THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATION COUNCIL OF TANZANIA

DIPLOMA IN TECHNICAL EDUCATION EXAMINATION

790 **AUTOMOBILE TECHNOLOGY**

Time: 3 Hour. **ANSWERS** **Year: 2018**

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 safety precautions a technician must observe when repairing hydraulic brake systems in a vehicle workshop.

One safety precaution is wearing protective gloves to prevent skin contact with brake fluid, which is corrosive and harmful.

Another precaution is wearing safety goggles to shield the eyes from splashes of brake fluid during bleeding or part removal.

It is important to ensure the vehicle is securely supported using jack stands before accessing brake components under the vehicle.

Cleaning the work area before and after repairs prevents contamination of hydraulic lines and improves visibility and safety.

Avoiding open flames and smoking is crucial because brake fluid is flammable, and its vapors can ignite easily.

(b) State three safety precautions to consider when using each of the following tools:
(i) Hammer
(ii) Bench vice
(iii) Hacksaw

When using a hammer, always check that the handle is firm and free from cracks, use the correct type of hammer for the task, and strike squarely to prevent glancing blows or flying particles.

For the bench vice, ensure the vice is bolted securely to the workbench, avoid over-tightening the workpiece, and never use the vice jaws as an anvil for hammering.

When using a hacksaw, use the appropriate blade for the material being cut, maintain correct blade tension to avoid snapping, and apply steady forward pressure without forcing the tool.

(c) Sketch and label three different chassis frame types used in vehicle construction.

- Ladder frame: Two long side rails connected by cross-members.
- Backbone frame: A central spine with support brackets for suspension and engine.
- Monocoque frame: Integrated body and frame structure providing strength and rigidity.

2. (a) (i) Define a reamer and state its purpose in engine servicing.

A reamer is a precision tool used to slightly enlarge or finish an already drilled hole to an accurate size with a smooth finish. In engine servicing, it is used to size and align bores such as valve guides or bushings.

(ii) Name four common types of reamers used in automotive workshops.

Four common types of reamers are hand reamers, machine (chucking) reamers, adjustable reamers, and taper reamers.

(iii) Describe the use of a micrometer screw gauge in engine part measurement.

A micrometer screw gauge is used to measure small dimensions with high precision, such as the thickness of engine components like piston rings, valve stems, and crankshaft journals.

(b) (i) What is engine backfiring in fuel systems?

Engine backfiring is the unintended ignition of the air-fuel mixture outside the combustion chamber, either in the intake manifold or exhaust pipe, causing a loud popping sound.

(ii) List four causes of backfiring in a fuel system.

- Causes of backfiring include
- incorrect ignition timing,
- lean air-fuel mixture
- faulty spark plugs
- **leakage in the exhaust valve or intake system.**

(c) Explain the purpose of adjusting steering geometry and describe how each of the following angles is corrected:

(i) Camber angle
Camber angle adjustment ensures the wheels tilt correctly inward or outward to maintain proper tire contact and prevent uneven wear. It is corrected by adjusting the strut mount or control arms.

(ii) Castor angle
Castor angle is the angle of the steering axis viewed from the side. Positive castor improves stability. It is adjusted by modifying the position of the suspension arms or using shims.

(iii) Toe-out angle

Toe-out angle is the difference in the distance between the front and rear of the wheels. It affects tire wear and cornering. It is corrected by adjusting the tie rod ends.

3. (a) Define the term "automotive engine" and explain its function in vehicle operation.

An automotive engine is a machine designed to convert chemical energy from fuel into mechanical energy, which powers the movement of a vehicle.

It functions by igniting an air-fuel mixture in combustion chambers, producing expanding gases that drive pistons, which in turn rotate the crankshaft.

This rotary motion is then transmitted through the transmission system to the wheels, propelling the vehicle forward or backward.

(b) Distinguish between two-stroke and four-stroke internal combustion engines. Give two examples for each.

A two-stroke engine completes a power cycle in two piston strokes and one crankshaft revolution, while a four-stroke engine completes the same in four strokes and two revolutions.

Two-stroke engines are generally simpler, lighter, and produce more power per cycle, but are less fuel-efficient and more polluting.

Four-stroke engines are more complex, heavier, and produce less power per revolution, but they are more fuel-efficient and environmentally friendly.

Examples of two-stroke engines include small motorcycle engines and chainsaw engines.

Examples of four-stroke engines include car engines and lawn mower engines.

(c) Explain how engine displacement (in cubic centimeters) is calculated and its relevance in vehicle tax rating.

