

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 4303Roll No.

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B.Tech.

(SEM II) EVEN SEMESTER THEORY EXAMINATION, 2009-2010

ENGINEERING MECHANICS

Time : 3 Hours

Total Marks : 100

- Note :** (i) This paper is in **three** sections. Section A carries 20 marks, Section B carries 30 marks and Section C carries 50 marks.
- (ii) Attempt **all** questions. Marks are indicated against each question part.
- (iii) Assume missing data suitably, if any.

SECTION - A

1. You are required to answer **all** the parts :

(10x2=20)

Choose correct answer for the following parts.

- (a) The necessary and sufficient condition for a system of coplanar forces to be in equilibrium.

(i) $\Sigma F_x = 0$

(ii) $\Sigma F_x = \Sigma F_y = 0$

(iii) $\Sigma M_0 = 0$

(iv) $\Sigma F_x = \Sigma F_y = \Sigma M_0 = 0$

- (b) The bending equation is :

(i) $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$

(ii) $\frac{M}{y} = \frac{\sigma}{I} = \frac{E}{R}$

(iii) $\frac{M}{y} = \frac{\sigma}{R} = \frac{E}{I}$

(iv) $\frac{M}{I} = \frac{\sigma}{R} = \frac{E}{y}$

- (c) The principle of conservation of energy can't be applied in the following situation :
- (i) body sliding down on a rough inclined plane.
 - (ii) simple pendulum
 - (iii) a particle executing SHM
 - (iv) a particle moving in a gravitational field
- (d) In UDL loading (w N/m), the maximum bending moment in case of simple supported beam is given as :
- (i) wL
 - (ii) $wL^2/2$
 - (iii) $wL^2/4$
 - (iv) $wL^2/8$

Fill in the blanks for the following parts :

You will be awarded full marks, if all the entries in a part are correct otherwise will be awarded zero.

- (e) The algebraic sum of the moments of two _____ forces with respect to any moment centre in their plane of action is equal to the moment of their _____ with respect to the same centre.
- (f) In a cantilever beam carrying a concentrated load at the free end, the bending moment will be zero at _____ and maximum at _____ .
- (g) The angular velocity (rad/sec) of a body rotating at N rpm is _____ and the linear velocity of a body rotating at ω rad/sec along a circular path of radius r is _____ .
- (h) In truss analysis, all forces acting on truss are applied at the _____ only and also lie in the _____ of truss.

Match the columns for the following parts :

You will be awarded full marks, if all the matches in a part are correct otherwise will be awarded zero.

- (i) Match the following columns. Column II shows the moment of inertia about a centroidal axis :

Column I	Column II
(i) Triangle	(P) $0.11 R^4$
(ii) Circle	(Q) $\pi R^4/4$
(iii) Semicircle	(R) $bh^3/12$
(iv) Rectangle	(S) $bh^3/36$

- (j) Match the following columns :

Column I	Column II
(i) Curvilinear motion	(P) Neither pure rotation nor pure translation
(ii) Rectilinear motion	(Q) Pure rotary motion
(iii) General plane motion	(R) Motion of particles remains parallel & straight
(iv) Instantaneous motion	(S) Motion of particles remains parallel & in curve

SECTION - B

2. Answer any three parts of the following :

(3x10=30)

- (a) Two cylinders A and B weighing 4 kN and 3 kN, respectively, rest on smooth inclined plane as shown in Figure 1. They are connected by a bar of negligible weight hinged to each cylinder at its geometric centre by smooth pins. Find the force P to be applied to the smaller cylinder at 45° to the vertical to hold the system in the given position.

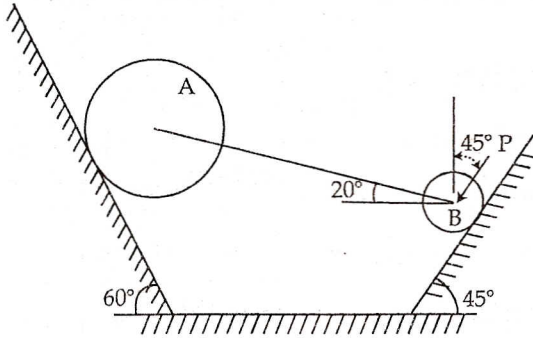


Figure - 1

- (b) Calculate the values of shear force and bending moments for the simple supported beam shown in Figure 2. Also draw the shear force and bending moment diagrams.

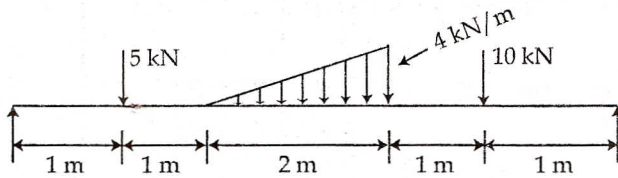


Figure - 2

- (c) Determine the moment of inertia of T section about the horizontal and vertical axes, passing through the C.G. of the section as shown Figure 3.

