THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATION COUNCIL OF TANZANIA

DIPLOMA IN TECHNICAL EDUCATION EXAMINATION

790 **AUTOMOBILE TECHNOLOGY**

Time: 3 Hour. **ANSWERS** **Year: 2016**

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) Explain five engine mechanical faults that may lead to poor acceleration in a petrol-powered vehicle.

Low engine compression caused by worn piston rings, valves, or head gasket leakage reduces power output and leads to sluggish acceleration.

Clogged air filters restrict airflow into the engine, reducing the volume of oxygen needed for combustion and causing hesitation or slow throttle response.

Faulty fuel injectors can disrupt fuel delivery, either by leaking or clogging, resulting in an incorrect air-fuel mixture and reduced engine performance.

A blocked or failing catalytic converter causes excessive backpressure in the exhaust system, preventing proper exhaust flow and limiting acceleration.

Sticking throttle body or malfunctioning throttle mechanism hinders proper air intake regulation, causing lag or resistance during acceleration.

(b) Describe the procedure for removing and inspecting spark plugs in a multi-cylinder engine.

Start by turning off the engine and allowing it to cool. Disconnect the battery to prevent accidental short circuits.

Label and remove the ignition wires or coil packs from each spark plug. Use a spark plug socket and extension bar to carefully unscrew each plug.

Visually inspect each spark plug for signs of wear, carbon buildup, oil fouling, or cracks. Check the electrode gap using a feeler gauge and compare it to the manufacturer's specification.

Record the condition of each plug and reinstall or replace as needed. Apply a small amount of anti-seize compound on the threads before reinstalling. Torque the spark plugs to the specified value and reconnect the wires or coils in the correct order.

(c) State three advantages of using iridium spark plugs compared to conventional copper spark plugs.

Iridium spark plugs last longer due to their higher melting point and stronger resistance to electrode wear, extending maintenance intervals.

They provide more consistent and reliable sparks, improving combustion efficiency, throttle response, and fuel economy.

Iridium plugs perform better under high engine loads and extreme temperatures, making them ideal for modern engines with higher compression and tighter tolerances.

2. (a) (i) What is the function of an idle air control (IAC) valve in an EFI system?

The idle air control (IAC) valve regulates the amount of air entering the engine at idle speed, ensuring a stable idle by compensating for varying engine loads and temperatures.

(ii) Mention four signs of a malfunctioning IAC valve.

An unstable or fluctuating idle may occur due to the IAC valve failing to adjust airflow properly.

The engine may stall when coming to a stop because insufficient air bypasses the throttle plate.

A rough or high idle speed can result from a stuck open or closed IAC valve.

The check engine light may illuminate if the ECU detects improper idle control.

(iii) How does the ECU regulate engine idle speed using the IAC valve?

The ECU monitors engine load, temperature, and other sensors to determine the ideal idle speed. It adjusts the IAC valve position to allow more or less air into the intake manifold, raising or lowering idle RPM as needed.

(b) (i) Differentiate between wet sump and dry sump lubrication systems.

A wet sump system stores engine oil in a pan below the crankshaft and uses a single pump to circulate oil throughout the engine.

A dry sump system stores oil in an external reservoir and uses multiple pumps to scavenge oil from the engine and supply it to critical components.

(ii) Explain two reasons why dry sump systems are used in performance vehicles.

Dry sump systems prevent oil starvation during hard acceleration, cornering, or braking by keeping oil away from the crankshaft and ensuring consistent flow.

They also allow for lower engine mounting by eliminating the deep oil pan, improving the vehicle's center of gravity and handling.

(c) Describe the air intake and filtration process in a modern turbocharged engine.

Air enters through the intake duct and passes through an air filter, which removes dust and debris. Clean air then enters the turbocharger compressor, where it is compressed and heated.

Compressed air passes through an intercooler, which cools the air to increase density before entering the intake manifold. This cooled, pressurized air improves combustion efficiency and engine power.

3. (a) Identify five causes of a petrol engine running rich and explain the effect on engine performance.

A faulty oxygen sensor may send incorrect signals to the ECU, resulting in excessive fuel injection and a rich mixture.

Leaking fuel injectors drip fuel even when not commanded, increasing fuel content in the combustion chamber.

A malfunctioning engine coolant temperature sensor can cause the ECU to think the engine is cold, enriching the mixture unnecessarily.

A clogged air filter restricts airflow, leading the ECU to compensate with more fuel to maintain combustion.

Faulty mass airflow (MAF) sensors can misreport air intake, causing the ECU to overfuel the engine.

