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Question Paper Code : 30253

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Third Semester

Automobile Engineering

ME 3351 – ENGINEERING MECHANICS

(Common to Civil Engineering/Industrial Engineering/Industrial Engineering and Management/Materials Science and Engineering/Mechanical Engineering/Mechanical Engineering (Sandwich)/Mechanical and Automation Engineering/Mechatronics Engineering/Production Engineering/Robotics and Automation/Safety and Fire Engineering)

(Regulations 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. The guy wire of a electric pole shown in Figure 1 makes 30° to the pole and is applying a force of 12 kN. Find the horizontal and vertical component of the force. Express it in the vector form taking horizontal direction as x-axis and vertical as y-axis.

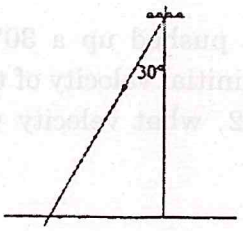

Fig. 1

2. Draw the free body diagram for the given Figure 2.

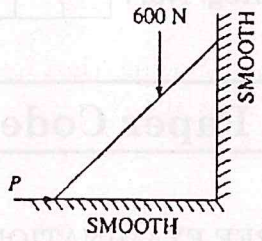

Fig. 2

3. Determine the moment of 400 N force acting at B in $x-y$ plane about point A, as shown in Figure 3.

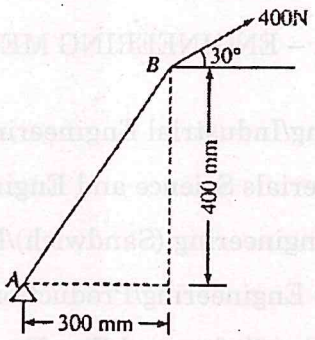

Fig. 3

4. Define Sliding Vector.

5. Derive Centroid of a Semicircle.

6. Derive Moment of inertia of a triangle about the base.

7. List out the laws of Coloumb Friction.

8. Define Angle of Friction.

9. The motion of a particle moving in a straight line is given by the Expression $s = t^3 - 3t^2 + 2t + 5$, where, s is the displacement in metres and t is the time in seconds. Determine velocity and acceleration after 4 seconds.

10. A body weighing 300 N is pushed up a 30° plane by a 400 N force acting parallel to the plane. If the initial velocity of the body is 1.5 m/s and coefficient of kinetic friction is $\mu = 0.2$, what velocity will the body have after moving 6 m?

PART B — (5 × 13 = 65 marks)

11. (a) Three cables are connected at A, where the forces P and Q are applied as shown in Figure 11(a). Knowing that Q = 0, find the value of P for which the tension in cable AD is 305 N. (13)

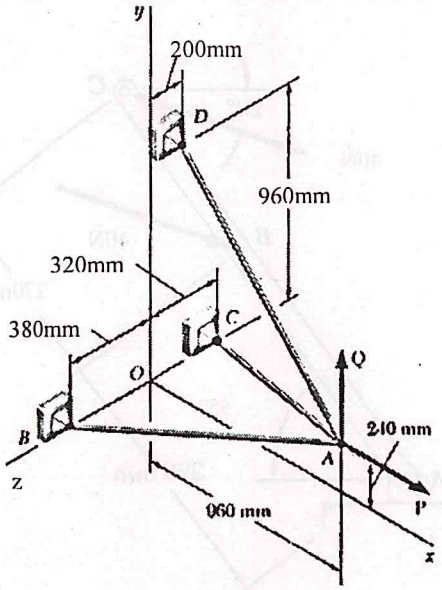

Fig. 11(a)

Or

(b) A rectangular plate is supported by three cables as shown in Figure 11(b). Knowing that the tension in cable AC is 60 N, determine the weight of the plate. (13)

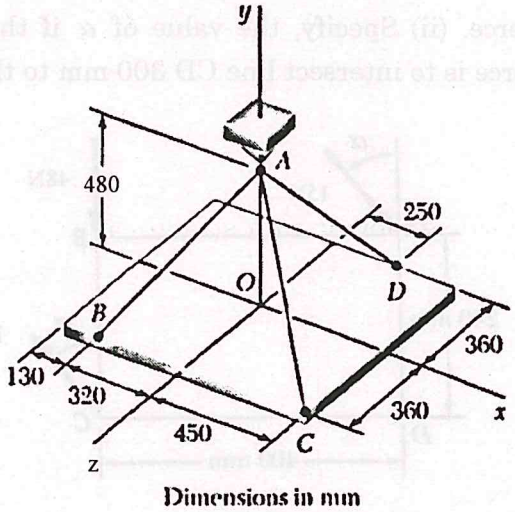

Fig. 11(b)

