U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

September / October 2023 Semester End Main Examinations

Programme: B.E. **Semester: III**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 22ME3PCSOM/19ME3DCSOM/15ME3DCSOM **Max Marks: 100**
Course: Strength of Materials

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may suitably be assumed.

UNIT - I

1 a) Derive the expression that relates modulus of elasticity to bulk modulus. **05**

b) If a tension test bar is found to taper uniformly from (D – a) mm diameter to (D + a) mm diameter, determine the percentage error involved in using the mean diameter to calculate the Young's modulus from the experiment. **07**

c) A 400 mm long bar has rectangular cross-section 10 mm × 30 mm. This bar is subjected to (i) 15 kN tensile force on 10 mm × 30 mm faces, (ii) 80 kN compressive force on 10 mm × 400 mm faces, and (iii) 180 kN tensile force on 30 mm × 400 mm faces. Determine the change in volume if $E = 2 \times 10^5$ N/mm^2 and $\nu = 0.3$. **08**

OR

2 a) A steel tube 45 mm external diameter and 3 mm thick encloses centrally a solid copper bar of 30 mm diameter. The bar and the tube are rigidly connected together at ends at a temperature of 30˚ C. Find the stress in each metal when heated to 180˚ C. Given: $\alpha_s = 1.08\times10^{-5}$ /˚C, $\alpha_c = 1.7\times10^{-5}$ /˚C, E_s = 210 GPa and E_c = 110 GPa. **06**

b) A member is subjected to direct stresses in two mutually perpendicular directions. Derive expressions for normal & tangential stresses on a plane inclined arbitrarily within the member. **08**

c) State of stress at a point in a material is as shown in the Fig. 2(c). Determine (i) principal stresses in both magnitude and direction. (ii) maximum shear stress in both magnitude and direction. **06**

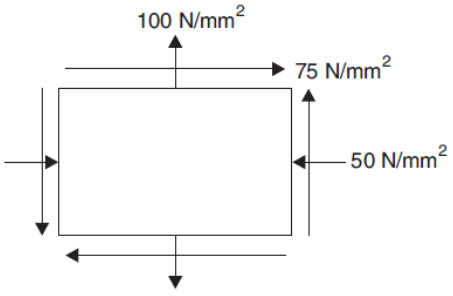

Fig. 2(c)

UNIT - II

3 a) Sketch indicative diagrams for shear force and bending moment variations in a cantilever beam for the following types of loads: (i) concentrated load, (ii) UVL & (iii) externally applied moment. **06**

b) A 14-m long simply supported beam with an overhang at the right end is loaded as shown in the Fig. 3(b). Draw SFD & BMD for the beam and determine point of contraflexure (if any). **14**

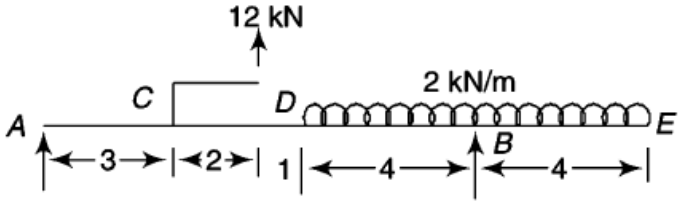

Fig. 3(b)

UNIT - III

4 a) Derive the flexure equation for a beam subjected to pure bending. **08**

b) A 320 mm x 160 mm I section beam has 20 mm thick flanges and a 15 mm thick web. At a certain cross-section, it is acted upon by a bending moment of 100 kN.m and a shear force of 200 kN. Plot the variations of bending and shear stresses along the section of the beam. **12**

OR

5 a) A cantilever beam is subjected to a point load at its free-end. Using double-integration method, derive expressions for slope and maximum deflection at the free-end. **08**

b) A simply supported beam has its supports 8 m apart at A & B. It carries a UDL of 6 kN/m between A & B starting at 1 m and ending at 5 m from A. The end B of the beam has an overhang of 1 m and at the free end, a concentrated load of 8 kN is applied. Determine the maximum deflection between A & B, given, $E = 2.1 \times 10^5$ N/mm^2 and $I = 2 \times 10^7$ mm^4. **12**

UNIT - IV

6 a) State all the assumptions made in torsion theory. Write the torsion equation and describe all the terms involved in that equation. **06**

b) A solid steel shaft transmits 100 kW at 150 rpm. Determine the suitable diameter of the shaft if the maximum torque exceeds the mean torque by 20% in each revolution. The shear stress is not to exceed 60 MPa. Also, find the maximum angle of twist in a length of 4 m of the shaft. Take G = 80 GPa. **06**

c) What percentage of strength of a solid circular steel shaft 100 mm diameter is lost by boring an axial hole of 50 mm diameter in it? Compare the strength and weight ratio of the two cases? **08**

UNIT - V

7 a) Wall thickness of a cylindrical shell of 800 mm internal diameter and 2 m long is 10 mm. if the shell is subjected to an internal pressure of 1.5 MPa, determine the following: (i) maximum intensity of shear stress induced & (ii) change in dimensions of the shell. Take E = 205 GPa & $\nu = 0.3$. **05**

b) A thick cylinder has inner and outer diameters as 120 mm and 180 mm respectively. It is subjected to an external pressure of 9 MPa. Find the value of internal pressure which can be applied if the maximum stress is not to exceed 30 MPa. Draw the curves showing the variation of Hoop and radial stresses through the thickness of the cylinder. **07**

c) Derive expression for Euler's crippling load for a column whose both ends are fixed. **08**

******