CBCS SCHEME

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17AU34

Third Semester B.E. Degree Examination, Jan./Feb. 2023
Mechanics of Materials

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

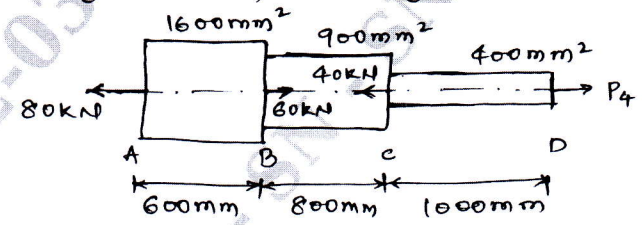
Module-1

1 a. Define Hooke's law, modulus of elasticity, poisson ratio and strain. **(04 Marks)**

b. Derive an expression for the total extension of the tapered circular bar cross-section of diameter D and d, when it is subjected to an axial pull of load P. **(06 Marks)**

c. A steel bar ABCD varying sections is subjected to the axial forces as shown in Fig.Q.1(c). Find the value of P4 necessary for equilibrium. If $E = 2 \times 10^5 N/mm^2$. Determine:
i) Stresses in various segments ii) Total elongation of bar. **(10 Marks)**

Fig.Q.1(c)



OR

2 a. Derive the relationship between Young's modulus and modulus of rigidity in the form of $E = 9GK/3K+G$. **(10 Marks)**

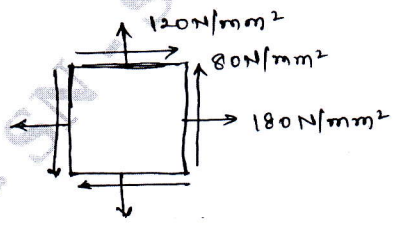
b. A compound bar is made of a central steel plate 60mm wide and 10mm thick to which copper plates 40mm wide by 5mm thick are connected rigidity on each side. The length of the bar at normal temperature is 1 meter. If the temperature is raised by 80°C. Determine the stresses in each metal and the charge in length. Take $E_s = 200GN/m^2$, $\alpha_s = 12 \times 10^{-6}/°C$, $E_c = 100GN/m^2$, $\alpha_c = 17 \times 10^{-6}/°C$. **(10 Marks)**

Module-2

3 a. What are principal stresses and principal planes? **(04 Marks)**

b. For the state of stress shown in Fig.Q.3(b), determine:
i) The direction of principal planes.
ii) The magnitude of principal stresses.
iii) The magnitude of the maximum shear stress and its direction. Indicate all the above planes by a sketch. Also draw the Mohr's circle for the above stress state. **(16 Marks)**

Fig.Q.3(b)



OR

4 a. Derive an expression for circumferential and longitudinal stress for thin cylinder. **(08 Marks)**

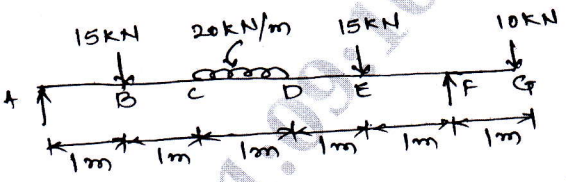
b. A thick cylinder of external and internal diameters of 300mm and 180mm is subjected to an internal pressure of $42N/mm^2$ and external pressure $6N/mm^2$. Determine the stresses in material. Now if the external pressure is doubled, what internal pressure can be maintained without exceeding the previously determined maximum stress? **(12 Marks)**

Module-3

5 a. Define shear force, bending moment and point of contra flexure. **(04 Marks)**

b. Draw the bending moment and shear force diagram for the beam loaded as shown in Fig.Q.5(b). **(16 Marks)**

Fig.Q.5(b)



OR

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

b. A simply supported beam has a span of 4m and a rectangular cross-section 100mm × 200mm. Find the uniformly distributed load it can carry, if the maximum bending stress and maximum shear stress are not to exceed $10N/mm^2$ and $0.6N/mm^2$ respectively. **(10 Marks)**

Module-4

7 a. Derive the relation for a circular shaft when subjected to torsion. Also list out the assumption made while driving the relation. **(08 Marks)**

b. 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 the twist 1° per meter length. Determine the diameter required if

i) The shaft is solid.

ii) The shaft is hollow with external diameter twice the internal diameter. Take $G = 80kN/mm^2$. **(12 Marks)**

OR

8 a. Derive an expression for Euler's buckling load in a column when both ends are fixed. **(10 Marks)**

b. A 2m long pin ended column of square cross-section is to be made of wood. Assuming E = 12GPa and allowable stress being limited to 12MPa, determine the size of the column to support the following load safety. i) 95kN ii) 200kN. Use factor of safety of 3 and Euler's crippling load for buckling. **(10 Marks)**

Module-5

9 a. Define the following: i) Modulus of Resilience ii) Strain energy. **(04 Marks)**

b. Derive an expression for strain energy stored in a body applied with a gradually applied load. **(08 Marks)**

c. Calculate the strain energy stored in a bar 2m long, 50mm wide and 40mm thick, when it is subjected to a tensile load of 60kN. Take E = 200GPa. **(08 Marks)**

OR

10 a. Write a short on maximum distortion energy theory. **(08 Marks)**

b. A solid circular shaft is subjected to a bending moment of 40kN-m and a torque of 10kN-m. Design a diameter of the shaft according to,

i) Maximum principal stress theory.

ii) Maximum shear stress theory.

iii) Maximum strain energy theory.

Take $\mu = 0.25$, stress at elastic limit = $200N/mm^2$, Factor of safety = 2. **(12 Marks)**

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