C 40942 (Pages : 2) Name.....

Reg. No.....

# FOURTH SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION APRIL 2013

## ME 09 403/PTME 09 402—MECHANICS OF SOLIDS

(2009 Scheme)

[Regular / Improvement / Supplementary]

Time : Three Hours Maximum : 70 Marks

### Part A

*Answer* **all** *questions.*

1. Show that the volumetric strain of a body is the algebraic sum of the linear strains in three mutually perpendicular directions.
2. Derive an expression for the shear stress produced in a circular shaft subjected to torsion.
3. State the assumptions involved in the theory of simple bending.
4. Define and explain principal planes and principal stresses.
5. Write the assumptions made in Euler's theory of columns. Also mention its limitations.

(5 × 2 = 10 marks)



### Part B

*Answer any* **four** *questions.*

1. Define stress, strain and elasticity. Derive a relation between stress and strain of an elastic body.
2. Show that the volumetric strain of a body is the algebraic sum of the linear strains in three mutually perpendicular directions.
3. Derive an expression for the shear stress produced in a circular shaft which is subjected to torsion. What are the assumptions made in the above derivation ?
4. The maximum shear stress experienced by a shaft of diameter 70 mm is 70 MPa. Compute shear stress at a point where the radius of 35 mm.
5. Explain Maximum principal strain theory, Maximum strain energy theory of failure that governs the design of a stressed system.
6. Derive the Eulers formula for a column hinged at both ends.

(4 × 5 = 20 marks)

### Part C

1. Three bars made of Copper, Zinc and Aluminum are equal length and have cross-sectional areas of 400, 800 and 1200 $mm^2$ respectively. They are rigidly connected at their ends. If compound member is subjected to a longitudinal pull of 350 kN, estimate the proportion of load carried by each bar and induced stresses. Take elastic moduli of Copper, Zinc and Aluminum to be $1.2 \times 105$ $N/mm^2$ $1.0 \times 105$ $N/mm^2$ and $0.89 \times 105$ $N/mm^2$ respectively.

*Or*

Turn over

2. The modulus of rigidity of a material is $0.8 \times 105$ N/mm$^2$. When a 6 mm × 6 mm rod of this material was subjected to an axial pull of 3600 N it was found that the lateral dimension of the rod changed to 5.9991 mm × 5.9991 mm. Find the Poisson's ratio and the modulus of elasticity.

3. A solid circular shaft transmits 75 KW at 200 r.p.m. Calculate the shaft diameter if the twist in the shaft is not exceed 10 in 2 metres length of shaft and the shearing stress is limited to 50 N/mm$^2$. Take C = $1 \times 10^5$ N/mm$^2$.

*Or*

4. Draw shear force bending moment diagrams for the cantilever beam shown in Fig. 1.

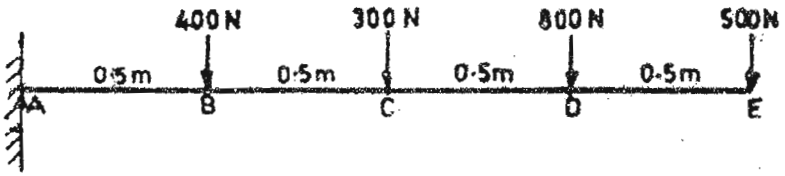


Fig. 1.

5. Two wooden planks 150 mm × 50 mm each are connected to form a T-section of a beam. If the movement of 3.4 kNm is applied around the horizontal neutral axis, inducing tension below the neutral axis, find the stresses at the extreme fibers of the cross-section. Also calculate the total tensile force on the cross-section.

*Or*

6. A steel girder of uniform section, 14 metres long is simply supported at its ends. It carries concentrated loads of 90 kN and 60 kN at two points 3 metres and 24.5 meters from the two ends respectively. Calculate :

   (a) The deflection of girder at the points under the two loads ;

   (b) The maximum deflection

   Take E = 200 GN/m$^2$.

7. The A rectangular block of material is subjected to a tensile stress of 100 N/mm$^2$ on a one plane and a tensile stress of 50 N/mm$^2$ on a plane at right angles, together with shear stresses of 60pa on the same planes.

   Find :

   (a) The direction of the principal planes

   (b) The magnitude of the principal stress.

   (c) The magnitude of the greatest shear stress.

*Or*

8. A column with one end hinged and other end fixed has a length of 5 m. and a hollow circular cross-section of outer diameter 100 mm. and wall thickness 10 mm. If E = $1.6 \times 105$ N/mm$^2$. and crushing strength $f$ = 350 N/mm$^2$, find the load that the column may carry with a factor of safety of 2.5 according to Euler theory and Rankine-Gordon theory. Take $\alpha$ = 1/4500.

(4 × 10 = 40 marks)