Appendix Z

TRANSPORTATION, DISTRIBUTION AND LOGISTICS
YOUTH APPRENTICESHIP

MOBILE EQUIPMENT MAINTENANCE PATHWAY
AUTO/LIGHT TRUCK SYSTEMS
UNIT 18

Auto Technician – Auto/Light Truck Systems

Competency (Work Tasks)	Performance Standards What employer checks for while doing task. **Train YA Student on.** YA student will ...	Learning Objectives What to know/learn to do this task. **Content Suggested** for Class/Reading/On-the-Job Training.
ENGINE REPAIR & PERFORMANCE (NATEF A1 & A8)		
1. Install engine covers using gaskets, seals, & sealers	Obtain equipment and materials needed Review safety and service procedures Inspect for leaks prior to disassembly Clean old gaskets carefully Match holes and sealing surfaces perfectly Apply appropriate sealer type Align and hand screw all bolts Tighten all fasteners in steps Use crisscross tightening pattern to specified torque After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Identify commonly used automotive fasteners Summarize safety rules relating to fasteners, gaskets, seals, and sealants Explain the reason for tightening the bolts a little at a time in a crisscross pattern
2. Assist to remove & replace timing belt, verify camshaft timing	Obtain equipment and materials needed Review safety and service procedures Set the number 1 cylinder to TDC Remove the timing belt cover and timing belt Line up timing marks on the camshaft and crankshaft sprockets Slip the belt over the sprockets Move the tensioner into the belt to hold the belt on its sprockets Adjust belt tension to specification Install timing belt cover After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Describe the construction and operation of a camshaft Compare the types of camshaft drives Explain the importance of regular timing belt maintenance Cite safety procedures to follow when servicing engine front ends
3. Perform cooling system pressure tests to identify leaks	Obtain equipment and materials needed Review safety and service procedures Remove the radiator cap once the engine is sufficiently cooled Check the coolant's condition and color	Summarize the functions of a cooling system Explain the operation and construction of major cooling system components Compare cooling system design variations Explain the importance of antifreeze

	Visually inspect the cooling system for leaks, loose or missing fan belts, low coolant level, abnormal water pump noises, coolant in the oil, combustion leakage into the coolant Determine the coolant's freezing point using a coolant hydrometer Look down the radiator neck while the engine is running up to operating temperature to observe circulation Check thermostat if circulation is poor Connect a cooling system pressure tester to the radiator fill neck Pump the pressure tester until the pressure reaches the release pressure marked on the cap Leave the tester connected and watch for leaks Check for signs of heater core leaks on the ground under the engine Check for leaks at the pump drive shaft Check for leaks at all hose fittings, gaskets, and engine freeze (core) plugs Tighten, repair or replace parts as needed After testing, prepare for service or cleanup work area, return tools to proper location, complete appropriate documentation	List common cooling system problems and their symptoms Describe the most common causes of system leakage, overheating, and overcooling Discuss common safety precautions for servicing cooling systems
4. Inspect, replace, adjust drive belts, tensioners, & pulleys	Obtain equipment and materials needed Review safety and service procedures Locate your vehicle drive belts Inspect the belts by turning them sideways and looking for cracks, glazing or visible signs of fraying Replace the belts by loosening the mounting and retaining bolts or nuts on the accessory that it drives Pry the accessory towards the belt, allowing the belt to loosen enough to come off the pulley Remove the belt from the crankshaft pulley Install the new belt by positioning it on the crankshaft pulley and then slipping it over the pulley of the accessory Pry the accessory from the belt to tighten the slack Adjust the belt tension so that there is no more than 1/2" deflection, up or down Reinstall any other belts you removed and adjust them	Describe the purpose of a vehicle's engine drive belts Discuss the composition of drive belts and common wear tear Locate common accessory drive belts and what they run Describe the issues with stretched belts Explain why belts should not be over-tightened

	Start the engine and turn on the accessory run by the belt that you just changed Check that the belt or belts that you removed are not slipping under the engine load If there is a slipping belt, turn off the engine, readjust the belt and check again After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	
5. Remove, inspect, replace thermostat & gasket/seal	Obtain equipment and materials needed Review safety and service procedures Observe the coolant through the opening in the radiator neck as the engine warms Use a temperature probe to touch the thermostat outlet hose Unscrew bolts holding thermostat housing to engine Tap housing free Lift off housing and thermostat Scrape old gasket material off housing Check for gaps between housing and sealing surface File or sand surface flat if warped Remove thermostat and test in water on a hot plate Replace thermostat if it does not open at correct temperature Install new thermostat centered in housing with pellet toward inside of engine Position new gasket with approved sealer Torque thermostat bolts to specification After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Describe the purpose and common components associated with the thermostat Describe common problems associated with the thermostat Explain procedures for replacing a rubber thermostat housing seal instead of a gasket List precautions to take with combined plastic housings
6. Inspect, remove, replace water pump	Obtain equipment and materials needed Review safety and service procedures INSPECT Wiggle the fan or pump pulley up and down to check for worn pump bearings Warm engine and then shut off Squeeze top of radiator hose while another technician restarts the engine to check for pump operation Observe coolant in radiator with engine at operating	Describe the purpose and common components associated with the water pump Describe common problems associated with the water pump Discuss common safety precautions for servicing water pumps

