UGANDA BUSINESS AND TECHNICAL EXAMINATIONS BOARD

MODULAR ASSESSMENT GUIDE

PROGRAMME: NATIONAL CERTIFICATE IN AUTOMOTIVE MECHANICS (NCAM)

JANUARY 2022

PREAMBLE

The modular assessment is aimed at testing trainees on the basic and fundamental knowledge and skills of automotive service, maintenance and repair while putting emphasis on core requirements of a well-trained automotive mechanic required by world of work. The assessment is in line with the requirements stipulated in the automotive curriculum of the National Curriculum Development Centre. Furthermore, the assessment stresses the major elements of a Health and Safety Management System which will help trainees to exhibit improved OHSE awareness and understand the best safety practices while at work.

The assessment will concentrate on the completed module to verify whether the trainee has acquired all the necessary competences of the module and to test whether the training outcome has been achieved.

The competences to be assessed are clearly defined for each module covered within the time allocated. The modules assessed per package in this course are in the manner that will help the trainee exhibit particular skills to be used to execute various tasks of the respective time of study.

The modular assessment stipulates that each module should be fully assessed with all the necessary technology, mathematics, technical drawing science and calculations. This means that the sub - modules in module like; mathematics, technical drawing science and calculations have been identified to fall under particular modules to help the trainee apply them to the given module at a particular study time.

As stipulated by the NCDC curriculum for National Certificate in Automotive Mechanics, if implemented, this assessment should produce Automotive Mechanics who are able do the following:

1. Exhibit improved OHSE awareness.
2. Fabricate components and machine parts
3. Service and maintain engines in good working conditions.
4. Install, repair and maintain the electrical/ electronic system in a vehicle
5. Prepare reports, budgets, and operation plans
6. Promote and ensure safety of workers and plant
7. Initiate and manage small Business Enterprises.

SUMMARY OCCUPATIONS, MODULES AND SUB-MODULES

OCCUPATION	MODULE	SUB-MODULE
1. Occupational Health and Safety Officer/Guide	Occupational Health and Safety Awareness	a. Safety Responsibilities b. Application of HSE c. Employee involvement d. Hazards Identification and Control e. Safety beyond work zones f. Accidents Prevention and investigation
2. Auto-Fabricator and Fitter Mechanic	Automotive Fitting and Fabrication	a. Measuring and marking out b. Fitting and holding tools c. Heat Treatment of metals d. Joining Materials and Forging e. Temporary Joining of materials f. Permanent Joining of materials (Welding, Electric arc welding, gas welding, soldering and brazing) g. Forging
3. Engine and its systems maintenance, service and repair mechanic	Engine and its Systems Maintenance, Service and Repair	a. General Engine Diagnosis b. Cylinder Head and Valve Train Diagnosis and Repair c. Wedge tools and setting Torque application d. The Cam e. Engine Block Diagnosis and Repair f. Determination of Engine capacity g. Conversion of basic units h. Mensuration i. Inspecting Engine revolutions (speed) j. Inspecting cylinder bore wear k. Determining TDC and BDC for an internal combustion engine l. Orthographic and isometric projection m. Using Assembly drawings to dismantle and assemble engine and its components n. D. Cooling and lubrication Systems Diagnosis and Repair o. Viscosity of lubrication oil (both use and new oil) p. Temperature and Heat q. E. Fuel, Ignition, Intake and Exhaust r. Systems Inspection and Service s. Properties of gases t. Integration
4. Manual Drive Train Maintenance, Service And Repair Mechanic	Manual Transmission , Drive Train and Axles	a. Clutch Diagnosis and Repair b. Frictional torque transmitted by clutches c. Transmission Diagnosis and Repair d. Transaxle (Transfer Gear box) Gear box Diagnosis and Repair e. Drive Shaft/Half-Shaft and Universal f. Joint/Constant Velocity (CV) Joint g. Diagnosis and Repair (Front and Rear h. Wheel Drive) i. Drive Axle Diagnosis and Repair j. Ring and Pinion Gears k. Differential Case/Carrier Assembly l. Limited Slip/Locking Differential m. Axle Shafts and Housing

		n. Four-Wheel Drive/All-Wheel Drive o. Component Diagnosis and Repair p. Ratios, proportions and percentages in gear mesh analysis q. Gearbox ratio, Rear Axle ratio, Overall gear ratio and Efficiency of the drive train r. Involute Gear construction
5. Automatic Transmission and Transaxle Maintenance, Service and Repair Mechanic	Automatic Transmission and Trans-Axle	a. General Transmission/Transaxle Diagnosis b. Mechanical/Hydraulic Systems c. Electronic Systems d. In-Vehicle Transmission/Transaxle e. Maintenance and Repair f. Off-Vehicle Transmission/Transaxle Repair g. Removal and Installation h. Disassembly and Assembly i. Friction and Reaction Units j. Using Assembly drawings to dismantle and assemble Transmission and its components
6. Suspension and Steering Maintenance, Service and Repair Mechanic	Suspension and Steering	a) Steering Systems Diagnosis and Repair b) Forces on vehicles c) Steering system calculations d) Steering angles e) Suspension Systems Diagnosis and Repair f) Application of Simple Harmonic Motion in the Suspension system analysis
7. Brakes Service and Repair Mechanic	**1.** Brakes System	a) Hydraulic, Power Assist, and Parking b) Brake Systems Diagnosis and Repair c) Inspection of retardation/ braking force d) Drum Brake Diagnosis and Repair e) Friction f) Disc Brake Diagnosis and Repair g) E. Electronic Brake Control Systems: Antilock h) Brake System (ABS), Traction Control i) System (TCS), and Electronic Stability j) Control System (ESC) Diagnosis and Repair k) Service Air Brakes l) Pneumatic braking system inspection m) Service Auxiliary Brakes (The auxiliary braking systems that improve the safety on the road and provides savings on the service brakes)
8. Wheels & Tyres Service And Alignment Maintenance Mechanic	Wheels and tyres	a) Wheel Alignment Diagnosis, Adjustment, and Repair b) Wheel and Tyre Diagnosis and service c) Specifications and recommendations for tyres
9. Auto Electrical Mechanic	Auto Electrical / Electronic Systems	a) General Electrical/Electronic System diagnosis b) Battery and Starting System diagnosis and repair c) Charging System diagnosis and repair d) Lighting Systems diagnosis and repair e) Instrument Cluster and Driver Information Systems diagnosis and repair

		f) Body Electrical Systems diagnosis and repair
10. Automotive Air Conditioning Maintenance, Service and Repair Mechanic	Vehicle Interior Heating And Air Conditioning	a) Heating, Ventilation, A/C (HVAC) and b) Engine Cooling System Service, diagnosis, and repair c) Refrigeration System Component diagnosis and repair d) Operating Systems and related controls diagnosis and repair
11. Engine Diagnosis Mechanic	Automotive Engine Diagnosis	a) Engine General Diagnosis b) Ignition System diagnosis and repair c) Fuel, Air Induction and Exhaust Systems d) diagnosis and repair e) Emission Control Systems Diagnosis and repair f) Positive Crankcase Ventilation g) Exhaust Gas Recirculation h) Secondary Air Injection (AIR) and i) Catalytic Converter j) Evaporative Emissions Controls k) Computerized Engine Controls Diagnosis and Repair
12. Light Vehicle Diesel Engines Service and Repair Mechanic	Light Vehicle Diesel Engines	a) General Diagnosis b) Cylinder Head and Valve Train c) Engine Block Diagnosis and Repair d) Lubrication and Cooling Systems e) Diagnosis and Repair f) Air Induction and Exhaust Systems g) Diagnosis and Repair h) Fuel System Diagnosis and Repair
13. Vehicle Body Repair and Spray Mechanic	Vehicle Body Repair and Spray	a) Preparation b) Outer Body Panel Repairs, Replacements, and Adjustments c) Metal Finishing and Body Filling d) Glass and Hardware e) Welding, Cutting, and Removal f) Plastic Repair g) Surface Preparation h) Spray Gun Operation and Related Equipment i) Paint Mixing, Matching, and Applying j) Solving Paint application problems during the application process k) Finish Defects, Causes, and Cures
14. Diesel Fuel Injection Systems Repair Mechanic	Diesel Fuel Injection Systems	a) Prepare to diagnose and repair diesel fuel injection system b) Diagnose diesel fuel injection system c) Fuel System Diagnosis and Repair d) Complete work processes

Other Support Modules

1. Trade Calculations
2. Communication and computer skills
3. Entrepreneurship skills
4. Kiswahili

MODULE DETAILS

Module 1: OCCUPATIONAL HEALTH AND SAFETY AWARENESS

Total contact hours: 34

Training Outcome: By the end of this module, the Trainee should be able to ensure health and safety in the workshop and beyond work zones.

SUB-MODULES	DUTIES/ TASKS	COMPETENCES
a) The need for Health and safety b) Safety Responsibilities c) Application of HSE d) Employee involvement e) Hazards Identification and Control f) Safety beyond work zones g) Accidents Prevention and investigation	a) Organisation and layout of workshops/Automobile garages b) Properly handle hazardous fluids(e.g. acid, A/c gases, radiator high temperature water, brake fluid, oils, powders among others) c) Deal with hazards and incidents like fire, electric shocks, fumes and gases d) Proper usage of workshop tools. i.e. using tools for tasks they are designed for.(for instance pressure gauges, Multimeter, manual/hand tools and machines) e) Use fire extinguishers and other fire fighters	a) Observes Workshop regulations, precautions and hazards in the work processes; b) Proper illumination maintained in the w/shop during operations c) Proper ways of lifting of heavy loads in the workshop d) Proper securing of ladders, jacks, vehicle stands etc. e) First aid in the workshop, factories and at sites. f) observes Work ethics and integrity g) ensures Self-consciousness at work and beyond work zones observed during operations h) engages in Team work for complex/multiple workshop tasks i) cleans, organizes the workshop and ensures path ways are open as a means of escape route in case of accidents. j) maintains personal Safety and hygiene at work, in everyday decisions and beyond work zones. a) Proper use tyre inflation cages

Module 2: AUTOMOTIVE FITTING AND FABRICATION

Total contact hours: 100

Training Outcome: By the end of this module, the Trainee should be able to fit and fabricate automotive component attachments

SUB-MODULE	DUTIES/TASKS	COMPETENCE
Measuring and marking out	a) Take measurement in various units b) Test for accuracy and proper fitting/ mating of part as required. c) Mark-out parts during disassembly, measuring	a) Read, convert and interpret measurements of various units. b) Selects and uses recommended measuring tools to takes required c) Understands various standard measurement units and coverts units correctly d) Selects and uses recommended marking-out tools for marking out. e) Takes measurements
Fitting and holding tools	a) Selection fitting and holding tools for specific purposes b) Proper use of various fitting and holding tools to accomplish specific tasks c) Care for fitting and holding tools	a) Identifies fitting and holding tools and selects them according their use during repair and fabrication. b) Interprets working drawings. c) Performs structural repair on vehicles d) Fabricates simple vehicle components. e) Observes OSHE while using fitting and holding tools.
Heat Treatment of metals	Tempering, Hardening, Normalising, Surface hardening and Annealing metals	The leaner heat treats metallic components of the vehicle according to the required application
Joining Materials and Forging	**1. Temporary Joining of materials** a) Riveting b) Rebating c) Joining parts with bolts and nuts d) Adhesive bonding e) Use of locking devices f) Health, safety **2. Permanent Joining of materials** (Welding, Electric arc welding, gas welding, soldering and brazing) a) Identify the suitable soldering/welding method for a specific joint. b) Prepare part for welding in accordance with joint specification	1. Uses the rivet gun the correctly to Joins parts firmly. 2. Fastens parts together with a bolt and nut. 3. Applies adhesive correctly to join parts. 4. Is able to lock and unlock parts with various locking devices 5. Selects and applies suitable welding methods and techniques to join parts. 6. Aligns and fits parts 7. Applies the various forging methods and technique to shape metals 8. Adjust welding current to requirements 9. Set gas flame at gas torch to requirements 10. Use of applicable welding technique for a given joint 11. Self-health, safety and care of welding, soldering and brazing equipment.

	c) Select suitable welding material/filler rod and flux for a specific joint d) Joins materials with soldering, brazing, gas and electric welding. e) Service, and replace exhaust manifold, exhaust pipes, oxygen sensors, air/fuel ratio sensors, mufflers, catalytic converters, resonators, tailpipes, and heat shields. f) Test for exhaust system restriction or leaks; determine needed action. g) Inspect, test, clean and repair or replace turbocharger or supercharger and system components. h) Repair and weld exhaust pipe gas leakages **3. Forging** a) Perform cold forging b) Selects suitable forging tools for a particular forging task. c) Lighting the hearth d) Perform hot forging at a recommended temperature to shape metals. e)	Self-health, safety and care of forging equipment.

