CBCS SCHEME

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17ME34

Third Semester B.E. Degree Examination, Feb./Mar. 2022
Mechanics of Materials

Time: 3 hrs. Max. Marks: 100

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

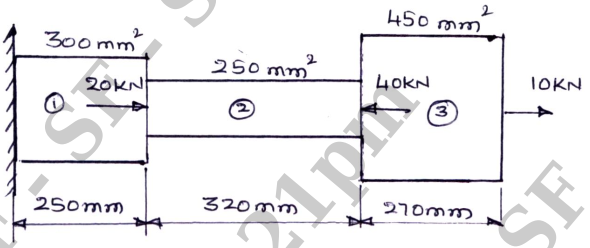
Module-1

1 a. State and explain Hooke's Law. **(02 Marks)**

b. A circular rod of length 'L' has its cross – section varying linearly from larger end diameter 'd_1' to smaller end diameter 'd_2' is subjected to an axial pull 'F'. Derive an expression for an extension of the rod. **(07 Marks)**

c. A stepped bar with three different portions has a fixed portion at one of its ends. The stepped bar is subjected to forces as shown in Fig. Q1(c). Determine the stresses and deformations induced in each portion. Also find the net deformation induced in the stepped bar. Take E = 200 GPa. **(11 Marks)**

Fig. Q1(c)



OR

2 a. Establish a relationship between Modulus of Elasticity (E), Modulus of Rigidity (G) and Poisson's ratio (γ). **(10 Marks)**

b. A compound bar is made of a central steel plate 60mm wide and 10mm thick to which copper plates 40mm wide by 5mm thick are connected rigidly on each side. The length of the bar at normal temperature is 1 meter. If the temperature is raised by 80°C, determine the stresses in each materials and the change in length. Take E_S = 200GPa , E_C = 100GPa , $\alpha_S = 12 \times 10^{-6}$/°C , $\alpha_C = 17 \times 10^{-6}$/°C. **(10 Marks)**

Module-2

3 a. Derive expressions for Normal and Tangential stresses on an inclined plane in a body under biaxial direct stress condition. **(06 Marks)**

b. A point in a body is subjected to tensile stresses 100MPa and 70MPa along two mutually perpendicular directions. The point is also subjected to shear stress of magnitude 50MPa. Determine i) Normal stress and shear stress acting on a plane which is at an angle of 120° with reference to the 100MPa stress plane.
ii) Magnitude of principal stresses and maximum and minimum shear stresses.
iii) Orientations of principal planes and maximum and minimum shear stress planes.
iv) Normal stress on the planes of maximum and minimum shear stresses.
v) Sketch the planes. **(14 Marks)**

OR

4 a. Stating the assumptions made, derive Lame's equations for thick cylinders. **(10 Marks)**

b. A cylindrical pressure vessel of 3m long and is having 1m internal diameter and 15mm thickness. Calculate the maximum intensity of shear stress induced and also the changes in the dimensions of the cylinder if it is subjected to an internal fluid pressure of $1.5 N/mm^2$. Take $E = 2 \times 10^5 N/mm^2$ and Poisson's ratio $\gamma = 0.3$. **(10 Marks)**

Module-3

5 a. Establish a relationship between load intensity shear force and bending moment in a beam. **(04 Marks)**

b. Draw the shear force and bending moment diagrams for the beam loaded as shown in Fig. Q5(b). Locate the point of contra flexure if any. **(16 Marks)**

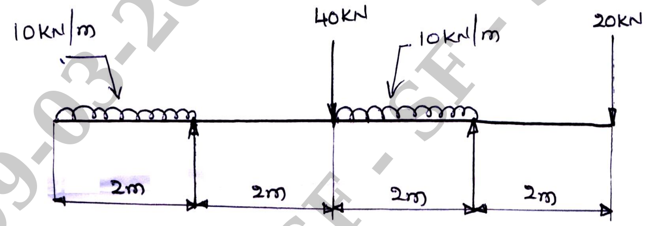


Fig. Q5(b)

OR

6 a. Stating the assumptions made, derive bending equation $\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$ with usual notations. **(10 Marks)**

b. A simply supported beam of span 5m has a cross – section 150mm × 250mm. If the permissible stress is $10 N/mm^2$, find

i) Maximum intensity of uniformly distributed load it can carry.

ii) Maximum concentrated load P applied at 2m from one end it can carry. **(10 Marks)**

Module-4

7 a. Determine the diameter of solid shaft which will transmit 440KW at 280 rpm. The angle of twist must not exceed one degree per meter length and the maximum torsional shear stress is to be limited to $40 N/mm^2$. Take $G = 84 KN/mm^2$. **(08 Marks)**

b. A solid shaft transmits 250KW at 100 rpm. If the shear stress is not to exceed $75 N/mm^2$, what should be the diameter of the shaft? If this shaft is to be replaced by a hollow one whose internal diameter = 0.6 times outer diameter. Determine the size and the percentage saving in weight, the maximum shear stress being the same. **(12 Marks)**

OR

8 a. Derive an expression for Euler's Buckling load in a column with one end fixed and other end free. State the assumptions made in Euler's theory of columns. **(10 Marks)**

b. A hollow cast iron column whose outside diameter is 200mm and has a thickness of 20mm is 4.5m long and is fixed at both ends. Calculate the safe load by Rankine's formulae using a factor of safety of 2.5. Find the ratio of Euler's to Rankine's load. Take $E = 1 \times 10^5 N/mm^2$ and Rankine's constant = $\frac{1}{1600}$ for both ends pinned case and $\sigma_C = 550 N/mm^2$. **(10 Marks)**

Module-5

9 a. State and prove Castigliano's theorem II. **(08 Marks)**

b. Derive an expression for Strain energy due to torsion in shafts. **(04 Marks)**

c. A bar with circular cross – section as shown in Fig. Q9(c) is subjected to a load of 10KN. Determine the strain energy in the bar. Take E = 2.1×10^5 N/mm^2. **(08 Marks)**

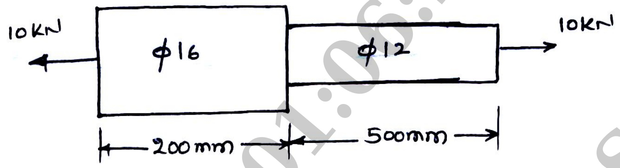


Fig. Q9(c)

OR

10 a. State the following theories of failure :
i) Maximum Principal Stress theory ii) Maximum Shear Stress theory. **(06 Marks)**

b. A bolt is subjected to an axial pull of 12KN together with a transverse shear force of 6KN. Determine the diameter of the bolt by using
i) Maximum Principal Stress theory ii) Maximum Shear Stress theory.
Take Elastic Limit in tension = 300N/mm^2 , Factor of safety = 3. **(14 Marks)**

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