	temperature REMOVE Unbolt all brackets and components (air conditioning compressor, power steering pump, alternator, etc.) Unscrew ALL bolts holding pump to engine Lightly tap pump housing to free pump Scrape off old gasket or sealer material REPLACE Install water pump gasket using approved sealer Work o-ring seal into bottom of groove if applicable Fit pump onto the engine straight into place Start all bolts be hand Check all bolt lengths are the same Torque all fasteners a little at a time in a pattern Install the other components Tighten pulley properly After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	
7. Perform cylinder cranking & running compression tests	Obtain equipment and materials needed Review safety and service procedures Remove all spark plugs Block open the throttle Disable the ignition system Disable the electronic fuel injection if applicable Screw the compression gauge into one of the spark plug holes Crank the engine to rotate about 4-6 compression strokes Record gauge readings Repeat for each cylinder Repeat while engine is running Compare gauge readings to specifications Consult worksite professional to determine further tests, inspections or repairs After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Describe engine size measurements based on bore, stroke, displacement, and number of cylinders Explain engine compression ratio and how it affects engine performance Explain engine torque and horsepower ratings Describe the different methods used to measure and rate engine performance Explain volumetric efficiency, thermal efficiency, mechanical efficiency, and total engine efficiency Cite safe practices when making engine performance measurements Explain the purpose and procedure of the compression test Compare compression testing for gasoline versus diesel engines Describe the use and purpose of a compression gauge Explain when an engine compression test is indicated
8. Perform cylinder leakage tests	Obtain equipment and materials needed Review safety and service procedures	Explain the purpose and procedure of the cylinder leakage test

	Remove crankcase filler cap Remove radiator filler cap Ensure radiator is filled to prescribed level Locate TDC using a whistle tester adaptor on the tester in the cylinder spark plug hole Rotate engine until cylinder to be tested is at TDC Remove whistle and connect leak tester Check cylinder leakage tester reading Look for air leaking noise or air bubbles Consult worksite professional to determine further tests, inspections or repairs Unblock the throttle valve Reconnect the ignition system Reinstall the spark plugs and air filter After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Describe the use and purpose of a cylinder leakage tester Explain the use of the whistle adaptor on the leakage tester Explain when a cylinder leakage test is indicated
9. Remove, replace spark plugs	Obtain equipment and materials needed Review safety and service procedures Check spark plug wires number and location Remove ignition coils if necessary Grasp the spark plug wire boot and pull the wire off the plug o Twist the boot back and forth if needed Use compressed air to clean debris Unscrew each plug and remove with tools Inspect plugs Install new or serviced spark plugs with correct gap o Thread head by hand then use ratchet o Tighten according to spec Re-attach wires and coils correctly After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Explain the purpose and common problems associated with bad spark plugs Describe methods for testing spark plugs Discuss safety precautions removing and replacing spark plugs
10. Inspect exhaust manifold, pipes, muffler, catalytic converter, resonator, & heat shields	Obtain equipment and materials needed Review safety and service procedures Position vehicle Use a light to closely inspect the exhaust system components for leaks, rust, and loose connections	Explain the relationship between engine performance and exhaust emission Explain the construction and design of intake and exhaust manifolds Describe the basic parts of an exhaust system Explain the most common reasons for exhaust system

	Focus attention on muffler, pipe connections, gaskets and pipe bends After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	failures Describe the appearance of exhaust leaks on components Compare exhaust system design differences Explain the fundamental parts of a turbocharging system Summarize the construction and operation of a supercharging system Cite safety procedures for working on exhaust systems
11. Remove, replace radiator	Obtain equipment and materials needed Review safety and service procedures Cool radiator INSPECT Inspect the outside for debris Inspect radiator shroud for breaks Spray water from back of radiator to push debris out the front Inspect radiator cap and filler neck for cracks, tears, nick or dents Have neck repaired as needed REMOVE Place catch pan under radiators petcock Drain radiator Disconnect hoses, oil cooler lines, and wires to sensors and fans Remove brackets or bolts to remove radiator from its mounting REPLACE Ensure rubber mounts are in place in their brackets Carefully lower radiator into place without hitting and damaging it Connect all hoses, lines and wires After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Explain the purpose and common components associated with the radiator Describe common problems associated with the radiator Discuss common safety precautions for servicing a radiator
AUTOMATIC TRANSMISSION & TRANSAXLE (NATEF A2)		
12. Inspect, replace external seals, gaskets, bushings	Obtain equipment and materials needed Review safety and service procedures Inspect transmission for leakage Replace seals, gaskets, bushings as required After servicing, verify service and make adjustments as	List problems associated with worn transmission bushings, seals and gaskets Explain where to locate bushings