Module 3: ENGINE AND ITS SYSTEMS MAINTENANCE, SERVICE AND REPAIR

Total contact hours: 306

Training Outcome: By the end of the module the trainee should be able to maintain, service and repair an engine and its systems

SUB-MODULE	DUTIES/TASKS	COMPETENCE
General Engine Diagnosis	a) Verify customer concern and/or road test vehicle; determine needed action. b) Determine if no-cranking, cranks but will not start, or hard starting condition is an engine mechanical problem, or is caused by another vehicle subsystem. c) Inspect engine assembly for fuel, oil, coolant and other leaks; determine needed action. d) Isolate engine noises and vibrations; determine needed action. e) Perform engine manifold vacuum or pressure tests; determine needed action. f) Perform cylinder power balance tests; determine needed action. g) Perform cylinder compression tests; determine needed action. h) Perform cylinder leakage/leak-down tests; determine needed action. i) Research system operation using technical information to determine service procedures and specifications.	a) describes the basic construction and principle of operation of 2 stroke cycle and 4stroke cycle Internal Combustion (IC) engine. b) inspects engine components for damage/distortion and takes necessary action c) dismantles/ disassembles and reassemble engine components in a recommended sequential procedure d) diagnose engine faults such as loss of power, wear, noise, leaks from oil, coolant and fuel and determine the necessary action for repair e) carries out routine engine maintenance/service f) Diagnose the cause of excessive oil consumption, coolant consumption, unusual engine exhaust color and odor; determine needed action.
Cylinder Head and Valve Train Diagnosis and Repair	a) Remove cylinder heads, disassemble, clean, and prepare for inspection. b) Visually inspect cylinder heads for cracks, warpage, corrosion, leakage, and the condition of passages; determine needed repairs. c) Inspect and repair damaged threads where allowed; install core and gallery plugs. d) Inspect, test, and verify valve springs for squareness, pressure, and free height comparison; replace as needed. e) Inspect valve spring retainers, rotators, valve locks, and valve lock grooves. f) Replace valve stem seals. g) Inspect valve guides for wear; check valve stem-to-guide clearance; determine needed repairs. h) Inspect valves and valve seats; determine needed repairs.	a) dismantles the cylinder head and inspects it for any damages b) tests and inspects cylinder head components for wear. c) services cylinder head and its components d) performs valve adjustment and timing according to manufacturer's specification

	i) Check valve spring installed (assembled) height and valve stem height; determine needed repairs. j) Inspect pushrods, rocker arms, rocker arm pivots, and rocker arm shafts for wear, bending, cracks, looseness, and blocked oil passages; repair or replace as required. k) Inspect hydraulic or mechanical lifters/lash adjusters; replace as needed. l) Adjust valves on engines with mechanical or hydraulic lifters. m) Inspect camshaft drive gear train components (includes gear, chain and belt systems); repair or replace as needed. n) Inspect and measure camshaft journals and lobes; measure camshaft lift; determine needed repairs. o) Inspect and measure camshaft bore for wear, damage, out-of-round, and alignment; determine needed repairs. p) Inspect valve timing; time camshaft(s) to crankshaft. q) Inspect cylinder head mating surface condition and finish, reassemble and install gasket(s) and cylinder head(s); replace/torque bolts according to manufacturers' procedures. r) Inspect overhead camshaft variable valve timing components; repair or replace as needed. s) Inspect variable valve lift components; repair or replace as needed.	
Wedge tools and setting Torque application	a) Identifying the classes of levers in relation to engine dismantling tools belong (spanners, hammers, screw drivers among others) b) Computes the torque applied to a spanner to loosen or tighten a cylinder head bolt or nut given the length of a spanner c) Setting various torques on a torque wrench	a) Differentiates between the classes of levers b) Computes and sets various torques on a torque wrench
The Cam	a) Construct the displacement diagram and cam profile of a cam with flat follower for one complete revolution of the cam b) Inspecting valve opening and closure (proper seating and sealing)	a) construct the different forms of cams and cam profiles b) inspects the cam for any irregularities or wear by observing its profile
Engine Block Diagnosis and Repair	a) Remove and disassemble engine block; clean, identify selective parts, mark location and orientation, and prepare components for inspection and reassembly. b) Visually inspect engine block for cracks, corrosion, the condition of passages, core	a) dismantles the engine block b) inspects entire engine block for wear and measures ovality and tapper of bores and engine blocks flatness c) measures and inspects journal bearings for wear.

	and gallery plug hole condition, surface warpage, and surface finish and condition; inspect piston oil cooling nozzle/jets for damage, proper alignment and restrictions; determine needed action. c) Inspect and repair damaged threads where allowed; install core and gallery plugs. d) Clean and inspect cylinder walls; measure cylinder bore; determine needed action. e) Inspect crankshaft for endplay, journal damage, keyway damage, visual surface cracks, thrust flange and sealing surface condition; check oil passage condition; measure journal wear; check crankshaft reluctor ring/tone wheel (where applicable); determine needed action. f) Inspect main bearing wear patterns; inspect and measure main bearing bores and cap alignment; mark caps for location and direction; clean and inspect crankshaft girdle (bed plate/ladder) where applicable. g) Install main bearings and crankshaft; check bearing clearances and endplay; inspect, replace and torque bolts according to manufacturer's procedures. h) Inspect camshaft bearings for excessive wear and alignment; replace bearings if necessary; install camshaft, timing chain and gears; check endplay. i) Inspect auxiliary (balance, intermediate, idler, counterbalance or silencer) shaft(s), drive(s)/gear(s), chain(s), and support bearings for damage and wear; time balance shaft to crankshaft; determine needed action. j) Inspect, measure, service or replace pistons and piston/wrist pins; identify piston and bearing wear patterns caused by connecting rod alignment concerns; determine needed action. k) Inspect connecting rods and bearings for damage, bore condition, and pin fit; mark caps for location and direction; determine needed action. l) Inspect, measure, and install or replace piston rings; assemble piston and connecting rod; install piston/rod assembly; check bearing clearance and side-play; install connecting rod bearings; inspect, replace and torque fasteners according to manufacturer's procedures.	d) grind and reface engine block as specified by manufacturer

	m) Inspect, reinstall or replace crankshaft vibration damper/harmonic balancer. n) Inspect crankshaft flange and flywheel mating surfaces; inspect and replace crankshaft pilot bearing/bushing (if applicable); inspect flywheel/flex-plate and flywheel ring gear for cracks and wear (includes dual-mass flywheel); measure flywheel run-out; determine needed action. o) Inspect and replace pans and covers. p) Assemble the engine using gaskets, seals, formed-in-place (tube-applied) sealants, and thread sealers according to manufacturers' specifications; reinstall engine; prime lubrication system as needed. q) Inspect in-block camshaft variable valve timing components; repair or replace as needed. r) Inspect cylinder deactivation system; determine needed action.	
Determination of Engine capacity	a) Measure the cylinder bore and stroke b) Compute the clearance and swept volume for each cylinder c) Compute the engine capacity	measures cylinder bore and stroke and uses these to compute engine capacity and compression ratio for a given engine
Conversion of basic units	a) Metric conversion of SI Units b) Fractions(L.C.M and H.C.M) and decimals	performs elementary conversion and manipulation of SI units
Mensuration	Calculation of area, perimeter, volume and total surface area	determines engine capacity
Inspecting Engine revolutions (speed)	a) Compute the force applied on the piston during the power/ expansion stroke for a given gas pressure b) Hence compute the force exerted by the connecting rod to rotate the crankshaft c) Compute the speed of the crankshaft which is the engine speed.	a) determines the force applied to the piston during the power stoke b) determines the engine rpm
Inspecting cylinder bore wear	a) Measure the ovality and taper of the cylinder b) Determine the piston and ring size to fit the rebored cylinder c) Rebore the cylinder to the available standard piston size.	
Determining TDC and BDC for an internal Combustion engine	a) Applying the principles of loci construct the loci of a point on a connecting rod of a trunk slider(piston) mechanism on complete rev of the crank shaft b) Determine the top dead and bottom dead centres	a) Constructs the crank slider mechanism and determines the length of the stroke b) Determines the strokes made by the piston per crankshaft revolution.

	c) Measure the stroke of the piston/slider for one complete rev of the crank shaft	
Orthographic and isometric projection	a) Draw to a given scale the engine component in: i. Isometric projection. ii. Oblique projection b) Draw in the engine components in: i. First angle orthographic projection ii. Third angle orthographic projection	a) Constructs the isometric, oblique and orthographic projection of engine parts b) Interprets working/ production drawings
Using Assembly drawings to dismantle and assemble engine and its components	a) Interpret the drawings by the manufacturer b) Relate and assemble or dismantle parts as instructed by the manufacturers Assembly drawing.	relates and assembles engine parts as specified by manufacturer's production drawings
Cooling and lubrication Systems Diagnosis and Repair	a) Diagnose engine lubrication system problems; perform oil pressure tests; perform engine oil dye test; determine needed action. b) Disassemble and inspect oil pump (includes gears, rotors, housing, pick-up assembly and variable displacement components); measure oil pump clearance; inspect pressure relief devices, control systems, and pump drive (includes belt/chain drive); determine needed action. c) Inspect, flush, and test internal and external engine oil coolers; determine needed action. d) Change engine oil and filter(s) using proper type, viscosity, and rating per manufacturer's specifications. e) Perform cooling system pressure tests; perform coolant dye test; determine needed action. f) Inspect and test radiator, heater core, pressure cap, and coolant recovery system; replace as required. g) Inspect, reinstall or replace, and adjust drive belt(s), tensioner(s), and pulleys. h) Inspect and replace engine cooling system and heater system hoses, pipes, fittings and valves. i) Inspect, test, reinstall or replace thermostat, coolant by-pass, and thermostat housing (including electronically controlled thermostats). j) Inspect and replace water pump(s) (including electrical water pumps).	The Trainee: 1.describes the constructional details of the air and water cooling system 2.identifies the causes of engine overcooling and performs the necessary action 3.replaces the water pump tensions fan belts, flushes/cleans the radiator 4.repairs the radiator leaks provides preventive maintenance to the cooling system

	k) Inspect and test coolant; drain, flush, and refill cooling system with recommended coolant; bleed air as required. l) Inspect and test fan (both electrical and mechanical), fan clutch, fan shroud, air dams, and cooling fan electrical circuits; repair or replace as required. m) Verify proper operation of engine related warning indicators.	
Viscosity of lubrication oil (both use and new oil)	a) Explain the properties of lubricating oil b) Check the viscosity of used oil in the engine prior to change c) For new engine oil read and interprete the S.A.E number before using it for engine service. d) Compare with the manufacturer's recommended oil viscosity before use	a) checks viscosity of engine oil and takes action as required b) Selects correct lubrication oil in accordance to manufacturer's specification
Temperature and Heat	a) Explain the process by which heat flows through liquids, solids and gases. b) Describe the changes of state that occur in an engine cooling system. c) Explain the ways by which heat is dissipation from an engine cooling system d) Inspect and write down the temperature at which a thermostat opens and closes e) Compute the amount of heat dissipated to the cooling water at the commencement of circulation	inspects the engine temperature and takes necessary action
Fuel, Ignition, Intake and Exhaust Systems Inspection and Service	a) Inspect, clean or replace fuel injection system components (including gasoline direct injection/GDI), intake manifold, and gaskets. b) Inspect, service or replace air filters, filter housings, and intake ductwork. c) Inspect turbocharger/supercharger systems; determine needed action. d) Test engine cranking system; determine needed repairs. e) Inspect and test positive crankcase ventilation (PCV) system components; replace as f) Locate and inspect Exhaust manifolds, Gaskets, Brackets, Clamps, Hangers & Flanges, Heat Shields & Insulators g) Exhaust pipes & tubing, Catalytic converter, Oxygen sensors, Mufflers/silencer, Exhaust pipe, connection joints, exhaust mountings and hanger brackets h) Diagonise faults of:	a) describes the constructional details of the air and water cooling system b) identifies the causes of engine overcooling and performs the necessary action c) replaces the water pump d) Tensions fan belts e) flushes/cleans the radiator f) repairs the radiator leaks g) provides preventive maintenance to the cooling system

	i) excessive loud noises while driving ii) engine misfires iii) gasoline odors iv) decrease in acceleration or power v) decrease in fuel efficiency vi) vibrations	
Properties of gases	a) Absolute temperature and pressure b) Apply Boyle's and Charles' law during compression and expansion (power) strokes. c) Determine Compression ratio of engine d) Determine Specific heat of gases during combustion e) Describe Adiabatic and isothermal expansion and compression in engine cycles	a) applies the science of properties of gases to engine cycles b) draws the P-V graphs for the internal combustion engine for both CI and SI
Integration	Determine the work done which is the area under the P-V graph	determine the horse power of a given engine

Module 4: MANUAL TRANSMISSION, DRIVE TRAIN AND AXLES

Total contact hours: 108

Training Outcome: By the end of the module the trainee should be able to maintain, service and repair Automotive - Manual Transmission, Drive Train and Axles.

