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

PAPER ID : 4301   **Roll No.** ☐☐☐☐☐☐☐☐☐☐☐

B. Tech.

(SEM. I) ODD SEMESTER THEORY EXAMINATION 2010-11

ENGG. MECHANICS

Time : 3 Hours   *Total Marks : 100*

Note :— (1) Attempt all questions. Marks are indicated against each question.

(2) Assume missing data suitably, if any.

SECTION—A

1. Attempt all parts :—   (10×2=20)

    Note : In parts (i) and (ii), choose the correct choice :

    (i)   A body of weight 100 N is resting on a rough horizontal table. The friction force acting on it is :

        (a) 20 N

        (b) 10 N

        (c) 0

        (d) The question cannot be answered without knowing the co-efficient of the friction.

    (ii) First moment of area about an axis is zero. The axis :

        (a) Must be an axis of symmetry

        (b) Must pass through CG

        (c) Both (a) and (b)

        (d) None

Note : **In parts (iii) and (iv), choose whether the statement is true or false :**

(iii) When nonconcurrent coplanar forces act on a body, it is possible that the resultant force is zero even if the body is not in equilibrium.

(iv) A solid shaft is stronger compared to a hollow shaft if material, weight and length of the shafts are same.

Note : **In parts (v) and (vi), fill in the blanks :**

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

(v) A perfect truss has minimum _____ joints and _____ members.

(vi) The bending stress at neutral axis is _____ and at the top layer is _____.

Note : **In parts (vii) and (viii), matching types :**

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

(vii) Match the following columns :—

	Column 1		Column 2
(a)	Moment of inertia of a circular plate of mass M and radius R about its axis is	(1)	$2MR^2/5$
(b)	Moment of inertia of a circular ring of mass M and radius R about its axis is	(2)	$MR^2/2$

	Column 1		Column 2
(c)	Moment of Inertia of a solid sphere of mass M and radius R about its diameter is	(3)	$2MR^2/3$
(d)	Moment of Inertia of a thin spherical shell of mass M and radius R about its diameter is	(4)	MR^2

(viii) Match the following columns :—

	Column 1		Column 2
(a)	In pure rotation of rigid body, the radial component of acceleration is	(1)	$R\alpha$
(b)	In pure rotation of rigid body, tangential component of acceleration is	(2)	$\dfrac{d^2s}{dt^2}$
(c)	In curvilinear motion of rigid body, the tangential component of acceleration is	(3)	$\dfrac{1}{R}\left(\dfrac{ds}{dt}\right)^2$
(d)	In curvilinear motion of rigid body, normal component of acceleration is	(4)	$R\omega^2$

Note : **In questions (ix) and (x), two statements are given followed by four choices. Choose the correct choice :**

(ix) **Statement 1 :** A moment of 10 N-m is applied in the middle of the simply supported beam. The magnitude of bending moment in the beam at the middle is 5 Nm.

Statement 2 : A cantilever beam of length 2 m carries 10 kN force at a distance of 1 m from the support. The bending moment at a distance of 1·5 m from the support is 15 kNm.

(a) Only statement 1 is true

(b) Only statement 2 is true

(c) Both statements are true

(d) Neither statement is true

(x) **Statement 1 :** A wire of length L is bent, the CG will remain at the middle.

**Statement 2 :** From a solid circular plate of radius R a concentric circular plate of radius R/2 is removed. CG will remain unchanged.

(a) Only statement 1 is true

(b) Only statement 2 is true

(c) Both statements are true

(d) Neither statement is true

SECTION—B

2. Answer any **three** parts of the following :— (10×3=30)

(a) A smooth weightless cylinder of radius 600 mm rests on a horizontal plane and is kept from rolling by an inclined string of length 1000 mm. A bar AB of length

1500 mm and weight 1200 N is hinged at A and placed against the cylinder of negligible weight. Determine tension in the string.
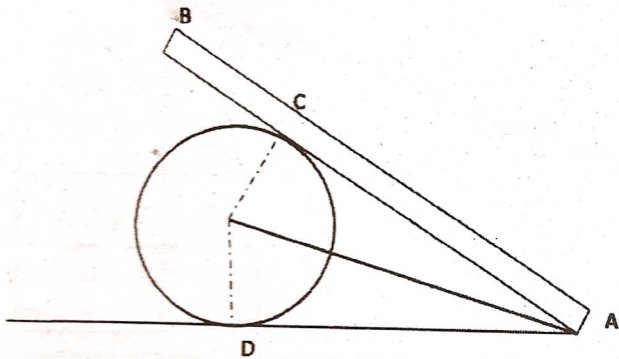

