THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATION COUNCIL OF TANZANIA

DIPLOMA IN TECHNICAL EDUCATION EXAMINATION

790 **AUTOMOBILE TECHNOLOGY**

Time: 3 Hour. **ANSWERS** **Year: 2017**

Instructions

1. This paper consists of t**en (10)** 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) Describe five symptoms of a failing head gasket in an internal combustion engine.

One symptom is the presence of white smoke from the exhaust pipe, indicating that coolant is leaking into the combustion chamber and being burned.

Another symptom is coolant contamination with oil, visible as a milky or frothy substance in the radiator or on the dipstick, due to internal fluid mixing.

Engine overheating may occur because the blown head gasket allows combustion gases into the cooling system, reducing its efficiency.

Loss of engine power is common, as a leaking head gasket reduces cylinder compression, affecting combustion and performance.

Bubbles in the radiator or coolant reservoir during engine operation indicate exhaust gas leakage into the cooling system, another sign of gasket failure.

(b) Explain the correct procedure for testing engine compression using a compression gauge.

First, warm up the engine to operating temperature and disable the ignition and fuel systems to prevent accidental starting during cranking.

Remove all spark plugs to ensure even cranking pressure and install the compression tester into the first cylinder's spark plug hole.

Crank the engine with the throttle fully open for about five revolutions while observing the pressure gauge. Record the maximum pressure reading.

Repeat the procedure for all cylinders, then compare the readings. All cylinders should have similar readings within about 10–15% of each other. A significant variation indicates internal engine wear or leakage.

(c) State three possible effects of low engine compression on overall performance.

Low engine compression reduces engine power output, leading to sluggish acceleration and poor throttle response.

It causes rough idling or engine misfiring, especially during cold starts, as fuel may not ignite properly due to insufficient compression.

It increases fuel consumption and emissions because incomplete combustion results in wasted fuel and more unburned hydrocarbons in the exhaust.

2. (a) (i) What is the purpose of a camshaft position sensor in an engine management system?

The camshaft position sensor provides information about the position and speed of the camshaft to the ECU. This data helps the ECU determine proper timing for fuel injection and ignition in relation to the piston position.

(ii) Mention four signs that may indicate a failing camshaft position sensor.

Engine stalling or hesitation during acceleration can occur due to incorrect timing signals.

Hard starting or no-start conditions may arise when the ECU cannot determine the proper timing.

Poor fuel economy and reduced performance happen because fuel injection becomes less efficient without accurate sensor data.

The check engine light may illuminate, and diagnostic codes related to camshaft position may be stored in the ECU.

(iii) How does the ECU respond when the camshaft position sensor fails?

If the sensor fails, the ECU may enter a default or limp mode using preset values. It may rely solely on crankshaft position data, resulting in reduced performance and possible delayed ignition or injection.

(b) (i) Differentiate between sequential and simultaneous fuel injection systems.

Sequential fuel injection delivers fuel to each cylinder individually, timed with the intake stroke, improving efficiency and combustion.

Simultaneous injection sends fuel to all injectors at the same time regardless of piston position, leading to less precise fuel delivery and potential waste.

(ii) Give two advantages of sequential injection over simultaneous injection.

Sequential injection improves fuel economy by delivering fuel only when each intake valve is opening, reducing fuel wastage.

It also improves emissions control by optimizing combustion timing, leading to cleaner exhaust gases and better throttle response.

(c) Explain the intake process in a naturally aspirated engine and how it differs from a turbocharged engine.

In a naturally aspirated engine, air is drawn into the cylinders by atmospheric pressure and vacuum created during the intake stroke. The engine relies solely on engine speed and atmospheric conditions for air volume.

In a turbocharged engine, a turbocharger compresses incoming air using energy from exhaust gases. This increases the air density, allowing more air (and fuel) into the cylinder, resulting in higher power output compared to a naturally aspirated engine of the same displacement.

3. (a) Identify five possible causes of a rough idle in a petrol engine.

A dirty or faulty idle air control valve disrupts airflow at idle, causing fluctuations in engine speed.

Vacuum leaks in hoses or intake manifold allow unmetered air into the engine, disrupting the air-fuel ratio.

Worn spark plugs or ignition coils cause misfires, leading to uneven combustion and idle roughness.

Dirty fuel injectors may spray unevenly or partially clog, causing fuel delivery issues at idle.

