



MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2023/2024 ACADEMIC YEAR

**FIRST YEAR SECOND SEMESTER EXAMINATION FOR BACHELOR OF
SCIENCE IN TECHNOLOGY IN MECHANICAL**

EMT105: ENGINEERING MECHANICS

DURATION: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer Question one and any other two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

- a) A force of 15N is applied perpendicular to the edge of a door 0.8m wide at an angle of 60° to the edge as shown in figure below. Find the moment of the force above the hinge (4marks)
- _____
- b) A smooth circular cylinder of radius 1.5m is lying in a triangular groove, one side of which makes 15° angle and the other 40° angle with the horizontal. Find the reactions at the surfaces of contact, if there is no friction and the cylinder weights 10_____ (4marks)
- c) A square ABCD has sides equal to 200mm forces of 150N each at along CB and AD. Find the moment of the couple, which will keep the system in equilibrium (3marks)
- d) State the assumptions made, while finding out forces in the members of a perfect frame (4marks)
- e) Define the term center of gravity (2marks)
- f) Find the centre of gravity of 100mm x 150mm x 30mm T-section shown in figure 2
- _____
- g) State the principle of conservation of moment_____ (3marks)
- h) State the three Newton's Laws of motion (6marks)

SECTION TWO: ANSWER ANY TWO QUESTIONS

QUESTION TWO (20 MARKS)

1. The 500-N force F is applied to the vertical pole shown in figure 3
- Write F in term of the unit vectors i and j and identify both its vector and scalar components (3marks)
 - Determine the scalar components of the force vector F along the x' and y' axes (2marks)
 - Determine the scalar components of F along the x- and y' – axes (3marks)

2. A force F with a magnitude of 100N is applied at the origin O of the axes x - y - z as shown in Figure 4. The line of action of F passes through a point A whose coordinates are 3m, 4m and 5m. determine,
 - i. The x , y , and z scalar components of F (2marks)
 - ii. The projection F_{xy} of F on the x - y plane (2marks)
 - iii. The projection F_{OB} of F along the line OB (3marks)
3. A light string $ABCDE$ whose extremity A is fixed, has weights w_1 and w_2 attached to it at B and C . It passes around a small smooth peg at D carrying a weight of 300N at the free end E as shown in figure 5. If in the equilibrium position, BC is horizontal and AB and CD make 150° and 120° with BC , find
 - i. Tensions in the portion AB , BC and CD of the string (3marks)
 - ii. Magnitudes of w_1 and w_2 (2marks)
- 4.

QUESTION THREE (20 MARKS)

- 1) A uniform Lamina shown in figure 6 consists of a rectangle, a circle and a triangle. Determine the centre of gravity of the lamina. All dimensions are in mm (8marks)
- 2) A solid body formed by joining the base of a right cone of height H to the base of a right circular cylinder of height _____. Calculate the distance of the centre of mass of the solid from its plane face, when $H=120\text{mm}$ and $h=30\text{mm}$ (see figure 7) (4marks)
- 3) An inclined truss shown in Figure 8 is loaded as shown. Determine the nature and magnitude of the forces in the members BC , GC and GF of the truss (8marks)

QUESTION FOUR (20 MARKS)

- 1) The motion of a particle is given $a = t^3 - 3t^2 + 5$, where a is the acceleration in m/s^2 and t is the time in seconds. The velocity of the particle at $t=1$ second is 6.25m/s, and the displacement is 8.30meters. calculate the displacement and the velocity at $t=2$ seconds (6marks)
- 2) A riveting machine is driven by a 4kw motor. The moment of inertia of the rotating parts of the machine is equivalent to 140kgm^2 at the shaft on which one flywheel is mounted. At the commencement of operation, the flywheel is making 240v.p.m.

- i. If closing a rivet occupies 1 second and consumes 10kNm of energy, find the reduction of speed of the flywheel (6marks)
 - ii. What is the maximum rate at which the rivets can be closed? (2marks)
- 3) A horizontal bar 1.5m long and of small cross-section rotates about vertical axis through one end. It accelerates uniformly from 1200r.p.m. to 1500r.p.m. in an interval of 5 seconds.
- a) What is the linear velocity at the beginning and end of the interval (3marks)
 - b) What are the normal and tangential components of the acceleration of the mid-point of the bar after 5 seconds after the acceleration begins (3marks)