U.S.N.										

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

Autonomous Institute Affiliated to VTU

August 2023 Semester End Make-Up Examinations

Programme: B.E. **Semester: III**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 22ME3PCSOM/19ME3DCSOM/15ME3DCSOM **Max Marks: 100**
Course: Strength of Materials **Date: 14.08.2023**

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

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

UNIT - I

1 a) A bar of thickness t tapers uniformly from a width of b_1 at one end to b_2 at other end over a length L. Obtain the expression for the change in length of the bar if it is subjected an axial force P. Deduce this expression for a bar of uniform width. **10**

b) A plane element is subjected to stress components of $\sigma_x = 60$ MPa, $\sigma_y = -40$ MPa and $\tau = 10$ MPa. Determine the maximum shear stress. Also determine the planes of zero shear stress and the corresponding normal stresses. Illustrate with a sketch these planes and their stresses. **10**

OR

2 a) For a plane element subjected to a general two-dimensional stress system, derive the expressions for normal and tangential stress on a plane inclined at an angle of θ (CCW) to the x-plane. **08**

b) A rigid member ABC pinned at end A is connected by two bars; a steel bar CE and a copper bar BD as shown in figure Q2b. The setup is stress-free at 20°C. If the temperature of the whole assembly is raised by 40°C, find the stresses induced in steel and copper bars. **12**

	For steel bar	For copper bar
Area	400 mm^2	600 mm^2
Modulus of elasticity	2×10^5 N/mm^2	1×10^5 N/ mm^2
Coefficient of thermal expansion	12×10^{-6} °C	18×10^{-6} °C

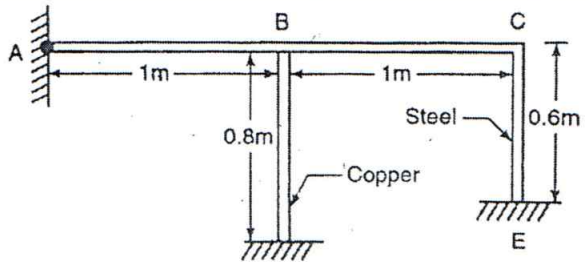

Figure Q2b

UNIT - II

3 a) A simply supported beam of length L is subjected to an external clockwise moment of magnitude M at a point, distance a from the left support. Obtain the shear force diagram and bending moment diagram for the same. Comment on the behaviour if the moment is changed to CCW. **08**

b) An overhanging beam of span 5 m is loaded as shown in figure Q3b. Draw the SFD and BMD indicating all the significant values including the point of contraflexure. **12**

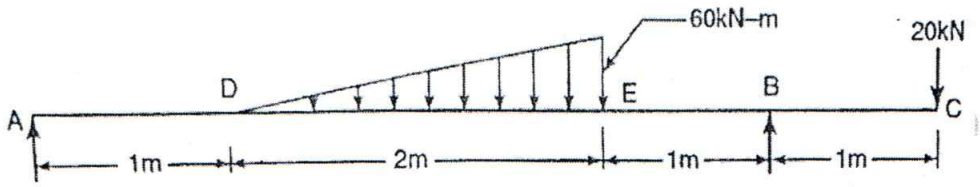

Figure Q3b

UNIT - III

4 a) With usual notations, derive the Euler-Bernoulli bending equation of the form **08**

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

b) A cast iron beam has an I-section with top flange 80 mm × 40 mm, web 120 mm × 20 mm and bottom flange 160 mm × 40 mm. If the tensile stress is not to exceed 30 MPa and compressive stress 90 MPa, what is the maximum intensity of uniformly distributed load the beam can carry if its span is 6 m and it is simply supported with larger flange in tension? **12**

OR

5 a) The following equation gives deflection of a beam of span L subjected to distributed load of intensity w. **08**

$$y = \frac{1}{EI}\left[-\frac{wL^3x}{24} + \frac{wLx^3}{12} - \frac{wx^4}{24}\right]$$

Investigate the boundary conditions and identify the type of supports of the beam and the type of load. Also obtain the maximum deflection for the same.

b) For the beam loaded as shown in figure Q5b, use Macaulay's method to obtain deflection and slope in the beam. Also compute the deflection at point C if E = 200 GPa and $I = 60 \times 10^{-6}\ m^4$. **12**

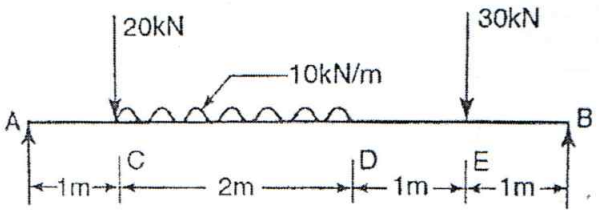

Figure Q5b

UNIT - IV

6 a) Prove that a hollow shaft is stronger and stiffer than the solid shaft of the same material, length and weight. **10**

b) A steel shaft (G = 80 GPa) is required to transmit 245 kW power at 240 rpm. The maximum torque may be 1.5 times the mean torque. The shear stress in the shaft should not exceed 40 MPa and the twist 1° per meter length. Determine the required diameter if (i) the shaft is solid. (ii) The shaft is hollow with external diameter twice the internal diameter. **10**

UNIT - V

7 a) Derive Euler's expression for buckling load in a column fixed at one and and free at other end. **10**

b) A thick cylinder of external and internal diameters of 300 mm and 180 mm is subjected to an internal pressure of 42 MPa and external pressure of 6 MPa. Determine the stresses in the material. Plot the variation of radial stress and hoop stress across the thickness. **10**

******