SUB-MODULE	DUTIES/TASKS	COMPETENCES
Clutch Diagnosis and Repair	a) Diagnose clutch noise, binding, slippage, pulsation, chatter, pedal feel/effort, and release problems; determine needed repairs. b) Inspect, adjust, and replace clutch pedal linkage, brackets, bushings, pivots, springs, and electrical switches. c) Inspect, adjust, replace, and bleed hydraulic clutch slave/release cylinder, master cylinder, lines, and hoses; clean and flush hydraulic system; refill with proper fluid. d) Inspect, adjust, and replace release (throw-out) bearing, bearing retainer, lever, and pivot. e) Inspect and replace clutch disc and pressure plate assembly; inspect input shaft pilot and splines. f) Inspect pilot bearing/bushing inner and outer bores; inspect and replace pilot bearing/bushing. g) Inspect and measure flywheel and ring gear; inspect dual-mass flywheel where required; repair or replace as necessary. h) Inspect engine block, clutch (bell) housing, transmission case mating surfaces, and alignment dowels; inspect engine core plugs, rear main engine seal, and other sources of fluid contamination; determine needed repairs. i) Measure flywheel surface run-out and crankshaft end play; determine needed repairs. j) Inspect, replace, and align powertrain mounts.	a) identifies the various types of manual transmission system b) tests the manual transmission system for normal operation and recommends accordingly c) diagnoses the manual transmission system faults and takes decisions. d) maintains and repairs the manual transmission system as required. e) assembles and aligns manual transmission parts as specified by the manufacturer f) ensures health, safety and security when working on manual transmission systems.
Frictional torque transmitted by clutches	a) Count the number of springs and measure the force that can be transmitted by each b) Count the number of frictional faces c) Measure the mean radius of clutch plate(s) from the centre. d) Compute the torque transmitted by the clutch	

Transmission Diagnosis and Repair	a) Diagnose transmission noise, difficult shifting, gear clash, jumping out of gear, fluid condition and type, and fluid leakage problems; determine needed repairs. b) Inspect, adjust, lubricate and replace transmission external shift assemblies, linkages, brackets, bushings/grommets, cables, pivots, and levers. c) Inspect and replace transmission gaskets, sealants, seals, and fasteners; inspect sealing surfaces. d) Remove and replace transmission; inspect transmission mounts. e) Disassemble and clean transmission components; reassemble transmission. f) Inspect, repair, and/or replace transmission shift cover and internal shift forks, bushings, bearings, levers, shafts, sleeves, detent mechanisms, interlocks, and springs. g) Inspect and replace input (clutch) shaft, bearings, and retainers. h) Inspect and replace output (main) shaft, gears, thrust washers, bearings, and retainers/ snap rings; measure clearance and end play. i) Inspect and replace synchronizer hub, sleeve, keys (inserts), springs, and blocking (synchronizing) rings/mechanisms; measure blocking ring clearance. j) Inspect and replace countershaft, counter (cluster) gear, bearings, thrust washers, and retainers/snap rings. k) Inspect and replace reverse idler gear, shaft, bearings/bushings, thrust washers, and retainers/snap rings. l) Measure and adjust bearing preload or end play (shim/spacer selection procedure). m) Inspect, repair, and replace extension housing and transmission case mating surfaces, bores, dowels, bushings, and vents. n) Inspect and replace transmission components related to speedometer operation. o) Inspect, test, and replace transmission sensors, actuators, and switches. p) Inspect lubrication systems. q) Check fluid level; refill with recommended fluid.	

Transaxle (Transfer Gear box) Gear box Diagnosis and Repair	a) Diagnose transaxle noise, difficult shifting, gear clash, jumping out of gear, fluid condition and type, and fluid leakage problems; determine needed repairs. b) Inspect, adjust, lubricate and replace transaxle external shift assemblies, linkages, brackets, bushings/grommets, cables, pivots, and levers. c) Inspect and replace transaxle gaskets, sealants, seals, and fasteners; inspect sealing surfaces. d) Remove and replace transaxle; inspect, replace, and align transaxle mounts and e) Sub-frame/cradle assembly f) Disassemble and clean transaxle components; reassemble transaxle. g) Inspect, repair, and/or replace transaxle shift cover and internal shift forks, levers, bushings, shafts, sleeves, detent mechanisms, interlocks, and springs. h) Inspect and replace input (clutch) shaft and output (main) shaft, gears, thrust washers, bearings, and retainers/snap rings i) Inspect and replace synchronizer hub, sleeve, keys (inserts), springs, and blocking (synchronizing) rings; measure blocking ring clearance. j) Inspect and replace reverse idler gear, shaft, bearings/bushings, thrust washers, and retainers/snap rings. k) Inspect, repair, and/or replace transaxle case mating surfaces, bores, dowels, bushings, bearings, and vents. l) Inspect and replace transaxle components related to speedometer operation. m) Inspect, test, and replace transaxle sensors, actuators, and switches. n) Diagnose differential assembly noise and wear; determine needed repairs. o) Remove and replace differential final drive assembly. p) Inspect, measure, adjust and replace differential pinion (spider) gears, shaft, side gears, thrust washers, side bearings, and case/carrier. q) Diagnose limited slip differential noise, slippage, and chatter problems; determine needed repairs.	

	r) Measure and adjust shaft and differential bearing preload and end play (shim/spacer selection procedure) s) Inspect lubrication systems t) Check fluid level; refill with proper fluid	
Drive Shaft/Half-Shaft and Universal Joint/ Constant Velocity (CV) Joint Diagnosis and Repair (Front and Rear Wheel Drive)	a) Diagnose drive/half shaft and universal/CV joint noise and vibration problems; determine needed repairs. b) Inspect, service, and replace shafts, yokes, boots, and universal/CV joints; verify proper phasing. c) Inspect, service, and replace center support and intermediate shaft bearings. d) Check and correct drive/propeller shaft balance. e) Measure drive shaft run-out. f) Measure and adjust drive shaft working angles. g) Diagnose, inspect, service, and replace wheel bearings, seals, and hubs.	
Drive Axle Diagnosis and Repair	**1. Ring and Pinion Gears** a) Diagnose noise, vibration, and fluid leakage problems; determine needed repairs. b) Inspect and replace companion flange, yoke, and pinion seal; measure companion flange run-out. c) Measure ring gear run-out; determine needed repairs. d) Inspect and replace ring and pinion gear set, collapsible spacers/sleeves, shims, and bearings. e) Measure and adjust drive pinion depth. f) Measure and adjust drive pinion bearing preload (collapsible spacer sleeve or shim type). g) Measure and adjust differential (side) bearing preload, and ring and pinion backlash (threaded adjuster or shim type). h) Perform ring and pinion tooth contact pattern checks; determine needed adjustments. **2. Differential Case/Carrier Assembly** a) Diagnose differential assembly noise and vibration problems; determine needed repairs. b) Remove and replace differential assembly.	

	c) Inspect, measure, adjust and replace differential pinion (spider) gears, shaft, side gears, thrust washers, side bearings, and case/carrier. d) Measure differential case/carrier run-out; determine needed repairs. **3. Limited Slip/Locking Differential** a) Diagnose limited slip differential noise, slippage, and chatter problems; determine needed repairs. b) Inspect, drain, and refill with proper lubricant. c) Inspect, adjust, repair or replace limited slip or locking assembly components. **4. Axle Shafts and Housing** a) Diagnose rear axle shaft noise, vibration, and fluid leakage problems; determine needed repairs. b) Inspect and replace rear axle shaft wheel studs. c) Remove, inspect, adjust, and/or replace rear axle shafts, splines, seals, bearings, and retainers. d) Measure rear axle flange run-out and shaft end play; determine needed repairs. e) Inspect axle housing and vent.	
Four-Wheel Drive /Full-Wheel Drive Component Diagnosis and Repair	a) Diagnose drive assembly noise, vibration, leakage and steering problems; determine needed repairs. b) Inspect, adjust, and repair transfer case manual shifting mechanisms, bushings, mounts, levers, and brackets. c) Remove and replace transfer case. d) Disassemble transfer case; clean and inspect internal transfer case components; determine needed repairs. e) Reassemble transfer case. f) Check transfer case fluid level; drain and refill with proper fluid. g) Inspect, service, and replace drive/propeller shaft and universal/CV joints. h) Inspect, service, and replace drive axle universal/CV joints and drive/half-shafts. i) Inspect, service, and replace wheel bearings, seals, and hubs.	

	j) Check transfer case and axle seals and all vents. k) Diagnose drive system actuation and engagement concerns; repair or replace components as necessary (including: viscous, hydraulic, magnetic, mechanical, vacuum, and electrical/electronic). l) Inspect tyres for condition and matching circumference; verify proper size for vehicle application.	
Ratios, proportions and percentages in gear mesh analysis	Compute, Simplify ratios and calculate percentages	determines the gear ratios of simple and compound gears using the knowledge of ratios and proportions.
Gearbox ratio, Rear Axle ratio, Overall gear ratio and Efficiency of the drive train	Perform the necessary calculations for gears in mesh	a) Compute the gearbox ratio for each gear (both forward and reverse gears) b) Compute the rear axle ratio c) Compute the overall gear ratio d) Compute the mechanical advantage and velocity ratio of the drive
Involute Gear construction	Construct the involute gear.	a) Computes gear data from given data b) applies the various geometrical techniques to construct the involute gear.

Module 5: AUTOMATIC TRANSMISSION /TRANS-AXLE

Total contact hours: 70

Training Outcome: By the end of the module the trainee should be able to maintain, service and repair Automotive - Automatic Transmission /Transaxle.

SUB-MODULE	DUTIES/TASKS	COMPETENCES
General Transmission /Transaxle Diagnosis	**1. Mechanical/Hydraulic Systems** a) Road test the vehicle to verify mechanical/hydraulic system problems based on driver's concern; research vehicle service history; determine necessary action. b) Diagnose noise, vibration, harshness, and shift quality problems; determine necessary action. c) Diagnose fluid loss, type, level, and condition problems; determine necessary action. d) Perform pressure tests; determine necessary action. e) Diagnose torque converter stator/one-way clutch failure; determine necessary action.	a) identifies the various types of automatic transmission system b) identifies the systems and parts of the automatic transmission c) identifies Automatic Transmission Fluid (ATF) according to manufacturer's specification d) maintains and services the automatic transmission system

	f) Perform torque converter clutch (lock-up converter) mechanical/hydraulic system tests; determine necessary action. **2. Electronic Systems** a) Road test the vehicle to verify electronic system problems based on driver's concern; search vehicle service history; determine necessary action. b) Diagnose pressure concerns on transmissions equipped with electronic pressure control; determine necessary action. c) Perform torque converter clutch (lock up converter) electronic system tests; determine necessary action. d) Diagnose electronic transmission control systems using appropriate test equipment, service information, technical service bulletins, and schematics; diagnose problems in electrical/electronic circuits (including data communications); determine necessary action. e) Verify proper operation of charging system; check battery, connections, and power/ground circuits. f) Differentiate between engine performance, or other vehicle systems, and transmission/ transaxle related problems; determine necessary action. g) Diagnose shift quality concerns resulting from problems in the electronic transmission control system; determine necessary action.	e) diagnoses automatic transmission system faults and take decisions on what to do. f) Differentiate between engine performance, or other vehicle systems, and transmission/ transaxle related problems g) dismantles the automatic transmission system. h) maintains and repairs the automatic transmission system as required. i) assembles the automatic transmission system parts correctly ensures health, safety and security. j) performs a stall test on the transmission system
In-Vehicle Transmission/Transaxle Maintenance and Repair	a) Inspect, adjust, and replace manual valve shift linkage and transmission range sensor/ switch (inhibitor/neutral safety switch). b) Inspect and replace external seals and gaskets. c) Inspect and replace driveshaft yoke, drive axle joints, bushings, and seals. d) Check condition and operation of engine cooling system; inspect transmission cooler, lines and fittings. e) Inspect valve body mating surfaces, bores, valves, springs, sleeves, retainers, brackets, check balls, screens, spacer plates, and gaskets; replace as necessary. f) Torque valve body fasteners to specification using the proper sequence. g) Inspect accumulator and servo bores, pistons, seals, pins/pin bores, springs, and retainers; repair or replace as necessary. h) Inspect, test, adjust, repair, or replace electrical/electronic components and circuits	

	including control modules, solenoids, sensors, relays, terminals, connectors, switches, and harnesses; inspect, test, and verify control module inputs, outputs, and data communications. i) Inspect, replace, and/or align power train mounts. j) Replace fluid and filter(s); verify proper fluid level and type (for transmissions with, or without, a dipstick).	
Off-Vehicle Transmission/Transaxle Repair	1. **Removal and Installation** a) Remove and install transmission/transaxle; inspect engine core plugs, rear crankshaft seal, transmission dowel pins, dowel pin holes, and mating surfaces. b) Inspect converter flex (drive) plate, converter attaching bolts, converter pilot, crankshaft pilot bore, converter pump drive surfaces. c) Install torque converter and establish correct converter-to-pump engagement; inspect converter free movement for pilot engagement during transmission installation. d) Inspect, test, flush or replace transmission fluid cooler. e) Inspect brackets, wiring harnesses, fuel lines, heat shields, inspection covers, vents, cooler lines, and related components for proper routing and installation. f) Perform module or component coding and/or programming (including adaptive learning reset); road test to confirm proper operation. 2. **Disassembly and Assembly** a) Disassemble, clean, and inspect transmission case, sub-assemblies, mating surfaces, and thread condition. b) Inspect and measure fluid pump components; replace as necessary. c) Check bearing preload; inspect, measure, and adjust as needed. d) Check end play; inspect, measure, and adjust as needed. e) Inspect shafts; replace as necessary. f) Inspect fluid delivery circuit, including seal rings, ring grooves, sealing surface areas, feed pipes, orifices, and encapsulated check valves (balls). g) Inspect and/or measure bushings, thrust washers, and bearings; replace as necessary. h) Inspect and measure components of the planetary gear assembly; replace as necessary.	

	i) Inspect case bores, passages, bushings, vents, mating surfaces, and dowel pins; repair or replace as necessary. j) Inspect valve body mating surfaces, bores, valves, solenoids, springs, sleeves, retainers, brackets, check balls, screens, spacer plates, and gaskets; replace as necessary. k) Inspect transmission/transaxle drive chains, sprockets, belts, pulleys/sheaves, gears, bearings, and bushings; replace as necessary. l) Inspect and measure transaxle final drive components; repair, replace and/or adjust as necessary. m) Assemble after repair. 3. **Friction and Reaction Units** a) Inspect components of the hydraulic clutch pack assembly; replace as necessary. b) Measure clutch pack clearance; adjust as necessary. c) Air test the operation of clutch and servo assemblies. d) Inspect components of one way clutch assemblies; replace as necessary. e) Inspect bands and drums (housings/ cylinders); replace and/or adjust as necessary.	
Using Assembly drawings to dismantle and assemble Transmission and its components	a) Interpret the drawings given by the manufacturer manual. b) Relate and assemble or dismantle parts as instructed by the manufacturers Assembly drawing. c) Construct a sectional view on a given cutting plane for the assembly	