	needed, cleanup work area, return tools to proper location, complete appropriate documentation	
13. Inspect powertrain mounts	Obtain equipment and materials needed Review safety and service procedures Visually inspect each mount for breakdown, oil soaked, separation Assist worksite professional to replace mounts if needed After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	List problems associated with damaged power train mounts Describe how to replace powertrain mounts
MANUAL DRIVE TRAINS & AXLES (NATEF A3)		
14. Drain/refill differential or transfer case housings	Obtain equipment and materials needed Review safety and service procedures Position vehicle Remove the drain plug; drain fluid Replace drain plug Fill housing with appropriate fluid to correct level After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Discuss the components and purpose of the transfer case Define differentials and their purpose Explain when transfer case service is indicated List common problems associated with faulty differentials or transfer cases Discuss common safety precautions for servicing differentials and transfer cases
15. Remove & replace drive axle shafts	Obtain equipment and materials needed Review safety and service procedures Loosen lug nuts Position vehicle Remove the wheel, brake calipers, and rotor Remove the knuckle bolts Remove the hub, axle nut and dust shield Remove the axle shaft carefully Insert the new axle shaft Replace the items removed in reverse order After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Discuss the purpose and components of the drive axle Explain common problems associated with a faulty drive axle Discuss precautions to take when removing and replacing a drive axle
SUSPENSION & STEERING (NATEF A4)		
16. Assist to disable & enable supplemental restraint system (SRS)	Obtain equipment and materials needed Review safety and service procedures Turn the steering wheel so the wheels are straight Turn ignition to OFF and remove key DISABLE	Explain how vehicle body and frame construction works with restraint systems to protect a vehicle's occupants Identify and locate the most important parts of vehicle restraint systems Describe the purpose for restraint systems

	Locate fuse center Remove supplemental inflatable restraint (SIR) fuse Remove the insulator panel Remove the connector position assurance (CPA) from the steering wheel module coil connector Disconnect the steering wheel module coil connector from the vehicle harness connector Install the insulator panel ENABLE Turn the steering wheel so the wheels are straight Turn ignition to OFF and remove key Connect the steering wheel module coil connector to the vehicle harness connector Install the CPA to the steering wheel module coil connector Remove the insulator panel Install the SIR fuse into the body control module fuse center Install the insulator panel Turn ignition to ON After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Describe restraint system design variations Summarize the operation of restraint system sensors, inflator modules, and electronic control modules Explain Enabling zones Describe different air bag systems
17. Assist to remove, inspect, replace, adjust power steering pump drive belt	Obtain equipment and materials needed Review safety and service procedures Loosen the bolts holding the pump to its brackets Push inward on the pump to release tension Remove old belt Obtain correct belt and install in reverse order of removal Adjust belt tension to specifications After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Describe the purpose and components associated with power steering Describe how to pry to tighten a power steering belt Explain how to test the power steering belt tension Discuss common safety precautions for servicing a pump drive belt
18. Assist to remove, reinstall power steering pump	Obtain equipment and materials needed Review safety and service procedures Remove nuts, bolts, hoses and brackets attached to power steering pump Remove pump Replace with new pump Re-attach nuts, bolts, hoses and brackets as required	Describe the purpose and components associated with power steering Discuss common problems associated with a faulty power steering pump Discuss common safety precautions for servicing a power steering pump

	After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	
19. Inspect, replace, adjust tie rod ends (sockets), tie rod sleeves, & clamps	Obtain equipment and materials needed Review safety and service procedures REMOVE Separate the tie rod end form the steering knuckle or center link using a fork or puller Measure or mark tie rod end length Loosen the adjustment sleeve Unscrew the tie rod end Inspect for wear and damage REPLACE Turn the new tie rod end into the sleeve until it is the exact length of the old tie rod Install the tie rod ball stud in the center link or steering knuckle Tighten the fasteners to specification Install new cotter pins and bend correctly Tighten the adjustment sleeve Check steering action Check toe for proper adjustment After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Explain why it is important to mark the tie rod end length Compare the differences between a linkage steering and a rack-and-pinion steering system Describe the operation of hydraulic and electric-assist power steering systems Explain the operation of four-wheel steering systems
20. Assist to inspect, remove, install upper &/or lower ball joints	Obtain equipment and materials needed Review safety and service procedures Position the vehicle Remove the shock absorber Inspect the ball joint wear indicator or measure play in the joint by physically moving the control arm and joint Install a spring compressor on the coil spring Remove the nut securing the ball joint to the steering knuckle Separate the knuckle and the joint Press, screw or drill out the worn ball joint Clean the threads in the control arm if applicable Install new ball joints into the control arm Torque the ball joint properly After servicing, verify service and make adjustments as	Explain the purpose of upper and lower joints in a suspension and steering system Compare compression versus tension ball joints Discuss removal methods for removing worn pressed, bolted or screwed ball joints List common problems associated with faulty joints Discuss common safety precautions for servicing joints

