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AGRICULTURAL ENGINEERING LEVEL 6

ENG/OS/AGR/CC/03/6/

Apply Principles of Mechanical Science

July/August 2025

Printed By: And Vocational College Date: 29.07.2025 07:39 AM

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## TVET CURRICULUM DEVELOPMENT, ASSESSMENT AND CERTIFICATION COUNCIL (TVET CDACC)

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### WRITTEN ASSESSMENT

**Time: 3 HOURS**

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### INSTRUCTIONS TO CANDIDATE

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1. This paper consists of TWO sections: A and B.
2. Attempt ALL questions in section A and ANY THREE (3) questions in section B.
3. Marks for each question are indicated in the brackets.
4. Candidates are provided with a separate answer booklet.
5. Do not write on the question paper.

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**This paper consists of SIX (6) printed pages**

**Candidates should check the question paper to ascertain that all  
pages are printed as indicated and that no questions are missing.**

## SECTION A (40 MARKS)

**Attempt ALL the questions in this section.**

1. On a tractor overhead engine head, the valve and tappet assembly have a mass of 200g. At a given engine speed, the force to open the valve is 20N. Calculate the acceleration of the valve under these conditions. (3 Marks)
2. Velocity is defined as the change of displacement per unit time. Differentiate between linear velocity and angular velocity. (2 Marks)
3. A quantity of gas occupies a volume of  $5m^3$  at an absolute pressure of  $140kPa$ . It is then compressed at a constant temperature until its absolute pressure is  $560 kPa$ . Determine the volume of the gas at the end of compression. (2 Marks)
4. Define the following terms. (4 Marks)
  - a. Sensible heat
  - b. Newton's second law of motion
  - c. Energy
  - d. Power
5. A vehicle of mass 3 tonnes is travelling at 40.2km/h. Determine the kinetic energy of the vehicle at this speed. (4 Marks)
6. Tractor systems rely on frictional forces for optimum operation. Outline FOUR instances where friction is advantageous on tractor components. (4 Marks)
7. An instant horizontal rope towing a vehicle makes an angle of  $70^\circ$  with the front axle. If the force in the tow rope is 1300 N, calculate;
  - a. The effective force pulling the vehicle forward. (2 Marks)
  - b. The force pulling the vehicle sideways. (2 Marks)
8. Water in a cooling system of a tractor circulates at the rate of 0.2 liters per second, and the temperature rises from  $60^\circ C$  to  $70^\circ C$ . Calculate the heat energy absorbed by the cooling water per minute. (4 Marks)
9. Force is defined as resistance to motion. List THREE characteristics of force. (3 Marks)
10. An engine drives a tractor against a total resistance of 2kN over a distance of 200m in 15s. Calculate the work done. (3 Marks)
11. A resultant force is the single force which would have the same effect if replaced by a number of forces acting at a point. List FOUR methods used to determine the resultant force of two coplanar forces acting at a point. (4 Marks)

12. A brake rod is subjected to a tensile force of 2.5 kN. If the diameter of the rod is 8mm.

Calculate the stress induced in the rod.

(3 Marks)

## SECTION B (60 MARKS)

**Attempt Any THREE Questions in This Section**

13. Moments are applied intermination of reaction forces of structural members to different loads.

a. Define the following terms

(i) Moment of a force

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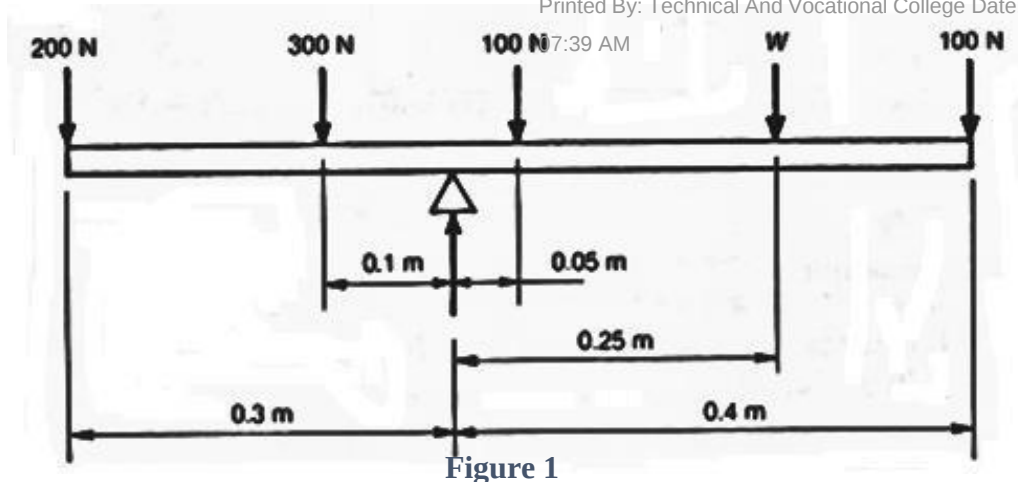
(ii) Uniform beam

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(2 Marks)

b. The mass of the lever given in **Figure 1** below is equivalent to the load of 100 N.