Module 6: SUSPENSION AND STEERING

Total contact hours: 52

Training Outcome: By the end of the module the trainee should be able to maintain, service and repair Vehicle Steering and Suspension systems

SUB-MODULE	DUTIES/TASKS	COMPETENCE
Steering Systems Diagnosis and Repair	**1. Steering Columns** a) Diagnose steering column noises and steering effort concerns (including manual and electronic tilt and telescoping mechanisms); determine needed action. b) Inspect and replace steering column, steering shaft U-joint(s), flexible coupling(s), collapsible columns, intermediate shafts, and steering wheels (including steering wheels and columns equipped with airbags and/or other steering wheel/column mounted controls, sensors, and components). c) Disable, enable, and properly handle airbag system components during vehicle service following manufacturers' procedures. d) Diagnose, inspect, adjust, repair or replace components (including motors, sensors, switches, actuators, harnesses, and control units) of steering column-mounted, electronically controlled, hydraulically and/or electrically assisted steering systems; initialize systems as required. 2. **Steering Units** a) Diagnose steering gear (non-rack and pinion type) noises, binding, vibration, b) Free-play, steering effort, steering pull (lead), and leakage concerns; determine needed action. c) Diagnose rack and pinion steering gear noises, binding, vibration, free-play, steering effort, steering pull (lead), and leakage concerns; determine needed action. d) Inspect power steering fluid level and condition; determine fluid type and adjust fluid level in accordance with vehicle manufacturers' recommendations.	a) adjusts and sets the various steering geometry angles in relation to Ackermann's principle as recommended by the manufacturer b) diagnoses steering and suspension systems faults and takes necessary decisions. c) differentiates between steering and suspension system faults. d) performs wheel alignment according to the manufacturer's specifications. e) maintains services and repairs the steering and suspension system as required. f) ensures health, safety and security when working on the steering and suspension system.

	e) Inspect, adjust, align, and replace power steering pump belt(s), tensioners, and pulleys. f) Diagnose power steering pump noises, vibration, and fluid leakage; determine needed action. g) Remove and replace power steering pump; inspect pump mounting and attaching brackets; remove and replace power steering pump pulley; transfer related components. h) Perform power steering system pressure and flow tests; determine needed action. i) Inspect and replace power steering hoses, fittings, O-rings, coolers, and filters. j) Inspect steering gear (non-rack and pinion type) seals and gaskets; remove and replace steering gear. k) Remove and replace rack and pinion steering gear; inspect mounting services; inspect and replace mounting bushings and brackets. l) Adjust steering gear (non-rack and pinion type) worm bearing preload and sector lash. m) Adjust rack and pinion steering gear. n) Inspect and replace rack and pinion steering gear bellows/boots. o) Flush, fill, and bleed power steering system. p) Diagnose, inspect, repair or replace components of variable-assist and/or variable ratio steering systems. q) Diagnose, inspect, adjust, repair or replace components (including motors, sensors, switches, actuators, harnesses, and control units) of rack-mounted, electronically controlled, hydraulically and/or electrically assisted steering systems; initialize systems as required. 3. **Steering Linkage** a) Inspect and adjust (where applicable) front and rear steering linkage geometry. b) Inspect and replace pitman arm. c) Inspect and replace center link (relay rod/drag link/intermediate rod). d) Inspect, adjust (where applicable), and replace idler arm and mountings. e) Inspect, replace, and adjust tie rods, tie rod sleeves/adjusters, clamps, and tie rod ends.	

	f) Inspect and replace steering linkage damper(s).	
Forces on vehicles	a) Determine the maximum velocity during cornering. b) Determine overturning and skidding speeds for a given steering radius.	analyses overturning and skidding speeds for a given track radius and vehicle dimesions.
Steering system calculations	a) Measure the diameter of the steering wheel b) Count the number of turns of a steering wheel used to move a drop from lock to lock. c) Compute the steering box gear ratio. d) Compute the torque applied to the steering wheel for a given effort/force by the driver e) Compute the efficiency of the steering system. f) Hence suggest ways of reducing the driver's effort on the steering wheel using the above analyses.	
Steering angles	Compute the cornering angles for a given vehicle steering geometry	computes the cornering angles for a given Ackermann's layout
Suspension Systems Diagnosis and Repair	1. **Front Suspensions** a) Diagnose front suspension system noises, handling, ride height and ride quality concerns; determine needed action. b) Inspect and replace upper and lower control arms, bushings, hardware, and shafts. c) Inspect and replace rebound and jounce bumpers/bump stops. d) Inspect, adjust, and replace track bar, strut rods/radius arms, and related mounts/ bushings. e) Inspect and replace upper and lower ball joints. f) Inspect solid front axle assembly for damage and misalignment. g) Inspect and replace front steering knuckle/spindle assemblies and steering arms. h) Inspect and replace front suspension system coil springs and spring insulators (silencers). i) Inspect and replace front strut(s), strut bearing(s) and strut mount(s). j) Inspect, replace, and adjust front suspension system torsion bars and mounts. k) Inspect and replace front stabilizer bar (sway bar), bushings, brackets, and links. l) Inspect and replace shock absorbers, mounts, and bushings.	

	m) Diagnose, service and/or replace front wheel bearings and/or hub assemblies. n) Diagnose, inspect, adjust, repair or replace components (including sensors, switches, actuators, harnesses, and control units) of electrically/hydraulically/pneumatically controlled suspension systems (including primary and supplemental suspension and ride control systems); initialize as needed. o) Inspect and repair front sub-frame/cradle/cross-member mountings, bushings, brackets, and bolts. 2. **Rear Suspensions** a) Diagnose rear suspension system noises, handling, ride height and ride quality concerns; determine needed action. b) Inspect and replace rear suspension system coil springs and spring insulators (silencers). c) Inspect and replace rear suspension system lateral links/arms (track bars), control (trailing) arms, stabilizer bars (sway bars), bushings, and mounts. d) Inspect and replace rear suspension system leaf spring(s), leaf spring insulators (silencers), shackles, brackets, bushings, center pins/bolts, U-bolts, and mounts. e) Inspect and replace rear rebound and jounce bumpers/bump stops. f) Inspect and replace rear strut and/or upper strut mount. g) Inspect non-independent rear axle assembly for damage and misalignment. h) Inspect and replace rear ball joints and tie rod/toe link assemblies. i) Inspect and replace rear knuckle/spindle assembly. j) Inspect and replace shock absorbers, mounts, and bushings. k) Diagnose, service, and/or replace rear wheel bearings and/or hub assemblies. l) Diagnose, inspect, adjust, repair or replace components (including sensors, switches, actuators, harnesses, and control units) of electrically/hydraulically/pneumatically controlled suspension systems (including primary and supplemental suspension and ride control systems).	

	m) Inspect and repair rear sub-frame/cradle/cross-member mountings, bushings, brackets and bolts.	
Application of Simple Harmonic Motion in the Suspension system analysis	a) Explain the conditions for a system to execute simple harmonic motion b) Demonstrate how periodic motion is applied to the suspension system. c) Compute the amplitude of a coil and leaf spring for a given vehicle weight and deflection by a hump or road surface irregularity d) Explain damped oscillations in the suspension system as applied to SHM	

Module 7: BRAKE SYSTEMS

Total contact hours: 60

Training Outcome: By the end of the module the trainee should be able to maintain, service and repair Vehicle Brake systems.

SUB-MODULES	DUTIES /TASKS	COMPETENCES
Hydraulic, Power Assist, and Parking Brake Systems Diagnosis and Repair	**1. Master Cylinder** a) Diagnose poor stopping, dragging, high or low pedal, and hard or spongy pedal caused by the master cylinder; determine needed repairs. b) Measure and adjust master cylinder pushrod length. c) Check master cylinder for failures by pressing brake pedal; determine needed repairs. d) Diagnose the cause of master cylinder external fluid leakage. e) Remove and replace master cylinder; bench bleed and install master cylinder; verify master cylinder function. 2. **Lines and Hoses** a) Diagnose poor stopping, pulling or dragging caused by problems in the lines and hoses; determine needed repairs. b) Inspect brake lines and fittings for leaks, dents, kinks, rust, cracks or wear; c) inspect for loose fittings and supports; determine needed repairs.	a) inspects and tests brakes for normal operation and comes up with necessary decisions b) diagonises braking system faults and takes necessary action c) carries out the necessary replacement of faulty components of the braking system d) performs the necessary brake adjustments and bleeding. e) ensures health, safety and security when working on the braking system. f) Inspects the brake drum, pads, shoes and discs for wear and takes necessary action.

	d) Inspect flexible brake hoses for leaks, kinks, cracks, bulging, wear or corrosion; e) inspect for loose fittings and supports; determine needed repairs. f) Replace brake lines, hoses, fittings and supports; fabricate brake lines using proper material and flaring procedures (double flare and ISO types). g) Inspect brake lines and hoses for proper routing and support. **3. Valves and Switches** a) Diagnose poor stopping, pulling or dragging caused by problems in the hydraulic system valve(s); determine needed repairs. b) Inspect, test and replace metering, proportioning, pressure differential and combination valves. c) Inspect, test, replace and adjust load or height sensing-type proportioning valve(s). d) Inspect, test and replace brake system warning lights, indicators, switches, sensors and circuits; test, adjust and repair or replace brake stop light/brake pedal position switch sensor, lamps and related circuits. **4. Bleeding, Flushing and Leak Testing** a) Diagnose poor stopping, pulling, dragging or incorrect pedal travel caused by problems in the brake fluid; determined needed repairs. b) Bleed and/or flush hydraulic system using manual, pressure, vacuum or gravity method(s). c) Pressure test brake hydraulic system. d) Select, handle, store and install proper brake fluids (including silicone fluids). Fill master cylinder to proper level. **5. Power Assist Units**	

	a) Inspect and test brake pedal linkage for binding, looseness and adjustment; determine needed repairs. b) Test pedal free travel with and without engine running to check power booster operation. c) Check vacuum supply (manifold or auxiliary pump) to vacuum-type power booster. d) Diagnose vacuum-type power booster unit for vacuum leaks and proper operation; inspect the check valve for proper operation; repair, adjust or replace parts as necessary. e) Diagnose hydro-boost system for leaks and proper operation; repair or replace parts as necessary; refill and bleed system following manufacturers' specifications. f) Diagnose electronic brake servo/brake simulator system for proper operation; determine needed repairs. **6. ► Parking Brake** a) Diagnose parking brake system operation (including electronic parking brakes); inspect cables and parts for wear, rust and corrosion; clean or replace parts as necessary; lubricate assembly. b) Adjust parking brake assembly; check operation. c) Test the parking brake indicator light, switch and wiring. d) Retract integral and/or electronic parking brake caliper piston(s) according to manufacturers' specifications. e) Adjust calipers with integrated parking brakes according to manufacturers' recommendations.	
Inspection of retardation/ braking force	a) Measure the diameter of the wheels and master cylinder pistons. b) Compute the braking force on the drum or disc for a given driver's effort applied on the brake pedal	checks the braking force and adjusts the free-play.
Drum Brake Diagnosis and Repair	a) Diagnose poor stopping, pulling, dragging or incorrect pedal travel	

	caused by drum brake hydraulic problems; determine needed repairs. b) Diagnose poor stopping, noise, pulling, grabbing, dragging, pedal pulsation or incorrect pedal travel caused by drum brake mechanical problems; determine needed repairs. c) Remove, clean, inspect and measure brake drums; follow manufacturers' recommendations in determining need to machine or replace. d) Machine drums according to manufacturers' procedures and specifications. e) Using proper safety procedures, remove, clean and inspect mechanical brake components, such as: shoes/linings, springs, pins, self-adjusters, levers, clips, brake backing (support) plates and other related brake hardware; determine needed repairs. f) Lubricate brake shoe support pads on backing (support) plate, self-adjuster mechanisms and other brake hardware. g) Inspect wheel cylinder(s) for leakage, operation and mounting; remove and replace wheel cylinder(s); bleed system. h) Following manufacturers' specifications, install brake shoes and related hardware. i) Pre-adjust brake shoes and parking brake before installing brake drums or drum/hub assemblies and wheel bearings. j) Reinstall wheel, torque lug nuts, and make final checks and adjustments. k) Diagnose wheel bearing noises and vibration problems; determine needed repairs. l) Remove, clean, inspect, repack wheel bearings or replace wheel bearings and races; replace seals; replace hub and bearing assemblies; adjust wheel/hub bearings according to manufacturers' specifications.	
Friction	a) Explain the importance of friction in brakes	explains the importance of friction in brakes.

	b) Compute the frictional force given the coefficient of friction between the pad and disc or drum and shoe lining. c) Determine the braking efficiency of a vehicle using its stopping distances and other parameters.	
Disc Brake Diagnosis and Repair	a) Diagnose poor stopping, pulling, dragging or incorrect pedal travel caused by disc brake hydraulic problems; determine needed repairs. b) Diagnose poor stopping, noise, pulling, grabbing, dragging, pedal pulsation or incorrect pedal travel caused by disc brake mechanical problems; determine needed repairs. c) Retract brake caliper piston(s) according to manufacturers' recommendations. d) Remove caliper assembly from mountings; inspect for leaks and damage to caliper housing. e) Clean and inspect caliper mountings, slides/pins and threads for wear and damage. f) Remove, clean and inspect pads and retaining hardware; determine needed repairs, adjustments and replacements. g) Clean caliper assembly; inspect external parts for wear, rust, scoring and damage; replace any damaged or worn parts; determine the need to repair or replace caliper assembly. h) Clean, inspect and measure rotor with a dial indicator and a micrometer; follow manufacturers' recommendations in determining the need to index, machine or replace the rotor. i) Remove and replace rotor. j) Machine rotor, using on-car or off-car method, according to manufacturers' procedures and specifications. k) Install pads, calipers and related attaching hardware; lubricate components following manufacturers' procedures and specifications; bleed system and inspect for leaks. l) Reinstall wheel, torque lug nuts, and make final checks and adjustments.	

