THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATION COUNCIL OF TANZANIA

DIPLOMA IN TECHNICAL EDUCATION EXAMINATION

790 **AUTOMOBILE TECHNOLOGY**

Time: 3 Hour. **ANSWERS** **Year: 2005**

Instructions

1. This paper consists of **eight (8)** questions.
2. Answer any **five (5)** questions
3. Each question carries **twenty (20)** marks.
4. Programmable calculators, cellular phones and other unauthorized materials are **not** allowed in the examination room.
5. Write your **Examination Number** on every page of your answer booklet(s).

1. (a) Explain five causes of abnormal engine noise and their effects on engine performance.

Worn crankshaft bearings cause a knocking sound at low engine speeds. This leads to reduced oil pressure and potential engine seizure if ignored.

Valve clearance that is too wide causes tapping or ticking noises during idling or acceleration. This reduces valve opening duration and affects engine breathing and efficiency.

Loose timing chains or belts result in a rattling noise and can cause incorrect valve timing, leading to poor combustion and misfiring.

Detonation or knocking due to using low-octane fuel produces a sharp metallic pinging. It can damage pistons and cylinder walls over time.

Piston slap occurs when cold pistons don't fit tightly in the cylinder, causing a slapping sound that affects combustion stability and fuel economy.

(b) Describe the diagnostic steps a technician should take when an engine misfires during acceleration.

Connect a scan tool to check for diagnostic trouble codes (DTCs) related to misfiring cylinders or fuel delivery problems.

Inspect spark plugs for wear, fouling, or improper gaps, and replace them if necessary.

Test ignition coils and leads for weak or inconsistent spark using an oscilloscope or multimeter.

Check fuel pressure using a fuel pressure gauge to ensure the pump and injectors are delivering adequate fuel.

Perform a compression test to rule out mechanical issues such as worn valves or piston rings that can cause cylinder imbalance.

(c) Outline the procedure for checking valve clearance in an overhead camshaft engine.

Allow the engine to cool completely and remove necessary components like the valve cover for access to the camshaft and rocker arms.

Rotate the crankshaft until the cam lobe for the cylinder being checked points away from the valve follower, ensuring the valve is fully closed.

Insert a feeler gauge between the camshaft lobe and the follower or tappet and compare the gap to manufacturer specifications.

If the clearance is outside the specified range, adjust it by replacing the shim or adjusting the screw, depending on the engine design.

Repeat the procedure for all valves and reassemble components, then start the engine to confirm smooth operation.

2. (a) Compare carburetor and electronic fuel injection (EFI) systems in terms of efficiency and control.

Carburetors mechanically mix air and fuel using pressure differences, making them simpler but less precise. EFI systems use sensors and the ECU for accurate fuel delivery, improving efficiency.

Carburetors cannot adjust quickly to changes in load or altitude, while EFI systems can adapt in real time for optimal performance.

EFI provides better cold start behavior and fuel atomization, while carburetors may require manual chokes and produce more emissions.

EFI systems offer more consistent air-fuel ratios across various engine conditions, resulting in better throttle response and fuel economy.

(b) State four components of an EFI system and explain their functions.

The fuel injector sprays a fine mist of fuel into the intake manifold or combustion chamber for efficient mixing with air.

The ECU (engine control unit) processes data from sensors and determines the correct fuel quantity and injection timing.

The oxygen sensor measures exhaust oxygen levels to help the ECU maintain the ideal air-fuel mixture for emissions and performance.

The fuel pressure regulator maintains constant pressure in the fuel rail to ensure consistent injector operation.

(c) Explain three reasons why fuel filters should be replaced regularly in a vehicle.

Fuel filters trap contaminants such as dirt and rust, preventing them from reaching the injectors and causing clogs or wear.

A clogged filter reduces fuel flow, leading to lean mixtures, poor acceleration, and engine hesitation.

Regular replacement ensures consistent fuel pressure and protects expensive components like the fuel pump and injectors from damage.

3. (a) Describe the process of clutch engagement and disengagement in a manual transmission system.

When the clutch pedal is released, the pressure plate presses the clutch disc against the flywheel, allowing engine torque to transfer to the transmission input shaft.

As the clutch pedal is pressed, the release bearing pushes the diaphragm spring, pulling the pressure plate away from the clutch disc.

This disengages the clutch disc from the flywheel, interrupting power flow and allowing the driver to shift gears without damaging the transmission.

The process allows for smooth starts, gear changes, and stopping without stalling the engine.

(b) Explain the function and operation of a release bearing in a clutch system.

The release bearing sits between the clutch fork and the diaphragm spring of the pressure plate.

When the clutch pedal is pressed, the clutch fork pushes the bearing forward against the diaphragm spring.

This movement relieves pressure on the clutch disc, disengaging the engine from the transmission.

The bearing ensures smooth, low-friction movement and prevents metal-to-metal contact between the fork and spring.

(c) State three causes of clutch slippage and how each can be corrected.

Worn clutch linings reduce friction, causing the disc to slip under load. Replacing the clutch disc corrects this issue.

Oil contamination from a leaking rear main seal or gearbox input shaft seal reduces friction. Fixing the leak and replacing the contaminated disc is necessary.

Weak or broken pressure plate springs reduce clamping force. Replacing the pressure plate restores proper engagement.

4. (a) With the help of a diagram, explain the power flow in a four-speed manual gearbox.

In first gear, the smallest gear on the input shaft meshes with the largest gear on the output shaft, providing maximum torque and lowest speed.

