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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: III**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 23ME3PCSOM/22ME3PCSOM **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 be suitably assumed.

		UNIT - I	*CO*	*PO*	Marks
1	a)	A bar of thickness t tapers uniformly from a width b_1 at one end to b_2 at other end over a length L. Obtain 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.	*CO1*	*PO 1*	**10**
	b)	A plane element is subjected to stress components of σ_x = 60 MPa, σ_y = - 40 MPa and τ = 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.	*CO2*	*PO1 PO2*	**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.	*CO1*	*PO1*	**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.	*CO2*	*PO1 PO2*	**12**

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

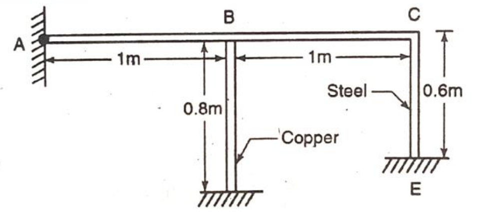
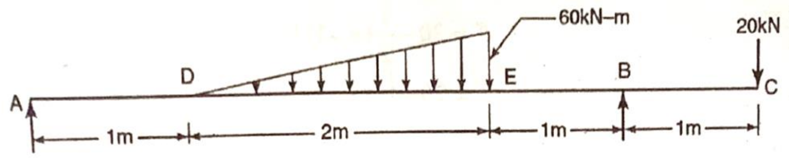
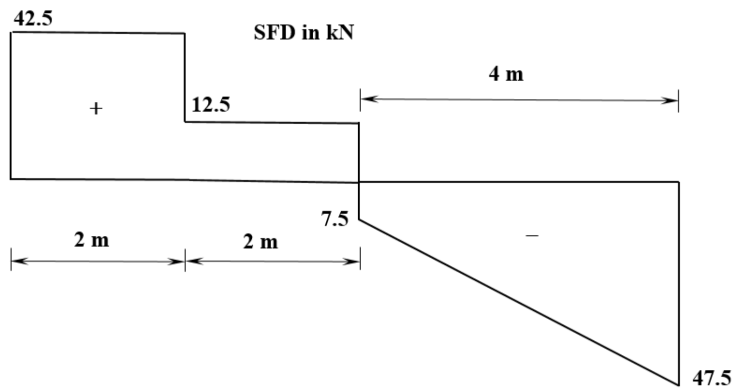


Figure Q2b

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 – II			
	3	a)	With respected to a loaded beam, define: shear force at a section, and bending moment at a section. Indicate how they are computed. With suitable illustrations, identify their sign conventions.	*CO1*	*PO1*	**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.  **Figure Q3b**	*PO2* *PO4*	*PO1* *PO2*	**12**
			OR			
	4	a)	With suitable illustrations, derive the relationship between intensity of load, shear force and bending moment in a beam subjected to arbitrary loading.	*CO1*	*PO1*	**10**
		b)	Figure Q4b indicates the SFD for a simply supported beam. Obtain the loading diagram. Also determine the BMD for the same. Comment on the point on contraflexure.  **Figure Q4b**	*PO2* *PO4*	*PO1* *PO2*	**10**
			UNIT - III			
	5	a)	With usual notations, derive the Euler-Bernoulli bending equation of the form $\frac{M}{I}=\frac{\sigma}{y}=\frac{E}{R}$ Mention the prominent assumptions made in the theory.	*CO1*	*PO1*	**10**
		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.	*CO2*	*PO1* *PO2*	**10**

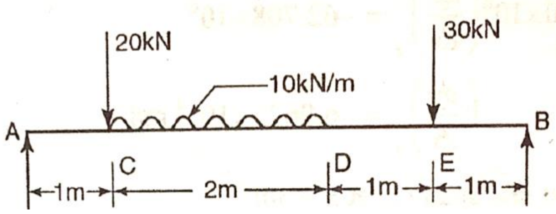


Figure Q5b

			OR			
	6	a)	For a cantilever subjected to a moment M at the free end, obtain the expression for deflection. What is the maximum deflection in the beam?	*CO1*	*PO1*	**08**
		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?	*PO2* *PO4*	*PO1* *PO2*	**12**
			UNIT - IV			
	7	a)	Prove that a hollow shaft is stronger and stiffer than the solid shaft of the same material, length and weight.	*CO3*	*PO1*	**10**
		b)	A solid transmission shaft of diameter = 200/π mm whose rotation rate is 600 rpm is to transmit an average shear load of 120 N while being driven by an electric motor. Since the motor was exposed to a dusty environment for 700 operating hours, a lot of dust particles had settled in the bearing supporting the transmission shaft. This is causing a power loss of 20 percent. Calculate the actual power transmitted, in kW, by the shaft under such conditions.	*CO2*	*PO2*	**10**
			OR			
	8	a)	List the assumptions in the theory of pure torsion. What type of stress is observed when a shaft of diameter d is twisted about its cross section? Write the torsion equation identifying the terms involved. Illustrate the stress distribution across the section of a shaft with a simple sketch if the shaft is under Pure Torsion.	*CO1*	*PO1*	**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.	*PO2* *PO3*	*PO1* *PO2*	**10**
			UNIT - V			
	9	a)	Derive Euler's expression for buckling load in a column fixed at one end and free at another end.	*CO1*	*PO1*	**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. Generate a plot of the variation of radial stress and hoop stress across the thickness.	*CO2*	*PO1* *PO2*	**10**
			OR			
	10	a)	Differentiate hoop stress and longitudinal stress in thin cylinders.	*CO1*	*PO1*	**04**
		b)	A cylindrical shell of 3000 mm length is subjected to an internal fluid pressure of 1500 kPa. Its internal perimeter is 1000π mm with a wall thickness of 15 mm. Estimate the hoop stress, longitudinal stress and maximum shear stress in MPa if the ends are riveted by flat lids.	*CO2*	*PO1* *PO2*	**06**
		c)	A cylindrical column with a length of 4 m has a diameter which is one twentieth of its length. Its shear modulus is 80 GPa and Poisson's ratio is 0.31. It is fixed to a base plate while supporting a load at the top. Calculate the slenderness ratio. Estimate the maximum load, in kN, that it can withstand without buckling considering a safety factor of 3.	*CO2*	*PO1* *PO2*	**10**

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