	m) Road test vehicle and burnish/break-in pads according to manufacturer's recommendations. n) Diagnose wheel bearing noises and vibration problems; determine needed repairs. o) Remove, clean, inspect, repack wheel bearings or replace wheel bearings and races; replace seals; replace hub and bearing assemblies; adjust wheel/hub bearings according to manufacturers' specifications. p) Distinguish between brake component vibration and tyre/wheel vibration; determine needed repairs.	
Electronic Brake Control Systems: Antilock Brake System (ABS), Traction Control System (TCS), and Electronic Stability Control System (ESC) Diagnosis and Repair	a) Follow manufacturers' service and safety precautions when inspecting, testing and servicing electronic brake control system hydraulic, electrical, and mechanical components. b) Diagnose increased stopping distance, wheel lock-up, false activation, pedal feel, pedal travel, pedal pulsation and noise concerns associated with the electronic brake control system; determine needed repairs. c) Observe electronic brake control system indicator/light(s) at start-up and during road test; determine if further diagnosis is needed. d) Diagnose electronic brake control system, electronic control(s), components and circuits (with or without DTCs) using on-board diagnosis and/or recommended test equipment such as: scan tool, digital multimeter (DMM), digital storage oscilloscope (DSO); determine needed repairs. e) Bleed and/or flush the electronic brake control hydraulic system following manufacturers' procedures. f) Remove and install electronic brake control system components following manufacturers' procedures and specifications; perform module set-up/initialization. g) Test, diagnose and service electronic brake control system sensors (speed, yaw, steering angle, brake pedal position, etc.) and circuits following	

	manufacturers' recommended procedures (includes output signal, resistance, amperage, shorts to voltage/ground and frequency data.). h) Diagnose electronic brake control system braking concerns caused by vehicle modifications (wheel/tyre size, curb height, final drive ratio, etc.) and other vehicle mechanical and electrical/electronic modifications (communication, security, radio, etc.). i) Repair wiring harness and connectors following manufacturers' procedures. j) Diagnose brake problems resulting from failures of interrelated systems (for example: electronic stability control, antilock brake, traction control, collision avoidance/ mitigation). k) Clear diagnostic trouble codes (DTCs) and verify the repair.	
Service Air Brakes	a) Carry out service on i. Compressor: ii. Reservoirs: iii. Brake chambers: iv. Brake shoes and drums or brake rotors and pads: v. primary and secondary circuits. vi. drain out the wet tank. b) Inspect any rubber boots and seals for ABS connecters and also inspect for any signs of wear. c) Confirm that the push rods and slack adjusters are properly operating, because these are essential to maintaining the adjustment of the brake shoes in relation to the drum. d) Inspect the push rod actuation from the brake chambers, particularly any broken or weak springs. e) Inspect the parking brakes for leaks in each chamber, or damaged components.	
Pneumatic braking system inspection	a) Determine the pressure of air in a reservoir given its specification or by a pressure gauge b) Compute the force applied to an air brake actuator and unloader valve.	carries out pressure checks and reads pressures gauges in the entire pneumatic braking system
Service Auxiliary Brakes	a) Maintain Auxiliary Brake/ Retarders i. Hydraulic Retarders	

(The auxiliary braking systems that improve the safety on the road and provides savings on the service brakes	ii. Exhaust brake/ Retarders iii. Eddy current Retarders b) Carry out Inspection checks on i. Air Clearance ii. Axis Seal iii. Output Shaft Seal iv. Fastening Bolts v. electrical appliances wire connections c) Check and fastening the ground wire	

Module 8: WHEELS AND TYRES

Total contact hours: 56

Training Outcome: By the end of the module the trainee should be able to maintain, service and repair Wheels and Tyres

SUB-MODULE	DUTIES/TASKS	COMPETENCES
Wheel Alignment Diagnosis, Adjustment, and Repair	a) Diagnose vehicle wander, drift, pull, hard steering, bump steer, memory steer, torque steer, and steering return concerns; determine needed action. b) Measure vehicle ride height; determine needed action. c) Measure front and rear wheel camber; determine needed action. d) Adjust front and/or rear wheel camber on suspension systems with a camber adjustment. e) Measure caster; determine needed action. f) Adjust caster on suspension systems with a caster adjustment. g) Measure and adjust front wheel toe. h) Center the steering wheel. i) Measure toe-out-on-turns (turning radius/angle); determine needed action. j) Measure SAI/KPI (steering axis inclination/king pin inclination); determine needed action. k) Measure included angle; determine needed action. l) Measure rear wheel toe; determine needed action. m) Measure thrust angle; determine needed action. n) Measure wheelbase setback/offset; determine needed action.	a) Inspects vehicle wheels and tyres and decides action needed b) Diagonises tyre problems and takes necessary action c) Performs the necessary balancing and alignment of wheels in accordance manufacturers' specifications. d) Comes with documented recommendations for vehicle owners/customers on tyre life

	o) Check front and/or rear sub-frame/cradle/cross-member alignment; determine needed action. p) Perform electronic control module calibration/recalibration; perform initialization or relearn procedure as required. q) Diagnose wheel alignment problems caused by damaged component mounting locations; determine needed action.	
Wheel and Tyre Diagnosis and service	a) Diagnose tyre wear patterns; determine needed action. b) Inspect tyre condition, size, and application (load and speed ratings). c) Measure and adjust tyre air pressure. d) Diagnose wheel/tyre vibration, shimmy, and noise concerns; determine needed action. e) Rotate tyres/wheels and torque fasteners according to manufacturers' recommendations. f) Diagnose problems with radial and lateral run-out of wheel assembly; measure wheel, tyre, axle flange, and hub run-out (radial and lateral); determine needed action. i) Diagnose tyre pull (lead) problems; determine needed action. ii) Dismount and mount tyre on wheel. iii) Balance wheel and tyre assembly. g) Test and diagnose indirect/direct tyre pressure monitoring systems (TPMS); determine needed action; perform system initialization/relearn as required.	
Specifications and recommendations for tyres	a) Check the all the tyres for pressure balance b) Set the tyre pressure to the manufacturer's recommendation. c) For a given tyre surface area, determine the volume of air it can hold at a specified manufacturer's pressure. d) Show that a smaller tyre holds air at a higher pressure than a bigger one.	

Module 9: AUTO-ELECTRICAL / ELECTRONIC SYSTEMS

Total contact hours: 54

Training Outcome: By the end of the module the trainee should be able to maintain, service and repair Automotive Electrical/Electronic systems.

SUB-MODULE	DUTIES/TASKS	COMPETENCE
General Electrical/Electronic System Diagnosis	a) Check voltages and voltage drops in electrical/electronic circuits; interpret readings and determine needed repairs. b) Check current flow in electrical/electronic circuits; interpret readings and determine needed repairs. c) Check continuity and resistances in electrical/electronic circuits and components; interpret readings and determine needed repairs. d) Check electronic circuit waveforms; interpret readings and determine needed repairs. e) Use scan tool data, bidirectional controls, and/or diagnostic trouble codes (DTCs) to diagnose electronic systems; interpret readings and determine necessary action. f) Find shorts, grounds, opens, and resistance problems in electrical/electronic circuits; determine needed repairs. g) Measure and diagnose the cause(s) of abnormal key-off battery drain (parasitic draw); determine needed repairs. h) Inspect, test, and replace fusible links, circuit breakers, fuses, diodes, and current limiting devices. i) Read and interpret electrical schematic diagrams and symbols. j) Research applicable vehicle and service information, such as vehicle service history, service precautions, technical service bulletins, and service campaigns/recalls. k) Diagnose failures in the data bus communications network; determine needed repairs. l) Remove and replace control modules; program, reprogram, code, initialize, and/or configure as needed.	a) trouble shoots electrical and electronic component in the automobile. For instance; fuses, sensors, alternator, battery, switches, flushers, relays ignition coils, starter motor among others b) measures current, voltage and resistance in automobile electronic/ electronic circuits in comparison with manufacturers specifications and takes necessary action c) tests for open, short circuit, ground and proper function of electrical and electronic components in automobile circuits. d) interpretes readings and wave form display of various automotive circuits and systems; comes up with correct decision on rectification if required e) tests automobile batteries, maintains and service them as required. f) starts vehicle and interpretes displays on automobile dashboard for both computerised and non-computerised automobiles; takes necessary action if required.
Battery and Starting System Diagnosis and Repair	a) Perform battery state-of-charge test; determine needed service. b) Perform battery tests (load and capacitance); determine needed service. c) 3. Follow manufacturer's procedure to restore (or maintain if applicable) electronic memory functions. d) Perform battery charge in accordance with manufacturer's recommendations.	

	e) Inspect, clean, repair and/or replace battery(ies), battery cables, connectors, clamps, hold-downs, trays, and vent tubes. f) Jump-start a vehicle using jumper cables, a booster battery or auxiliary power supply. g) Perform starter current draw test; determine needed repairs. h) Perform starter circuit voltage drop tests; determine needed repairs. i) Inspect, test, repair and/or replace starter, relays, solenoids, modules, switches, connectors, and wires of starter circuits. j) Differentiate between electrical and engine mechanical problems that cause a slow crank, no-crank, extended cranking, or a cranking noise condition.	
Charging System Diagnosis and Repair	a) Diagnose charging system problems that cause a no-charge, a low charge, or an overcharge condition; determine needed repairs. b) Inspect, reinstall and/or replace pulleys, tensioners and drive belts; adjust belts and check alignment. c) Perform charging system voltage output test; determine needed repairs. d) Perform charging system current output test; determine needed repairs. e) Inspect and test generator (alternator) control components including sensors, regulators, and modules; determine needed repairs. f) Perform charging circuit voltage drop tests; determine needed repairs. g) Inspect, test, repair and/or replace connectors, terminals, and wires of charging system circuits. h) Remove, inspect, and replace generator (alternator).	
Lighting Systems Diagnosis and Repair	a) Diagnose the cause of brighter than normal, intermittent, dim, and continuous or no operation of exterior lighting; determine needed repairs. b) Inspect, replace, aim and/or level headlight assemblies and auxiliary light assemblies (fog lights/driving lights), including high-intensity discharge (HID) and LED systems. c) Inspect, test, repair and/or replace switches, relays, bulbs, LEDs, sockets, connectors, terminals, wires, and control modules of exterior lighting. d) Diagnose the cause of turn signal and/or hazard light system malfunctions; determine needed repairs. e) Inspect, test, repair and/or replace switches, flasher units, bulbs, sockets, connectors, terminals, wires, and control modules of turn signal and hazard light circuits.	

	f) Diagnose the cause of intermittent, dim, continuous or no operation of interior lighting circuits (such as: courtesy, dome, map, vanity, glove box, cargo, trunk, hood, instrument, and accent lighting); determine needed repairs. g) Inspect, test, repair and/or replace switches, relays, bulbs, sockets, connectors, terminals, wires, and control modules of interior lighting circuits (such as: courtesy, dome, map, vanity, glove box, cargo, trunk, hood, instrument, and accent lighting). h) Inspect, test, repair and/or replace trailer wiring harness, relays, connectors, and control modules (including brake control).	
Instrument Cluster and Driver Information Systems Diagnosis and Repair	a) Diagnose the cause of intermittent, dim, no lights, continuous operation, or no brightness control of instrument lighting circuits; determine needed repairs. b) Inspect, test, repair and/or replace switches, relays, bulbs, LEDs, sockets, connectors, terminals, wires, and control modules of instrument lighting circuits. c) Diagnose the cause of high, low, intermittent, or no readings on electronic instrument cluster gauges; determine needed repairs. d) Diagnose the cause of constant, intermittent, or no operation of warning lights, indicator lights, audible warning devices, and other driver information systems; determine needed repairs. e) Inspect, test, repair and/or replace bulbs, sockets, connectors, terminals, switches, relays, sensors, timers, wires, gauges, sending units, electronic components, and control modules of electronic instrument clusters and driver information system circuits.	
Body Electrical Systems Diagnosis and Repair	a) Diagnose operation of comfort and convenience accessories and related circuits (such as: power windows, power seats, adjustable pedal height, power locks, trunk locks, remote start, moon roof, sunroof, sun shade, keyless entry, voice activation, phone pairing technology, wireless connectivity, steering wheel controls, camera systems, park assist, cruise control, and automated exterior lighting); determine needed repairs. b) Inspect, test, repair and/or replace components, connectors, terminals, and wiring of comfort and convenience accessories. c) Diagnose operation of heated and cooled accessories and related circuits (such as: heated/cooled seats, heated steering wheel, heated mirror, heated glass, and heated/ cooled cup holders); determine needed repairs.	

	d) Inspect, test, repair and/or replace components, connectors, terminals, and wiring of heated and cooled accessories. e) Diagnose operation of security/anti-theft systems and related circuits (such as: theft deterrent, door locks, keyless entry, remote start, and starter/fuel disable); determine needed repairs. f) Inspect, test, repair and/or replace components, connectors, terminals, and wiring of security/anti-theft systems. g) Diagnose operation of entertainment/ infotainment and related circuits (such as: radio, DVD, navigation, amplifiers, speakers, antennas, and voice-activated accessories); determine needed repairs. h) Inspect, test, repair and/or replace components, connectors, terminals, and wiring of entertainment/infotainment systems. i) Diagnose operation of safety systems and related circuits (such as: supplemental restraint systems, wipers, washers, horn, speed control, collision avoidance, telematics, heads-up display, park assist, and camera systems); determine needed repairs. j) Inspect, test, repair and/or replace components, connectors, terminals, and wiring of safety systems.	

