CBCS SCHEME

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17ME34

Third Semester B.E. Degree Examination, Dec.2023/Jan.2024
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. Draw the Stress – Strain curve for a typical ductile and brittle material indicating salient points on them. **(05 Marks)**

b. A solid truncated conical bar of circular cross – section tapers uniformly over a entire length from diameter "D" at its one end to diameter "d" at the other end. Derive the expression for change in length when the bar is subjected to axial force "P" applied at each end. **(07 Marks)**

c. The following results were obtained in a tensile test on Chromium – Vanadium steel specimen of original diameter 2cm and a gauge length of 4cm. At the limit of proportionality, the load was 80kN and the extension measured was 0.054mm. The maximum load withstand by the specimen was 143 kN. When the two parts were fitted together after being broken at a load of 139kN, the length between the gauge points was found to be 6.03cm and the diameter at the neck was 1.72cm. Calculate Young's modulus , Maximum stress and True braking stress. Also calculate the percentage of Elongation and Contraction. **(08 Marks)**

OR

2 a. Explain the reason for the development of stress in bars, when their temperature rises or falls. Accordingly calculate the nature and magnitude of stress induced in the rod of 2.5m length and 25mm diameter, when its temp rises by 77°C with the both ends of the rod are fixed. Assume E = 210 GPa and $\alpha = 12.6 \times 10^{-6}$ / °C. **(06 Marks)**

b. Define Composite Bars. How will you find the stresses and load carried by each member of a composite bar? **(06 Marks)**

c. The diameter of a specimen is found to reduce by 0.0045mm, when it is subjected to a tensile force of 18kN. The initial diameter of the specimen is 20mm. Taking modulus of rigidity for the material of specimen as 45 GPa, determine the value of Young's modulus and Poisson's ratio. **(08 Marks)**

Module-2

3 a. Define Principal Stresses and Principal Planes in the general two – dimensional stress system. **(04 Marks)**

b. Derive the expression for normal and shear stress on an oblique plane which is inclined at an angle 'θ' with respect to plane of σ_x. **(08 Marks)**

c. The state of stress at a point in a general two – dimensional stress system is as shown in Fig. Q3(c). Determine i) Principal stresses and their planes ii) Maximum shear stresses and their planes. **(08 Marks)**

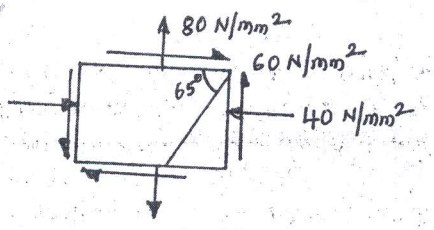


Fig. Q3(c)

OR

4 a. Define Thin Cylinders. Name the stresses developed in a thin cylinder subjected to internal fluid pressure. **(04 Marks)**

b. A thin cylinder of diameter "d", thickness "t" is subjected to an internal pressure 'P'. Prove that the change in volume, $\Delta V = \frac{Pd}{4tE}(5-4\mu).V$, where E = Young's modulus of elasticity, μ = Poisson's ratio and V = Volume of the cylinder. **(08 Marks)**

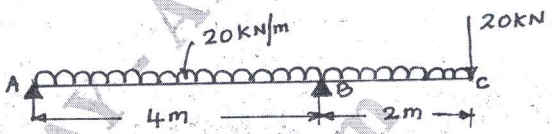
c. A thick pipe with internal diameter 400mm is to carry a fluid at a pressure of 13MPa. If the maximum stress in the material of the pipe is restricted to 150MPa, calculate the minimum thickness of the pipe required. Plot the variation of radial and circumferential stresses across the thickness of the wall of the pipe. **(08 Marks)**

Module-3

5 a. Explain the terms : i) Sagging bending moment ii) Hogging bending moment iii) Point of Contra flexure. **(06 Marks)**

b. Draw the shear force and bending moment diagram for the loaded beam as shown in Fig. Q5(b). Locate the point of contra flexure if any. **(14 Marks)**

Fig. Q5(b)



OR

6 a. Prove that $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$ with usual notations. **(08 Marks)**

b. Prove that the maximum transverse shear stress is 1.5 times the average shear stress in a beam of a rectangular cross section. **(06 Marks)**

c. Show that for a simply supported beam of length "L" subjected to uniformly distributed load of intensity P_o N/m over a entire span, the maximum deflection is $\frac{5}{384}\frac{P_o L^4}{EI}$. **(06 Marks)**

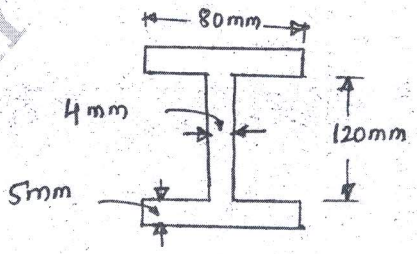
Module-4

7 a. Define Polar Modulus. Find the expression for Polar modulus of a solid circular shaft. **(04 Marks)**

b. A hollow stress shaft 3m long must transmit a torque of 36 kN-m. The total angle of twist in this length is not to exceed 2.5° and allowable shearing stress is limited to 90MPa. Determine inside and outside diameter of the shaft, if G = 79 GPa and $d_i = 0.6\ d_o$. **(10 Marks)**

c. An I – Section as shown in Fig. Q7(c), subjected to a torque 'T', find the maximum value of 'T' if the shear stress is limited to 35N/mm^2 and the angle of twist per meter length to 6°. Assume G = 83GPa. **(06 Marks)**

Fig. Q7(c)



OR

8 a. Distinguish between : i) Buckling and Crushing ii) Long and short columns. **(06 Marks)**

b. Derive the expression for Euler's crippling load for a column with one end is fixed and the other free. **(06 Marks)**

c. Compute the ratio of crippling loads of Euler's and Rankin's for an axially loaded tubular column 3m long with both ends are hinged. The inner diameter of the column is 50mm and has a thickness of 20mm. Assume E = 200GPa and Crushing strength limited to 335 MPa. Take Rankine's constant = $\frac{1}{7200}$. **(08 Marks)**

Module-5

9 a. State and prove First theorem of Castigliano. **(10 Marks)**

b. Derive an expression for elastic strain energy stored in a circular shaft under torsion. **(06 Marks)**

c. The shear stress in a material at a point is 55 N/mm^2. Determine the strain energy stores in a material due to shear stress. Assume G = 80 GPa. **(04 Marks)**

OR

10 a. What do you understand by the term "Theories of Failure"? State and explain maximum principal stress theory of failure. **(08 Marks)**

b. A mild steel shaft of 90mm diameter subjected to a torque of 84 kN – m and a bending moment of 50kN – m. The shaft material has a yield stress of 370 MPa in simple tension. Determine the failure of the material will occur or not according to maximum shear stress theory. If not then find the factor of safety. **(12 Marks)**

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