CS/B.TECH/ODD/SEM-1/ME-101/2017-18

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Paper Code : ME-101

ENGINEERING MECHANICS

Time Allotted : 3 Hours   Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words as far as practicable.*

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

   i) Volumetric strain of a rectangular body subjected to an axial force, in term on terms of linear strain ε and Poisson's ratio $\sqrt{}$ is given by

      a) $\varepsilon (1 + 2\sqrt{})$ b) $\varepsilon (1 - 2\sqrt{})$

      c) $\varepsilon (1 + \sqrt{})$ d) $\varepsilon (1 - \sqrt{})$.

ii) A berge is pulled by two tugboats as shown in figure. What will be the value of θ so that the tension in the rope 2 is minimum ?
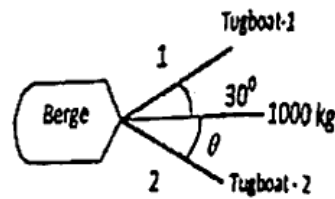
a) 30°

b) 60°

c) 45°

d) 0°.

iii) Given $\vec{F}_1 = 7\vec{j} + 5k$ and $\vec{F}_2 = 3\hat{i} + 4\hat{k}$. The magnitude of the scalar product of these vectors is

a) 21

b) 12

c) 20

d) 15.

iv) Under static condition, when the motion is impending, the friction force F is the

a) $F = \mu_s N$

b) $F > \mu_s N$

c) $F < \mu_s N$

d) unpredictable.

v) A body of weight 40 N is placed on a horizontal plane having μ = 0.4. A pull force of P is applied at an angle θ with the horizontal. The minimum value of P will be

a) 10.86 N

b) 12.37 N

c) 14.85 N

d) 20 N.

vi) The moment of inertia of a semicircle of radius R about its centroidal axis x-x is

a) 0.22 R^4.

b) 0.055 R^4.

c) 0.11 R^4

d) none of these.

vii) The velocity-time relationship of a moving particle is given by the equation $\dot{x} = (1/2)ct^2$, where $c = 2.4$ m/s². Determine the displacement of the particle at the instant t = 3 seconds, if there is no initial displacement.

   a) 10.8 m   b) 9 m

   c) 12.7 m   d) 3.6 m.

viii) When a body slides down an inclined surface (angle of inclination = θ), the acceleration f of the body is given by

   a) $f = g$ b) $f = g \sin θ$ x^2

   c) $f = g \cos θ$ d) $f = \tan θ$.

ix) If moment of the body is doubled, its kinetic energy will

   a) get doubled   b) get halved

   c) get quadrupled   d) remain same.

x) If i and j are two Cartesian unit vectors then

   a) $i.j = 0$ b) $i.j = 1$

   c) $i.j = 2$ d) none of these.

xi) M.I. of circular area whose diameter is d about an axis perpendicular to the area passing through its centre is given by

   a) $\pi d^4/64$ b) $\pi d^4/32$

   c) $\pi d^4/12$ d) $\pi d^4/16$.

xii) Null vector is known as

   a) negative vector   b) unit vector

   c) zero vector   d) all of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.　　3 × 5 = 15

2. A force given by $F = 3i + 2j - 4k$ is applied at the point P (1, -1, 2). Find the moment of the force F about the point O (2, -1, 3) & about origin.

3. A simply supported beam AB of span 4m is carrying point loads of 5kN, 2kN & 3kN at 1m, 2m & 3m from the left supported at A. Calculate the reactions at the supports A & B.　http://www.makaut.com

4. A particle travels along a straight line with a velocity $v_p = \dfrac{a}{b + x_p}$. Determine the acceleration when $x_p = 2m$.

Given that $a = 6m^2/s$ and $b = 3m$.

