CBCS SCHEME

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18MR34

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. Define :
i) Poisson's ratio
ii) Modulus of Rigidity
iii) Bulk Modulus
iv) Factor of safety. **(04 Marks)**

b. Derive an expression for the extension of a tapering bar whose diameter d_2 at one end tapers linearly to a diameters d_2 at the other end in a length L. Under an axial pull P and the elastic modulus of its material is E. **(08 Marks)**

c. A brass bar having cross sectional area 300mm^2 is subjected to axial forces as shown in Fig.Q1(c). Find the elongation of the bar when E = 84GPa.

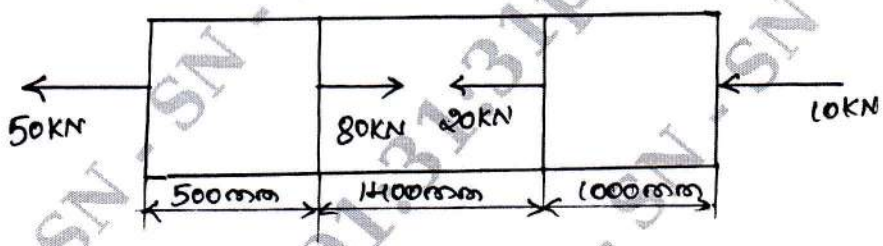

Fig.Q1(c) **(08 Marks)**

OR

2 a. Explain volumetric strain and obtain expression for volumetric strain for a circular bar. **(05 Marks)**

b. Establish a relationship between the modulus of elasticity and modulus of rigidity. **(07 Marks)**

c. A steel rail is lead so that there is no stress in the rails at 10°C. The maximum temperature expected is 45°C. Find :
i) Minimum gap between 2 rails to be left so that temperature stresses do not develop if the length of each rail 30m.
ii) Stress developed in the rails at the maximum temperature if there is no allowance for expansion
iii) Stress developed in the rails at the maximum if there is an expansion allowance of 7.5mm/rail
iv) Maximum temperature to have no stress in the rails if he expansion allowance is 15mm/rail
v) If the stress developed is 20N/mm^2. What is the gap between the rails at the maximum temperature? Take E = 2×10^5N/mm^2 and $\alpha = 12 \times 10^{-6}$/°C. **(08 Marks)**

Module-2

3 Stress acting on the strained material is as shown in Fig.Q3. Determine :
i) Normal stress
ii) Shear stress
iii) Resultant stress
iv) Principal stresses and their location
v) Maximum shear stress and its location
Verify the results graphically.

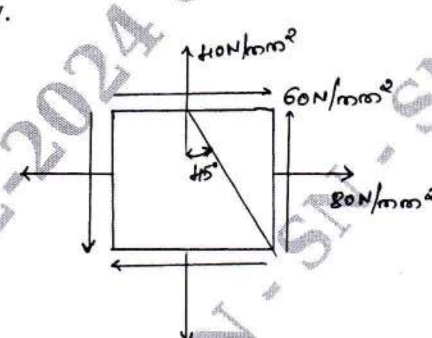

Fig.Q3 **(20 Marks)**

OR

4 a. A thin cylinder of diameter d, thickness t, is subjected to an internal pressure of p. Prove that the change in volume, $dv = \frac{pd}{4^{TE}}(5-4\mu)v$. Where E = Young's modulus, μ = Poisson's ratio and v = volume of the cylinder. **(08 Marks)**

b. A pipe of 400mm of internal diameter and 100mm thickness contains a fluid pressure $80N/mm^2$. Find the maximum and minimum hoop stresses across the section. Also sketch the radial and hoop stress distribution across the section. **(12 Marks)**

Module-3

5 a. Explain shear force and bending moment. **(04 Marks)**

b. Draw shear force and bending moment diagram for the beam shown in Fig.Q5(b).

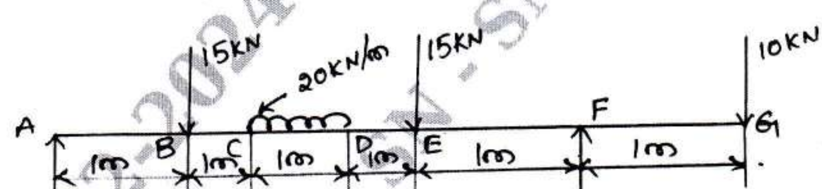

Fig.Q5(b) **(16 Marks)**

OR

6 a. What are the different types of loads acting on a beam? Explain with sketches. **(08 Marks)**

b. A simply supported beam AB of 6m span is loaded as show in Fig.Q6(b). Draw SFD and BMD.

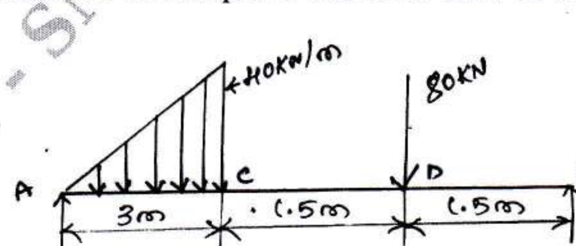

Fig.Q6(b) **(12 Marks)**

Module-4

7 a. Prove the relations $\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$ with usual notations. **(10 Marks)**

b. A cast iron beam has an I – section with top flange 80mm × 40mm, web 120mm × 20mm and bottom flange 160mm × 40mm. If tensile stress is not to exceed $30N/mm^2$ and compressive stress $90N/mm^2$, what is the maximum uniformly distributed load the beam can carry over a simply supported span of 6m if the larger flange is in tension? **(10 Marks)**

OR

8 a. Derive differential equation for deflection with usual notations. **(10 Marks)**

b. Find the deflection at C in the beam loaded as shown in Fig.Q5(b). Take EI = $10,000kN\text{-}m^2$.

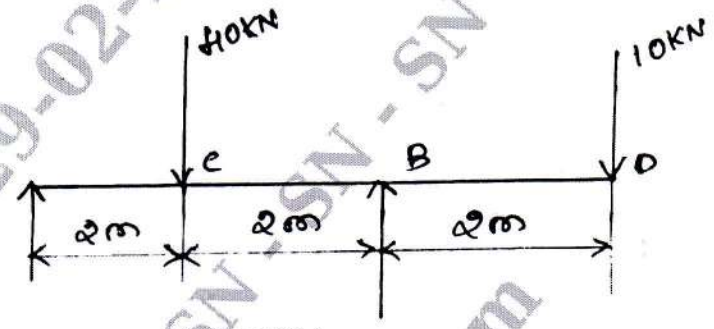

Fig.Q8(b) **(10 Marks)**

Module-5

9 a. A shaft is required to transmit 245KW power at 240rpm. The maximum torque may be 1.5 times the mean torque. The shear stress in the shaft should not exceed $40N/mm^2$ and twist 1°/m length. Determine the diameter required if a shaft is solid and shaft is hollow with external diameter twice the internal diameter. G = $80kN/mm^2$. **(10 Marks)**

b. A brass tube of external diameter 80mm and internal diameter 50mm is closely fitted to a steel rod of 50mm diameterto form a composite shaft. If a torque of 6kN is to be resisted by this shaft. Find the maximum stresses developed in each material and angle to twist in 2m length. $G_B = 40 \times 10^3 N/mm^2$ and $G_S = 80 \times 10^3 N/mm^2$. **(10 Marks)**

OR

10 a. Derive an expression for the critical load in a column subjected to compressive load, when both the ends are hinged, also mention the assumptions made in the derivation. **(10 Marks)**

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

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