Engine displacement is calculated using the formula:
Displacement = $(\pi \div 4) \times \text{bore}^2 \times \text{stroke} \times \text{number of cylinders}$.

The bore is the diameter of the cylinder, and the stroke is the distance the piston travels.

The value obtained in cubic centimeters (cc) indicates the engine size.

In Tanzania, vehicle tax is often based on engine size (cc), meaning larger engines are taxed at higher rates.

(d) Briefly describe the steps followed during injector testing using:
(i) Visual spray test
(ii) Leak-off test
(iii) Pressure build-up test

In a visual spray test, the injector is connected to a test rig and pressurized; the spray pattern is observed for uniformity and fineness.

For the leak-off test, the injector is pressurized and checked for fuel leakage at the nozzle when it should be fully closed.

In the pressure build-up test, the injector is tested to ensure it opens only at the specified pressure; a gauge is used to measure the pressure at which injection starts.

4. (a) A four-cylinder inline engine follows a 1-3-4-2 firing order. Complete the following table by assigning the correct strokes for each cylinder:

Cylinder No:	1	2	3	4
1st Stroke:	P	I	C	E
2nd Stroke:	E	C	I	P
3rd Stroke:	I	P	E	C
4th Stroke:	C	E	P	I

P = Power stroke
C = Compression stroke
E = Exhaust stroke
I = Induction stroke

Each pair of cylinders (1 & 4 and 2 & 3) moves together but performs opposite strokes in the firing sequence.

(b) Explain how the intake stroke occurs in a spark ignition engine.

During the intake stroke, the piston moves downward from the top dead center to the bottom dead center.

As the piston descends, the intake valve opens while the exhaust valve remains closed.

A mixture of air and fuel is drawn into the combustion chamber due to the pressure difference created by the downward piston movement.

This stroke is critical for preparing the cylinder for the compression phase.

(c) Identify four physical differences between petrol and diesel engines.

Petrol engines use spark plugs to ignite the air-fuel mixture, while diesel engines rely on high compression to ignite the fuel.

Petrol engines generally operate at higher RPMs and produce smoother performance compared to diesel engines.

Diesel engines are built with stronger components to withstand higher pressures resulting from compression ignition.

Petrol engines are lighter and usually less noisy, while diesel engines are heavier and tend to be noisier.

5. (a) State four advantages of diesel engines over petrol engines for commercial vehicles.

Diesel engines offer better fuel efficiency, making them more economical over long distances.

They produce higher torque at lower RPMs, which is beneficial for heavy-load applications.

Diesel engines are more durable and have a longer lifespan due to their robust construction.

They emit less carbon monoxide and hydrocarbon emissions, making them more environmentally compliant under specific conditions.

(b) A diesel engine produces 110 Nm torque at 1800 rpm. The drive passes through a gearbox with a gear ratio of 4:1. If the transmission efficiency is 92%, calculate:
(i) The torque at the output shaft
(ii) The output speed of the shaft

(i) Torque at output shaft = Input torque × Gear ratio × Efficiency
= 110 × 4 × 0.92
= 404.8 Nm

(ii) Output speed = Input speed ÷ Gear ratio
= 1800 ÷ 4
= 450 rpm

(c) State four essential properties required of a good engine coolant.

The coolant should have a high specific heat capacity to absorb and carry away heat efficiently.

It must have a low freezing point and high boiling point to function in all temperature conditions.

The coolant should be non-corrosive to avoid damaging engine components like the radiator and water pump.

It should also be chemically stable and non-toxic for environmental and user safety.

6. (a) Explain why pinion and crown wheel adjustments are necessary in a differential unit.

Adjustments are required to maintain the correct backlash between the crown wheel and pinion for smooth power transmission.

Proper alignment ensures that the teeth mesh correctly, reducing wear and noise during operation.

It also helps prevent premature failure of the gears and enhances the life of the differential components.

Correct adjustment ensures optimal torque delivery to the drive shafts, maintaining vehicle stability and control.

(b) (i) What is the function of the clutch release bearing?

The clutch release bearing allows smooth disengagement of the clutch by transferring force from the clutch pedal to the pressure plate fingers.

(ii) Describe how the release bearing operates when the clutch pedal is depressed.

When the clutch pedal is pressed, the release bearing moves forward, pressing against the diaphragm spring or release fingers of the pressure plate.

This action releases pressure on the clutch disc, allowing it to rotate freely from the flywheel and interrupting torque transmission.

(iii) Explain the path of torque from the flywheel to the transmission input shaft.

