assembly parts)
3. Demonstrate cleaning and "blowing" dry procedures and inspection of all parts to be reassembled
4. Define carburetor and exhaust gas recirculation (EGR)
5. Disassemble, clean and overhaul carburetor

**Section (B-VIII)**
**(8-28)**

Instructors and Interns will apply:

**INSPECT, REMOVE AND REPLACE MANIFOLD CONTROL VALVE**

PERFORMANCE OBJECTIVE: Given a vehicle, tools and an approved high temperature lubricant, service or repair manifold heat controls. The valve will be checked and serviced or replaced as necessary. When operating, the heat riser valve will close when cold, will open when engine is accelerated and will open wide when hot.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain the operation of the manifold heat riser controls
3. Explain reason for carburetor heat
4. Identify a manifold heat riser
5. Remove and replace manifold control valve

**Section (B-VIII)**
**(8-45)**
Instructors and Interns will apply:

**REMOVE AND REPLACE TURBOCHARGER**

PERFORMANCE OBJECTIVE: Given a vehicle, necessary repair manuals, access to required tools and equipment, remove and replace turbocharger. Examine each component and record condition. Check carburetor, plenum chamber, turbine assembly, waste gate and actuator, compressor and oiling system.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain turbocharger design and operation
3. Explain troubleshooting the turbocharger
4. Explain each component of the turbocharger
5. Demonstrate the use of the tools and equipment necessary to remove and replace the turbocharger
6. Describe the advantages and disadvantages of turbocharger
7. Demonstrate the proper way to remove, clean, inspect, and replace turbocharger/supercharger system components
8. Identify the causes of turbocharger/supercharger failure; determine needed repair

**Section (B-VIII)**
**(8-30)**
Instructors and Interns will apply:

**CHECK AND ADJUST WASTE GATE**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, test and adjust waste gate. When completed the gate must open properly and smoothly to the desired manufacturer's specifications. If any deviation is noted, a reason must be stated.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain the purpose of the turbocharger waste gate
3. Identify the waste gate location in the exhaust system
4. Adjust the actuator and waste gate activating rod

**Section (B-VIII)**
**(8-45)**
Instructors and Interns will apply:

**DIAGNOSE HOT OR COLD STARTING AND DRIVE-ABILITY PROBLEMS OF FUEL INJECTED SYSTEMS**

PERFORMANCE OBJECTIVE: Given a vehicle with drive-ability or starting problems, diagnose possible causes and make appropriate repairs.

ENABLING OBJECTIVES:

1. Determine and adjust proper idle speed
2. Determine causes of misfire or power loss by testing components and replace/repair components as needed.
3. Determine causes of poor mileage, flooding, stalling, hesitation by performing appropriate checks and replace/repair components as needed

**Section (B-VIII)**
**(8-32)**
Instructors and Interns will apply:

**SET IDLE SPEED TO SPECIFICATION (FUEL INJECTION)**

PERFORMANCE OBJECTIVE: Given a vehicle with fuel injection, necessary service manuals and tools, adjust idle speed to specification. Care should be taken to use proper test equipment.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain idle speed adjustments
3. Describe the differences between throttle body and ported injection and their adjustments
4. Explain test equipment required for adjustments
5. Set idle speed to manufacturer's specifications

**Section (B-VIII)**
**(8-45)**
Instructors and Interns will apply:

**REMOVE AND REPLACE FUEL INJECTORS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and tools, replace or service the fuel injection nozzle. When completed all bolts must be properly torqued and any lines or wires must be correctly secured and routed. Any "O" rings or seals must not leak.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when handling fuel
2. Discuss the advantages servicing or rebuilding a fuel injection nozzle
3. Demonstrate removal and replacement of injection nozzle
4. Explain function of "O" rings
5. Remove and replace fuel injectors

**Section (B-VIII)**
**(8-01)**
Instructors and Interns will apply:

**SERVICE THROTTLE BODY INJECTION SYSTEM**

PERFORMANCE OBJECTIVE: Given a vehicle, necessary tools and repair manuals, service and/or repair a throttle body injection fuel system. It is necessary to service air control system, computer control system, sensors and fuel delivery system.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe the difference between carburetion and throttle body fuel injection
3. Describe the air control system
4. Describe the different sensors
5. Describe the computer control system
6. Describe the fuel delivery system
7. Clean and service components of throttle body