(b) For the simply supported beam as shown in figure, draw shear force and bending moment diagrams after finding the equations for shear force and bending moment.
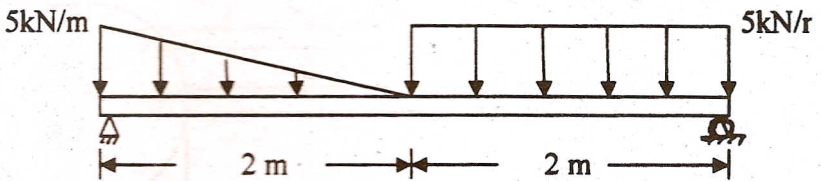
(c) Rod AB of weight 500 N is supported by a cable wrapped around a semi-cylinder having coefficient of friction of 0·2. A weight C weighing 100 N can slide without friction on rod AB. What is the maximum range x from centerline the mass C can be placed without causing slippage ?
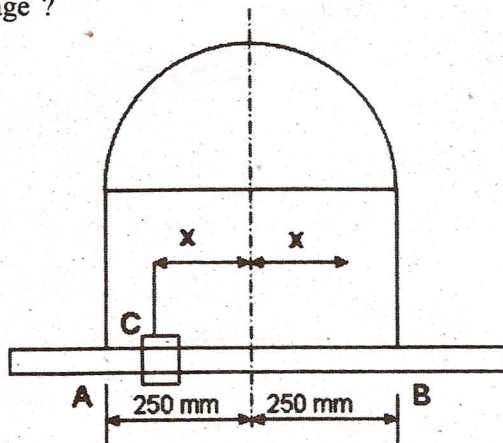
(d) A homogeneous sphere weighing 10 kg is attached to a slender rod of mass 2 kg. If the system is released from horizontal position in rest condition, find the magnitude of angular acceleration. Also find angular velocity of system when it passes through vertical position.
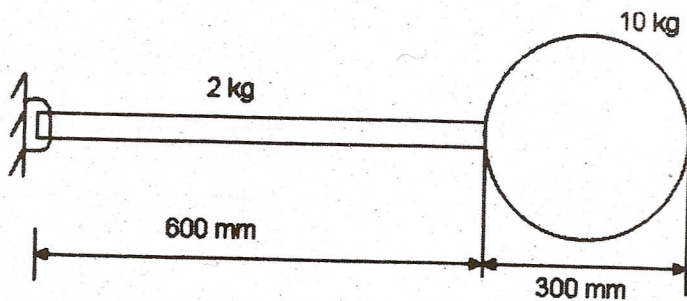
(e) (i) What do you understand by "Pure Bending" ?

(2)

(ii) Determine the suitable values for inside and outside diameters of hollow steel shaft whose internal diameter is 0·6 times its external diameter. The shaft transmits 220 kW at 200 rpm. The allowable shear stress is limited to 75 MPa, and angle of twist is limited to 1° per meter. The modulus of rigidity for shaft material is 80 kN/mm². **(8)**
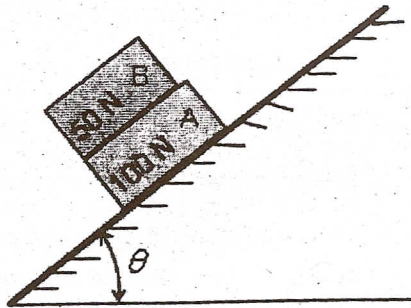
SECTION—C

3. Attempt any **one** part of the following :— **(10)**

(a) (i) State and prove Lami's theorem.