	needed, cleanup work area, return tools to proper location, complete appropriate documentation	
21. Inspect, remove, install front stabilizer bar bushings, brackets, links	Obtain equipment and materials needed Review safety and service procedures Position the vehicle Inspect the bar for damage and loose fittings Remove bushings, bracket and links Remove damaged bar Re-attach bar with links, brackets and bushings After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Discuss the purpose of the stabilizer bar Describe common problems associated with a faulty stabilizer bar Discuss common safety precautions for servicing the stabilizer bar
22. Assist to inspect, remove, install strut cartridge or assembly, strut coil spring, insulators, & upper strut bearing mount	Obtain equipment and materials needed Review safety and service procedures Position the vehicle Unbolt the steering knuckle or bearing support, the brake lines and upper strut assembly- to- body fasteners Mark the cam bolt for later camber re-adjustment Remove the strut assembly (coil spring and chock) as a single unit Inspect for wear and damage Install in reverse order Adjust camber and toe when replacing After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Explain the purpose and components of struts Explain the operation of the four common types of springs Compare the various types of suspension systems List common problems associated with faulty struts Discuss common safety precautions for servicing struts
23. Inspect rear suspension system leaf springs, bushings, center pins/bolts, & mounts	Obtain equipment and materials needed Review safety and service procedures Position the vehicle Inspect springs, bushings, pins/bolts, mounts for springs sticking out, wear, tear and missing parts Notify worksite professional if replacement is indicated After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Explain the purpose and components of struts Explain the operation of the four common types of springs Compare the various types of suspension systems List common problems associated with faulty rear suspension Discuss common safety precautions for servicing rear suspension
24. Perform pre-alignment inspection & measure vehicle ride height	Obtain equipment and materials needed Review safety and service procedures Inspect all steering and suspension related parts are in good working condition	Explain the principles of wheel alignment List the purpose of each wheel alignment setting Describe the use of different types of wheel alignment equipment

	Check for loose wheel bearings, wheel or tire run-out, worn tires, and tires of varied types and sizes, proper tire inflation Measure curb height and weight Check cradle alignment After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	List common problems associated with a faulty alignment Discuss common safety precautions for alignments
25. Dismount, inspect, balance, remount tire on wheel	Obtain equipment and materials needed Review safety and service procedures Remove wheels Dismount tires from wheel using tire changing machine Inspect tires for wear and tear STATIC BALANCE Add wheel weights opposite the heavy area of the wheel DYNAMIC BALANCE Add weights exactly where they are needed using a dynamic balancing machine Remount tire on the wheel Install tires on the vehicle After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Explain static and dynamic wheel balance Explain what is happening to the tire and steering when tires are imbalanced Summarize different methods of balancing wheels and tires Compare and contrast on-vehicle and off-vehicle balancing methods Compare different types of balancing machines Discuss how rear wheel drive or limited slip differential impacts on-car balancing procedures Explain the operation of the tire changing machine List common problems associated with a faulty wheel balance Discuss common safety precautions for servicing wheels
26. Inspect tire for air loss; Repair tire using internal patch	Obtain equipment and materials needed Review safety and service procedures Fill tire with air Place tire in a drum of water or wet tire with hose Look for air bubbles Mark the leak Remove tire from the wheel Inspect the inside surface for the puncture Fill injury with recommended plug or sealant Select patch of correct size and material Scuff the area the patch will cover Apply adhesive to inner liner Place patch on inner liner Use stitching tool to tightly bond patch After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	List common causes of tire air loss Discuss why tires are no longer recommended to be patched without dismounting Explain why areas larger than 13 millimeter or punctures in sidewalls should not be repaired or patched List common problems associated with underinflated or overinflated tires Discuss common safety precautions for servicing tires