**Section (B-VIII)**
**(8-45)**
Instructors and Interns will apply:

**SERVICE PORTED FUEL INJECTION**

PERFORMANCE OBJECTIVE: Given a vehicle, necessary tools and service manuals, service and/or repair ported fuel injection. It is necessary to check or service wiring, sensors, computer system, fuel lines, injectors and pressure pump.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe operation of ported injection
3. Describe necessary service of ported injection
4. Describe timing of injectors
5. Demonstrate service of injection system

**Section (B-VIII)**
**(8-36)**
Instructors and Interns will apply:

**SERVICE PV SYSTEM**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, test and/or repair PCV system. Upon completion the mechanic will note any faulty or worn parts. Hoses must be of the appropriate length and correctly routed.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain the difference between "closed" and "open" crankcase ventilation
3. Describe a "down draft" tube operation
4. Demonstrate manifold vacuum test for PCV hose connection port
5. Service the PCV system and replace worn or faulty components

**Section (B-VIII)**
**(8-45)**
Instructors and Interns will apply:

**SERVICE EVAPORATIVE CONTROL SYSTEM**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, check and service the fuel evaporation system. When they are completed the lines will be examined for length, security, and proper routing.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain the purpose of the fuel evaporation system
3. Describe the manner of function of this unit
4. Identify the places where fuel evaporates and explain how evaporation is controlled
5. Demonstrate method for testing the system
6. Service evaporative control system components

**Section (B-VIII)**
**(8-38)**
Instructors and Interns will apply:

**SERVICE THERMOSTATIC AIR CLEANER**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, service the thermostatic air cleaner. When completed all hoses should be connected correctly, the hot air pipe should be installed, and door operation should have been checked.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe how this air cleaner functions and how it assists the drive-ability of a Vehicle in cold weather
3. Demonstrate test of air filter element
4. Explain PCV system filter, if equipped
5. Inspect and test components of intake air temperature control systems; replace as needed

**Section (B-VIII)**
**(8-45)**
Instructors and Interns will apply:

**SERVICE AIR INFECTION SYSTEM**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual, exhaust gas analyzer and necessary tools, test the AIR system. When completed, the student's reading will be compared to actual emission's readings. The student will compare the reading to specifications and determine if the system is functioning properly.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain the purpose of the AIR system
3. Demonstrate use of an exhaust gas analyzer
4. Demonstrate proper exhaust gas analyzer test connections
5. Solve any exhaust gas problems (leaks and failure to meet specifications)

**Section (B-VIII)**
**(8-40)**
Instructors and Interns will apply:

**INSPECT, REMOVE AND REPLACE AIR PUMP AND BELTS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools and parts, remove and replace AIR system components. This will include the air pump, belt, diverter valve, manifold/distribution lines and check valve. When completed the alignment, whether or not bolts have been torqued, leakage and hose and line routing will be examined.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain how a faulty component in the AIR system can cause an explosion in the exhaust system
3. Explain need for AIR system in meeting pollution standards
4. Demonstrate test of system with exhaust gas analyzer

**Section (B-VIII)**
**(8-45)**
Instructors and Interns will apply:

**SERVICE EXHAUST GAS RECIRCULATION (EGR) SYSTEM**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual, vacuum pump and necessary tools, test and service the EGR valve and component operation. Upon completion the length and routing of the hose will be examined. Gasket security and positioning will also be checked. When finished the EGR valve must open and close completely when vacuum is applied and released.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain the purpose of routing burned exhaust gas back into the engine combustion chamber
3. Perform test of EGR valve
4. Explain effect of recirculation of exhaust gases on combustion chamber

**Section (B-VIII)**
**(8-42)**
Instructors and Interns will apply:

**SERVICE IGNITION TIMING CONTROL**

PERFORMANCE OBJECTIVE: Given a vehicle, necessary service manuals, tools and proper test equipment, service controls for ignition timing. Care must be taken to use proper test equipment.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while working on a live engine
2. Explain operation of electronic timing controls
3. Demonstrate use of test equipment
4. Describe location of sensors for adjusting timing
5. Define EST, ECM, HEI and how they are related
6. Determine service needed from trouble codes related to timing controls

**Section (B-VIII)**
**(8-45)**
Instructors and Interns will apply:

**TEST THE EXHAUST EMISSION USING AN HC/CO TESTER**

PERFORMANCE OBJECTIVE: Given a vehicle, necessary service manuals, tools and test equipment, perform two-gas and four-gas emission test.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions while running the engine
2. Define HC, CO, NOx, soot and smog
3. Describe procedures for testing emission
4. Explain what test equipment is required
5. Define emission requirements
6. Demonstrate test procedures

**Section (B-VIII)**
**(8-44)**
Instructors and Interns will apply:

**REMOVE AND REPLACE CATALYTIC CONVERTER BEADS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual, required tools and replacement beads, service catalytic converter. When completed a check will be made to see if all old beads were removed, the proper amount of new beads were installed, and the filler plug was tightened.