(ii) A system of forces acting on a cantilever beam is shown in figure. Reduce this system to a single force system and find the point of application of this force on the beam.
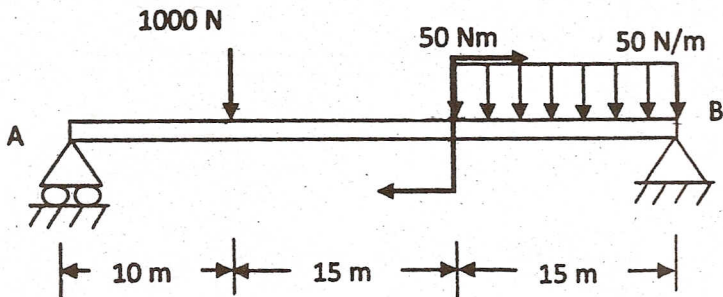
(b) Blocks A and B, of weight 150 N and 200 N, respectively rest on an inclined plane as shown in the figure. The coefficient of friction between the two blocks is 0·3 and between block A and inclined plane is 0·4. Find the value of θ for which either one or both the blocks start slipping. At that instant, what is the friction force between B and A ? Between A and inclined plane ?
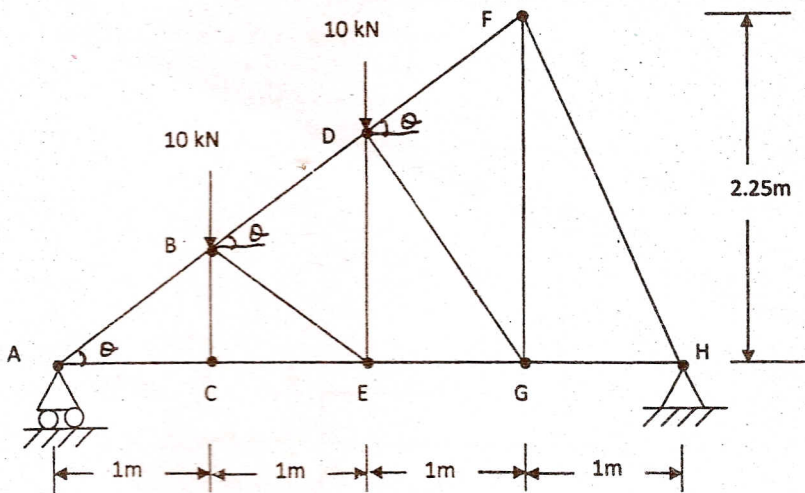

4. Attempt any **one** part of the following :— **(10)**

(a) For the beam shown in figure, draw the shear force and bending moment diagrams.

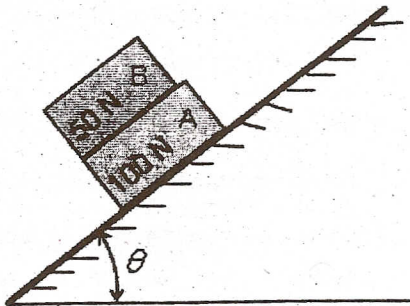(b) For the simply supported truss shown in figure, find the forces in the members BD, DE, EG, and CE.

5. Attempt any **two** parts of the following :— (5×2=10)

(a) A wire is bent into a closed loop A-B-C-D-E-A as shown in figure in which portion AB is circular arc. Determine the centroid of the wire.
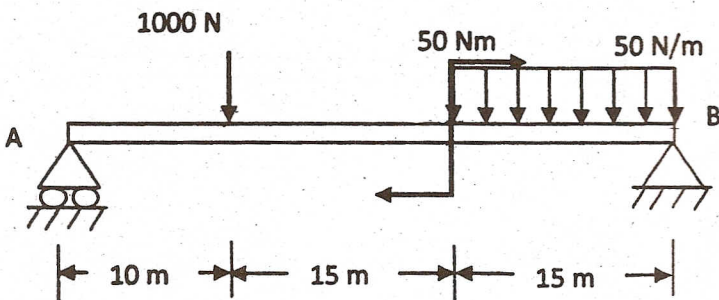
(b) Blocks A and B, of weight 150 N and 200 N, respectively rest on an inclined plane as shown in the figure. The coefficient of friction between the two blocks is 0·3 and between block A and inclined plane is 0·4. Find the value of θ for which either one or both the blocks start slipping. At that instant, what is the friction force between B and A ? Between A and inclined plane ?
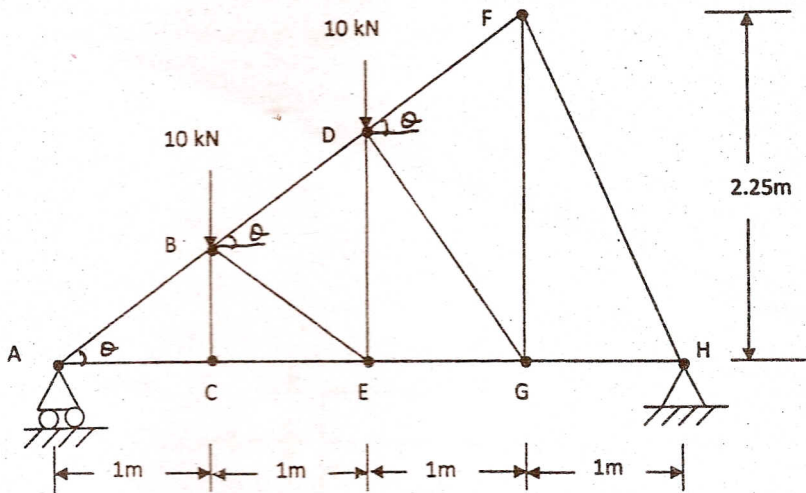