Running rich leads to black smoke from the exhaust, poor fuel economy, and carbon buildup on spark plugs and valves.

(b) Explain how to test a throttle position sensor (TPS) using a digital multimeter.

Turn off the engine and locate the TPS on the throttle body. Disconnect the sensor's electrical connector.

Set the multimeter to the voltage or resistance setting depending on manufacturer specifications. Connect the multimeter probes to the signal and ground terminals.

Slowly open the throttle by hand while observing the multimeter. The voltage should increase smoothly with throttle movement. Any jumpy or unchanging readings indicate a faulty TPS.

(c) What is the purpose of an engine control module (ECM), and how does it interact with engine sensors?

The ECM is the central computer that manages engine operation by processing data from various sensors. It controls fuel injection, ignition timing, idle speed, emissions, and other critical parameters.

It receives inputs from sensors such as oxygen, crankshaft position, coolant temperature, and throttle position sensors, and adjusts actuator outputs like injectors, IAC valve, and ignition coils accordingly.

(d) List three potential causes of poor fuel economy in a vehicle.

Under-inflated tires increase rolling resistance, requiring more engine power and thus higher fuel consumption.

A dirty air filter restricts airflow, leading to a rich fuel mixture and inefficient combustion.

Worn spark plugs result in incomplete combustion, wasting fuel and reducing engine efficiency.

4. (a) Explain four reasons that may cause a vehicle engine to crank but fail to start.

Lack of fuel due to an empty tank, clogged fuel filter, or failed fuel pump prevents combustion from taking place.

Ignition system failure such as a bad crankshaft position sensor or ignition coil disrupts spark delivery to the cylinders.

A faulty immobilizer or anti-theft system may block fuel or spark signals, preventing the engine from starting.

Low compression in one or more cylinders caused by worn piston rings or a blown head gasket may hinder ignition even with fuel and spark.

(b) Describe how a fuel pressure test is performed on a multipoint injection system.

Locate the fuel rail and connect a fuel pressure gauge to the service port or install a tee in the line if no port is available.

Turn the ignition key to the ON position without starting the engine to pressurize the system. Observe the pressure reading and compare it to the manufacturer's specification.

Start the engine and monitor the pressure at idle. A drop may indicate a weak fuel pump or leaking injector. Turn off the engine and check how long the pressure holds to evaluate system sealing.

(c) What is meant by ignition timing advance, and why is it critical for engine efficiency?

Ignition timing advance refers to initiating the spark before the piston reaches top dead center during the compression stroke.

It ensures that peak cylinder pressure occurs at the optimal point after TDC, maximizing power output and fuel efficiency. Too little advance causes loss of power, while too much may cause knocking.

(d) Mention three benefits of using a distributor-less ignition system in modern engines.

It improves ignition accuracy and timing consistency by using crankshaft or camshaft sensors instead of mechanical distributors.

Fewer moving parts result in increased reliability, lower maintenance, and longer component life.

It allows for better control of spark timing per cylinder, improving combustion efficiency, fuel economy, and emissions.

5. (a) List four functions of a radiator cap in a vehicle cooling system.

It maintains pressure within the cooling system, raising the boiling point of the coolant for better heat dissipation.

It seals the radiator, preventing coolant loss and contamination.

It allows excess pressure to escape into the overflow tank via a spring-loaded valve, preventing system damage.

It permits coolant return from the overflow tank as the system cools and contracts, maintaining consistent coolant levels.

(b) A 4-cylinder diesel engine has a bore of 100 mm and a stroke of 110 mm. Calculate the engine displacement in liters.

Convert bore and stroke to meters:
Bore = 100 mm = 0.1 m
Stroke = 110 mm = 0.11 m
Number of cylinders = 4

Volume per cylinder = $(\pi / 4) \times \text{bore}^2 \times \text{stroke}$
$= (3.1416 / 4) \times (0.1)^2 \times 0.11$
$= 0.000863\ m^3$ per cylinder

Total displacement = $0.000863 \times 4 = 0.003452\ m^3$ = **3.452 liters**

(c) State four negative effects of operating an engine without a functioning thermostat.

Without a thermostat, the engine may run too cool, reducing fuel efficiency and preventing the engine from reaching optimal operating temperature.

Excessive cooling delays warm-up time, increasing engine wear and fuel consumption during short trips.

Emission control systems may not function properly, resulting in increased exhaust pollution.

Poor heater performance inside the cabin may occur due to low engine temperature, especially in cold weather.