Module 10: VEHICLE INTERIOR HEATING AND AIR CONDITIONING

Total contact hours: 60

Training Outcome: By the end of the module the trainee should be able to maintain, service and repair Automotive Air Conditioning systems.

SUB-MODULE	DUTIES/ TASKS	COMPETENCES
Heating, Ventilation, A/C (HVAC) and Engine Cooling System Service, Diagnosis, and Repair	a) Identify system type and conduct performance test on the A/C system; determine needed repairs. b) Diagnose A/C system problems indicated by system pressures and/or temperature readings; determine needed repairs. c) Diagnose A/C system problems indicated by sight, sound, smell, and touch procedures; determine needed repairs. d) Leak test A/C system; determine needed repairs. e) Identify A/C system refrigerant and existing charge amount; recover refrigerant. f) Evacuate A/C system. g) Inspect A/C system components for contamination; determine needed repairs. h) Charge A/C system with refrigerant. i) Identify A/C system lubricant type and capacity; replenish lubricant if necessary. j) Inspect and replace passenger compartment (cabin air, pollen) filter. k) Disarm and enable the airbag system for vehicle service following manufacturers' recommended procedures. l) Read diagnostic trouble codes (DTCs) and interpret scan tool data stream. m) Read and interpret technical literature (service publications, bulletins, recalls, and information including wiring schematics). n) Use a scan tool, Digital Multimeter (DMM), or digital storage oscilloscope (DSO) to test HVAC system sensors, actuators, circuits, and control modules; determine needed repairs. o) Verify proper operation of certified equipment. p) Recycle or properly dispose of refrigerant. q) Label and store refrigerant. r) Test refrigerant cylinders for non-condensable gases; identify refrigerant. s) Identify the procedures and equipment necessary to service, diagnose, and repair A/C systems in hybrid/electric vehicles.	a) Describes the layout of the Vehicle Air conditioning (AC) Heating and ventilation. b) Troubleshoots Air conditioning system faults and causes c) Carries out servicing of the Vehicle Air conditioning (AC) Heating and ventilation d) Repairs faulty Air condition's components e) Performs charging and discharging the Air conditioning Refrigerant f) Detects AC system leakages g) Observes the safety precautions

	t) Diagnose the cause of temperature control problems in the heater/ventilation system; determine needed repairs. u) Diagnose window fogging problems; determine needed repairs. v) Perform engine cooling system tests (flow, pressure, electrolysis, concentration, and contamination); determine needed repairs. w) Inspect and replace engine coolant hoses and pipes. x) Inspect, test, and replace radiator, pressure cap, coolant recovery system, and water pump. y) Inspect, test, and replace thermostat, thermostat by pass, and housing. z) Identify, inspect, recover coolant; flush and refill system with proper coolant; bleed system as necessary. aa) Inspect, test, and replace fan (both electrical and mechanical), fan clutch, fan belts, fan shroud, and air dams. bb) Inspect, test, and replace heater coolant control valve (manual, vacuum, and electrical types), and auxiliary coolant pump. cc) Inspect, flush, and replace heater core.	
Refrigeration System Component Diagnosis and Repair	**1. Compressor and Clutch** a) Diagnose A/C system problems that cause the protection devices (pressure, thermal, b) and electronic controls) to interrupt system operation; determine needed repairs. c) Inspect, test, and replace A/C system pressure, thermal, and electronic protection devices. d) Inspect, adjust, and replace A/C compressor drive belts, pulleys, and tensioners. e) Inspect, test, service, and replace A/C compressor clutch components or assembly. f) Identify required lubricant type; inspect and correct level in A/C compressor. g) Inspect, test, service or replace A/C compressor, mounting, and fasteners. **2. Evaporator, Condenser, and Related Components** a) Inspect, repair, or replace A/C system mufflers, hoses, lines, filters, fittings, and seals. b) Inspect A/C condenser for proper air flow. c) Inspect, test, and clean or replace A/C system condenser; check mountings and air seals.	

	d) Inspect and replace receiver/drier, accumulator/drier, or desiccant. e) Inspect, test, and replace expansion valve(s). f) Inspect and replace orifice tube(s). g) Inspect A/C evaporator for proper air flow. h) Inspect, test, clean, or replace evaporator(s). i) Inspect, clean and repair evaporator housing, and water drain. j) Inspect, test, and replace evaporator pressure/temperature control systems and devices. k) Identify, inspect, and replace A/C system service valves and valve caps. l) Inspect and replace A/C system high pressure relief device. **3. Electrical** a) Diagnose the cause of failures in the electrical control system of heating, ventilating, and A/C (HVAC) systems; determine needed repairs. b) Inspect, test, repair, and replace HVAC heater blower motors, blower motor speed controls, resistors, switches, relays/modules, wiring, and protection devices. c) Inspect, test, repair, and replace A/C compressor clutch coil, relay/ modules, wiring, sensors, switches, diodes, and protection devices. d) Inspect, test, repair, and replace A/C-related powertrain control systems and components. e) Inspect, test, repair, and replace load sensitive A/C compressor cut-off systems. f) Inspect, test, repair, and replace engine cooling/condenser fan motors, relays/modules, switches, sensors, wiring, and protection devices. g) Inspect, test, adjust, repair and replace climate control system electric actuator motors, relays/ modules, switches, sensors, wiring, and protection devices (including dual/multi-zone systems). h) Inspect, test, service, or replace HVAC panel assemblies. **4. ► Vacuum/Mechanical** a) Diagnose the cause of failures of the heating, ventilating, and A/C (HVAC) vacuum and mechanical control systems; determine needed repairs.	

	b) Inspect, test, service, or replace HVAC control panel assemblies. c) Inspect, test, adjust, and replace HVAC control cables and linkages. d) Inspect, test, and replace HVAC vacuum system actuators (diaphragms/motors), hoses, reservoir, check valve, and restrictors. e) Inspect, test, adjust, repair, or replace HVAC ducts, doors, and outlets (including dual/multi-zone systems).	
Operating Systems and Related Controls Diagnosis and Repair	**1. Automatic and Semi-Automatic Heating, Ventilating, and A/C Systems** a) Diagnose temperature control system problems; determine needed repairs (including dual/multi-zone systems). b) Diagnose blower system problems; determine needed repairs (including dual/multi-zone systems). c) Diagnose air distribution system problems; determine needed repairs (including dual/ multi-zone systems). d) Diagnose compressor clutch control system; determine needed repairs. e) Inspect, test, or replace climate and blower control sensors. f) Inspect, test, and replace door actuator(s). g) Inspect, test, and replace heater coolant control valve and controls. h) Inspect, test, and replace electric and vacuum motors, solenoids, and switches. i) Inspect, test, or replace Automatic Temperature Control (ATC) control panel and/or climate control computer/module; program, code, or initialize as required. j) Check and adjust calibration of Automatic Temperature Control (ATC) system. k) Diagnose data communication issues, including diagnostic trouble codes (DTCs) that affect climate control system operation.	

Module 11: AUTOMOTIVE ENGINE DIAGNOSIS

Total contact hours: 70

TRAINING OUTCOME: By the end of the module the trainee should be able to perform Engine Trouble-shooting and Diagnosis.

SUB-MODULE	DUTIES/ TASKS	COMPETENCES
Engine Diagnosis Mechanic	a) Verify driver's complaint, perform visual inspection, and/or road test vehicle; determine needed action. b) Research applicable vehicle and service information, such as engine management system operation, vehicle service history, service precautions, technical service bulletins, and service campaigns/recalls. c) Diagnose noises and/or vibration problems related to engine performance; determine needed action. d) Diagnose the cause of unusual exhaust color, odor, and sound; determine needed action. e) Perform engine manifold vacuum or pressure tests; determine needed action. f) Perform cylinder power balance test; determine needed action. g) Perform cylinder cranking, relative, and running compression tests; interpret test results; determine needed action. h) Perform cylinder leakage/leak-down test; determine needed action. i) Diagnose engine mechanical, electrical, electronic, fuel, and ignition problems with an oscilloscope, engine analyzer, and/or scan tool; determine needed action. j) Prepare and inspect vehicle for HC, CO, NOx, CO2, and O2 exhaust gas analysis; perform test and interpret exhaust gas readings. k) Verify valve adjustment on engines with mechanical or hydraulic lifters. l) Verify camshaft timing; verify operation of camshaft timing components, including engines equipped with variable valve timing; determine needed action. m) Diagnose emissions or drivability problems caused by oil related issues, such as incorrect pressure, poor quality, incorrect level, or incorrect type used for the application. n) Verify engine operating temperature, check coolant level and condition, perform cooling system pressure test; determine needed action. o) Inspect and test mechanically/ hydraulically/ electronically operated fans, fan clutch, fan	a) Describes the Engine Management systems and Diagnosis procedures. b) Uses Diagnosis Scan tools (OBD) on Engine systems c) Troubleshoots Engine system to identify faults d) Performs tests and take readings e) Interprets Diagnosis Trouble codes (DTC) f) Clears diagnostic trouble codes (DTCs), g) Run all OBD II monitors, and verify the repairs h) Observes the safety precautions

	shroud/ducting, and fan control devices; determine needed action. p) Read and interpret electrical schematic diagrams and symbols. q) Test and diagnose emissions or drivability problems caused by battery condition, connections, or excessive key-off battery drain; determine needed action. r) Perform starter current draw test; determine needed action. s) Perform starter and charging circuit voltage drop tests; determine needed action. t) Test and diagnose engine performance problems resulting from charging system failures; determine needed action. u) Inspect, adjust, and replace alternator (generator) drive belts, pulleys, clutches, tensioners and/or fans. v) Inspect, test, and repair or replace system components, connectors and wires in the starter and charging control circuits.	
Ignition System Diagnosis and Repair	a) Diagnose ignition system related problems such as no-starting, hard starting, engine misfire, poor drivability, spark knock, power loss, poor mileage, and emissions problems; determine root cause; determine needed action. b) Interpret ignition system related diagnostic trouble codes (DTCs); determine needed action. c) Inspect, test, repair, or replace ignition primary circuit wiring and components. d) Inspect, test, service, repair or replace ignition system secondary circuit wiring and components. e) Inspect, test, and replace ignition coil(s). f) Inspect, test, and replace ignition system sensors; adjust as necessary. g) Inspect, test, and/or replace ignition control module (ICM) and/or powertrain/engine control module (PCM/ECM); reprogram/initialize as needed.	
Fuel, Air Induction and Exhaust Systems Diagnosis and Repair	a) Diagnose fuel system related problems, including hot or cold no-starting, hard starting, poor drivability, incorrect idle speed, poor idle, flooding, hesitation, surging, engine misfire, power loss, stalling, poor mileage, and emissions problems; determine root cause; determine needed action. b) Interpret fuel or induction system related diagnostic trouble codes (DTCs); analyze fuel trim and other scan tool data; determine needed action.	

	c) Inspect fuel tank, filler neck, and gas cap; inspect and replace fuel lines, fittings, and hoses; determine needed action. d) Inspect, test, and replace fuel pump(s) and/or fuel pump assembly; inspect, service, and replace fuel filters. e) Inspect and test fuel pump control circuits and components; determine needed action. f) Inspect, test, and repair or replace fuel pressure regulation system and components of fuel injection systems; check fuel for contaminants and quality; perform fuel pressure/ volume test. g) Inspect, test, service and/or replace throttle assembly; make related adjustments and/or perform initialization or relearn procedure as required. h) Inspect, test, clean, and replace fuel injectors and fuel rails. i) Inspect, service, and repair or replace air filtration system components. j) Inspect throttle assembly, air induction system, intake manifold and gaskets for air/vacuum leaks, restrictions and/or unmetered air. k) Remove, clean, inspect, test, and repair or replace fuel system vacuum and electrical components and connections. l) Inspect, service, and replace exhaust manifold, exhaust pipes, oxygen sensors, air/fuel ratio sensors, mufflers, catalytic converters, resonators, tailpipes, and heat shields. m) Test for exhaust system restriction or leaks; determine needed action. n) Inspect, test, clean and repair or replace turbocharger or supercharger and system components.	
Emission Control Systems Diagnosis and Repair	**1. Positive Crankcase Ventilation** a) Test and diagnose emissions or drivability problems caused by positive crankcase ventilation (PCV) system. b) Inspect, service, and replace positive crankcase ventilation (PCV) filter/breather cap, valve, oil separator tubes, orifice/metering device, and hoses. **2. Exhaust Gas Recirculation** a) Test and diagnose drivability problems caused by the exhaust gas recirculation (EGR) system. b) Interpret exhaust gas recirculation (EGR) related scan tool data and diagnostic trouble codes (DTCs); determine needed action.	

	c) Inspect, test, service, and replace components of the EGR system, including EGR valve, tubing, passages, vacuum/pressure controls, filters, hoses, electrical/electronic sensors, controls, solenoids and wiring of exhaust gas recirculation (EGR) systems. **3. Secondary Air Injection (AIR) and Catalytic Converter** a) Test and diagnose emissions or drivability problems caused by the secondary air injection or catalytic converter systems. b) Interpret secondary air injection system related scan tool data and diagnostic trouble codes (DTCs); determine needed action. c) Inspect, test, service, and replace mechanical components and electrical/electronic components and circuits of secondary air injection systems. d) Inspect catalytic converter. Interpret catalytic converter related diagnostic trouble codes (DTCs); analyze related scan tool data to determine root cause of DTCs; determine needed action. 4. **Evaporative Emissions Controls** a) Test and diagnose emissions or drivability problems caused by the evaporative emissions control (EVAP) system. b) Interpret evaporative emissions-related scan tool data and diagnostic trouble codes (DTCs); determine needed action. c) Inspect, test, and replace canister, lines/hoses, filters, mechanical and electrical components of the evaporative emissions control (EVAP) system.	
Computerized Engine Controls Diagnosis and Repair	a) Retrieve and record diagnostic trouble codes (DTCs), OBD II monitor status and freeze frame data. b) Diagnose the causes of emissions or drivability problems with stored or active diagnostic trouble codes (DTCs). c) Diagnose the causes of emissions or drivability problems without diagnostic trouble codes (DTCs). d) Use a scan tool, digital multimeter (DMM), or digital storage oscilloscope (DSO) to inspect or test computerized engine control system sensors, actuators, circuits, and powertrain/engine control module (PCM/ECM); determine needed action.	

	e) Measure and interpret voltage, voltage drop, amperage, and resistance using digital multimeter (DMM) readings. f) Test, remove, inspect, clean, service, and repair or replace power and ground distribution circuits and connections. g) Inspect, test, and/or replace the powertrain/engine control module (PCM/ECM); reprogram/initialize as needed. h) Diagnose drivability and emissions problems resulting from failures of interrelated systems (for example: cruise control, security alarms/theft deterrent, torque management, traction controls, A/C, non-OEM installed accessories). i) Clear diagnostic trouble codes (DTCs), run all OBD II monitors, and verify the repair.	