Torque is transmitted from the flywheel to the clutch disc, then through the clutch hub to the transmission input shaft.

The transmission then modifies the torque based on the selected gear and passes it through to the output shaft and finally to the wheels.

(iv) What is the effect if the release bearing remains free during operation?

If the release bearing remains free and does not engage properly, it can cause incomplete disengagement of the clutch.

This leads to gear grinding, clutch slipping, and accelerated wear of the clutch components.

(c) Outline five essential properties required for clutch friction plate linings.

The lining should have high frictional properties to transmit torque effectively.

It must resist high temperatures generated during engagement and disengagement.

The material should not wear out quickly to ensure a long service life.

It should have good resistance to oil and contaminants that may enter the clutch assembly.

The lining must engage smoothly without sudden jerks or noise.

(d) (i) Identify the usual thermostat location in a car cooling system.

The thermostat is typically located in the housing where the upper radiator hose connects to the engine, near the cylinder head or water outlet.

(ii) Describe a simple method for testing thermostat functionality.

Place the thermostat in a container of water and heat the water gradually.

Use a thermometer to monitor the water temperature and observe if the thermostat begins to open at its rated temperature (usually between 80°C and 90°C).

If it does not open or opens too early, it should be replaced.

7. (a) State four major functions performed by the front axle in a vehicle.

The front axle supports the weight of the front part of the vehicle including the engine in front-engine designs.

It facilitates steering by allowing the front wheels to pivot and change direction.

It absorbs road shocks through the suspension system connected to it.

The front axle also helps maintain the alignment and position of the front wheels.

(b) (i) Describe the construction and working principle of the rack and pinion steering system.

The system consists of a circular pinion gear connected to the steering shaft and a linear rack gear.

When the steering wheel is turned, the pinion rotates and moves the rack sideways, converting rotary motion into linear motion.

This linear movement is transferred to the tie rods and steering arms, turning the wheels left or right.

(ii) State three functions of a delivery valve in a fuel injection system.

The delivery valve ensures prompt closure of the injection line after injection to prevent dribbling.

It maintains residual pressure in the fuel line to allow quick and consistent injection in the next cycle.

The valve also helps reduce pressure surges and noise during injector operation.

(c) The following parts were removed during engine dismantling of a 4-cylinder engine. Tabulate their costs:

Overhaul kit – 260,000
Main bearings – 27,000
Connecting rod bearings – 23,000
Camshaft bearings – 13,000 × 4 = 52,000
Piston rings – 70,000
Inlet valves – 16,000 × 4 = 64,000
Exhaust valves – 17,000 × 4 = 68,000
Rocker shaft – 22,000
Crankshaft sleeve – 53,000
Thrust bearings – 26,000 × 2 = 52,000

Total cost =
260,000 + 27,000 + 23,000 + 52,000 + 70,000 + 64,000 + 68,000 + 22,000 + 53,000 + 52,000 = **691,000 TZS**

8. (a) Describe the effect of the following on a leaf spring system:
(i) Cracked bushings
(ii) Broken centre bolt
(iii) Loose U-bolts
(iv) Broken spring leaf

Cracked bushings cause play in the spring eye connection, resulting in noise and poor alignment.

A broken centre bolt can cause misalignment of the leaf spring stack, leading to instability or side movement.

Loose U-bolts reduce clamping force on the spring, allowing it to shift and cause steering or suspension issues.

A broken leaf causes loss of load-bearing capacity and can make the vehicle lean or sag on one side.

(b) (i) Outline five causes of pre-ignition in internal combustion engines.

Carbon deposits in the combustion chamber can retain heat and ignite the air-fuel mixture prematurely.

Overheated spark plugs may ignite the charge before the spark event.

Incorrect spark plug heat range can lead to uncontrolled ignition.

Low octane fuel may ignite under compression alone, leading to pre-ignition.

Excessive engine operating temperature may also lead to premature ignition.

(ii) How is a condenser tested for functionality?

Disconnect the condenser from the ignition system and use a multimeter to test for resistance.

A properly functioning condenser should show a brief deflection on the meter that returns to infinity.

No deflection or a constant reading indicates a shorted or open condenser.

(c) Explain the general procedure for setting ignition timing in a petrol engine manually.

First, rotate the crankshaft to bring the piston in cylinder 1 to top dead center on the compression stroke.

Align the timing marks on the crankshaft pulley and timing cover.

Loosen the distributor hold-down clamp and rotate the distributor until the breaker points just begin to open.

Lock the distributor in position and confirm timing using a timing light while the engine is idling.