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**Figure 1**

i. Determine the magnitude of the load **W** required for the lever to remain horizontal.

(5 Marks)

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ii. Find the value of the reaction force at the support.

(3 Marks)

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c. Describe the THREE states of equilibrium.

(6 Marks)

d. Highlight FOUR simple machines used to make work easier.

(4 Marks)

14. Machines use principles of motion to perform work through linear or angular motion.

a. A load of 126 kN is lifted by a pulley block system consisting of three

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pulleys in the upper block and two pulleys in the lower block. If the efficiency of the system at this load is 84 percent. Determine;

(2 Marks)

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(i) Mechanical advantage.

(2 Marks)

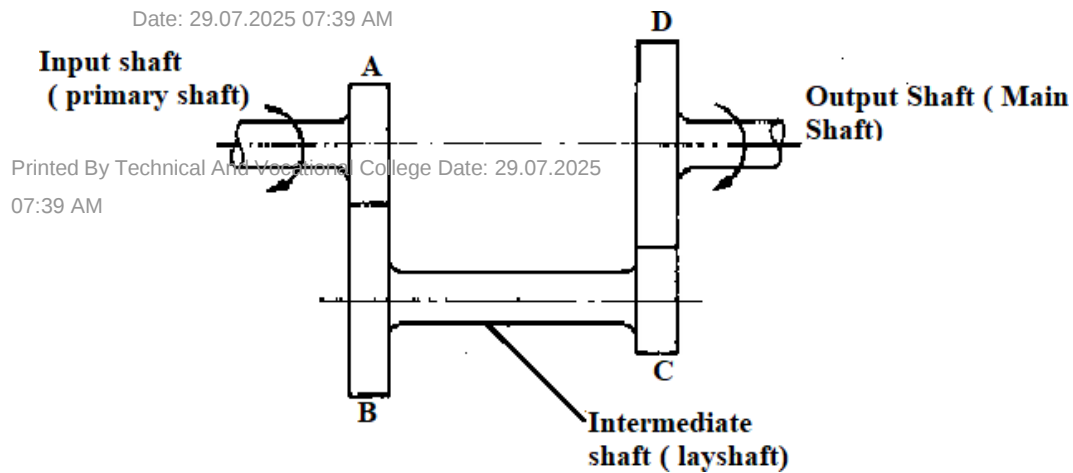
(iii) The effort required to lift the load.

(2 Marks)

(iv) The effort required to overcome the resistances.

(4 Marks)

- b. A gearbox is driven in second gear in the layout in **Figure 2** below where a constant mesh pinion A and B have 15 and 32 teeth respectively. The second gear pinion D on the main shaft has 16 teeth and meshes with the layshaft gear C having 16 teeth.



**Figure 2**

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- The second gear ratio. (3 Marks)
  - The propeller shaft speed for an engine speed of 4000 rev/min. (2 Marks)
- c. A combine harvester is accelerated uniformly a speed of 27km/h.

Calculate:

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- The time required to attain a speed of 81km/h. (3 Marks)
- heat energy is either supplied to them or taken away from them.

- a. Differentiate between specific latent heat of fusion and latent heat of vaporization.

(2 Marks)

- b. The permissible rise in temperature of the cooling water is 30 K. Calculate the mass of cooling water required to condense 5 kg of steam at atmospheric pressure and temperature of 100°C. Take specific heat capacity of water as  $4.2 \frac{kJ}{kg K}$  and specific

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- latent heat of vaporization of steam as 2260 kJ/kg (9 Marks)

- c. Pressure of a tractor tyre at 12°C is found to be 1.75 bar. Determine the tyre gauge reading when the temperature increases to 38°C. Assuming the volume of air in the tyre is constant. (Take atmospheric pressure to be 1.01 bar.) (4 Marks)

- d. An object weighs 1.04N in air, 0.64N when fully immersed in water and 0.72N when fully immersed in a liquid. If the density of water is  $1000 \text{ kg m}^{-3}$ . Calculate the density (5 Marks)

16. Internal combustion engines use high pressure combustible fuel air mixture to perform useful work using force.

- a. Define the following terms as used in gas laws. (4 Marks)

(i) Charles' law

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(ii) Boyle's law

(iii) Compression ratio

(iv) Pressure

- b. A six-cylinder engine has a bore of 70 mm and a stroke of 80mm. If the clearance volume of one cylinder is  $42\,000 \text{ mm}^3$ , calculate; (6 Marks)

(i) The compression ratio of the engine. (4 Marks)

(ii) The capacity of the engine in liters. (2 Marks)

- c. State FOUR factors that govern pressure in liquids. (4 Marks)

- d. Outline THREE differences between scalar and vector quantities (6 Marks)

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