5. Determine the tensile force in cables AB and BC as shown in Fig. 1. Assume the pulleys to be frictionless.
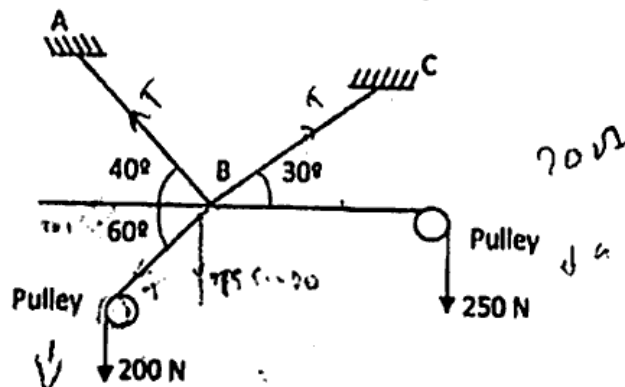

Fig.-1

6. A weight Q = 12 N rests in a right-angled trough, as shown in Fig. 2. Determine the forces exerted on the sides of the trough at D and E if all surfaces are perfectly smooth.
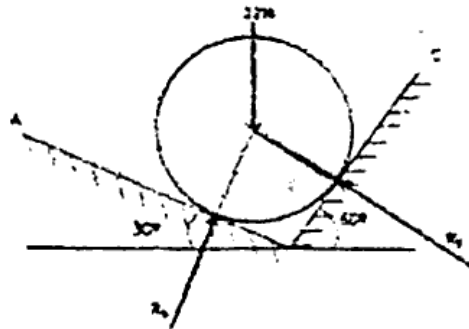

Fig.-2

7. A roller of radius 50 cm and weight 4000 N is to be pulled over rectangular block of height 30 cm as shown in figure 3. A force P is applied tangentially at point C through a string wound the circumference of the roller. Find the magnitude of force P required just to turn the wheel over the corner of rectangular block. Also determine the magnitude and direction of reaction at A and B. All surfaces are assumed to be smooth.
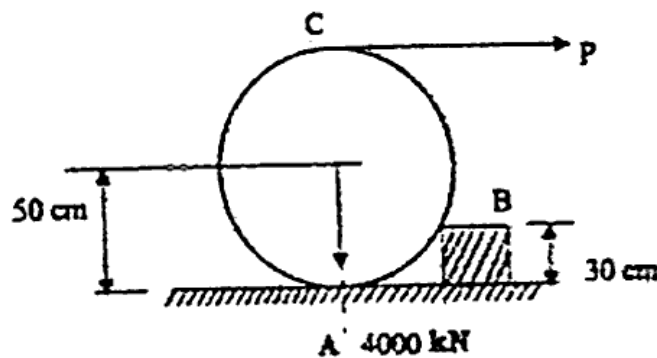

Fig.-3

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following.   3 × 15 = 45

8. a) Two cylinders are supported in a right-angled wedge support as shown in figure 4. The side OL

makes 30° angle with horizontal. The diameters of the cylinders A and B are 250mm and 500mm, and their weights being 100N and 400N, respectively. Determine the reactions R between all contact points. 8
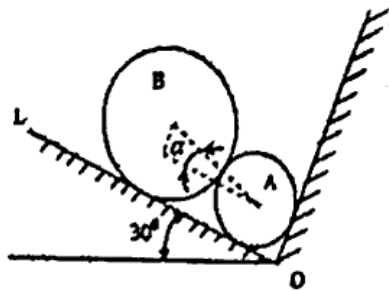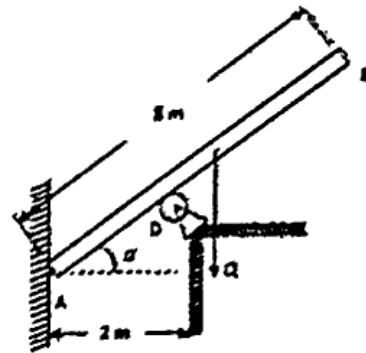

Fig.-4   Fig.-5

b) A heavy prismatic bar AB of weight 'Q' and length $2l$ rests on a very small frictionless roller at D and against a smooth vertical wall at A, as shown in figure 5. Determine the angle α that the bar must make with the horizontal in the condition of equilibrium. 7