4. Attempt any **one** part of the following :— (10)

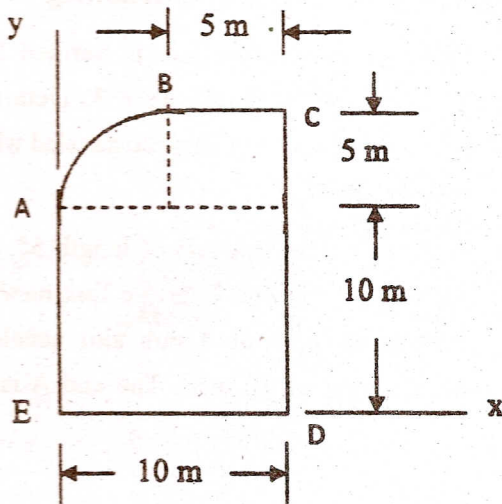(a) For the beam shown in figure, draw the shear force and bending moment diagrams.

(b) For the simply supported truss shown in figure, find the forces in the members BD, DE, EG, and CE.

5. Attempt any **two** parts of the following :—   (5×2=10)

(a) A wire is bent into a closed loop A-B-C-D-E-A as shown in figure in which portion AB is circular arc. Determine the centroid of the wire.

(b) Find the principal moment of inertia about the origin of the area shown in figure.

All dimensions are in mm.
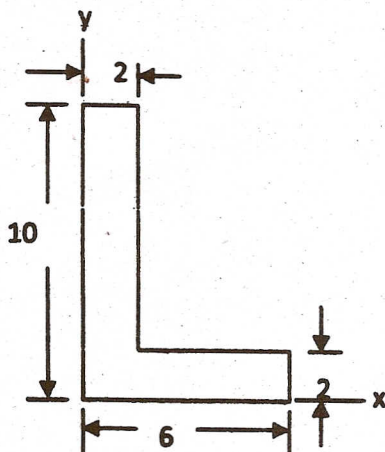
(c) Derive an expression for moment of inertia of a solid sphere about its diameter.

4.
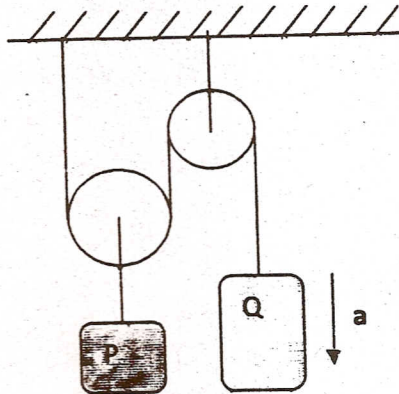
6. Attempt any **two** parts of the following :— (5×2=10)

(a) The motion of a particle is defined by the relation $x = 6t^4 - 2t^3 - 12t^2 - 3t + 3$. Determine the time, position, velocity and distance traveled when acceleration is zero.

(b) A straight rigid link AB of length 50 cm is shown in the figure. The end B of the link moves along x-axis with a velocity of 4 m/s and accelerates with an acceleration of 10 m/s². The end A is constrained to

EM

move along y-axis. Find the velocity and acceleration of the end A at the given instant.
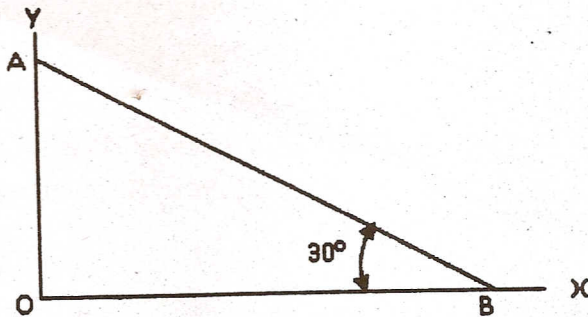
(c) Two weights P and Q are connected by the arrangement shown in figure. Neglecting friction and the inertia of the pulleys and cord, find the acceleration a of the weight Q. Assume that P = 178 N and Q = 133·5 N.

7. Attempt any **two** parts of the following :—   (5×2=10)

(a) Define Poisson's ratio. Prove that its value lies between zero and half.

(b) Determine the dimensions of a simply supported rectangular steel beam 6 m long to carry a brick wall 250 mm thick and 3 m high, if the brick weighs 20 kN/m³ and maximum permissible bending stress is 800 N/cm². The depth of a beam is 1·50 times its width.

(c) For torsion of a circular shaft, derive the torsion equation. State all the assumptions at the beginning.