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B. E. (Third Semester) Examination, April-May 2021

(Old Scheme)

(Mech. Engg. Branch)

MECHANICS of SOLIDS-I

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Attempt all questions. Part (a) of each question is compulsory and carrying 2 marks each and attempt any* ***two*** *parts from (b), (c) and (d) of question no. 1 and any one part from (b) and (c) of question no. 2, 3, 4 and 5.*

Unit-I

1. (a) Define Poisson's ratio. 2

(b) A steel rod of length 4 m and diameter 200 mm is being stayed between two plates at a temperature of 20°C. Make calculations for the force enerted by the rod after it has been heated to 60°C. 7

(i) When the plate donot yield

(ii) When the yielding at two ends is 1 mm.

Take $\alpha_s = 12 \times 10^{-6}$ /°C and $E_s = 2 \times 10^5$ N/mm^2.

(c) A straight bar 450 mm long is 10 mm in diameter for the first 200 mm length and 20 mm in diameter for the remaining length. If the bar is subjected to an axial push of 10 kN, determine decrease in length of the bar.

Take modulus of elasticity of bar material.

$E = 2 \times 10^5$ N/mm^2. 7

(d) Derive an expression for the Young's modulus, modulus of rigidity and Poisson's ratio. 7

Unit-II

2. (a) Define neutral plance and neutral axis. 2

(b) Prove that : 14

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

where, M = moment of resistance, I = moment of inertia of the section about N. A., σ = Bending

stress, E = Young's modulus and R = Radius of curvature of neutral axis.

(c) An I-section steel beam is simply supported at its both ends and carries a uniformly distributed load over the entire span of 2 m. The beam has the following dimensions. Flanges : 180 mm × 60 mm; Web = 240 mm × 60 mm.

If the maximum shear stress is not to exceed 40 MN/m^2 and maximum bending stress in compression and tension is limited to 80 MN/m^2, calculate the intensity of uniformly distributed load per meter length. 14

Unit-III

3. (a) Define deflection and slope of a beam when it is loaded. 2

(b) Determine the slope and deflection at the end B of the prismatic cantilever beam when it is loaded by 90 kN-m anticlockwise couple and a 50 kN point load at the free end. The span length of the beam is 3 m and its flexural rigidity EI is 10^4 kN/m^2. 14

(c) A beam 4 m long is freely supported at the ends. It

carries concentrated loads of 20 kN each at points 1 m from the ends. 14

Calculate :

(i) Maximum slope and deflection of the beam

(ii) Slope and deflection under each load

Use Macaulay's method and Take EI = 13000 kN-m^2

Unit-IV

4. (a) Define torsional rigidity. 2

(b) Derive the Torsion equation : 14

$$\frac{T}{J}=\frac{Z}{R}=\frac{W}{l}$$

Where the symbols have the usual meanings. State clearly the assumptions involved.

(c) A close-coiled helical spring has coil diameter to wire diameter ratio of 6. The spring deflects 3 cm under an axial load of 500 N and the maximum shear stress is not to exceed 300 MPa. Find the diameter and length of the spring wire required. Shearing modulus of wire material = 80 GPa. 14

Unit-V

5. (a) Define the term oblizuity. 2

(b) A plane element in a body is subjected to a normal stress of 15 kN/m^2 (tensile) in the n-direction as well as a shearing stress of 5 kN/m^2 (clockwise a long perpendicular to x-axis). Draw Mohr's circle to determine :

(i) Normal and shearing stress intensitis on a plane inclined at an angle of 40° to the normal stress.

(ii) Principal stresses and their direction

(iii) Maximum sharing stress.

(c) Determine the magnitude of principal stresses and maximum shearing stress and direction of planes carrying these stresses.

Also find the resultant stress on plane BC. 14