CBCS SCHEME

USN

15ME/MA34

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

Mechanics of Materials

Time: 3 hrs. Max. Marks: 80

Note:* 1. *Answer any FIVE full questions, choosing ONE full question from each module.
2. *Missing data may be suitably assumed.*

Module-1

1 a. Define : (i) Hooke's law (ii) Lateral strain (iii) Poisson's ratio **(03 Marks)**

b. Derive an expression for the extension of uniformly tapering rectangular bar subjected to axial load P. **(05 Marks)**

c. A steel bar ABCD of varying sections is subjected to the axial forces as shown in Fig. Q1 (c). Find the value of P necessary for equilibrium. If E = 210 KN/mm^2, determine (i) Stresses in various segments and (ii) Total elongation of the bar. **(08 Marks)**

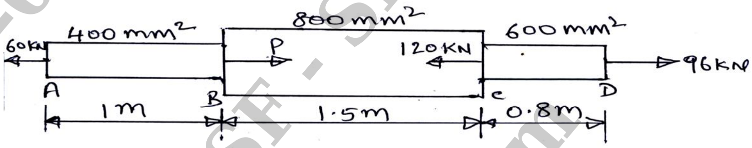

Fig. Q1 (c)

OR

2 a. Define (i) Modulus of elasticity (ii) Modulus of rigidity and (iii) Bulk modulus. **(03 Marks)**

b. Establish the relationship between Young's modulus and rigidity modulus. **(05 Marks)**

c. A bar of brass 25 mm diameter is enclosed in a steel tube of 50 mm external diameter and 25 mm internal diameter. The bar and the tube are both initially 1.5 m long and are rigidly fastened at both ends using 20 mm diameter pins. Find the stresses in the two materials when the temperature rises from 30°C to 100°C. Take E for steel = 200 KN/mm^2, E for brass = 100 KN/mm^2, α for steel = $11.6\times10^{-6}/^\circ C$ and α for brass = $18.7\times10^{-6}/^\circ C$. Find also shear stress induced in the pins. **(08 Marks)**

Module-2

3 a. Derive the expression for resultant stress on a oblique plane inclined at an angle θ with vertical axis in a biaxial direct stress system. **(06 Marks)**

b. The state of stress at a point in a strained material is as shown in Fig. Q3 (b). Determine (i) the direction of the principal planes (ii) The magnitude of principal stresses and (iii) Magnitude of the maximum shear stress. **(10 Marks)**

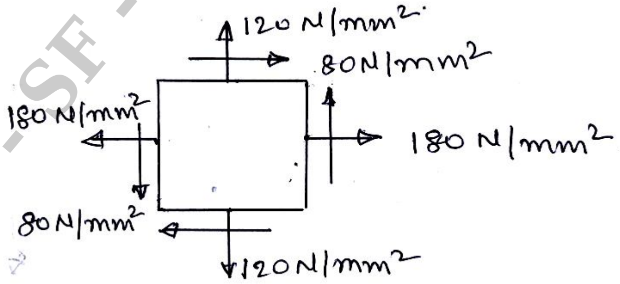

Fig. Q3 (b)

OR

4 a. Prove that volumetric strain in thin cylinder is given by $\frac{Pd}{4tE}(5-4\mu)$, with usual notations. **(06 Marks)**

b. A pipe of 400 mm internal diameter and 100 mm thickness contains a fluid at a pressure 80 N/mm^2. Find the maximum and minimum hoop stresses across the section. Also sketch the radial and hoop stress distribution across the section. **(10 Marks)**

Module-3

5 a. What are the different types of loads acting on a beam? Explain with sketches. **(06 Marks)**

b. The simply supported beam shown in Fig. Q5 (b) carries two concentrated loads and uniformly distributed load. Draw SFD and BMD. **(10 Marks)**

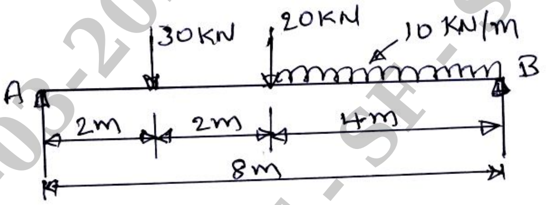

Fig. Q5 (b)

OR

6 a. Enumerate the assumptions made in the theory of simple bending. **(06 Marks)**

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

Module-4

7 a. Prove that a hollow shaft is stronger that the solid shaft of the same material, length and weight. **(06 Marks)**

b. The working condition to be satisfied by a shaft transmitting power are, (i) the shaft must not twist more than 1° in a length of 15 times diameter (ii) The shear stress must not exceed 80 MN/m^2. What is the actual working stress and diameter of the shaft to transmit 736 KW at 200 rpm? Take shear modulus as 80 GN/m^2. **(10 Marks)**

OR

8 a. Define slenderness ratio and derive Euler's expression for buckling load for column with both ends hinged. **(06 Marks)**

b. A built up I-section has an overall depth of 400 mm is as shown in Fig. Q8 (b). It is used as a beam with simply supported ends and it deflects by 10 mm when subjected to a load of 40 kN/m length. Find the safe load if this I-section is used as a column with both ends hinged. Use Euler's formula. Assume a factor of safety 1.75 and take $E = 2\times10^5$ N/mm^2. **(10 Marks)**

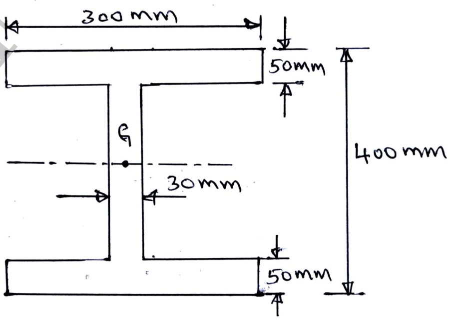

Fig. Q8 (b)

Module-5

9 a. Derive an expression for strain energy, when member subjected to bending. **(06 Marks)**

b. The maximum stress produced by a pull in a bar of length 1 m is 150 N/mm^2. The area of the cross sections and length are shown in Fig. Q9 (b). Calculate the strain energy stored in the bar of $E = 2\times10^5$ N/mm^2. **(10 Marks)**

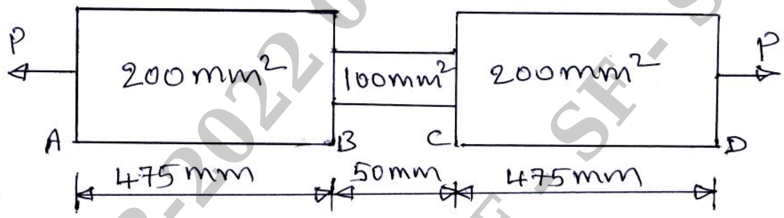

Fig. Q9 (b)

OR

10 a. Explain : (i) Maximum principal stress theory (ii) Maximum shear stress theory. **(06 Marks)**

b. At a section of a mild steel shaft, the maximum torque is 8437.5 N-m and maximum bending moment is 5062.5 N-m. The diameter of the shaft is 90 mm and the stress at the elastic limit in simple tension for the material of the shaft is 220 N/mm^2. Determine whether the failure of the material will occur or not according to the maximum shear stress theory. If not find the factor of safety. **(10 Marks)**

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