**Registration No.:**

**1st Semester Regular/Back Examination: 2024-25**
**SUBJECT: Engineering Mechanics**
**BRANCH(S): CIVIL, CHEM, BIOTECH, CSIT, AE, AERO, AEIE, AUTO, CSE, CSE, CSEAI, CSEAIML, CSEDS, CST, ECE, ECE, ETC, EEE, EE, ELECTRICAL, ELECTRICAL & C.E, IT, MECH, MINERAL, MINING, MME, CSEIOT, EEVDT**
**Time: 3 Hours**
**Max Marks: 100**
**Q.Code: R512**
**Answer Question No.1 (Part-I) which is compulsory, any eight from Part-II and any two from Part-III.**
**The figures in the right hand margin indicate marks.**

**Part-I**

**Q1** **Answer the following questions:** (2 x 10)
  **a)** What is a free body diagram (FBD)?
  **b)** State the Varignon's principle of moments.
  **c)** What is a couple? What is the arm of a couple and its moment?
  **d)** State the laws of friction.
  **e)** Define coefficient of friction and angle of repose.
  **f)** Differentiate between center of gravity and centroid.
  **g)** State Pappus's theorem with an example.
  **h)** State D'Alembert's principle with an example.
  **i)** Define Coefficient of Restitution.
  **j)** Write an expression showing that path of projectile is a parabola.

**Part-II**

**Q2** **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** (6 x 8)
  **a)** The magnitude of two forces is such that when acting at right angles produce a resultant force of $\sqrt{20}$ N and when acting at $60^0$ produce a resultant of $\sqrt{28}$ N. Calculate the magnitude of the two forces.

  **b)** Two locomotives on opposite banks of a canal pull, a vessel moving parallel to the banks by means of two horizontal ropes. The tensions in these ropes have been measured to be 20 kN and 24 kN while the angle between them is $60^0$. Find the resultant pull on the vessel and the angle between each of the ropes and the sides of the canal.

  **c)** A ladder 5 meters long rests on a horizontal ground and leans against a smooth vertical wall at an angle 65° with the horizontal. The weight of the ladder is 800 N and acts at its middle. The ladder is at the point of sliding, when a man weighing 650 N stands on a rung 1.5 metre from the bottom of the ladder. Calculate the coefficient of friction between the ladder and the floor.

**d)** State and prove Lami's Theorem.

**e)** A block weighing 1000 N, overlying a 10° wedge on a horizontal floor and leaning against a vertical wall, is to be raised by applying a horizontal force to the wedge. Assuming the coefficient of friction between all the surface in contact to be 0.3, determine the minimum horizontal force required to raise the block.

**f)** A semicircular area is removed from a trapezium as shown in Fig. 1 (dimensions in mm). Determine the centroid of the remaining area.
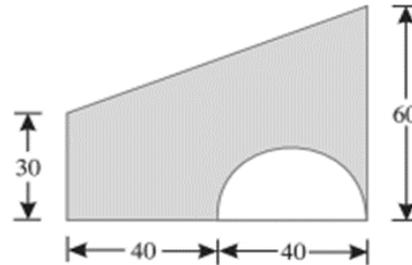


30

60

|← 40 →|← 40 →|

**Figure 1**

**g)** Find the moment of inertia of a triangle about its centroid.

**h)** At a certain instant, a body of mass 10 kg, falling freely under the force of gravity, was found to be falling at the rate of 20 m/s. What force will stop the body in (i) 2 seconds and (ii) 2 meters?

