

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

PAPER ID : 0429

Roll No.

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B.Tech.

(SEM. III) ODD SEMESTER THEORY EXAMINATION

2010-11

STRENGTH OF MATERIAL

Time : 3 Hours

Total Marks : 100

Note : (1) Attempt **all** questions. All questions carry equal marks.

(2) Assume any missing data if required.

1. Attempt any **two** of the following : **(10×2=20)**

(a) A two dimensional state of stress is given by :

$$\sigma_{xx} = 10 \text{ MPa}, \sigma_{yy} = 5 \text{ MPa} \text{ and } \sigma_{xy} = 2.5 \text{ MPa.}$$

Determine the following on a plane inclined at an angle of 30° from x-plane in anticlockwise direction.

(i) Normal stress

(ii) Shear stress

(iii) Resultant stress and

(iv) Principal stresses at the point.

(b) One end of a spring is fixed on horizontal plane with its axis in vertical direction. When it supports a mass of 10 kg, the spring is compressed by 2.0 cm. The maximum principal stress in the spring wire is 20 MPa and maximum shear

stress is 10 MPa. Find the maximum value of the deflection and the stresses when the same mass is allowed to freely fall and strike the spring.

- (c) A bar of length 1.5 m, cross sectional area 20 cm² and mass 30 kg is hanging in vertical direction. A force of 200 N is applied at the free end of bar. Using Castigliano's theorem, determine the elongation in the bar due to the force and self weight of the bar.

2. Attempt any **two** of the following : (10×2=20)

- (a) A 20 mm diameter shaft of length 500 mm is fixed at one end. A torque, T is applied at its free end. The linear strain at surface of shaft at an angle of 45° from the axis is 4.0×10^{-3} . Determine :

- (i) Torque
- (ii) Angle of twist and
- (iii) Shear stress in the shaft.

Take $E = 2.0 \times 10^{11}$ and $G = 8.0 \times 10^{10}$.

- (b) A fixed beam of length 2.0 m carries a concentrated load of 10 kN at its mid span. Determine the reaction and bending moment at the support and deflection at the mid span. Flexural stiffness of the beam is 2.0×10^7 Nm².
- (c) A 100 mm × 150 mm wooden bar is to be symmetrically loaded with two equal forces, P as shown in Fig.1. Determine the position of loads and their magnitude when a bending stress of 10 MPa and shearing stress of 2.5 MPa are just reached. Neglect the weight of the beam.

3. Attempt any two of the following : (10×2=20)

(a) A closed coiled helical spring made of 10 mm diameter steel bar has 8 coils of 150 mm mean diameter. Calculate the elongation, torsional stress and strain energy/unit volume when the spring is subjected to an axial load of 130 N. Take $G=80$ GPa. If instead of axial load, an axial torque of 9 Nm is applied, find the axial twist, bending stress and strain energy/volume. Take $E=200$ GPa.

(b) A 5 m long hollow column with fixed ends supports an axial load of 800 kN. The external diameter of the column is 240 mm. Determine the thickness of the column using Rankine's formula. Given that $a=1/6400$ and working stress of 80 MPa.

(c) Explain the term core of a section with reference to short columns. Derive an expression for finding out the core of a rectangular section.

4. Attempt any two of the following : (10×2=20)

(a) A thin spherical vessel having diameter of 1.50 m is of uniform thickness. It is filled with water at a gauge pressure of 2.0 MPa. A relief valve attached to the vessel is opened and water is allowed to escape until the pressure falls to atmospheric. If the volume of the water escaped is 4 litre, find thickness of the plate of the vessel. Bulk modulus of water is 2 GPa and Young's modulus of vessel material is 200 GPa and Poisson's ratio is 0.30.

- (b) A thick cylinder of 160 mm internal 240 mm external diameter is subjected to an external pressure 12 MPa. Determine the maximum internal pressure that can be applied if the maximum allowable normal stress is 36 MPa. Plot the variation of radial and hoop stresses.
- (c) Derive expressions for radial and hoop stresses in a thick cylinder with internal and external radii of a and b subjected to an internal pressure of p_i .

5. Attempt any **two** of the following : (10×2=20)

- (a) A simply supported I section beam of span 2 m carries a concentrated load of 4.0 kN at an angle of 20° from vertical as shown in Fig.2. The load passes through CG of the section. Determine the maximum bending stress in the beam.
- (b) A steel ring made of a rod of circular cross-section is pulled by a force of 8.0 kN. The mean diameter of the ring is 160.0 mm. Determine the increase diameter along the load. Take $E=200$ GPa.
- (c) An open ring has T section as shown in the Fig.3. Determine the stress at points P and Q.

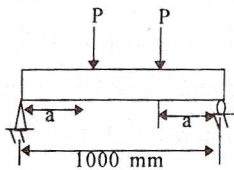


Fig.1

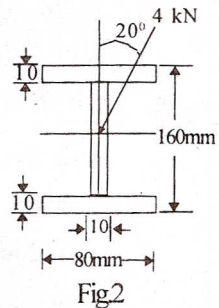
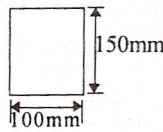


Fig.2

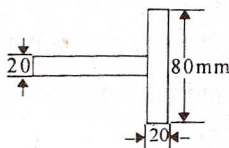
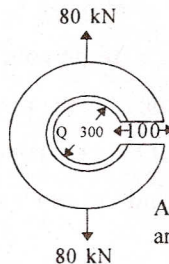


Fig.3



All dimensions are in mm