Printed Pages:03   **Sub Code: EME202**

Paper Id: | 1 | 4 | 0 | 2 | 0 | 2 | **Roll No.**

B.TECH.
(SEM II) THEORY EXAMINATION 2017-18
ENGINEERING MECHANICS

Time: 3 Hours   *Total Marks: 100*

Note: Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1.   **Attempt *all* questions in brief.**   **2 x 10 = 20**

   a. Explain how you will reduce the system of coplanar non-concurrent forces to a force and a couple.
   b. What is the difference between a beam and a frame?
   c. What is the condition of impending motion?
   d. Explain angle of friction.
   e. Differentiate between 'polar moment of inertia' and 'product of inertia'.
   f. A shaft rotating at 50 rpm about a fixed axis accelerates to 850 rpm in 22 sec. Determine the average angular acceleration.
   g. An elevator cage of a mineshaft, weighing 5 kN, is lifted or lowered by means of a wire rope. Starting from rest, it moves upwards with constant acceleration and acquires a velocity of 3 m/s within a distance of 3m. Calculate the tensile force in the cable during the accelerated motion.
   h. Define the total elongation of a prismatic bar with cross-sectional area A and length L. It is hanging freely under its own weight from a fixed support.
   i. Prove that in case of pure bending, the stress in any layer of the beam is directly proportional to its distance from the neutral axis.
   **j.** Distinguish isotropic material from homogeneous material.

SECTION B

2.   **Attempt any *three* of the following:**   **10 x 3 = 30**

   a. Write the relationship among load, shear force and bending moment. A heavy spherical ball of weight W rest in a V-shaped through whose sides are inclined at α and β to the horizontal. Determine the pressure exerted on each side. Neglect friction. Subsequently a similar spherical ball is placed on the side of inclination α and it is made to rest on the first ball. Work out the force exerted by the lower ball on the side inclined at β.
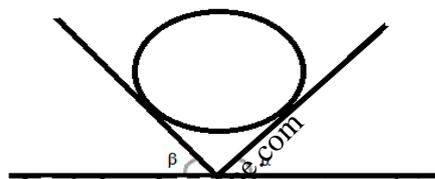
   b. Draw the shear force and bending moment diagram for the beam as shown below:
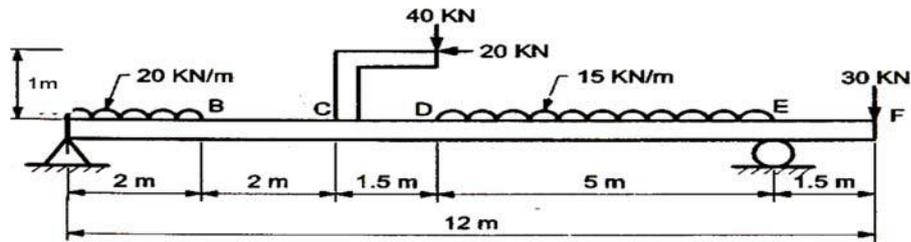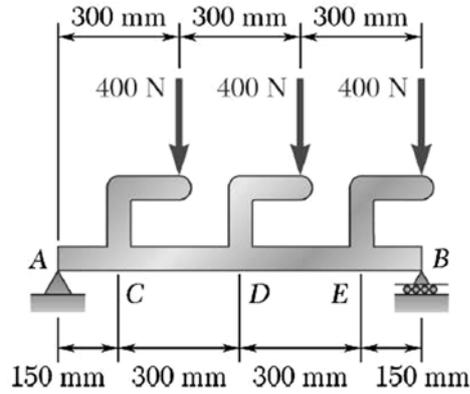
c. Determine the moment of inertia of the section as shown below about centroidal Y axis (dotted line). All dimensions are in mm.
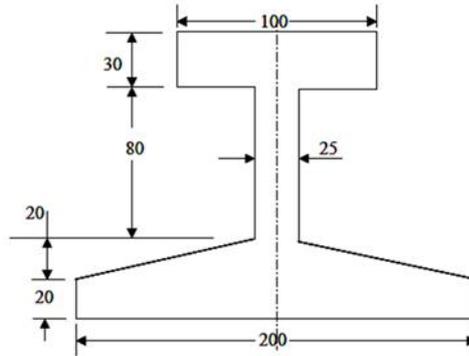

d. Define section modulus. How it is related to moment of inertia. A beam weighing 500 N is held in horizontal position by three wires. The outer wires are of brass of 1.2 mm dia. And attached to each end of the beam. The central wire is of steel of 0.6 mm diameter and attached to the middle of the beam. The beam is rigid and the wires are of the same length and unstressed before the beam is attached. Determine the stress induced in each wire. Take Young's modulus for brass as 80 GPa and for steel 200 GPa.

