Total number of printed pages: 04 **D/2nd Sem/DME 205**

2022

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) State the polygon law of forces. Discuss with an example how to find the resultant of forces using this law. [2+2 =4]

   c) Find the magnitude and direction of the resultant force of the following forces acting at a point on a body: 40 N acting **horizontally**; 20 N, 40 N and 50 N acting respectively at 60°, 120° and 250° from the horizontal; the angles are measured anti-clockwise. [7]

   d) A system of forces are acting at the corners of a rectangular block, as shown in Fig.1. Determine the magnitude of the resultant force. [5]

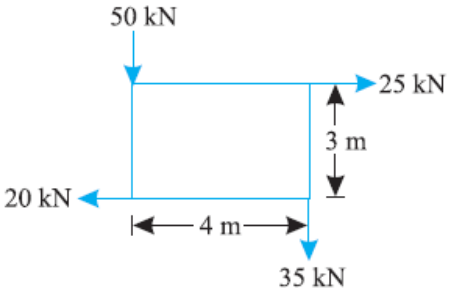


Fig.1

2. a) State the principle of transmissibility of forces and the principle of physical independence of forces. [2+2=4]

   b) State the parallelogram law of forces. Derive an expression for the magnitude and direction of the resultant using this law. [2+8 =10]

c) Find the value of force P & F so that the four forces shown in Fig. 2 produce an upward resultant of 300 N acting at 4 m from the left-hand end A of the bar. [6]

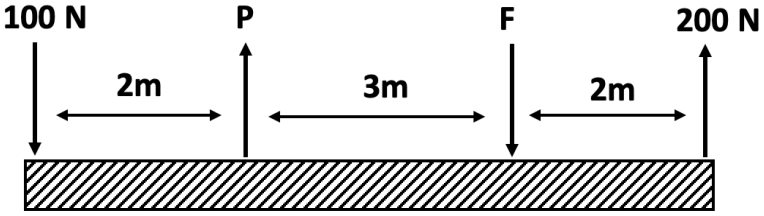
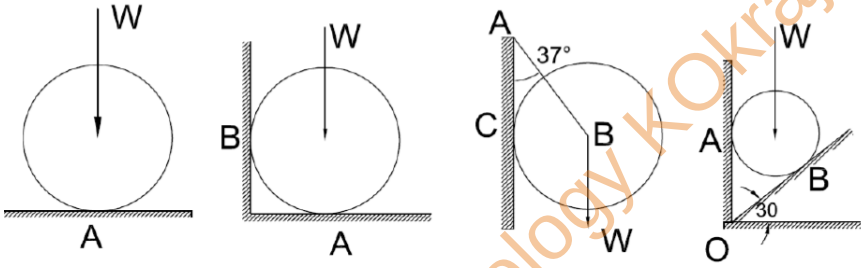


Fig. 2.

3. a) What do you mean by free body diagram (FBD)? Draw the FBD of the following Fig. 3. [2+ 4 = 6]



(i) (ii) (iii) (iv)

Fig. 3.

b) A body of weight 50 N is suspended from a horizontal beam AB by two strings AC and BC as shown in Fig. 4. The strings AC and BC make angle 30º and 45º with the beam AB. Using Lami's theorem, find the tensions in the strings AC and BC. [6]

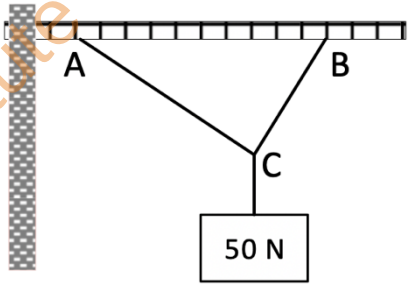


Fig. 4.

c) What are the necessary and sufficient conditions of equilibrium of a body? [2]

d) A beam AB of length 5 m supported at A and B carries two-point loads W_1 and W_2 of 3 kN and 5 kN, which are 1 m apart. If the reaction at B is 2 kN more than that at A, find the distance between the support A and the load 3 kN. [6]

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

b) Locate the centroid of the following Fig. 5 w.r.t. given reference axes. [8]

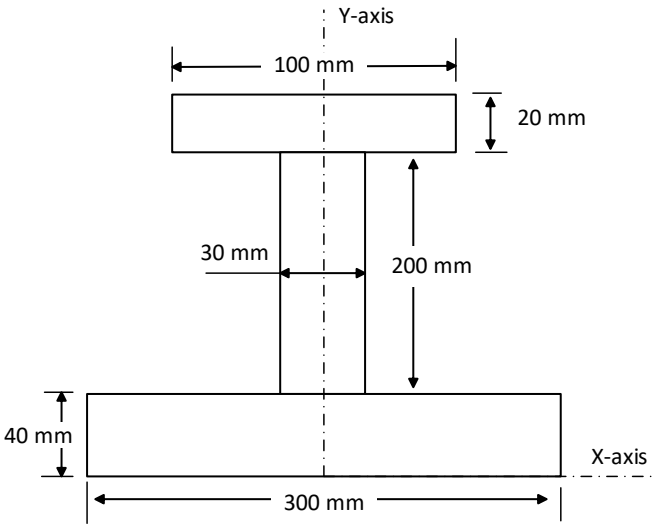


Fig. 5

c) A circular hole of 50 mm diameter is cut out from a circular disc of 100 mm diameter, as shown in Fig. 6. Find the centroid of the section from A. [5]

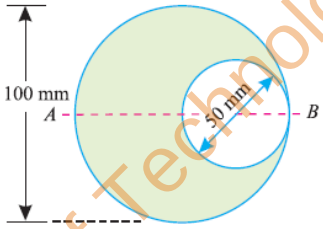


Fig. 6

d) A semicircle of 90 mm radius is cut out from a trapezium as shown in Fig. 5. Find the position of the centroid of Fig. 7. [5]

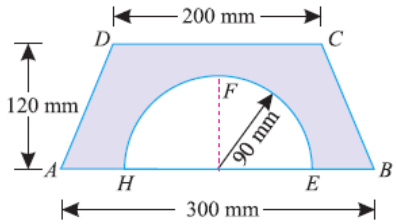


Fig. 7

5. a) Define the angle of friction and angle of repose. [2+2=4]
   b) State any three laws of static friction. [3]
   c) A body, resting on a rough horizontal plane, required a pull of 180 N inclined at 30° to the plane just to move it. It was found that a push of 220 N inclined at 30° to the plane just moved the body. Determine the weight of the body and the coefficient of friction. [10]

d) A load of 500 N is lying on an inclined plane, whose inclination with the horizontal is 30°. If the coefficient of friction between the load and the plane is 0.4, find the maximum horizontal force, which will keep the load in equilibrium. [3]

6. (a) Define displacement, velocity and acceleration of a body. Show that the equation of motion for the final velocity (v) of a body is

$$v = u + at$$

Where, u is the initial velocity,

t = time taken during which velocity changes from u to v. [3+3=6]

(b) A stone is dropped from the top of a tower of 50 m high. At the same time, another stone is thrown upwards from the foot of the tower with a velocity of 25 m/s. When and where the two stones cross each other ? [8]

(c) A particle, starting from rest, moves in a straight line, whose equation of motion is given by $s = 3t^3 + 2t^2 + 6t + 4$, where S is in meter and t is in second. Calculate the displacement, velocity and acceleration after 2 seconds. [6]

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