20052

Printed Pages – 7 **EME – 202**

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

**PAPER ID : 4303** **Roll No.**

**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 algebric 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.

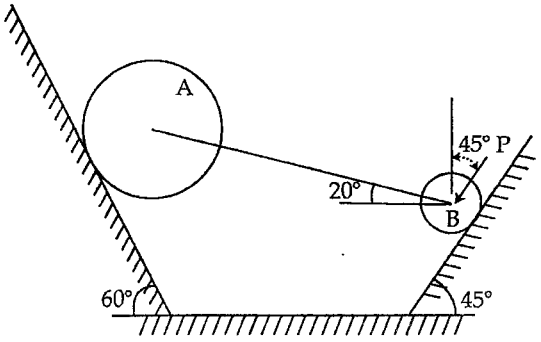


Figure - 1

(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.

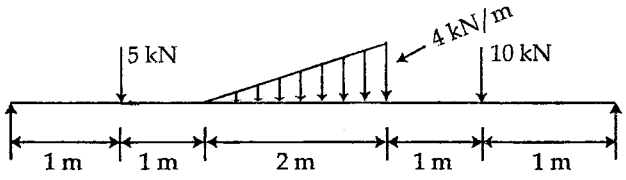


Figure - 2

(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.

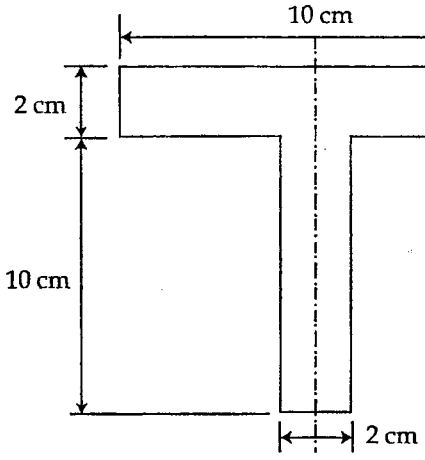


Figure - 3

(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/cm$^2$ and 1°, respectively for 210 cm length of shaft. G=8 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/sec$^2$ 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)**

(a) State and prove Varignon's theorem.

(b) Derive an expression for the ratio of belt tensions in a flat belt drive.

(c) Explain briefly different types of friction.

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

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

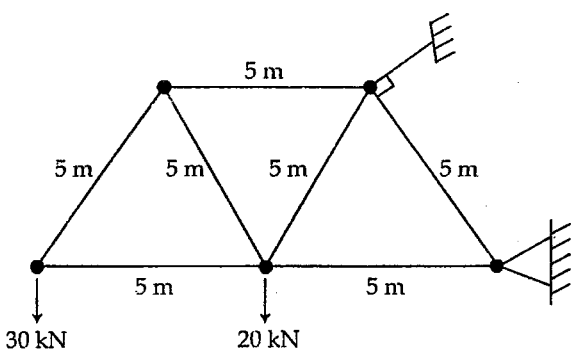


Figure - 4

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

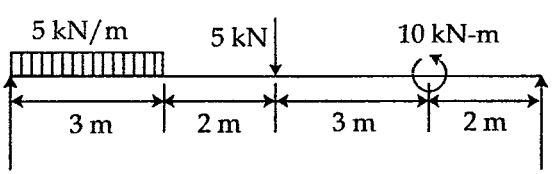


Figure - 5

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.

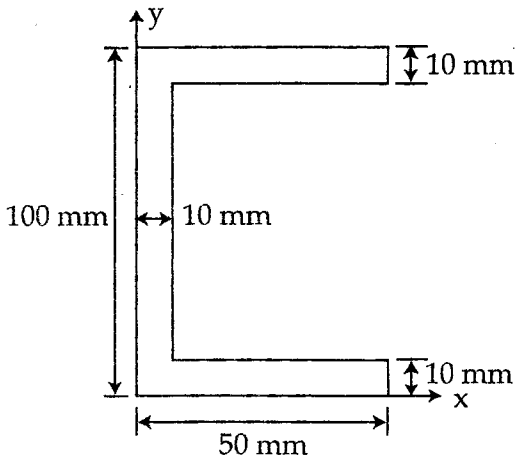


Figure - 6

(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.

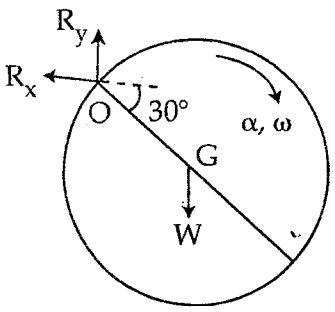


Figure - 7

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 $I = 8.5 \times 10^6$ $mm^2$.

(b) A rectangular bar of uniform cross-section 4 cm × 2.5 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 $E = 200$ $GN/m^2$, 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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