Total number of printed pages: 03 **D/2nd Sem./DME 205**

2023

ENGINEERING MECHANICS

Full Marks: 100

Time: Three hours

The figures in the margin indicate full marks for the questions.

Answer any five questions.

1. a) What are the basic and derived units? Distinguish between the scalar and vector quantities. [2+2=4]
   b) What do you mean by the resolution of a force? State the triangle law of forces. Discuss with an example how to find the resultant forces using this law. [2+2+2=6]
   c) The following forces act at a point: [10]
      i) 50 N towards North-East.
      ii) 60 N towards East.
      iii) 45 N inclined at 30° West of North
      iv) 35 N inclined at 60° South of West

   Determine the magnitude and direction of the resultant force of the above force system.

2. a) State the parallelogram law of forces. Derive an expression for the magnitude and direction of the resultant force using this law. [2+8 =10]
   b) Two forces of 50 N and 60 N act simultaneously at a point. Find the magnitude and direction of the resultant force if the angle between them is 75°. [4]
   c) Four parallel forces, 20 N, 10 N, 50 N and 30 N, are acting at points A, B, C and D, respectively, on the same plane as shown in Fig. 1. The distances of AB, BC and CD are 20 cm, 40 cm and 30 cm respectively. Find the resultant force and the resultant's distance from point A on the plane. (*Take +ve for the anticlockwise moment.*) [6]

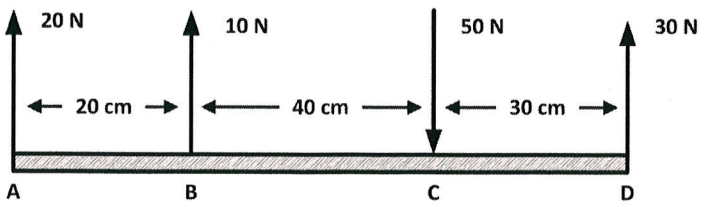

Fig. 1.

3. a) Define the term 'equilibrium' of a force system. State the principles of equilibrium of the following force systems of a body. [1+2+2=5]

   i) Two-force system

   ii) Three-force system

   b) What do you mean by free body diagram? State Lami's theorem. [2+ 2 = 4]

   c) A body of weight 50 N is suspended from a horizontal beam AB by two strings AC and BC, as shown in Fig. 2. The strings AC and BC make angles 30° and 45° with the beam AB. Using Lami's theorem, find the tensions in the strings AC and BC. [6]

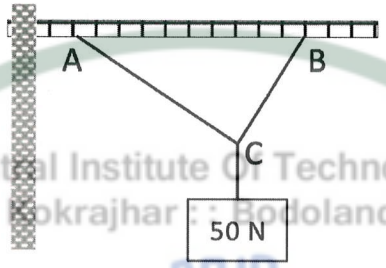

Fig. 2.

   d) The 50 N weight homogeneous smooth sphere rests on the two inclines as shown in Fig.3. Find the contact forces at A and B. [5]

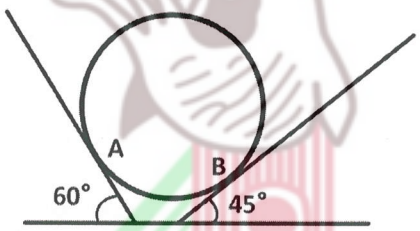

Fig. 3

4. a) Define centroid. How many centroids a body has? [1+1=2]

   b) Locate the centroid of the following Fig. 4 w.r.t. given reference axes. [8]

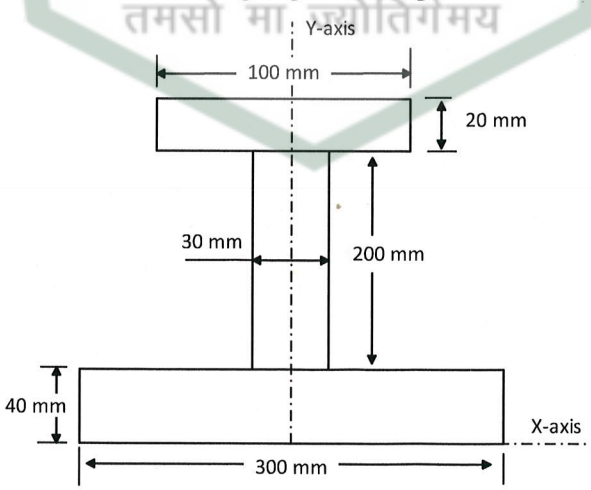

Fig. 4

c) A circular hole of 4 cm diameter is cut out from a rectangle of length 10 cm and breadth 8 cm, as shown in Fig. 5. Find the centroid of the shaded area. [5]

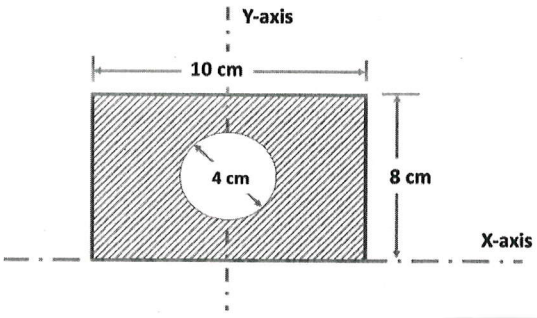

Fig. 5

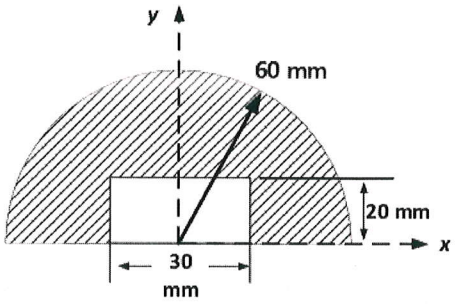

Fig. 6

d) A rectangle of length 30 mm and breadth 20 mm is cut out from a semicircle of radius 60 mm, as shown in Fig. 6. Find the position of the centroid of the shaded area. [5]

5. a) Define the coefficient of friction and angle of friction. State any three laws of static friction. [2+2+3=7]

b) A body of weight 550 N is lying on a rough *horizontal plane*. The coefficient of friction between the body and the horizontal plane is 0.25. Find the magnitude of the force required to move the body while the force is acting at an angle of 35° with the horizontal plane. [7]

c) A load of 550 N is lying on an *inclined plane*, whose inclination with the horizontal is 35°. The coefficient of friction between the load and the plane is 0.25. Find the minimum and maximum forces which will keep the load in equilibrium when the force is applied parallel to the inclined plane. [6]

6. (a) Define displacement, velocity and acceleration of a body. [3]

(b) Consider a body moving along a straight horizontal plane with an initial velocity of 10 m/s. If the uniform acceleration of the body was 0.5 m/s^2, determine the final velocity of the body after 20 seconds. Also, calculate the distance covered by the body after 20 seconds. [5]

(c) A man is driving his motorcycle at 45 kmph. He observes the red light 100 m ahead turn red. The traffic is timed to remain red for 20 sec. Find the minimum deceleration if the motorist wishes to pass the light without stopping. Also, find the speed of the motor as it passes the light. [6]

(d) A stone was thrown vertically upwards and reached a maximum height of 50 m. Determine the velocity with which the stone was thrown, and the time required to reach that height. [6]

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