**i)** Two bodies A and B of mass 80 kg and 20 kg are connected by a thread and move along a rough horizontal plane under the action of a force 500 N applied to the first body of mass 80 kg as shown in Fig. 2. The coefficient of friction between the sliding surfaces of the bodies and the plane is 0.25. Determine the acceleration of the two bodies and the tension in the thread, using D' Alembert's principle.
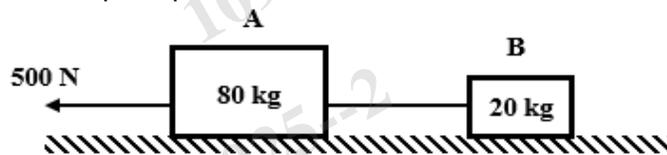


A

500 N

80 kg

B

20 kg

**Figure 2**

**j)** A ball overtakes another ball of twice its own mass and moving with 1/7 of its own velocity. If coefficient of restitution between the two balls is 0.75, show that the first ball will come to rest after impact.

**k)** Derive expression for (i) Horizontal Range and (ii) Maximum Height, when a particle is being projected from ground with velocity '$u$' at an angle '$\theta$'.

**l)** Two bodies weighing 200 N and 450 N are hung to the ends of a rope passing over an ideal pulley as shown in Fig. 3. With what acceleration the heavier body comes down and what is the tension in the string?
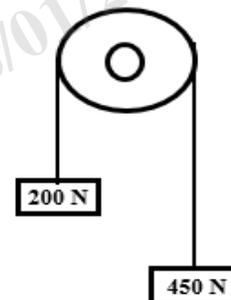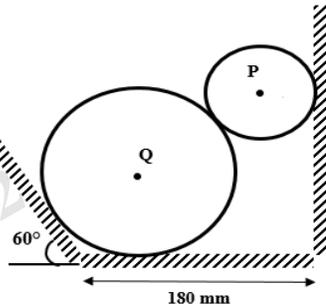


200 N

450 N

**Figure 3**

**Q3** Two cylinders P and Q rest in a channel as shown in Fig. 4. The cylinder P has diameter of **(16)** 100 mm and weighs 100 N, whereas the cylinder Q has diameter of 180 mm and weighs 300 N. If the bottom width of the box is 180 mm, with one side vertical and the other inclined at 60°, determine the forces at all the four points of contact.
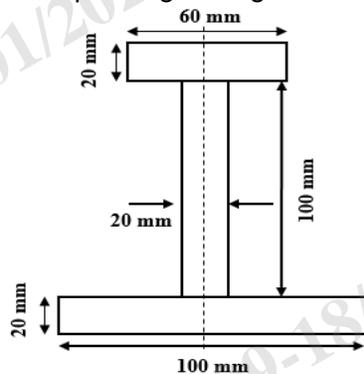


**Figure 4**

**Q4** Determine the reactions and the forces in each member of an equilateral triangular truss **(16)** supporting two loads as shown in Fig. 5.
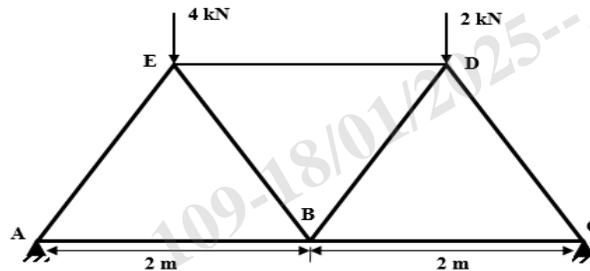


**Figure 5**

**Q5** An I-section is made up of three rectangles as shown in Fig. 6. Find the moment of inertia of **(16)** the section about the horizontal axis passing through the center of gravity of the section.



**Figure 6**

**Q6 a)** The motion of a particle is defined by the relations: $x = t^2 + 3t$ and $y = t^3 - 8t^2 + 3$, where $x$ and **(10)** $y$ are in meters and $t$ is in seconds. (i) Write the equations defining the motion of the particle in vectorial form and (ii) Calculate the velocity and acceleration of the particle at $t = 3$ seconds with vector diagram.

**b)** A wheel increases its speed from 45 rpm to 90 rpm in 30 seconds. Find (i) angular **(6)** acceleration of the wheel, and (ii) no. of revolutions made by the wheel in these 30 seconds.