27. Assist to test & calibrate power steering pressure monitoring system for operation	Obtain equipment and materials needed Review safety and service procedures Connect the pressure gauge and shutoff valve into the high pressure hose Follow manufacturer procedure Torque hose fittings properly Ensure system is full of fluid Start engine and idle with test valve open Turn steering wheel back and forth Close test valve only for a few seconds and check pressure If readings are abnormal, check and adjust pressure relief valve and pump After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Discuss the purpose and components of the power steering pressure monitoring system Explain problems associated with power steering pressure malfunction Explain how to conduct the power steering pressure test Discuss common safety precautions preforming pressure tests
BRAKES (NATEF A5)		
28. Inspect brake lines, hoses, fittings for leaks kinks, rust, cracks, bulging, wear, loose fittings	Obtain equipment and materials needed Review safety and service procedures Position the vehicle Inspect all brake lines, hoses and connections for leaks on the floor, under the vehicle or at the wheels Check the brake lines for kinks or dents Check the brake hoses for cuts, cracks, bulges and wear Inspect the backing plates for fluid and grease Tighten loose fittings and supports After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Describe the construction of brake lines Explain brake line flaring techniques Explain how to verify brake fluid leakage versus another type of fluid Describe the proper procedures for tightening fittings List common problems associated with faulty brake lines Discuss common safety precautions for servicing brake lines
29. Select, handle, store, fill brake fluids	Obtain equipment and materials needed Review safety and service procedures Check brake fluid level Select, handle, store, and fill to proper level Locate fluid leaks Inspect for general problems with hoses, belts, and other components After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Describe the function and component of brake fluid Discuss common characteristics of brake fluid- viscosity, corrosion, compressibility Compare types of brake fluids

30. Bleed &/or flush brake system	Obtain equipment and materials needed Review safety and service procedures BLEED- MANUAL Attach one end of a hose to the bleeder screw Place the other end submerged in a jar partially filled with clean brake fluid Gently have another tech depress the brake pedal Open the bleed screw or fitting on the caliper or wheel cylinder while watching for air bubbles in the hose Close the bleeder screw or fitting; tell the tech release the brake pedal Repeat until no more bubbles come out of the hose Repeat procedure on the other brake assemblies or brake line connectors if needed BLEED- PRESSURE Pour enough brake fluid in the bleeder ball to reach the prescribed level Charge the ball with 10 to 15 pounds per square inch (psi) of air pressure Fill the master cylinder with brake fluid Install the adapter and hose on the master cylinder Open the valve on the hose Attach a bleeder hose to the farthest wheel cylinder bleed screw Submerge the free end of the hose in a glass container halfway filled with brake fluid Loosen the bleed screw Close off the bleed screw and remove the bleeder hose when fluid coming from the submerged end of the hose is free of air bubbles Repeat bleeding operation on the other wheel cylinders in proper order Close the valve at the bleeder ball hose Disconnect the bleeder from the master cylinder Check the brake fluid level in the reservoir FLUSH Pressure bleed all of the old brake fluid out of the system After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper	Compare bleeding vs. flushing Describe special precautions for master cylinders with plastic reservoirs List the components and operation of a brake system List common problems associated with a faulty brake system Discuss common safety precautions for servicing a brake system

	location, complete appropriate documentation	
31. Measure brake pedal height, travel, free play	Obtain equipment and materials needed Review safety and service procedures Determine if the brake pedal height can be adjusted Determine the brake pedal free height and travel Pump the brake pedal with the engine off to release the vacuum in the power booster Place a ruler against the car floor in the line with the arc of the brake pedal travel Move the pedal by hand to remove any pedal free play Moving the pedal, measure the pedal height at the top or bottom of the pedal Compare to vehicle specification After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Identify the parts of the brake pedal assembly Describe the operation and function of the brake pedal assembly
32. Check master cylinder for leaks & operation	Obtain equipment and materials needed Review safety and service procedures Position the vehicle Inspect the housing for leaks or cracks Check the fluid level in the master cylinder reservoir Check for unequal fluid levels in the master cylinder reservoir chambers on front disc or rear drum systems Inspect the condition of the fluid Add fluid if needed After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Describe basic procedures for servicing a master cylinder and a brake booster Identify the parts of a basic master cylinder and their function Describe possible causes and conditions of brake fluid in the master cylinder Discuss common safety precautions for servicing a master cylinder
33. Remove, clean, inspect, measure brake drum diameter	Obtain equipment and materials needed Review safety and service procedures Remove the tire and wheel assemblies Remove the brake drum Remove parts from the backing plate Inspect and clean parts Measure brake drum diameter using brake drum micrometer Reinstall shoes and drum After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Discuss common components and operation of brake drum systems Explain common problems associated with faulty brake drums Discuss common safety precautions for servicing brake drums