Second gear uses a slightly larger gear ratio to reduce torque and increase speed.

Third gear provides a direct or 1:1 ratio, where input and output shafts rotate at the same speed.

Fourth gear is usually overdrive, where the output shaft spins faster than the input, improving fuel economy.

The driver selects gears by moving the gear lever, which slides the synchronizer sleeve to engage different gear sets.

(b) Differentiate between synchromesh and constant mesh gears.

Synchromesh gears use synchronizers to match the speed of gears before engagement, allowing smooth, noiseless shifting without grinding.

Constant mesh gears have all gear pairs in constant engagement, but power is transferred only when the dog clutch or synchronizer connects the selected gear to the shaft.

Synchromesh improves gear selection comfort, while constant mesh ensures durability and readiness.

(c) Describe the symptoms and causes of worn-out gearbox bearings.

Whining or humming noise increases with vehicle speed, indicating bearing wear or damage.

Gear shifting may become stiff or rough as shaft misalignment increases due to worn bearings.

Oil leakage from the gearbox is another symptom, as worn bearings allow excessive shaft movement and seal damage.

5. (a) State four functions of the differential in a vehicle drivetrain.

The differential transmits engine torque from the driveshaft to the drive wheels, allowing the vehicle to move forward or backward.

It allows the left and right drive wheels to rotate at different speeds when turning, preventing tire scrubbing and improving cornering.

It helps distribute torque evenly to both wheels under normal driving conditions, maintaining traction and stability.

In rear-wheel-drive vehicles, it redirects power flow from the longitudinal driveshaft to the transverse axles connected to the wheels.

(b) Explain how limited slip differentials (LSDs) work and why they are used.

Limited slip differentials use clutches, cones, or viscous fluids to limit the difference in rotational speed between the two drive wheels.

When one wheel begins to slip or lose traction, the LSD transfers more torque to the wheel with better grip, improving traction.

LSDs are used to enhance handling and stability, particularly in high-performance vehicles, off-road vehicles, or when driving in slippery conditions.

(c) Describe the effects of driving with low differential oil level.

Low differential oil reduces lubrication, causing increased friction and overheating of gears and bearings.

This leads to premature wear, whining noises, and eventual gear failure if not corrected.

Prolonged operation without sufficient oil can damage seals and result in total differential failure, requiring costly repairs.

6. (a) Define bump steer and explain its causes in a steering system.

Bump steer is the unintended movement of the vehicle's wheels left or right when the suspension moves up or down over bumps.

It is caused by improper alignment of steering linkage and suspension geometry, especially unequal arc travel between the control arms and tie rods.

Worn suspension bushings or bent steering arms can also contribute to bump steer, affecting vehicle stability and steering accuracy.

(b) Explain the operation of a hydraulic power steering system.

Hydraulic power steering uses an engine-driven pump to pressurize fluid, which is directed through control valves to assist in turning the wheels.

When the steering wheel is turned, the control valve sends pressurized fluid to one side of the steering rack or gear, reducing steering effort.

As the wheel returns to center, the valve redirects fluid, allowing the system to assist in smooth and responsive steering.

(c) State three advantages of electric power steering over hydraulic systems.

Electric power steering only uses energy when needed, improving fuel efficiency compared to continuously operating hydraulic pumps.

It allows integration with driver-assist technologies like lane-keeping assist and automatic parking systems.

Electric systems require less maintenance since they don't use fluid, hoses, or belts, and are more compact and reliable.

7. (a) Describe the working principle of a thermal-type coolant temperature sensor.

A thermal-type coolant temperature sensor uses a thermistor, which changes resistance based on coolant temperature.

As coolant temperature increases, the thermistor's resistance decreases, altering the voltage signal sent to the ECU.

The ECU uses this data to adjust fuel injection, ignition timing, cooling fan operation, and dashboard temperature gauge.

(b) State three symptoms of a faulty engine coolant temperature sensor.

Poor fuel economy due to incorrect air-fuel mixture if the ECU receives false temperature readings.

Hard starting or rough idle, especially when cold, as the ECU may not adjust fuel enrichment correctly.

Cooling fans may fail to operate or run continuously, affecting engine cooling efficiency.

(c) Explain how a thermostat regulates engine temperature.

The thermostat stays closed during cold starts, restricting coolant flow and allowing the engine to warm up quickly.

When the coolant reaches the thermostat's rated temperature, it opens to allow flow to the radiator for cooling.

By opening and closing based on coolant temperature, it maintains the engine within its optimal operating range.

8. (a) Outline the procedure for performing a compression test on a petrol engine.

Warm up the engine to normal operating temperature to ensure accurate readings.

Disable the ignition and fuel systems to prevent the engine from starting during cranking.

Remove all spark plugs and insert the compression gauge into the first cylinder.

Crank the engine using the starter for about 5–6 revolutions and record the pressure reading.

Repeat the process for all cylinders and compare the values to manufacturer specifications.

(b) State the acceptable compression variation between cylinders and its implications.

Compression readings between cylinders should not vary by more than 10–15%.

Greater variation indicates mechanical issues such as worn rings, leaking valves, or head gasket failure, leading to rough idling or misfiring.

(c) List three causes of low compression in an engine and how each can be addressed.

Worn piston rings allow pressure to escape into the crankcase. Replacing the rings restores compression.

Leaking valves due to poor sealing or carbon buildup cause pressure loss. Valve lapping or replacement may be required.

A blown head gasket allows pressure to leak between cylinders or into the coolant. Replacing the gasket and checking head flatness resolves the issue.