CBCS SCHEME

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18AU34

Third Semester B.E. Degree Examination, June/July 2025
Mechanics of Materials

Time: 3 hrs. Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Module-1

1 a. Define the following :
i) Stress ii) Strain iii) Hooke's law iv) Factor of safety v) Elasticity. **(10 Marks)**

b. Derive the expression for elongation in taper round bar of length 'ℓ' tapering uniformly for diameter 'd_1' to 'd_2' and subjected to an axial load of 'F'. Modulus of elasticity is 'E'. **(10 Marks)**

OR

2 a. Derive relation between Young's modulus 'E' and rigidity modulus 'G'. **(10 Marks)**

b. A bar of 20 mm diameter is subjected to a pull of 50 kN. The measured extension on gauge length of 250 mm is 0.12 mm and change in diameter is 0.00375 mm. Determine :
i) Young's modulus ii) Poisson's ratio iii) Bulk modulus iv) Modulus of rigidity. **(10 Marks)**

Module-2

3 a. Derive an expression for normal and shear stresses on an oblique plane inclined at 'θ' with vertical axis (x-plane) in a biaxial system subjected to stresses σ_x and σ_y on mutually perpendicular axes. **(10 Marks)**

b. An element is subjected to principal tensile stresses across two perpendicular planes as shown in Fig Q3(b). Determine normal stress, shear stress and resultant stress on the plane EC. Determine also its obliquity. What will be the intensity of stress which is acting alone will produce the same maximum strain if Poisson's ratio is 0.33.

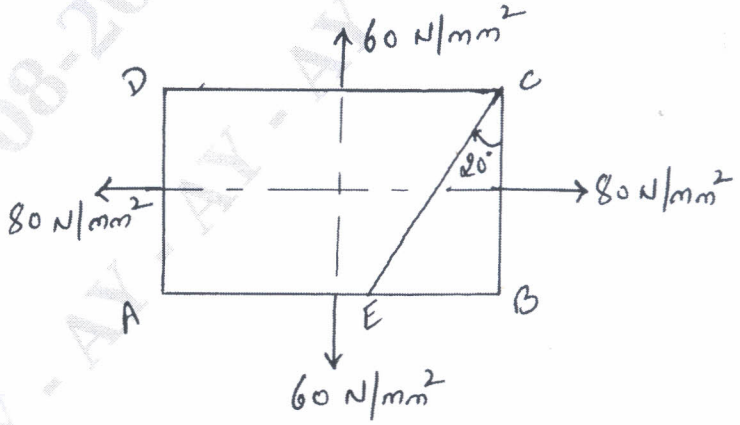

Fig Q3(b) **(10 Marks)**

OR

4 a. Derive expression for circumferential and longitudinal stresses for a thin cylinder of diameter 'd' length 'ℓ' and thickness 't' subject to internal pressure 'p'. **(10 Marks)**

b. A thin cylinder shell 1 m in diameter and 3 m long has a metal thickness of 10 mm. It is subjected to an internal fluid pressure of 3 MPa. Determine :

i) Circumferential and longitudinal stress
ii) Circumferential, longitudinal and volumetric strain
iii) Change in length, diameter and volume.

Also find the maximum shearing stress in the shell. Assume Poisson's ratio as 0.3 and E = 210 GPa. **(10 Marks)**

Module-3

5 a. Discuss the following :

i) Types of beams
ii) Types of loads
iii) Types of supports and reactions. **(10 Marks)**

b. A cantilever beam carries UDL and point loads as shown in Fig Q5(b). Find the reactions at the fixed end and draw the SFD and BMD.

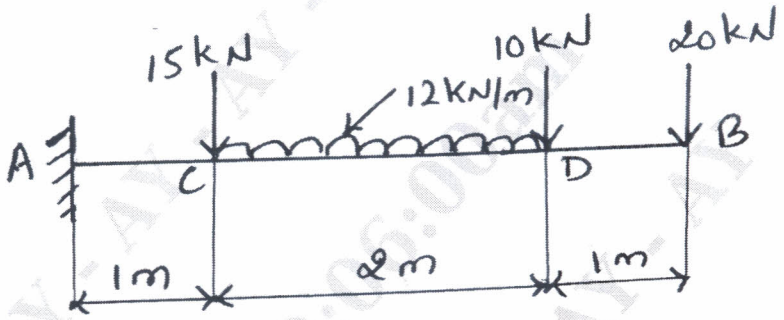

Fig Q5(b) **(10 Marks)**

OR

6 a. Derive the equation of bending $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$. **(10 Marks)**

b. A cast iron test beam 25 mm × 25 mm cross –section and 1 m long, supported at its ends fail when a central load at 800 N is applied on it. What UDL will break a cantilever of the same material 50 mm wide, 100 mm deep and 2 m long? **(10 Marks)**

Module-4

7 a. Derive the equation of torsion $\frac{T}{J} = \frac{\tau}{r} = G\theta/\ell$. **(10 Marks)**

b. Determine the diameter of the solid shaft which will transmit 440 kW at 280 rpm, if maximum torsinal shear stress is to be limited to 40 N/mm^2. Assume G = 84 kN/mm^2. **(10 Marks)**

OR

8 a. Derive an expression for Euler's crippling load for a column when both ends are fixed. **(10 Marks)**

b. Find the Euler's crippling load for a hollow cylindrical steel column of 40 mm external diameter and 4 mm thick. The length of the column is 2.5 m and is hinged at both ends. Also compute the Rankine's crippling load using constants 335 MPa and 1/7500. Take E = 205 GPa. **(10 Marks)**

Module-5

9 a. Derive an expression for strain energy stored in a body when the axial load is applied with an impact. **(10 Marks)**

b. A tensile load of 50 kN is gradually applied to a circular bar of 50 mm diameter and 4 m long. It the value of $E = 2 \times 10^5$ N/mm^2, determine :

i) Stress induced in the rod
ii) Deformation of the rod
iii) Strain energy absorbed by the rod. **(10 Marks)**

OR

10 a. Write a note on :

i) Maximum principal stress theory
ii) Maximum shear stress theory **(10 Marks)**

b. A plate of 45C8 steel (σ_{yt} = 353 MPa) is subjected to the following stresses. σ_x = 150 N/mm^2, σ_y = 100 N/mm^2 and τ_{xy} = 50 N/mm^2. Find the factor of safety by

i) Maximum principal stress theory
ii) Maximum shear stress theory. **(10 Marks)**

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