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Question Paper Code : 41373

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2024.

Second/Third Semester

Mechanical Engineering

ME 3351 – ENGINEERING MECHANICS

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

(Regulations 2021)

(Also common to PTME 3351 for B.E. (Part–Time) Regulations 2023)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define the following term
   (a) coplanar forces
   (b) concurrent forces

2. What is a free-body diagram and why is it important in mechanics?

3. How many reactions does a hinged support have, and why?

4. Define Varignon's Theorem of moments.

5. Define centroid and center of gravity.

6. State the parallel-axis theorem for moments of inertia.

7. Define Coloumb Friction law.

8. Define coefficient 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 meters and t is the time in seconds. Determine velocity and acceleration after 4 seconds.

10. State the principle of impulse and momentum for particles.

PART B — (5 × 13 = 65 marks)

11. (a) A particle is subjected to three concurrent forces: $F_1 = 200$ N along the positive x–axis, $F_2 = 150$ N at an angle of 60° above the x-axis, and $F_3 = 100$ N at an angle of 135° from the x-axis. Determine the magnitude and direction of the resultant force.

Or

(b) Two cylinders E, F of diameter 60 mm and 30 mm. Weighing 160 N and 40 N respectively are placed as shown in Fig. 11 (b). Assuming all the contact surfaces to be smooth, find the reactions at A, B and C.
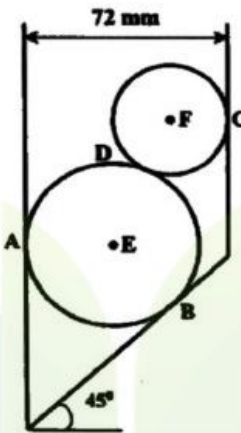
Figure 11 (b)

12. (a) A uniform beam of length 6 m and weight 200 N is supported at its ends. A weight of 400 N is placed 0.05 m from the left support. Calculate the reactions at the supports.

Or

(b) A system of connected flexible cable shown in figure.12 (b) is supporting two vertical forces 200 N and 250 N at point B and D. Determine the forces in various segments of the cable.
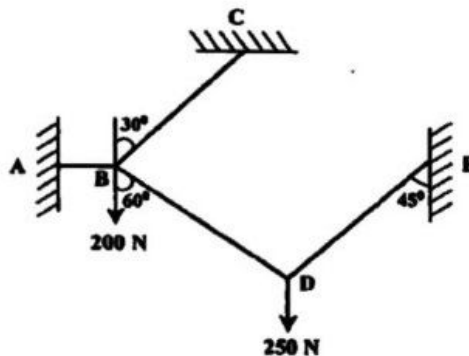

Figure 12 (b)

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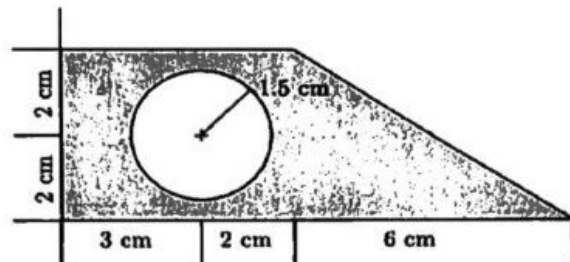13. (a) Determine the centroid and moment of interia of a composite area as shown in figure.13 (a).

Figure 13 (a)

Or

(b) An I-section is made up of three rectangles as shown in Figure.13 (b). Find the moment of inertia of the section about the horizontal axis passing through the center of gravity of the section.
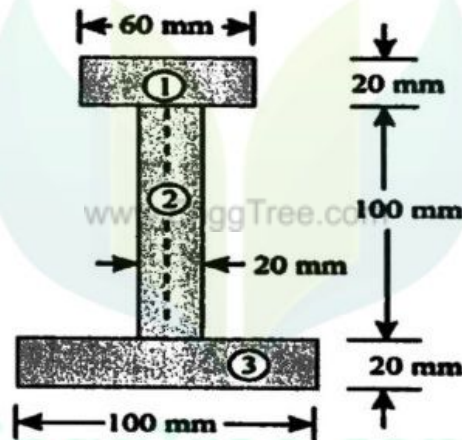

Figure 13 (b)

14. (a) A ladder 5 meters long rests on horizontal ground and leans against a smooth vertical wall at an angle 70° with horizontal. The weight of the ladder is 900 N and acts at its middle. The ladder is at the point of sliding, when a man weighing 750 N stands on a rung 1.5 meter from the bottom of the ladder. Calculate the coefficient of friction between the ladder and the floor.

Or

(b) A block weighing 500 N is placed on an inclined plane at 30°. If the coefficient of friction between the block and the plane is 0.2, determine whether the block will slide down and calculate the frictional force.

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15. (a) From the top of a 60 m tower, a bullet is fired at an angle of 60° with the horizontal, with a velocity of 120 m/s. Calculate the maximum height attained by the bullet and the time of its interval, when it strikes the ground.

Or

(b) Derive the expressions for the work–energy principle for particle and apply it to determine the velocity of a particle under a variable force along a straight line path.

PART C — (1 × 15 = 15 marks)

16. (a) Two weights 80 N and 20 N are connected by a thread and move along a rough horizontal plane under the action of a force 40 N, applied to the first weight of 80 N as shown in figure 16 (a). The coefficient of friction between the sliding surfaces of the weights and the plane is 0.3. Determine the acceleration of the weights and the tension in the thread using work–energy equation.
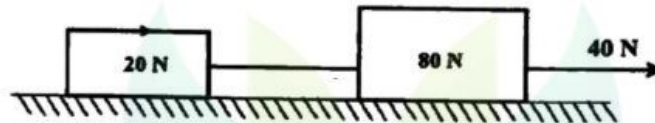

Figure 16 (a)

Or

(b) A steel ball of weight 60N is dropped onto a spring of stiffness 500 N/m from a height of 0.1 m. Find the maximum deflection of the spring (Use the work–energy principle)

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