6. (a) Describe the construction and operation of a double wishbone suspension system.

A double wishbone suspension consists of two control arms—an upper and a lower wishbone (or A-arm)—each connected to the wheel hub at one end and to the vehicle frame or subframe at the other. Between the arms, a coil spring and shock absorber are typically mounted.

As the wheel moves up and down over road surfaces, the wishbones control vertical motion while maintaining correct camber angle. The suspension geometry allows the wheel to remain more perpendicular to the road during cornering, enhancing grip and reducing tire wear. It is commonly used in performance and luxury vehicles due to its precise handling characteristics.

(b) Explain the effects of excessive toe-in and toe-out on tyre wear and vehicle stability.

Excessive toe-in causes the front edges of the tires to point inward too much, leading to outer shoulder wear and reduced directional stability. The vehicle may feel sluggish or resistant when turning.

Excessive toe-out, where the front edges of the tires point outward, causes inner-edge wear and makes the steering overly sensitive. This can lead to twitchy handling and poor straight-line tracking, especially at higher speeds.

(c) Mention three suspension faults that may result in poor ride quality.

Worn-out shock absorbers reduce the system's ability to dampen road vibrations, causing a bouncy or unstable ride.

Damaged or sagging springs lower the vehicle's ride height and lead to harsh bottoming over bumps or poor cornering stability.

Loose or worn suspension bushings allow excess movement in control arms, leading to clunking noises, vibration, and imprecise steering feedback.

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

It allows the driver to smoothly engage or disengage the engine from the gearbox when starting or stopping the vehicle.

It facilitates gear changes by temporarily disconnecting power flow, reducing stress on transmission components.

It enables the vehicle to idle with the engine running without transmitting motion to the wheels.

It provides overload protection by slipping under extreme loads, preventing drivetrain damage during sudden accelerations or misoperations.

(b) Explain the working principle of a diaphragm spring clutch.

The diaphragm spring clutch uses a single circular spring that functions as both the pressure and release mechanism. When the clutch pedal is released, the diaphragm spring pushes the pressure plate against the clutch disc and flywheel, transmitting engine torque to the gearbox.

When the clutch pedal is pressed, the diaphragm spring is pushed inward at its center, causing the outer edge to move away from the clutch disc. This releases pressure and disengages the clutch, interrupting power flow for gear shifting.

(c) An engine produces 200 Nm at 3000 rpm. The gearbox has a gear ratio of 2.8:1 and efficiency of 88%. Calculate the torque and speed at the output shaft.

Output speed = Engine speed ÷ Gear ratio
= 3000 ÷ 2.8 ≈ **1071.43 rpm**

Output torque = Engine torque × Gear ratio × Efficiency
= 200 × 2.8 × 0.88 = **492.8 Nm**

So, the output shaft rotates at approximately **1071 rpm** with a torque of **492.8 Nm**

8. (a) List four components of an emission control system and state the function of each.

The catalytic converter reduces harmful emissions like carbon monoxide, hydrocarbons, and nitrogen oxides by converting them into less harmful substances through chemical reactions.

The EGR (Exhaust Gas Recirculation) valve recirculates a portion of exhaust gases back into the intake to lower combustion temperature and reduce NOx emissions.

The evaporative emission control system (EVAP) prevents fuel vapors from escaping into the atmosphere by storing them in a charcoal canister until they can be burned in the engine.

The oxygen sensor monitors the oxygen level in the exhaust gases and sends feedback to the ECU to adjust the air-fuel mixture for efficient combustion and reduced emissions.

(b) Describe how an EGR valve helps reduce nitrogen oxide emissions.

The EGR valve opens to allow a controlled amount of exhaust gases to enter the intake manifold, where it mixes with the incoming air-fuel mixture. These gases absorb heat during combustion, lowering peak combustion temperatures. Since high temperatures promote the formation of nitrogen oxides (NOx), reducing the temperature results in lower NOx emissions.

(c) Identify four common exhaust-related faults and how each can be diagnosed in the workshop.

A cracked exhaust manifold can be diagnosed by visual inspection or by listening for ticking noises during engine warm-up.

A leaking exhaust gasket produces a hissing sound and can be confirmed with a smoke test or visual signs of soot around joints.

A clogged catalytic converter may cause engine power loss and can be diagnosed by measuring backpressure or using a temperature differential test before and after the converter.

Loose or damaged hangers allow the exhaust to sag or rattle; this can be diagnosed during underbody inspection by checking the alignment and movement of the exhaust system.