12. (a) Two parallel 40 N forces are applied to a lever as shown in Figure 12(a). Determine the moment of the couple formed by the two forces (i) by resolving each force into horizontal and vertical components and adding the moments of the two resulting couples, (ii) by using the perpendicular distance between the two forces, (iii) by summing the moments of the two forces about Point A. (13)

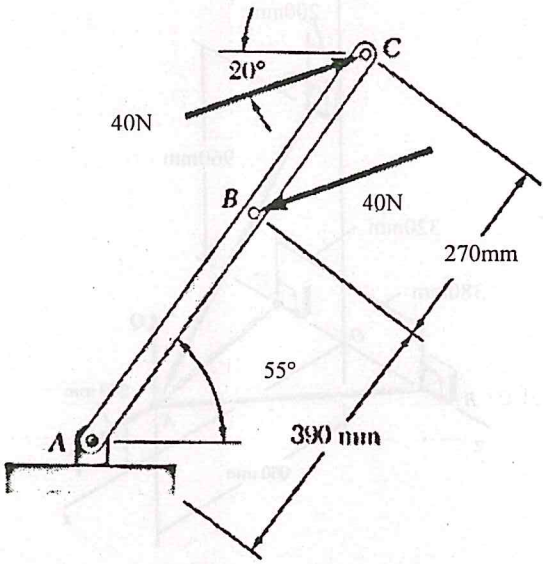

Fig. 12(a)

Or

(b) A rectangular plate is acted upon by the force and couple shown in Figure 12(b). This system is to be replaced with a single equivalent force. (i) For α = 40°, specify the magnitude and the line of action of the equivalent force. (ii) Specify, the value of α if the line of action of the equivalent force is to intersect line CD 300 mm to the right of D. (13)

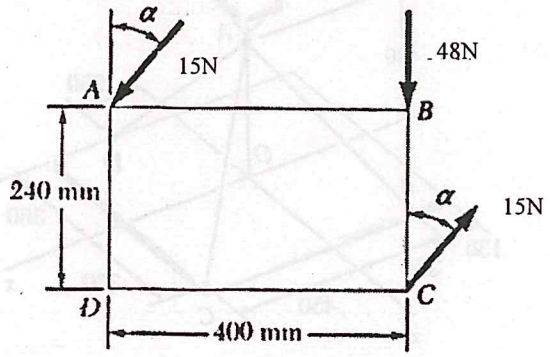

Fig. 12(b)

13. (a) Find moment of inertia of the shaded area shown in Figure 13(a) about axis AB. (13)

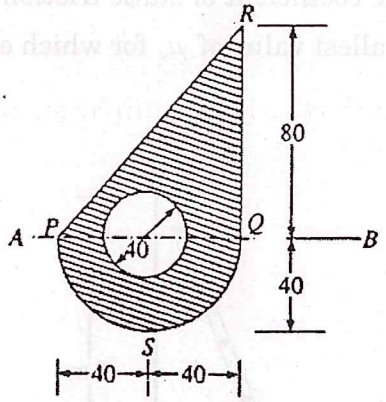

Fig. 13(a)

Or

(b) For the machine element shown in Figure 13(b), locate the x coordinate of the center of gravity. (13)

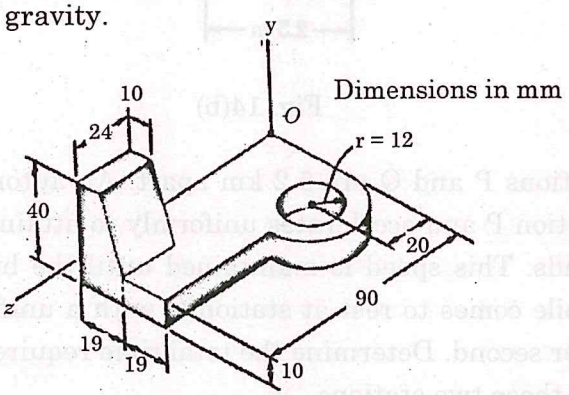

Fig. 13(b)

