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10AU/ME34

Third Semester B.E. Degree Examination, Dec.2018/Jan.2019
Mechanics of Materials

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. Missing data if any may be suitably assumed.

PART – A

1 a. Define (i) Modulus of elasticity (ii) Strength and ductility (iii) Nominal stress and True stress. Mention S.I. Units. **(05 Marks)**

b. Derive relation for elongation of a metallic bar, held vertically with length L, cross-sectional area A and specific weight 'w'. **(05 Marks)**

c. A stepped bar is subjected to axial forces as shown in Fig. Q1 (c). Determine total deformation in the bar and stresses induced in each part. $E = 2\times10^5$ N/mm^2.

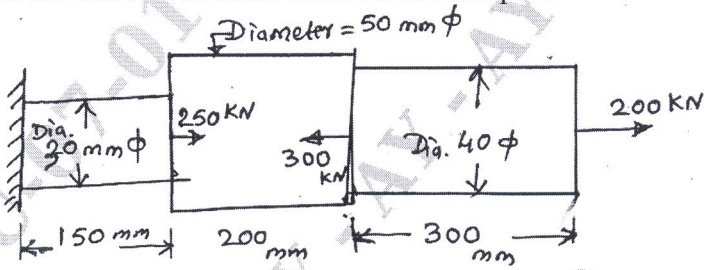

Fig. Q1 (c)

Find also percentage elongation of the stepped bar. **(10 Marks)**

2 a. A metallic bar, 500 mm long, 40 mm wide and 30 mm thick is subjected to 120 KN Tensile load along length 600 KN compressive load along thickness and 480 KN Tensile load along width of bar. Determine the following : (i) Change in volume (ii) Modulus of Rigidity (iii) Bulk modulus. Assume E = 150 GN/m^2 and $\frac{1}{m} = 0.30$. **(10 Marks)**

b. Define thermal stress and thermal strain. A copper tube of 30 mm external diameter and 20 mm internal diameter encloses a steel rod of 15 mm diameter. The ends are rigidly fastened to each other. Determine the stresses induced in tube and rod when the temperature increases from 25°C to 175°C. Calculate the thermal strain if length of assembly is 500 mm. Assume $E_S = 200$ GPa, $E_{Cu} = 100$ GPa, $\alpha_S = 12\times10^{-6}/^\circ C$, $\alpha_{Cu} = 18\times10^{-6}/^\circ C$. **(10 Marks)**

3 a. Define principal stresses and principal planes. Explain construction of Mohr's circle for analysis of stresses acting on a component. **(08 Marks)**

b. The state of stress at a point in a strained material is as shown in Fig Q3(b).

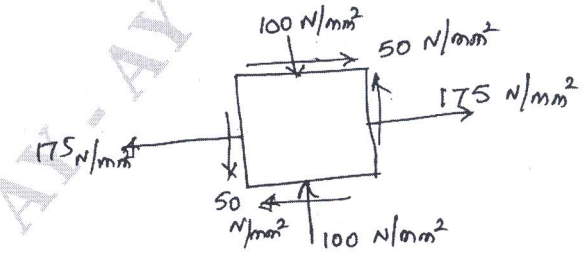

Fig. Q3 (b)

Determine (i) Direction and magnitude of principal planes and stresses.
(ii) The magnitude of maximum shear stress and its direction.
Sketch all planes. **(12 Marks)**

4 a. Define work and strain energy. **(04 Marks)**

b. Differentiate between thick and thin cylinders. Obtain relation between circumferential and longitudinal stress for thin cylinder with interal fluid pressure 'P'. **(06 Marks)**

c. A thick cylinder with internal diameter 300 mm and thickness 50 mm is subjected to an external pressure of 30 MN/m^2, when the internal pressure is 120 MN/m^2. Determine the stresses at external and internal surfaces of the cylinder and sketch the variation of stresses and radial pressure along thickness of the cylinder. **(10 Marks)**

PART – B

5 a. Define a beam and list the types of beams with sketches. **(04 Marks)**

b. Define shear force and bending moment, with sketches and sign conventions. **(04 Marks)**

c. Draw SF and BM diagrams for the loading on the beam. Determine the maximum bending moment and show the point of contraflexure, if overhang of beam is 2 meters in length. Find reactions at supports A and B. **(12 Marks)**

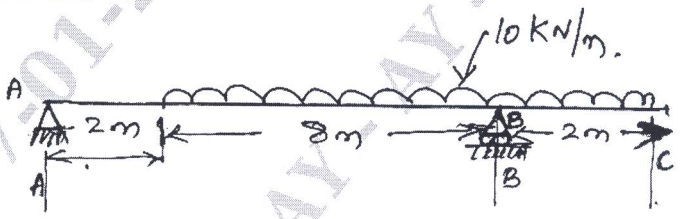

Fig. Q5 (c)

6 a. What are assumptions made in simple bending theory? Show that the maximum transverse shear stress in a beam is 1.5 times the average shear stress in a beam of rectangular cross section. **(10 Marks)**

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

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

(ii) The maximum point load P, applied at 2 m from one end it can carry. **(10 Marks)**

7 a. Derive an expression for maximum deflection of a Cantilever beam carrying a point load at its free end. **(08 Marks)**

b. A simply supported beam of span 10 m carries two concentrated loads 20 KN at 3 m and 40 KN at 6 m from left end support. Calculate the maximum deflection.
Take $E = 2 \times 10^5$ N/mm^2, $I = 2 \times 10^8$ mm^4. **(12 Marks)**

8 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. List the assumptions made in Torsion theory. A circular shaft transmits 210 KW of power at 180 rpm. Total angle of twist in a length of 3 m of shaft is 3°. Find the diameter of the shaft if the permissible shear stress is 60 N/mm^2. Take G = 84 GPa **(10 Marks)**

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