34. Assist to remove, clean, inspect, lubricate, reassemble brake shoes, springs, pins, clips, levers, adjusters, etc.	Obtain equipment and materials needed Review safety and service procedures Remove the tire and wheel assemblies Remove the brake drum Remove parts from the backing plate Inspect and clean parts Clean the wheel bearings Pack, grease, and install new seal Lubricate and check fit Reinstall shoes and drum After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Discuss common components of brake drum systems Explain common problems associated with faulty brake drums Discuss common safety precautions for servicing brake drums
35. Remove, clean, inspect, caliper assembly	Obtain equipment and materials needed Review safety and service procedures Position the vehicle Remove the wheels of the caliper to be serviced Mark the wheels for re-insertion Compress caliper piston(s) Remove the bolts from the caliper to the steering knuckle Lift the caliper away from the rotor Hang the caliper with a cord Replace worn or rusted retaining hardware Inspect the caliper housing for leaks or cracks Inspect the piston and bore for pitting, nicks, scrapes After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Identify the parts and functions of the caliper assembly and calipers Explain the operation of drum/disk brakes and power-assist units Explain how to service a disc brake assembly Explain how to service a drum brake assembly List common problems associated with a faulty caliper assembly Discuss common safety precautions for servicing a caliper assembly
36. Clean, inspect caliper mounting & slides/pins	Obtain equipment and materials needed Review safety and service procedures Position the vehicle Remove the wheels of the caliper to be serviced Mark the wheels for re-insertion Inspect the caliper mounting, slides and pins for cracks, breaks, missing pieces Check rotor for heat checking, cracks, and scorings After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper	Discuss components of a disc brake system Discuss common indications of disc brake system problems Define heat checking Discuss common safety precautions for servicing disc brakes

	location, complete appropriate documentation	
37. Remove, inspect, replace pads & retaining hardware	Obtain equipment and materials needed Review safety and service procedures Position the vehicle Remove the wheels of the caliper to be serviced Mark the wheels for re-insertion Compress caliper piston(s) Remove the bolts from the caliper to the steering knuckle Lift the caliper away from the rotor Hang the caliper with a cord Remove the clips (if applicable) and old pads from the caliper Fit the new pads into the calipers Compress the piston over the new brake pads in the caliper assembly with a C clamp Slide the caliper assemblies over the new pads Mount the caliper assembly Torque all bolts properly Install wheel and tighten lug nuts or bolts to specification After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Discuss components of a disc brake system Discuss common indications of disc brake system problems Describe the recommended intervals for brake pad inspections Define the purpose and operation of the brake pads Describe importance of operating a vehicle to burnish/break-in replacement brake pads according to manufacturer's recommendations Discuss common safety precautions for servicing disc brakes
38. Lubricate, reinstall caliper, pads, & related hardware	Obtain equipment and materials needed Review safety and service procedures Check the caliper cylinder wall for wear, scoring, or pitting Check the caliper piston for wear; replace with a new piston if needed Inspect all hoses; replace any that are leaking or show deterioration Clean all the caliper parts with an approved cleaner Lubricate all parts liberally with clean brake fluid Work the new seal into the cylinder bore groove Compress the piston back into the caliper Reassemble the caliper halves using new gaskets and seals if needed Clean and lubricate caliper attachment hardware After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper	Discuss components of a disc brake system Discuss common indications of disc brake system problems Explain the importance of lubricant on sliding surfaces Explain the importance of methodical bench cleaning and inspection for this procedure Discuss common safety precautions for servicing disc brakes

	location, complete appropriate documentation	
39. Clean, inspect, measure rotor, rotor thickness, variation, & lateral run-out	Obtain equipment and materials needed Review safety and service procedures Loosen the wheel lug nuts Position the vehicle Remove wheel and caliper assembly Inspect the disc surface for warp age, cracks or scoring Inspect the disc thickness for variation Measure thickness using an outside micrometer in several places around the disc Measure run-out using a dial indicator Compare readings to disc specifications Consult with worksite professional to determine if new disc or resurfacing is indicated After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Discuss components of a disc brake system Discuss common indications of disc brake system problems Define the purpose and operation of the rotor Describe when a rotor should be replaced Define run-out Explain how to measure disc thickness Discuss complications of a thin or warped disc Discuss common safety precautions for servicing rotors
40. Remove, reinstall rotor	Obtain equipment and materials needed Review safety and service procedures Loosen the wheel lug nuts Position the vehicle Remove wheel and caliper assembly Remove the rotor Reinstall new rotor After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Discuss the components brake disc systems Explain common problems associated with brake disc systems Define the purpose and operation of the rotor Describe when a rotor should be replaced Discuss common safety precautions for servicing rotors
41. Check brake pad wear indicator	Obtain equipment and materials needed Review safety and service procedures Remove the wheel Check the thickness of the brake pads Check the location of the wear indicator Service brake pads as needed After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Describe the function of the brake pad wear indicator Discuss components of a disc brake system Discuss common indications of disc brake system problems Describe the recommended intervals for brake pad inspections Define the purpose and operation of the brake pads Describe importance of operating a vehicle to burnish/break-in replacement brake pads according to manufacturer's recommendations Discuss common safety precautions for servicing disc brakes