A malfunctioning EGR valve that is stuck open can introduce exhaust gases during idle, disrupting combustion and causing instability.

(b) Describe how to carry out a charging system voltage test using a multimeter.

Set the multimeter to DC voltage and place the red lead on the battery's positive terminal and the black lead on the negative terminal.

With the engine off, check the resting voltage; it should read around 12.6 volts.

Start the engine and observe the reading again. A healthy charging system should produce 13.8 to 14.5 volts. If the voltage is below 13.5V or above 14.7V, the alternator or voltage regulator may be faulty.

(c) What is the purpose of a mass airflow sensor and how can it affect fuel delivery?

The mass airflow (MAF) sensor measures the amount of air entering the engine and sends this data to the ECU.

If the sensor gives incorrect readings, the ECU may inject too much or too little fuel, leading to a rich or lean mixture. This affects performance, fuel economy, and emissions.

(d) Mention three causes of irregular engine vibrations at idle.

A worn or broken engine mount can transmit engine movement directly to the vehicle chassis, causing noticeable vibrations.

Misfiring due to ignition or fuel system problems causes imbalance in engine firing, resulting in shaking at idle.

Uneven cylinder compression, due to valve or piston ring wear, causes inconsistency in engine power pulses, leading to rough idle.

4. (a) Explain four engine-related conditions that may cause overheating in a vehicle.

A malfunctioning thermostat may remain closed, blocking coolant flow to the radiator and causing the engine to overheat.

A leaking or low coolant level reduces the cooling system's ability to absorb and dissipate heat, leading to temperature spikes.

A faulty water pump may fail to circulate coolant effectively through the engine and radiator.

A clogged or blocked radiator restricts heat exchange between the coolant and outside air, preventing proper cooling.

(b) Describe the step-by-step procedure for replacing a thermostat in a vehicle cooling system.

Let the engine cool completely. Disconnect the battery and drain the coolant to a level below the thermostat housing.

Remove the housing bolts and detach the housing from the engine block. Take out the old thermostat and gasket.

Clean the mating surfaces of old gasket material. Place the new thermostat in the correct orientation and install a new gasket or sealant.

Reinstall the thermostat housing and tighten the bolts to the correct torque. Refill the coolant, bleed the system of air, reconnect the battery, and run the engine to check for leaks and proper temperature operation.

(c) Explain the effect of a stuck-open thermostat on engine operation and fuel economy.

A stuck-open thermostat allows coolant to circulate continuously, preventing the engine from reaching its ideal operating temperature.

As a result, the ECU keeps the fuel mixture rich, increasing fuel consumption and emissions. It also leads to reduced heater performance and accelerated engine wear over time.

(d) Give three possible reasons why a cooling fan may fail to operate when needed.

A blown fuse or relay can interrupt power to the fan motor, preventing activation even when the engine is hot.

A faulty coolant temperature sensor may fail to signal the ECU to engage the fan.

A failed fan motor or worn-out brushes may prevent the fan from spinning, even if power is present.

5. (a) List four functions of engine oil in internal combustion engines.

Engine oil lubricates moving parts, reducing friction and preventing metal-to-metal contact.

It carries away heat from internal engine components, assisting in temperature regulation.

It cleans the engine by suspending dirt, carbon, and metallic particles, preventing sludge buildup.

It forms a seal between the piston rings and cylinder walls, improving compression and reducing blow-by gases.

(b) A four-cylinder engine has a bore of 87 mm and a stroke of 92 mm. Calculate the total engine displacement in liters.

Convert to meters:
Bore = 0.087 m
Stroke = 0.092 m
Cylinders = 4

Volume per cylinder = $(\pi / 4) \times (0.087)^2 \times 0.092$
$= 0.000547\ m^3$

Total displacement = $0.000547 \times 4 = 0.002188\ m^3$
Convert to liters: $0.002188 \times 1000 =$ **2.188 liters**

(c) State four consequences of using the wrong viscosity oil in a modern engine.

Using oil that's too thick (high viscosity) may cause poor flow during cold starts, leading to increased wear on startup.

Oil that's too thin may fail to maintain proper pressure and form a protective film under high-load or high-temperature conditions.

Incorrect viscosity can lead to increased oil consumption or leaks, especially in engines with tight tolerances or worn seals.

It may trigger the check engine light or oil pressure warning due to the ECU detecting abnormal pressure levels.

6. (a) Explain the construction and function of a stabilizer (anti-roll) bar in a suspension system.

