CBCS SCHEME

USN | | | | | | | | | | |

18ME32

Third Semester B.E. Degree Examination, July/August 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. Define the following :
i) True stress ii) Resilience iii) Ductility iv) Toughness. **(04 Marks)**

b. Derive the expression for the extension of uniformly tapering circular rod subjected to axial load. **(08 Marks)**

c. A steel bar ABCD 4mt long subjected to forces as shown in Fig. Q1(c). Find the elongation of bar. Take E for the steel as 200 GPa. **(08 Marks)**

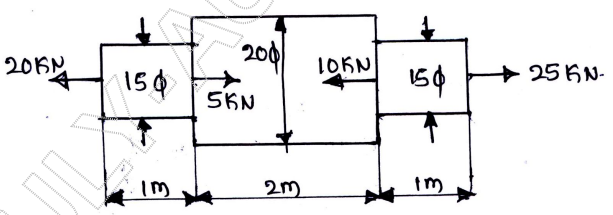

Fig. Q1(c)

OR

2 a. Define the following : i) Poisson's Ratio ii) Young's Modulus
iii) Modulus of Rigidity iv) Bulk modulus. **(04 Marks)**

b. A bar of 20mm diameter is tested in tension. It is observed that when a load of 37.7 KN is applied. The extension measured over a gauge length of 200mm is 0.12mm and contraction in diameter is 0.0036mm. Find Poisson's ratio and elastic constant E, G and K. **(08 Marks)**

c. A composite bar is rigidly fitted at the supports A and B as shown in Fig. Q2(c). Determine the reactions at the supports when the temperature rises by 20°C. Take E_a = 70 GN/m^2 , E_s = 200GN/m^2 , $\alpha_a = 11 \times 10^{-6}$/°C and $\alpha_s = 12 \times 10^{-6}$/°C. **(08 Marks)**

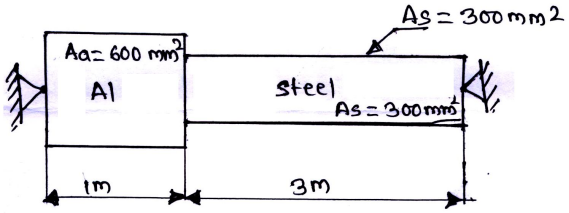

Fig. Q2(c)

Module-2

3 The state of stress in a two dimensionally stressed body is as shown in Fig. Q3. Determine the Principal planes , Principal stress , Maximum shear stress and their planes Analytically and Validate answer by graphically (using Mohr's circle). **(20 Marks)**

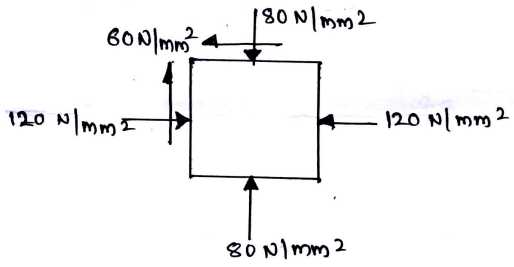

Fig. Q3

OR

4 a. Derive the expression for circumferential and radial stresses in the wall of thick cylinder [Lame's equation] with assumptions made. **(10 Marks)**

b. A thin cylindrical vessel made of steel plates 4mm thick with plane ends, carries fluid under pressure of $3N/mm^2$. The diameter of cylinder is 25cms and the length is 75cms. Calculate the longitudinal and hoop stresses in the cylinder wall and determine the change in diameter, length and volume of the cylinder. Take $E = 2.1 \times 10^5$ N/mm^2 and $1/m = 0.286$. **(10 Marks)**

Module-3

5 a. Explain different types of loads in beams. **(04 Marks)**

b. For the beam as shown in Fig. Q4(b). Determine the magnitude of load 'P' acting at point C, such that the reactions at supports A & B are equal. Draw shear force and bending moment diagram for the beam. Mark the silent points and their values on the diagram. Locate the point of contra flexure if any. **(16 Marks)**

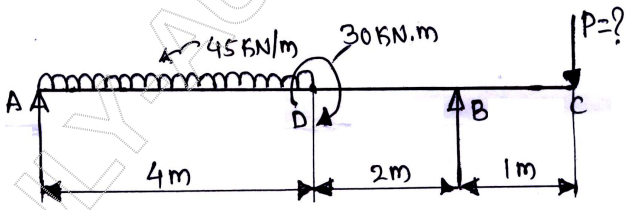

Fig. Q4(b)

OR

6 a. Derive the relation $\frac{M}{I} = \frac{\sigma b}{Y} = \frac{E}{R}$ with usual notations and list the basic assumptions. **(10 Marks)**

b. A rolled steel joint of I – Section used as simply supported beam has the following dimensions : Flange (250×25)mm , Web – 15mm thick , Overall depth – 50mm. If this beam carries a UDL of 50kN/m on a span of 4m, calculate the maximum stress produced due to bending. **(10 Marks)**

Module-4

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

b. A shaft is required to transmic 245 KW power at 240 rpm. The maximum torque may be 1.5 times the mean torque. The shear stress in the shaft should not exceed $40N/mm^2$ and the twist 1° per meter length. Determine the diameter required, if i) the shaft is solid
ii) the shaft is hollow with external diameter twice the internal diameter.
Take modulus of rigidity = $80KN/mm^2$. **(10 Marks)**

OR

8 a. List all assumptions and derive the torsional formula in standard form
$\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$. **(10 Marks)**

b. In a plate of C45 steel (σ_{yt} = 353 Mpa) subjected to a system of loads, following stresses are induced at critical point : $\sigma_x = 150$ N/mm^2 , $\sigma_y = 100N/mm^2$ and $\tau_{xy} = 50N/mm^2$. Check wheather there is failure according to i) Maximum Principal Stress theory.
ii) Maximum shear stress theory. If the material is safe, find the factor of safety as per both theories. **(10 Marks)**

Module-5

9 a. Derive the expression for strain energy due to shear. **(07 Marks)**

b. Define : i) Strain energy ii) Resilience iii) Proof Resilience iv) Modulus of Resilience. **(04 Marks)**

c. A 2m long pin ended column of square cross section is to be made up of wood. Assuming E = 12GPa and allowable stress being limited to 12MPa. Determine the size of the column to support the following load safety. i) 95 KN ii) 200 KN. Use factor of safety of 3 and Euler's crippling loads for buckling. **(09 Marks)**

OR

10 a. Derive an expression for critical load in a column subjected to compressive load, when one end is fixed and other end is free. **(10 Marks)**

b. Derive the expression for strain energy due to impact load for axial load applications. **(10 Marks)**

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