14. (a) Block A weighing 1000 N rests over block B which weighs 2000 N as shown in Figure 14(a). Block A is tied to wall with a horizontal string. If the coefficient of friction between A and B is 1/4 and between B and the floor is 1/3, what should be the value of P to move the block B if (i) P is horizontal? (ii) P acts 30° upwards to horizontal? (13)

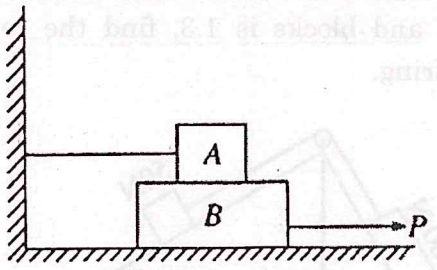

Fig. 14(a)

Or

(b) A 6.5-m ladder AB leans against a wall as shown in Figure 14(b). Assuming that the coefficient of static friction μ_s is the same at A and B, determine the smallest value of μ_s for which equilibrium is maintained. (13)

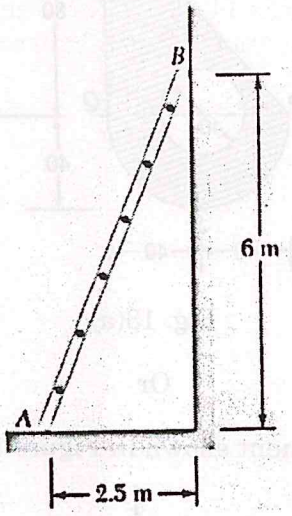

Fig. 14(b)

15. (a) Two stations P and Q are 5.2 km apart. An automobile starts from rest from station P and accelerates uniformly to attain a speed of 48 kmph in 30 seconds. This speed is maintained until the brakes are applied. The automobile comes to rest at station Q with a uniform retardation of one metre per second. Determine the total time required to cover the distance between these two stations. (13)

Or

(b) Two rough planes inclined at 30° and 60° to horizontal are placed Back to back as shown in Figure 15(b). The blocks of weights 50 N and 100 N are placed on the faces and are connected by a string running parallel to planes and passing over a frictionless pulley. If the coefficient of friction between planes and blocks is 1.3, find the resulting acceleration and tension in the string. (13)

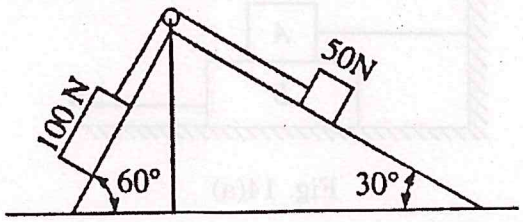

Fig. 15(b)

PART C — (1 × 15 = 15 marks)

16. (a) When they are 18 m apart, two blocks A and B are released from rest on a 30° incline. The coefficient of friction under the upper block A is 0.2 and that under the lower block B is 0.4 [Figure 16(a)]. In what time does block A reach the block B? After they touch and move as a single unit, what will be the contact force between them? Weights of the block A and B are 100 N, and 80 N respectively. (15)

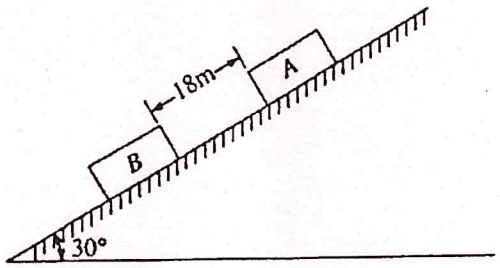

Fig. 16(a)

Or

(b) A 500-N concrete block is to be lifted by the pair of tongs shown in Figure 16(b). Determine the smallest allowable value of the coefficient of static friction between the block and the tongs at F and G. (15)

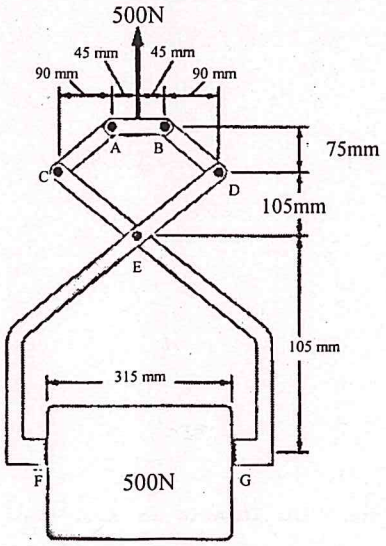

Fig. 16(b)