ENABLING OBJECTIVES:

1. Demonstrate precautions when working with exhaust systems
2. Describe what the beads are made from and how they help eliminate emissions
3. Remove and replace converter beads
4. Demonstrate test of exhaust emissions using exhaust gas analyzer

**Section (B-VIII)**
**(8-45)**
Instructors and Interns will apply:

**SERVICE DIESEL INJECTORS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and tools, remove and service diesel fuel injectors. When completed test all injectors for proper spray pattern and for "O" ring leaks.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when handling injector nozzles
2. Demonstrate removal and replacement of injectors
3. Describe and demonstrate servicing injectors
4. Inspect all fuel line fittings for leaks
5. Explain the use of "O" rings

**Section (B-VIII)**
**(8-46)**
Instructors and Interns will apply:

**REMOVE AND REPLACE DIESEL ENGINE FUEL FILTERS AND WATER SEPARATRO, IF SO EQUIPPED**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and tools, remove and replace diesel engine fuel filter and service water separator, if so equipped.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Locate fuel filter on vehicle
3. Locate water separator, if so equipped
4. Describe operation for replacement of fuel filter
5. Describe operation for servicing water separator
6. Check fuel lines for leaks when completed
7. Remove and replace fuel filter

**Section (B-VIII)**
**(8-47)**

Instructors and Interns will apply:

**CHECK AND ADJUST INJECTION PUMP TIMING**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, check and adjust injector pump timing.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions when working with injector pumps
2. Describe operation for adjusting pump timing
3. Describe built-in advance in the pump
4. Describe electrical controls for injector pump
5. Describe operation of the injector pump
6. Demonstrate timing of the pump

**Section (B-VIII)**
**(8-48)**

Instructors and Interns will apply:

**REMOVE AND REPLACE INJECTION PUMP**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, remove and replace injector pump.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe operation of injector pump
3. Describe the timing of the pump
4. Describe the two types of injector pumps (mechanical and electrical)
5. Demonstrate removal and replacement of pump

**Section (B-VIII)**
**(8-01)**

Instructors and Interns will apply:

**CHECK AND ADJUST IDLE AND MAXIMUM SPEEDS**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools, check and adjust idle and maximum speed of injector pump.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Refer to service manual for adjustments
3. Describe governor operation
4. Describe charging cycle
5. Describe discharge cycle
6. Demonstrate adjustment of idle and maximum speeds

**Section (B-VIII)**
**(8-58)**
Instructors and Interns will apply:

**TEST AND SERVICE PRE-HEAT SYSTEM**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual, necessary tools and equipment, test and service preheating or glow plug system. Care must be taken not to damage glow plugs when removing or replacing.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe procedures for testing glow plugs
3. Demonstrate test procedures
4. Demonstrate replacement of glow plugs

**Section (B-VIII)**
**(8-51)**
Instructors and Interns will apply:

**DIAGNOSE DIESEL FUEL EMISSION PROOBLEMS**

PERFORMANCE OBJECTIVE: Given a vehicle, necessary service manual, tools and proper test equipment, diagnose a diesel engine emission problem.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions with the engine running
2. Explain the difference between gas and diesel emissions
3. Describe test equipment required for testing emission
4. Name the emission produced by a diesel engine
5. Define particulate matter; define emission requirements
6. Demonstrate testing emission on a diesel engine

**Section (B-VIII)**
**(8-52)**

Instructors and **Interns will apply:**

**INSPECT EXHAUST SYSTEM**

PERFORMANCE OBJECTIVE: Given a vehicle, shop manual and necessary equipment, test exhaust system. All leaks, loose connections, misalignment, metal deterioration must be detected. System must function without leaks, noise, rattles or restrictions.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures
2. Explain danger of exhaust fumes in the passenger compartment
3. Describe restriction problems
4. Describe exhaust gas test for pollutants
5. Demonstrate exhaust gas analyzer test
6. Detect metal deterioration

**Section (B-VIII)**
**(8-53)**

Instructors and Interns will apply:

**REMOVE AND REPLACE TAIL PIPE**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools and equipment, remove and replace the tail pipe. The tail pipe must be installed with sufficient clearances and be attached securely. The tail pipe connections must not leak exhaust gases and must not rattle.

