CBCS SCHEME

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18AU34

Third Semester B.E. Degree Examination, June/July 2023
Mechanics of Material

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) Hooke's law ii) Poisson's ratio **(04 Marks)**

b. Derive an expression for the total elongation of a tappered circular bar cross section of diameter 'D' and'd'. When subjected to an axial load 'P' and the elastic modulus of its material is E. **(08 Marks)**

c. A Stepped bar of steel, held between two supports as shown in Fig Q1(c) is subjected load P_1 = 80 kN and P_2 = 60kN. Find the reaction developed at the end A and B.

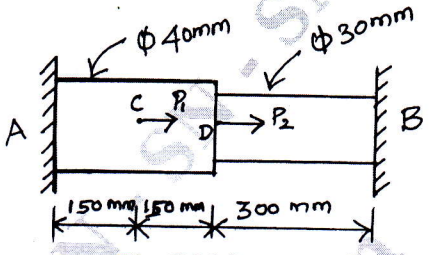

Fig Q1(c) **(08 Marks)**

OR

2 a. A steel tube of 50mm outer diameter and 10mm thick is fitted into a copper tube of inner diameter 50mm and 100mm thick. They are connected by using 20mm diameter pins at the ends. If the length of the compound bar is 600mm. Find the stresses produced in the tubes and pins when the temperature is raised by 25°C. Given
$\alpha_s = 12 \times 10^{-6}$ per °C ; $\alpha_c = 17.5 \times 10^{-6}$ per °C
$E_s = 2 \times 10^5$ N/mm^2 ; $E_c = 1.2 \times 10^5$ N/mm^2 **(10 Marks)**

b. Establish a relationship between the modulus of elasticity and modulus of rigidity. **(10 Marks)**

Module-2

3 a. Derive an expression for the normal stress and shear stress on plane inclined at 'θ to the vertical axis in two dimensional stress system with shear. Also prove that the sum of normal stresses on any two mutually perpendicular planes are always constant. **(10 Marks)**

b. At a certain point in a strained material the valves of normal stresses across two planes at right angle to each other are 80MPa and 32MPa both tensile and there is a shear stress of 32MPa clockwise on the plane carrying 80MPa stresses across the planes as shown in Fig Q3(b). Determine :
i) maximum and minimum normal stress ii) maximum shear stress

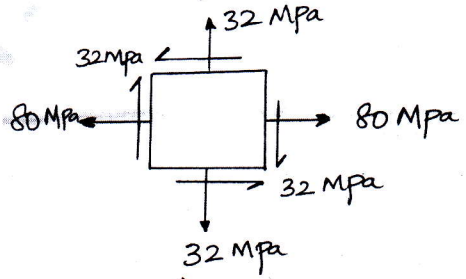

Fig Q3(b) **(10 Marks)**

OR

4 a. Differentiate between thin and thick cylinders. **(04 Marks)**

b. Derive an expression fro circumferential stress and longitudinal stress for a thin cylinder subjected to an external pressure 'P'. **(06 Marks)**

c. A thick cylindrical pipe of outside diameter 300mm and internal diameter 200mm is subjected to an internal fluid pressure of $20N/mm^2$ and external fluid pressure of $5N/mmm^2$. Determine the maximum hoop stress developed. Also sketch the radial and hoop stress distribution across the section. **(10 Marks)**

Module-3

5 Draw the shear force and bending moment diagram for a overhanging beam as shown in Fig Q5, also locate the point of contraflexure.

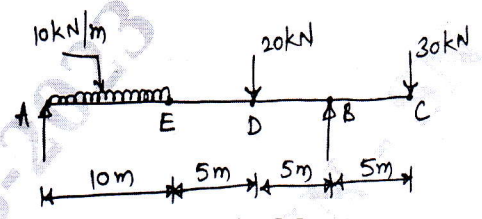

Fig Q5 **(20 Marks)**

OR

6 a. Draw shear force and Bending movement diagram for :

i) Cantilever beam with point load at free end ii) Cantilever beam with UDL

iii) Cantilever beam with UVL **(10 Marks)**

b. Explain different types of loads beams and support with neat sketches. **(10 Marks)**

Module-4

7 a. Derive torsional equation. **(10 Marks)**

b. A solid shaft is subjected to a maximum torque 25kN/m. Find a suitable diameter of a solid shaft, if the allowable shear stress and the twist are limited to $80N/mm^2$ and 1° respectively for a length of 20 times the diameter of the shaft (G = 80GPA) **(10 Marks)**

OR

8 a. Derive Euler's Buckling load formula for pin-end condition. **(10 Marks)**

b. A steel bar of rectangular cross section 30 × 50mm pinned at each end is 2m long. Determine the buckling load when it is subjected to axial compression and also calculate axial stress using Euler's expression. Determine the minimum length for which Euler's may be valid Take proportionality limit as 250MPa and E = 200GPa. **(10 Marks)**

Module-5

9 a. Explain Castigliano's theorem I and II. **(10 Marks)**

b. A load of 200N Falls through a height of 25mm on to a collar rigidly attached to the lower end of a vertical bar 2m long and $300mm^2$ cross sectional area. The upper end and the vertical bar if fixed.

i) Maximum instantaneous stress ii) Maximum instantaneous elongation

iii) Strain energy stoned in the vertical rod

Take E = 200 GPa. **(10 Marks)**

OR

10 a. Explain maximum principal stress theory and maximum shear stress theory. **(10 Marks)**

b. A bolt is subjected to an axial pull of 12kN together with transverse shear fore of 6kN. Determine diameter of the bolt using :

i) Maximum principal stress theory ii) Maximum shear stress theory

Take elastic limit in Tension = 300 MPa

Factor of safety = 3 **(10 Marks)**