Module 12: LIGHT VEHICLE DIESEL ENGINES

Total contact hours: 106

Training Outcome: By the end of the module the trainee should be able to service, repair and Maintain Light Vehicle Diesel Engines.

SUB-MODULE	DUTIES/ TASKS	COMPETENCES
General Diagnosis	a) Verify the complaint, and road/dyno-test vehicle; review driver/customer concerns/ expectations and vehicle service history (if available); determine further diagnosis. b) Record vehicle identification number (VIN). Identify engine model, calibration and serial numbers to research applicable vehicle and service information, service precautions, and technical service bulletins; determine needed actions. c) Perform scan tool check and visual inspection for physical damage and missing, modified, or tampered components; determine needed actions. d) Check and record electronic diagnostic codes, freeze frame and/or operational data; monitor scan tool data; determine further diagnosis. e) Clear diagnostic trouble codes (DTCs) and verify the repair. f) Inspect engine assembly and compartment for fuel, oil, coolant, exhaust, or other leaks; determine needed repairs. g) Inspect engine compartment wiring harness, connectors, seals, and locks; check for proper routing and condition; determine needed repairs. h) Listen for and isolate engine noises; determine needed repairs. i) Isolate and diagnose engine related vibration problems; determine needed actions. j) Check engine exhaust for abnormal odor and/or smoke color and volume; determine further diagnosis. k) Check fuel for contamination, quantity, quality, and consumption; determine needed actions. l) Perform crankcase pressure test; determine further diagnosis. m) Diagnose surging, rough operation, misfiring, low power, slow deceleration, slow acceleration, and shutdown problems; determine needed actions. n) Check cooling system for freeze point, level, contamination, condition, temperature, pressure, circulation, and fan operation; determine needed repairs.	a) Describes the Diesel Engine layout of main parts and systems. b) Performs Diesel Engine Maintenance overhaul and assembling c) Troubleshoots Diesel Engine and its systems to identify faults d) Carries out service and repairs on Diesel engine systems. e) Uses repair tools and equipment for diesel engines f) Observes the safety precautions

	o) Check lubrication system for contamination, oil level, temperature, pressure, filtration, and oil consumption; take oil sample and obtain oil analysis if needed; determine needed repairs. p) Diagnose no-cranking, cranks but fails to start, hard starting, and starts but does not continue to run problems; determine needed actions. q) Diagnose engine problems caused by battery condition, connections, or excessive key-off battery drain; determine needed repairs. r) Diagnose engine problems resulting from an electrical undercharge, overcharge, or a no-charge condition; determine needed action.	
Cylinder Head and Valve Train	a) Remove, inspect, disassemble, and clean cylinder head assembly(s). b) Inspect threaded holes, studs, and bolts for serviceability; service/replace as needed. c) Measure cylinder head thickness, and check mating surfaces for flatness, corrosion, d) warpage and surface finish; inspect for cracks/damage; check condition of passages; e) inspect core and gallery plugs; determine serviceability and needed repairs. f) Inspect valves, guides, seats, springs, retainers, rotators, locks and seals; determine serviceability and needed repairs. g) Inspect and/or replace injector sleeves, glow plug sleeves, and seals; pressure test to verify repair (if applicable); measure injector tip, nozzle, or pre-chamber protrusion where specified by manufacturer. h) Inspect, and/or replace valve bridges (crossheads) and guides; adjust bridges i) (crossheads) if applicable. j) Reassemble, check, and determine required cylinder head gasket thickness; install cylinder head assembly and gasket as specified by the manufacturer. k) Inspect pushrods, rocker arms, rocker arm shafts, electronic components, wiring harness, seals; repair/replace as needed. l) Inspect, install, and adjust cam followers, lash adjusters and retainers; adjust valve clearance if applicable. m) Inspect, measure, and replace/reinstall overhead camshaft and bearings; measure and adjust endplay. n) Inspect and time drive gear train components (includes gear, chain, and belt systems).	
Engine Block Diagnosis and Repair	a) Remove, inspect, service, and install pans, covers, ventilation systems, gaskets, seals, and wear rings.	

	b) Disassemble, clean and inspect engine block for cracks; check mating surfaces and related components for damage or warpage and surface finish; check deck height; check condition of passages, core, and gallery plugs; inspect threaded holes, studs, dowel pins and bolts for serviceability; service/replace as needed. c) Inspect and measure cylinder walls for wear and damage; determine needed service. d) Inspect in-block camshaft bearings for wear and damage; replace as needed. e) Inspect, measure, and replace/reinstall in-block camshaft; measure and correct end play; inspect, replace/reinstall, and adjust cam followers (if applicable). f) Clean and inspect crankshaft and journals for surface finish, cracks, and damage; check condition of oil passages; check passage plugs; measure journal diameters; check mounting surfaces; determine needed service. g) Determine the proper select-fit components such as pistons, connecting rod and main bearings. h) Inspect and replace main bearings; check cap fit and bearing clearances; check and correct crankshaft end play. i) Inspect, replace, verify, and adjust the drive gear train components (includes gear, chain, and belt systems). j) Inspect, measure, or replace pistons, pins, and retainers. k) Measure piston-to-cylinder wall clearance. l) Identify piston, connecting rod bearing, and main bearing wear patterns that indicate connecting rod and crankshaft alignment or bearing bore problems; check bearing bore and bushing condition; determine needed repairs. m) Check ring-to-groove fit and end gaps; install rings on pistons; assemble pistons and connecting rods and install in block; check piston height/protrusion; check liner height/protrusion (if applicable); replace rod bearings and check clearances; check condition, position, and clearance of piston cooling jets (nozzles). n) Inspect crankshaft vibration damper; determine needed repairs. o) Inspect flywheel/flex-plate and/or dual-mass flywheel (including ring gear) and mounting surfaces for cracks, wear, and run-out; determine needed repairs.	

Lubrication and Cooling Systems Diagnosis and Repair	a) Verify base engine oil pressure and check operation of pressure sensor/switch and pressure gauge; verify engine oil temperature and check operation of temperature sensor. b) Inspect, measure, repair/replace oil pump, housing, drives, pipes, and screens; check drive gear clearance. c) Inspect, repair/replace oil pressure regulator assembly including: housing, bore, spring, regulator valve(s), oil filter by-pass valve(s), and anti-drain back valve. d) Inspect, clean, test, and reinstall/replace oil cooler, by-pass valve, lines, and hoses. e) Inspect turbocharger lubrication and cooling systems; repair/replace as needed. f) Change engine oil and filters using proper type, viscosity, and rating per manufacturer specifications. g) Inspect and reinstall/replace pulleys, tensioners, and drive belts; adjust drive belts and check alignment. h) Verify coolant temperature; check operation of temperature and level sensors, switches, and temperature gauge. i) Inspect and replace thermostat(s), by-pass (es), housing(s), and seal(s). j) Flush and refill cooling system; following manufacturer's specification, add proper coolant type; bleed air from system. k) Inspect and replace water pump(s), housing(s), hoses, and idler pulley(s) or drive gear. l) Inspect radiator(s), pressure cap(s), and tank(s); pressure test cooling system and radiator cap(s); determine needed repairs. m) Inspect and repair/replace cooling fan, fan hub, fan clutch, controls, and shroud(s).	
Air Induction and Exhaust Systems Diagnosis and Repair	a) Inspect and service/replace air induction piping, air cleaner, and element; determine needed actions. b) Perform intake manifold pressure tests; inspect, test, clean, and/or replace charge air cooler and piping system; determine needed actions. c) Inspect test, and replace turbocharger(s) (including variable ratio/geometry VGT), pneumatic, hydraulic, vacuum, and electronic controls and actuators; inspect, test, and replace waste-gate and waste-gate controls. d) Inspect, test, and replace intake manifold(s), variable intake manifold(s), gaskets, actuators, temperature and pressure sensors, and connections. e) Perform exhaust back pressure and temperature tests; determine needed actions. f) Inspect and repair/replace exhaust manifold(s), gaskets, piping, mufflers, and mounting hardware.	

	g) Inspect, test, and repair/replace preheater/inlet air heater and/or glow plug system and controls. h) Inspect, test, and replace exhaust after treatment system components and controls, including diesel oxidation catalyst (DOC), selective catalyst reduction (SCR), diesel exhaust fluid (DEF), diesel particulate filter (DPF); check regeneration system operation. i) Inspect, test, service, and replace EGR system components including EGR valve(s), EGR cooler by-pass valve(s), EGR cooler(s), piping, electronic sensors, actuators, controls, and wiring. j) Inspect, test, and replace airflow control (throttle) valve(s) and controls. k) Inspect, test, and replace crankcase ventilation system components, including sensors, filters, valves, and piping.	
Fuel System Diagnosis and Repair	a) Inspect, clean, test, and repair/replace fuel system tanks, vents, caps, mounts, valves, single/dual supply and return lines, and fittings. b) Inspect, clean, test, and repair/replace fuel transfer and/or supply pump, sensors, strainers, fuel/water separators/indicators, filters, heaters, coolers, ECM cooling plates (if applicable), and mounting hardware. c) Check fuel system for air; determine needed repairs; prime and bleed fuel system; check and repair/replace primer pump. d) Inspect, test, and repair/replace low fuel pressure regulator supply and return systems, including low pressure switches. e) Inspect and reinstall/replace high-pressure injection lines, fittings, transfer tubes, seals, and mounting hardware. f) Inspect, adjust, and repair/replace electronic throttle and PTO control devices, circuits, and sensors. g) Perform on-engine inspections, tests, and replace high pressure common rail fuel system components and electronic controls. h) Perform on-engine inspections and tests; replace hydraulic electronic unit injector(s) (HEUI) components and electronic controls. i) Perform on-engine inspections and tests; replace pump-line-nozzle fuel system (PLN-E) components and electronic controls. j) Perform on-engine inspections and tests; replace electronic unit injector(s) (EUI) components and electronic controls. k) Inspect and replace electrical connector terminals, pins, harnesses, seals, and locks.	

	l) Connect diagnostic scan tool to vehicle/engine; access, verify and update software calibration settings, injector calibration codes; perform control module re-learn procedures as needed. m) Use a diagnostic scan tool to inspect and test electronic engine control system, sensors, actuators, electronic control modules, and circuits; determine further diagnosis. n) Measure and interpret voltage, voltage drop, amperage, and resistance readings using a digital multimeter (DMM) or appropriate test equipment. o) Diagnose engine problems resulting from failures of interrelated systems (for example: cruise control, security alarms/theft deterrent, transmission controls, exhaust after treatment systems, electronic stability control, or non-OEM installed accessories).	

Module 13: VEHICLE BODY REPAIR AND SPRAY

Total contact hours: 100

Training Outcome: By the end of the module the trainee should be able to perform vehicle body repair and spray.