e. Show that the instantaneous stress due to a suddenly applied load is twice the stress caused by gradual application of load. The load is axially acting on the bar. Find bulk modulus and lateral contraction for a circular bar of 45 mm diameter and increase in length is 2.5 mm for gauge length of 2.5 m. given that G= 0.43 × 10^5 N/mm² and E= 1.15 × 10^5 N/mm².

SECTION C

3. Attempt any *one* part of the following: **10 x 1 = 10**

a) Explain the phenomenon of rolling friction mentioning the factors affecting it. Determine the minimum angle θ at which a uniform ladder can be placed against a wall without slipping under its own weight. The coefficient of friction for all surfaces is 0.2.

b) Sketch stress-strain diagram for ductile material and explain its salient features. The moment of inertia of a beam section 50 cm deep is 69490 cm⁴. Find the longest span over which a beam of this section, when simply supported, could carry a uniformly distributed load of 50 KN/m run. The maximum flange stress in the material is not to exceed 110 N/mm².

4. Attempt any *one* part of the following: **10 x 1 = 10**

a) Draw the shear and bending-moment diagrams for the beam *AB* as shown below and determine the maximum absolute values of the shear and bending moment.

b) Determine the force in members GI, GJ, and HI of the truss shown.

6 panels @ 4 m = 24 m
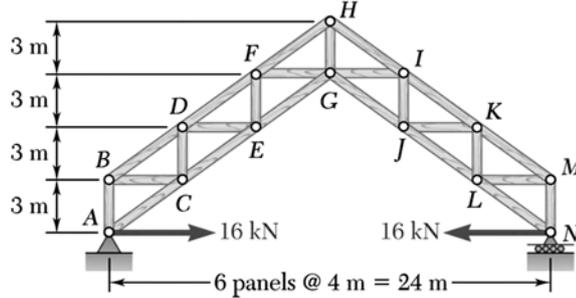
5. **Attempt any *one* part of the following:** 10 x 1 = 10

a) Determine the area moment of inertia of an ellipse about its two centroidal axes, and its polar moment of inertia.

b) For a solid right circular cone of base radius R, height h and mass M, derive an expression for its mass moment of inertia with respect to (a) a diameter of its base, (b) centroidal axis parallel to its base, and (c) an axis parallel to its base and passing through its vertex.

6. **Attempt any *one* part of the following:** 10 x 1 = 10

a) A flywheel is rotating freely clockwise at a speed of 2000 rpm. An anticlockwise torque is applied on the flywheel producing an angular acceleration defined by $\alpha = 6t$ rad/s^2. Determine the (a) time required to reduce clockwise angular speed to 1000 rpm, (b) time required to reverse direction of rotation, and (c) total number of revolutions during the first 12 sec. of the movement.

b) Why does a cyclist tilt inward while negotiating a curved path? A train weighing 4500 kN of weight. Determine the steady pull that the locomotive must exert if the speed of the train is to be increased from 15 km/h to 60 km/h within a period of 3 minutes.

7. **Attempt any *one* part of the following:** 10 x 1 = 10

a) Prove that in case of pure bending, the neutral axis passes through the centroid of the section. What percentage saving in weight would be obtained if a solid circular shaft is to be replaced by a hollow shaft whose inside diameter is 0.7 times the outside diameter; with the same length, material and maximum permissible shear stress? The solid shaft transmits 300 kW at 100 rpm and shear stress does not exceed 100 MPa.

b) A circular log of timber has diameter D. It is used as a beam. Find the dimensions of the strongest rectangular section which can be cut from it.