42. Remove, clean, inspect, repack, install wheel bearings, seals, hub	Obtain equipment and materials needed Review safety and service procedures Partially loosen the lug nuts Raise and secure the vehicle NON DRIVING WHEELS Remove the wheel, grease cap, cotter pin, nut lock, adjusting nut and safety washer Wiggle the hub and pull out the outer wheel bearing Unbolt brake caliper and secure Slide hub outward Inspect and wipe bearing and race clean Re-grease and pack bearings Re-install bearings and race DRIVING WHEELS Remove the lug nuts, axle nut and wheel Remove the caliper to the side Unbolt the brake disc from the hub if needed Remove steering knuckle and hub from vehicle Pack new bearings with grease Press new bearings into place Install new grease seal Press seal into hub; hub into steering knuckle Install steering knuckle, brake disc, caliper, other components SEALED BEARINGS Remove bearing bolts and hub Install new bearing assembly After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Discuss the purpose and basic components of wheel bearings and hubs Discuss common problems associated with failed bearings Compare serviceable bearings to non-serviceable sealed units Discuss common safety precautions for servicing bearings and hubs
43. Check parking brake cables & components	Obtain equipment and materials needed Review safety and service procedures Position the vehicle Remove the wheel Screw one lug to keep rotor in place Loosen parking brake cable at the equalizer Apply parking brake to determine movement Inspect the cables and linkages for wear, binding and corrosion	Describe the operation and components of parking brakes Describe lubricant procedures for metal vs. plastic coated cables Explain what excessive heavy drag could mean Identify traction control/vehicle stability control system components Describe the operation of a regenerative braking system List common problems associated with a faulty parking brakes

	Replace cables and linkages if needed Release the parking brake or engage one notch only Clean and lubricate the cable and linkages Turn the cable adjuster to remove excess slack Apply and release the parking brake to check for brake dragging After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Discuss common safety precautions for servicing parking brakes
44. Check parking brake operation & indicator lights	Obtain equipment and materials needed Review safety and service procedures Check the indicator light system Use a digital multimeter (DMM) to locate electric circuit problems Replace the bulb if needed After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Explain the function of the digital multimeter (DMM) Describe how the DMM works to measure voltage, voltage drop, current flow and resistance Describe the purpose of the ground lead in using the DMM Describe the operation and components of parking brakes List common problems associated with a faulty parking brakes Discuss common safety precautions for servicing parking brakes
45. Assist to replace wheel bearing & race	Obtain equipment and materials needed Review safety and service procedures Remove wheel and brake caliper Gently pry the bearing grease cup away from hub by turning the wheel a little each time Remove the cotter pin, retaining ring, and spindle nut Remove hub or rotor-hub assembly Inspect the bearing and race for scoring, flat spots, or broken rollers Knock the outer race from the hub Flip over the hub and knock out the inner race, bearing, and seal Pack the new inner and outer wheel bearings by either pressing grease into each roller by hand or using a bearing packer and grease gun Remove old grease from inside hub Use the wheel-bearing tool to seat inner race into hub Place the bearing in the race and use the tool again to seat the grease seal	Explain service procedures for wheel bearings Identify the parts of driving and non-driving hub and wheel bearing assemblies Explain the purpose of greasing each roller Describe how to choose the drift for the wheel bearing tool Demonstrate the torque needed to re-tighten the nut Describe the dangers of over-tightening the spindle nut

	Flip over the hub and repeat for the outer race Pack a good amount, but do not completely fill inside the hub with grease Clean all excess grease from outside the hub Place the hub on the spindle Tighten the nut just enough to seat the whole assembly while spinning the hub Loosen the nut then re-tighten to specifications Pack more grease into the bearing and bearing cup Replace retaining ring and secure with a new cotter pin Gently replace the bearing grease cup being careful not to dent it Remove all grease from the outer surface of the hub or rotor Grab the top and bottom of the hub and check for play After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	
ELECTRICAL/ELECTRONIC SYSTEMS (NATEF A6)		
46. Properly use a digital multimeter (DMM)	Obtain equipment and materials needed Review safety procedures Set the digital multimeter (DMM) to the correct voltage scale Connect the red lead to the appropriate point in the circuit to be measured Connect the black lead to the appropriate position on the circuit depending on the function to be measured Measure voltage, voltage drop, current flow and resistance After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Discuss causes and effects from shorts, grounds, opens, and resistance problems in electrical/electronic circuits Explain the use of wiring diagrams during the diagnosis (troubleshooting) of electrical/electronic circuit problems Explain the function of the digital multimeter (DMM) Describe how the DMM works to measure voltage, voltage drop, current flow and resistance Describe the purpose of the ground lead in using the DMM
47. Use wiring diagrams	Obtain equipment and materials needed Review safety and service procedures Locate the parts to be tested for electrical problems Follow the lines to show how wiring is attached into each component of the circuit Look for faulty relays and wires in the faulty part After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper	Explain the purpose and use of wiring diagrams Describe common components of wiring diagrams