ENABLING OBJECTIVES:

1. Practice appropriate safety procedures
2. Describe routing and clearance
3. Explain leak dangers
4. Explain types of hangers
5. Remove and replace tailpipe

**Section (B-VIII)**
**(8-58)**
Instructors and Interns will apply:

**REMOVE AND REPLACE MUFFLER**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools and equipment, remove and replace the muffler. The muffler must have the specified clearance and all supports must be tightened and clamps on the inlet and outlet torqued to prevent exhaust leakage and rattles.

ENABLING OBJECTIVES:

1. Demonstrate safety procedures
2. Demonstrate clamp bolt "freeing" agent and removal procedures
3. Explain "inlet" and "outlet" of muffler
4. Describe exhaust gas leak dangers
5. Describe clearance of system to include "U" bolt positions
6. Demonstrate methods of removal and replacement of muffler

**Section (B-VIII)**
**(8-55)**
Instructors and Interns will apply:

**REMOVE AND REPLACE EXHAUST PIPE**

PERFORMANCE OBJECTIVE: Given a vehicle, service manual and necessary tools and equipment, install the exhaust pipe. The exhaust pipe must fit the exhaust manifold outlet and be designed to fit supports and clamps. The system must be free of exhaust leaks and rattles.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Demonstrate use of bolt "freeing" agent and removal procedures
3. Demonstrate bolt torque procedure
4. Explain exhaust gas leak dangers
5. Identify proper exhaust manifold and exhaust pipe gaskets
6. Remove and replace exhaust pipe

**Section (B-VIII)**
**(8-56)**

Instructors and Interns will apply:

**INSPECT, REMOVE AND REPLACE CATALYTIC CONVERTER**

PERFORMANCE OBJECTIVE: Given a vehicle with a defective catalytic converter, access to necessary tools and service manual, remove and replace the converter in the system according to manufacturer's procedures. There should be no leaks or excessive back pressure of the exhaust system. The heat shield should be properly placed with proper clearance and no rattles.

ENABLING OBJECTIVES:

1. Practice appropriate safety procedures
2. Explain use of heat shield
3. Explain function of catalytic converter
4. Describe exhaust system back-pressure test
5. Demonstrate exhaust gas analyzer test
6. Explain why leaded fuel must not be used with converters
7. Remove and replace catalytic converter

**Section (B-VIII)**
**(8-57)**

Instructors and Interns will apply:

**PRESSURE-TEST COOLING SYSTEMS**

PERFORMANCE OBJECTIVE: Given a liquid cooled engine and a radiator pressure tester pump, pressure-test the cooling system. Any pressure drop in the system will be noted. System must hold pressure within manufacturer's specifications with no leaks.

ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain operation of pressure tester
3. Explain pressure drop problems
4. Inspect system for signs of leakage
5. Pressure-test the system

**Section (B-VIII)**
**(8-58)**
Instructors and Interns will apply:

**TEST RADIATOR CAPS**

PERFORMANCE OBJECTIVE: Given a vehicle with a liquid cooled engine which is pressurized, a radiator cap and a radiator cap tester, test cap for proper operation.
ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe how the radiator cap controls the sealed system and explain the purpose for pressurizing the system
3. Test the radiator cap

**Section (B-VIII)**
**(8-59)**
Instructors and Interns will apply:

**REMOVE AND REPLACE ENGINE FAN CLUTCHS**

PERFORMANCE OBJECTIVE: Given a vehicle with a fan clutch, service manual, necessary tools and equipment, test, remove and replace the fan clutch.
ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Describe operation and function of fan clutches
3. Explain use of fan shroud and the horsepower advantage of fan clutches
4. Demonstrate removal and replacement procedures

**Section (B-VIII)**
**(8-60)**
Instructors and Interns will apply:

**SERVICE ELECTRIC ENGINE COOLING FAN AND CONTROLS**

PERFORMANCE OBJECTIVE: Given a vehicle with an electrical cooling fan, service manuals, necessary testers, tools, equipment and supplies, service the electric cooling fan system.
ENABLING OBJECTIVES:

1. Demonstrate safety precautions
2. Explain function and operation of electrical cooling fans and circuitry
3. Trace cooling fan system circuitry on a wiring schematic
4. Explain procedures for testing and servicing electric cooling fans
5. Demonstrate testing and servicing electric cooling fans