SUB-MODULE	DUTIES/ TASKS	COMPETENCES
Preparation	a) Review damage report and replacement parts for accuracy. Inspect for prior damage and repairs. Inspect for proper systems operation. b) Identify potential health, safety, and environmental concerns associated with vehicle components and systems, i.e. ABS, air bags (SRS), refrigerants, hybrid electric vehicles, coolants, etc. c) Research and determine repair plan, procedures, and methods of overall repairs in accordance with the vehicle manufacturer's specifications and accepted industry procedures (including calibration/initialization of advanced vehicle systems). d) Position vehicle to perform repairs; lift, raise, or support if necessary. e) Remove damaged or undamaged interior and exterior trim and moldings/claddings as necessary; document missing or broken one-time use parts/fasteners/components, store removed parts/fasteners/components. f) Remove and store undamaged, non-structural body panels and components and mechanical/electrical components that may interfere with or be damaged during the repair process.	a) Describes the Vehicle Body parts layout. b) Carries out inspection of vehicle body panel parts c) Identifies damages on vehicle body panel parts d) Carries out repairs on damaged vehicle body parts. e) Uses vehicle Body and spray repair tools f) Observes the safety precautions

	g) Check for malfunction indicator lamp (MIL) illumination; scan all computer systems and retrieve codes and settings; identify battery disconnect procedures. h) Protect panels and parts adjacent to repair area to prevent damage during repair. i) Remove dirt, grease, wax, and other contaminants from areas to be repaired. j) Remove pinstripes, emblems and decals (transfers/overlays and other paint protection accessories); remove adhesives if necessary. k) Remove corrosion protection, under-coatings, sealers, and other protective coatings as necessary to perform repairs. l) Remove repairable plastics and other parts for off-vehicle repair. m) Identify safety considerations: Personal Protection Equipment (PPE), shock hazards, fumes, safety data sheet (SDS), etc. before beginning any repair operation.	
Outer Body Panel Repairs, Replacements, and Adjustments	a) Determine the extent of the direct (Primary) and indirect (Secondary) damage and the direction of impact; plan the methods and order of repair. b) Remove and replace bolted, riveted, adhesive/ bonded, and welded panels or panel assemblies. c) Identify the body panel substrate (high-strength steel, aluminum, magnesium, composite, etc.), determine the extent of damage for reparability or replacement. d) Remove, reinstall or replace, and adjust/align hood, hood supports, hood hinges, and hood latch/lock. e) Remove, reinstall or replace, and adjust/align deck lid, lid hinges, supports, and lid latch/lock. f) Remove, reinstall or replace and adjust/align doors, tailgates, hatches, supports, g) Lift-gates, latch/lock assemblies, handles, and hinges. h) Remove, reinstall or replace, and adjust/align bumpers, brackets, reinforcements, guards, absorbers, isolators, and mounting hardware. i) Remove, reinstall or replace and adjust/align front fenders; check and adjust gaps and clearances. j) Remove, reinstall or replace and adjust/align exterior lighting and mounting panels. k) Check outer body panel function, adjust as necessary for proper operation. l) Restore contours of a damaged panel to a surface condition suitable for metal finishing or body filling. m) Weld cracked or torn metal body panels. n) Apply protective coatings to restore corrosion protection. o) Remove damaged body panels; replace panels using a weld, weld-bond, adhesively-bonded, rivet, rivet-bond, or other fastening procedures. p) Repair door frame, repair or replace door skins; inspect intrusion beams.	

	q) Restore seam sealers, mastic, sound deadeners, and foam fillers. r) Diagnose and repair water leaks, dust leaks, wind noise, squeaks, rattles, and vibrations. s) Install interior and exterior trim, pinstripes, emblems, decals (transfers/overlays, vapor barriers), and protective film. t) Scan computer systems and verify proper system operation following outer body panel repair, replacement or adjustment.	
Metal Finishing and Body Filling	a) Remove paint and other coatings from the damaged area of a body panel. b) Heat-shrink stretched panel areas to proper contour. c) Cold-shrink stretched panel areas to proper contour d) Metal-finish the damaged area of a body panel to eliminate surface irregularities. e) Prepare surface for application of body filler material. f) Mix, apply and shape body filler material. g) Sand cured body filler material to contour.	
Glass and Hardware	a) Inspect, adjust, remove and/or replace moveable, electrically-heated, stationary, mechanically-fastened, bonded, and hinged glass. b) Inspect, adjust, repair, or replace window regulators, run channels, power mechanisms, and related controls. Reset automatic features and clear stored codes if necessary. c) Inspect, adjust, repair, remove or replace power glass roof panels and related controls. d) Reset automatic features and clear stored codes if necessary. e) Inspect, adjust, repair, remove, or replace removable, manually-operated glass roof panels and hardware. f) Diagnose and repair water leaks, dust leaks, wind noises; rattles, and vibrations; inspect, repair, or replace weather stripping. g) Inspect, adjust, and install convertible or retractable roof and related mechanisms. h) Reset automatic features and clear stored codes if necessary. i) Scan computer systems and verify proper system operation following stationary glass removal or replacement.	
Welding, Cutting, and Removal	a) Identify weldable and non-weldable materials used in vehicle construction. b) Identify the considerations for cutting, removing, and welding various types of steels, aluminum and other metals. c) Determine the correct welding process to be used in specific welding situations: [compression/inverter/squeeze type resistance spot (STRSW), GTAW (TIG), GMAW (MIG), MIG-brazing]; determine settings, electrode, wire	

	type, diameter, gas and bonding material to be used in specific welding processes. d) Adjust the welding equipment for proper operation. e) Perform test welds. Visually inspect, perform destructive test, and make adjustments as necessary. f) Determine proper work clamp (ground) location. g) Use the proper gun-to-joint angle, distance, speed, and direction of gun travel for welds being made in all positions. h) Select proper STRSW arm set, electrode type and diameter, and settings based on the location and material to be welded. i) Protect vehicle components (adjacent components, hybrid components, computers and other electronic modules) from possible damage caused by welding and cutting. j) Clean or prepare the metal to be welded; ensure proper weld joint fit-up; apply weld through primer if required. k) Select and prepare the correct joint type (butt, lap, etc.) for the repair. l) Identify and perform the correct type of weld (continuous, stitch, tack, plug, spot, slot, etc.) for each specific welding operation. m) Identify the causes of weld defects; perform required equipment maintenance and/or make necessary adjustments.	
Plastic Repair	a) Identify the types of plastic(s) or composite(s); determine reparability. b) Identify the proper plastic or composite repair/cleaning procedures; clean and prepare the surfaces of plastic or composite parts for repair. c) Repair plastic parts by welding or using adhesive repair materials; repair composite parts using adhesive repair materials; use reinforcing materials as required. d) Reshape plastic parts. e) Perform single or two-sided repairs in plastic or composite panels. f) Replace bonded plastic or composite body panels; straighten or align mounting locations. g) Replace mechanically fastened plastic or composite body panels; straighten or align mounting locations if necessary; torque fasteners to specifications. ■	
Surface Preparation	a) Identify and remove surface corrosion. b) Remove dirt, road grime, wax, adhesive residue, mold release agents, tree sap, markings or other contaminants from the area to be refinished and any adjacent vehicle surfaces. c) Inspect and identify substrate, substrate condition, type of finish, film thickness and surface condition; develop a plan for refinishing. d) Remove paint finish. e) Sand areas to be refinished.	

	f) Featheredge areas to be refinished. g) Identify type of substrate and apply suitable treatment or undercoat. h) Mask and protect areas that will not be refinished. i) Mix and apply primer-surfacer. j) Apply finishing filler to minor surface imperfections. k) Block sand area to which primer-surfacer and/or finishing filler have been applied. l) Remove dust residue from area to be refinished. m) Clean area to be refinished using proper cleaning solution. n) Remove, with a tack cloth, any dust or lint particles from the area to be refinished. o) Apply primer-sealer and/or adhesion promoter. p) Remove imperfections from primer-sealer. q) Prepare the adjacent areas for blending. r) Apply stone-chip resistant coating. s) Apply corrosion resistant coatings to repaired areas. t) Remove and apply decals, transfers, tapes, pinstripes (painted and/or taped). u) Take appropriate measures to eliminate static electricity v) Prepare surfaces for seam sealer application; evaluate the application of seam sealers prior to refinishing. w) Identify pin holing; determine the cause(s) and correct the condition.	
Spray Gun Operation and Related Equipment	a) Inspect, clean, adjust, maintain, and determine condition of spray guns and adequacy of related equipment (air hoses, regulator, air-lines, air source, filtration unit and spray environment). b) Adjust spray gun, air pressure, fluid, and pattern control valves. c) Select correct spray gun, needle, fluid tip, and air cap for material being sprayed. d) Force-dry sprayed materials (bake, infrared, UV lamps, airflow, etc.).	
Paint Mixing, Matching, and Applying	a) Determine the color, code, and type of finish on the vehicle. b) Identify paint color formula and the use of mixing equipment and materials. c) Mix and strain refinish material. d) Use appropriate spray gun technique (arc, angle, distance, speed, and spray pattern overlap) for the finish being applied. e) Apply selected product on test panel or let-down panel. f) Check color match; adjust as necessary. g) Apply single-stage topcoat for panel refinishing. h) Apply basecoat or multi-stage (mica, pearl, etc.) coats for spot, panel, blending, and overall refinishing. i) Apply clear-coat. j) Refinish interior and exterior trim components.	

Solving Paint application problems during the application process	a) Identify dirt or other foreign objects in the refinished surface; determine the source(s), and correct the condition. b) Identify a dry spray appearance in the refinished surface; determine the cause(s), and correct the condition. c) Identify the presence of fish-eyes (crater like appearance); determine the cause(s), and correct the condition. d) Identify lifting (surface distortion or wrinkling) of the refinished surface; determine the cause(s), and correct the condition. e) Identify mottling or streaking in metallic, mica, and effect paint finishes; determine the cause(s), and correct the condition. f) Identify excessive or lack of texture (orange peel); determine the cause(s), and correct the condition. g) Identify an overspray condition; determine the cause(s), and correct the condition. h) Identify sags and runs; determine the cause(s), and correct the condition. i) Identify color mismatch, due to application variables; determine the cause(s), and correct the condition. j) Identify tape tracking/marking; determine the cause(s), and correct the condition. k) Identify poor hiding/lack of coverage; determine the cause(s) and correct the condition	
Finish Defects, Causes, and Cures	a) Identify delamination (poor adhesion, peeling); determine the cause(s) and correct the condition. b) Identify finish cracking (crow's feet or line-checking, micro-checking, etc.); determine the cause(s) and correct the condition. c) Identify sags and runs in the refinished surface; determine the cause(s) and correct the condition. d) Identify blistering in the finished surface; determine the cause(s) and correct the	

Module 14: DIESEL FUEL INJECTION SYSTEMS

Total contact hours:100

TRAINING OUTCOME: By the end of the module the trainee should be able to perform Diesel Fuel Injection Systems Repair.

SUB-MODULE	DUTIES/ TASKS	COMPETENCES
Prepare to diagnose and repair diesel fuel injection system	a) Determine Job requirements from workplace instructions b) Interpret the available Diagnostic information c) Analyse Diagnostic options and those most appropriate to the circumstances d) Identify and manage Hazards and risks associated with the work	a) Describes the Diesel fuel injection systems layout. b) Carries out Diagnostic tests of Diesel fuel injection systems c) Performs Diesel pumps and Injector nozzle tests

	e) Select Diagnostic tools, equipment and check for serviceability	d) Interprets service and Repair manuals for Diesel fuel injection systems. e) Uses Diesel fuel injection systems service and repair tools f) Observes the safety precautions
Diagnose diesel fuel injection system	a) Checked, adjust and rectify as required according to manufacturer specifications b) Carry out Diagnostic tests are according to manufacturer specifications, workplace procedures, and environmental and safety requirements c) Identify Faults from diagnostic test results and determine causes of faults d) Carry out necessary adjustments and repairs. e) Inspect, clean, test, and repair/replace fuel system tanks, vents, caps, mounts, valves, single/dual supply and return lines, and fittings. f) Inspect, clean, test, and repair/replace fuel transfer and/or supply pump, sensors, strainers, fuel/water separators/indicators, filters, heaters, coolers, ECM cooling plates (if applicable), and mounting hardware. g) Check fuel system for air; determine needed repairs; prime and bleed fuel system; check and repair/replace primer pump. h) Inspect, test, and repair/replace low fuel pressure regulator supply and return systems, including low pressure switches. i) Inspect and reinstall/replace high-pressure injection lines, fittings, transfer tubes, seals, and mounting hardware. j) Inspect, adjust, and repair/replace electronic throttle and PTO control devices, circuits, and sensors. k) Perform on-engine inspections, tests, and replace high pressure common rail fuel system components and electronic controls. l) Perform on-engine inspections and tests; replace hydraulic electronic unit injector(s) (HEUI) components and electronic controls. m) Perform on-engine inspections and tests; replace pump-line-nozzle fuel system (PLN-E) components and electronic controls. n) Perform on-engine inspections and tests; replace electronic unit injector(s) (EUI) components and electronic controls. o) Inspect and replace electrical connector terminals, pins, harnesses, seals, and locks. p) Connect diagnostic scan tool to vehicle/engine; access, verify and update software calibration settings, injector	

	calibration codes; perform control module re-learn procedures as needed. q) Use a diagnostic scan tool to inspect and test electronic engine control system, sensors, actuators, electronic control modules, and circuits; determine further diagnosis. r) Measure and interpret voltage, voltage drop, amperage, and resistance readings using a digital multimeter (DMM) or appropriate test equipment. s) Diagnose engine problems resulting from failures of interrelated systems (for example: cruise control, security alarms/theft deterrent, transmission controls, exhaust after treatment systems, electronic stability control, or non-OEM installed accessories).	
Fuel System Diagnosis and Repair	a) Interpret Repair manual information b) Select Repair tools, equipment and materials. check according to manufacturer procedures c) Perform phasing and calibration of Injection pumps. d) Perform Injector nozzle pressure tests on a Test-bench. e) Repair and replace faulty components and adjustments. f) Confirm test results conforms with the provided specifications	
Complete work processes	a) Ensure Final inspection is made and system is ready for use b) Cleaned Work area is, waste and non-recyclable materials are disposed of, and recyclable material is collected c) Tools and equipment are checked and stored according to workplace procedures d) Workplace documentation is processed according to workplace procedures.	