	location, complete appropriate documentation	
48. Inspect, test fusible links, breakers, fuses	Obtain equipment and materials needed Review safety procedures Inspect the fuses, breakers and links for tripping or breaks Reset the breaker or replace the fuse as needed After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Identify types of circuit protection devices used in an electrical circuit Define the functions of a fuse, fuse box, fusible link, circuit breaker Compare circuit breakers to fuses Explain the common functions and locations of fuses and breakers in a vehicle Describe types of circuit faults Discuss common safety precautions for servicing fuses and breakers
49. Replace electrical connectors & terminal ends	Obtain equipment and materials needed Review safety procedures Unscrew/unplug the wire with terminal end Remove terminal end Replace new terminal end onto end of wire by soldering or crimping into place After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	List types of common automotive wiring Explain common causes of wire damage Identify types of wire damage Describe wire repair procedures List common types of insulation damage List common types of wiring connectors used in vehicles Explain how to terminate primary wires Discuss common safety precautions for servicing connectors
50. Perform starter current draw tests	Obtain equipment and materials needed Review safety and service procedures Determine starter type and main starter components Disable the ignition system to prevent the vehicle from starting Connect a digital multimeter (DMM) across the battery Measure battery voltage Crank the engine for no more than 15-30 seconds Note the voltage and current readings If values are not within specifications, further tests are needed After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Explain the function of a starter List the components and operation of a starter List common problems associated with a faulty starter Discuss common safety precautions for servicing a starter system Explain the purpose of the current draw test on a starter Define the order for starting system tests Explain typical procedures for a starting motor rebuild Describe the function of major ignition system components Explain vacuum, centrifugal, and electronic ignition timing advance
51. Perform starter circuit voltage drop tests	Obtain equipment and materials needed Review safety and service procedures Determine starter type and main starter components Disable the ignition system to prevent the vehicle from starting Connect the digital multimeter (DMM) leads correctly	Explain the function of a starter List the components and operation of a starter List common problems associated with a faulty starter Discuss common safety precautions for servicing a starter system Explain the purpose of the voltage drop test

	Check voltage drop across different parts of the starter control circuit using the wiring diagram Note voltage drop readings After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Define the order for doing voltage drop testing using a wiring diagram
52. Remove, install starter	Obtain equipment and materials needed Review safety and service procedures REMOVAL Disconnect the battery Remove any shielding that covers the starter or its bolts Disconnect any accessible wires on the starter If needed, lower exhaust pipes by carefully loosening the bolt/studs Support the starter and remove the starter retaining bolts Check for shims Lower the starter and disconnect any wiring not yet removed Inspect the flywheel teeth for chipping and breakage INSTALL Reverse the steps taken to remove the starter; return shims to the same place if applicable After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Explain the function of a starter List the components and operation of a starter List common problems associated with a faulty starter Discuss common safety precautions for servicing a starter Compare different types of starting motors Explain when it is best to repair vs. replace a starter motor
53. Remove, inspect, reinstall generator (alternator)	Obtain equipment and materials needed Review safety and service procedures Disconnect the battery REMOVE Loosen the bolts and remove the fan belt Remove the wires from the generator, note their location Remove the generator INSPECT Check for battery problems Check the condition of the generator belt; Replace if needed INSTALL Connect the wires back on the generator in the proper locations with insulating washers, if applicable Hand screw in the bolts without tightening	Explain the function of the alternator List the components and operation of an alternator List common problems associated with a faulty alternator Discuss common safety precautions for servicing an alternator Describe the importance of proper belt tightening

	Slip the belt over the engine and generator pulley Align belt properly Adjust belt tension correctly Tighten the bolts Reconnect the battery After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	
54. Remove, reinstall door panel	Obtain equipment and materials needed Review safety and service procedures Remove all screws that hold the door panel to the frame Unscrew and remove the door lock button Remove the inner door handle and window crank, if applicable Pop out the spring clips around the outside of the door panel After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation	Describe the importance of proper door removal Describe the parts of the door panel