9. a) The tension in the supporting cable AB, as shown in fig. 6 is 10kN. Write the force which the cable exerts on the boom BC as a vector T. Determine the angle θ_x, θ_y and θ_z which the line of action of T forms with the positive x, y and z axes. 8
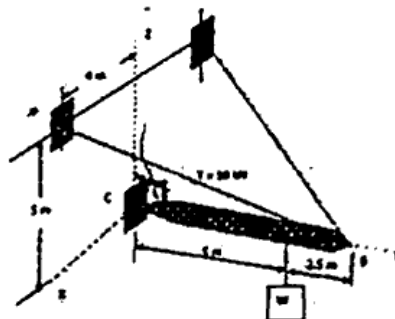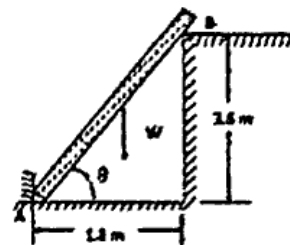

Fig.-6   Fig.-7

b) A 667.5 N man stands on the middle rung of a 222.5 N ladder as shown in figure 7. Assuming the end B rests on the corner of a wall and a stop at A to prevent slipping, find the reactions at A and B. 7

10. a) A block of weight W, height $2h$ and width $2c$ rests on a flat car which moves horizontally with constant acceleration a, as shown in Fig. 8. Determine (a) the value of the acceleration a at which slipping of the block on the car will impend if the coefficient of friction is μ and (b) the value of the acceleration at which tipping of the block about the edge A will impend, assuming sufficient friction to prevent slipping. http://www.makaut.com 7

b) A solid right circular cylinder of weight $W = 50$ N and cross-sectional area $A = 100$ cm^2 is suspended by a spring of constant $k = 2$N/cm and hangs partially submerged in water (w = 9810N/m^3), as shown in Fig. 9. Calculate the period τ for small vertical oscillations. Neglect inertia of water. 8
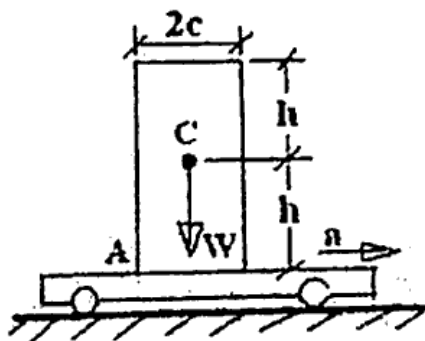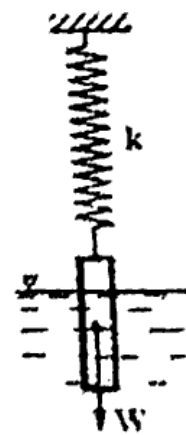
Fig.-8   Fig.-9

11. a) An I-section has the following dimensions in mm units.

Bottom flange = 100 × 20

Top flange = 60 × 20

Web = 100 × 20

Determine the moment of inertia of the I-section about centroidal x-x axis passing through its centroid & parallel to base. 9

b) Draw the stress-strain diagram of a mild steel specimen by showing all the salient points on it. 6

12. A ball is dropped vertically on to a 20° inclined plane at 'A'. The direction of rebound forms an angle of 35° with vertical. Knowing that the ball strikes the inclined plane at 'B' as shown in figure 10. Determine :

i) The velocity of rebound at 'A'

ii) The time required for the ball to travel from 'A' to 'B'

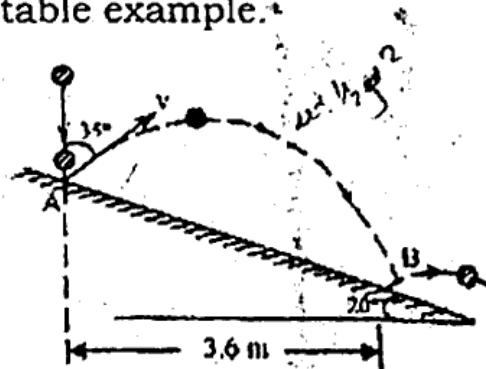iii) What do you mean by Free body diagram ? Explain with suitable example. 5 + 5 + 5

Fig.-10