A stabilizer bar, also called an anti-roll bar, is a solid or tubular steel rod that connects the left and right suspension systems of a vehicle, typically at the lower control arms. It is mounted to the vehicle frame or subframe through rubber bushings that allow it to twist.

Its function is to reduce body roll during cornering. When the vehicle leans into a turn, the bar resists the movement by twisting, transferring force from one side of the suspension to the other. This maintains a more level stance, improves grip, and enhances driver control during sharp turns or quick maneuvers.

(b) What are the effects of worn-out suspension bushings on handling and stability?

Worn-out suspension bushings cause excessive play in suspension components, leading to imprecise steering and reduced handling accuracy.

They create knocking or clunking noises during driving, especially when going over bumps or uneven surfaces.

They can cause uneven tire wear due to poor alignment retention and irregular movement in control arms.

The vehicle may exhibit instability during cornering or braking, increasing the risk of loss of control or unpredictable behavior.

(c) Identify three signs of a failing ball joint and their impact on safety.

A clunking noise when turning or going over bumps is a common sign of a worn ball joint, indicating excessive play or looseness.

Uneven tire wear, particularly on the inside or outside edges, occurs due to misalignment caused by loose ball joints.

Wandering or unstable steering, where the vehicle pulls to one side or feels loose on the road, compromises driving safety and control.

In severe cases, a completely failed ball joint can lead to wheel detachment or collapse of the suspension on one side, posing a major safety hazard.

7. (a) Give four functions of the gearbox in a vehicle transmission system.

It transmits engine torque to the drive wheels while allowing the vehicle to move at various speeds under different loads.

It enables the driver to select suitable gear ratios for acceleration, climbing, cruising, and reversing.

It allows the engine to operate within an efficient RPM range regardless of vehicle speed, optimizing fuel consumption and performance.

It provides a neutral position, disconnecting the engine from the drivetrain for starting or idling without wheel movement.

(b) Explain how gear ratios affect torque and speed in a manual transmission.

Higher gear ratios (e.g., 4:1) multiply engine torque significantly but reduce output shaft speed, making them suitable for low-speed, high-load conditions like starting or climbing.

Lower gear ratios (e.g., 1:1 or 0.8:1) transmit more speed and less torque, ideal for cruising at higher speeds with lower engine RPMs.

By selecting different gears, the driver controls how torque and speed are balanced according to driving conditions.

(c) An engine produces 220 Nm at 2800 rpm. If the gear ratio is 4.2:1 and transmission efficiency is 85%, calculate the output torque and output shaft speed.

Output speed = Engine speed ÷ Gear ratio
= 2800 ÷ 4.2
= **666.67 rpm**

Output torque = Engine torque × Gear ratio × Efficiency
= 220 × 4.2 × 0.85
= 220 × 3.57
= **785.4 Nm**

So, the output shaft rotates at approximately **667 rpm** and delivers **785.4 Nm** of torque.

8. (a) State four main sources of automotive noise pollution and their causes.

Exhaust system leaks or damaged mufflers cause loud engine noise, especially during acceleration or at high RPMs.

Worn-out or improperly lubricated suspension components produce creaking or knocking sounds over bumps or during turns.

Faulty wheel bearings generate humming or grinding noise that increases with vehicle speed, due to metal-to-metal contact.

Engine components like timing chains, valves, or belts may create rattling or ticking noises if loose, worn, or poorly adjusted.

(b) Describe how to inspect an exhaust system for leaks without using electronic diagnostic tools.

Start the engine and allow it to idle. Listen carefully for hissing or popping sounds along the exhaust system, which may indicate leaks.

Use a hand or cloth near joints or suspected leak points (without touching hot surfaces) to feel for escaping gases.

Visually inspect all exhaust pipes, joints, and clamps for cracks, holes, rust, or carbon soot marks that indicate leakage.

Apply light soapy water to joints while the engine is running; bubbles will form at leak points.

(c) Identify four effects of a leaking exhaust manifold on engine efficiency and emissions.

It allows exhaust gases to escape before reaching the oxygen sensor, causing inaccurate air-fuel adjustments and poor engine performance.

It increases engine noise and harshness, particularly during acceleration.

It may lead to higher emissions due to incorrect fueling and incomplete combustion adjustments by the ECU.

It can cause engine misfires or loss of power due to disrupted exhaust flow and unmetered air entry into the exhaust stream.