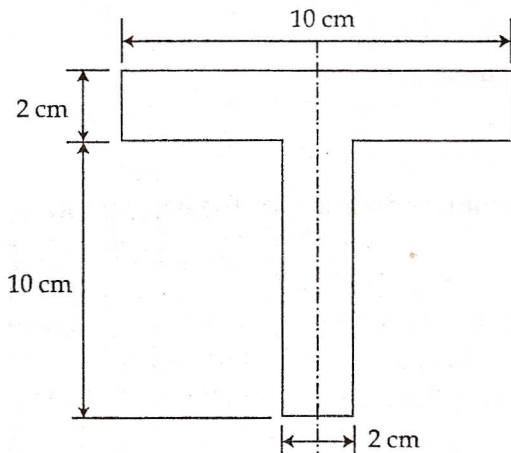


Figure - 3

- (d) A solid shaft is subjected to a maximum torque of 15 MN-cm. Determine the diameter of the shaft, if the allowable shear stress and the twist are limited to 1 kN/cm² and 1°, respectively for 210 cm length of shaft. $G=8 \text{ MN/cm}^2$.
- (e) The motion of a particle is given by $a=t^3-3t^2+5$, where a is the acceleration in m/sec² and t is the time in seconds. The velocity of the particle at $t=1$ sec. is 6.25 m/sec, and the displacement is 8.30 meters. Calculate the displacement and the velocity at $t=2$ sec.

SECTION - C

3. Answer any two parts of the following : (2x5=10)

- State and prove Varignon's theorem.
- Derive an expression for the ratio of belt tensions in a flat belt drive.
- Explain briefly different types of friction.

4. Answer any one part of the following : (10)

- Find the axial forces in all members of a truss as shown in Figure 4.

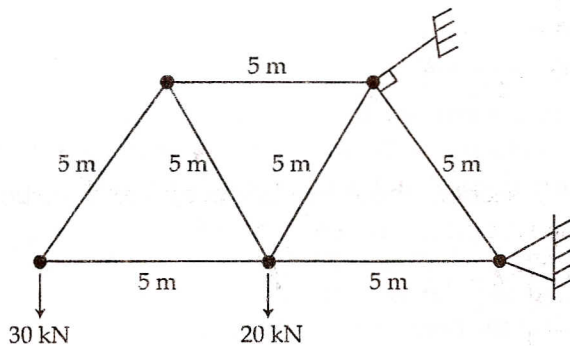


Figure - 4

- Draw the shear force and bending moment diagram for the beam loaded as shown in Figure 5.

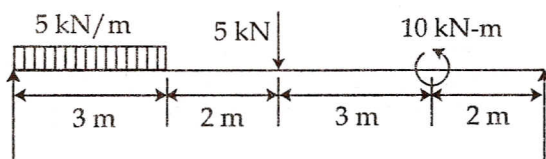


Figure - 5

5. Answer any two parts of the following :

(2x5=10)

- (a) Explain the following :
- (i) Product of inertia
 - (ii) Mass moment of inertia
- (b) Locate the centroid of channel section as shown in Figure 6.

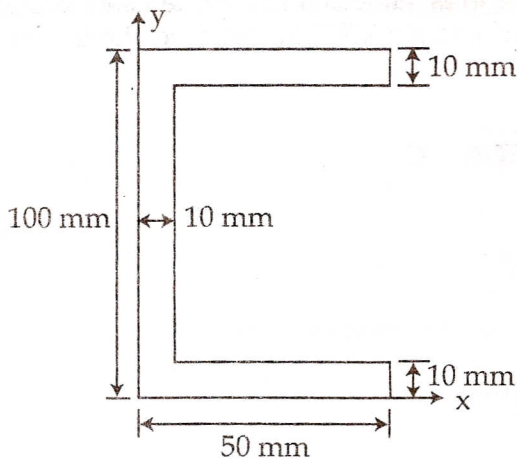


Figure - 6

- (c) Determine the mass moment of inertia of a rectangular plate of size axb and thickness t about the centroidal axis.

6. Answer any one part of the following :

(10)

- (a) A train starts from rest and moves along a curved track of radius 600 m with uniform acceleration until it attains a velocity of 70 km/h at the end of third minute. Determine the tangential, normal and total acceleration of the train at the end of second minute.
- (b) The cylinder shown in Figure 7 is 70 cm in diameter and weighs 500 N. It is rotating about the fixed axis O and has an angular velocity of 7 rad/s at the given instant. Using D'Alembert's principle, find the horizontal and vertical components of the reaction at O.

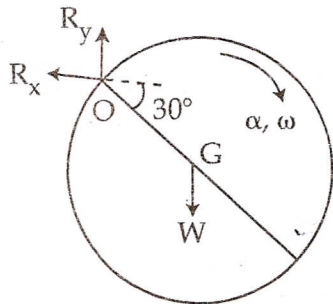


Figure - 7

7. Answer any two of the following :

(10)

- (a) A 300 mm deep rectangular beam is simply supported over a span of 6 m. What uniformly distributed load per meter the beam can carry if bending stress is not to exceed 110 N/mm^2 . Take $I = 8.5 \times 10^6 \text{ mm}^2$.
- (b) A rectangular bar of uniform cross-section $4 \text{ cm} \times 2.5 \text{ cm}$ and of length 2.2 m is hanging vertically from a rigid support. It is subjected to axial tensile loading of 10 kN. If density of steel is 8000 kg/m^3 and $E = 200 \text{ GN/m}^2$, find the maximum stress and the elongation of the bar.
- (c) Derive the torsion formula $\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$.

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