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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B.E. - Mechanical Engineering

Semester End Examination; August - 2023

Mechanics of Materials

Time: 3 hrs *Max. Marks: 100*

Course Outcome

The Students will be able to:

*CO1: **Classify** different types of stresses, strain and deformations induced in the mechanical components due to external loads.*

*CO2: **Estimate** thermal stresses; **calculate** principal stresses in simple 2D elements.*

*CO3: **Draw** Shear Force Diagrams and Bending Moment Diagrams for uniform beams for different types of loads and support conditions.*

*CO4: **Compute** and **analyze** bending and shear stresses and deflections induced in beams.*

*CO5: **Estimate** torsional stresses in circular shafts; **Analyze** columns under buckling load; **Analyze** perfect frames under loads.*

***Note**: I) **PART - A** is compulsory. **Two** marks for each question.*

*II) **PART - B**: Answer any **Two** sub questions (from a, b, c) for a Maximum of **18 marks** from each unit.*

Q. No.	Questions	Marks	BLs	COs	POs
	I : PART - A	**10**			
1 a.	Define Proof Resilience.	2	L1	CO1	PO1
b.	Define Principal Stresses.	2	L1	CO2	PO1
c.	Define Point of Contra flexure.	2	L1	CO3	PO1
d.	What is simple bending theory?	2	L1	CO4	PO1
e.	Define Torsional Rigidity.	2	L1	CO5	PO1
	II : PART - B	**90**			
	UNIT - I	**18**			
2 a.	Derive an expression for elongation of a tapered circular bar.	9	L2	CO1	PO1
b.	A circular steel bar having three segments is subjected to various forces at different cross sections as shown in Figure 1(c). Determine the necessary force to be applied at section C for the equilibrium of the bar. Also, find the total elongation of the bar. Take E = 202 GPa.	9	L3	CO1	PO1,2

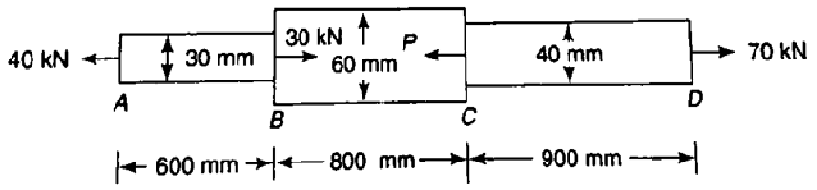

Figure 1(c)

c.	Derive the relation among modulus of elasticity, modulus of rigidity and bulk modulus.	9	L2	CO1	PO1

Contd…2

UNIT - II **18**

3 a. A compound bar of length 500 mm consists of strip of aluminium 50 mm wide x 20 mm thick and a strip of steel 50 mm wide x 15 mm thick rigidly joined at ends. If the bar is subjected to a load of 50N, find the stresses developed in each material and the extension of the bar. Take elastic modulus of aluminium and steel as $1x10^5$ N/mm^2 and $2x10^5$ N/mm^2 respectively — 9 L3 CO2 PO1,2

b. A steel tube of 50 mm outer diameter and 10 mm thick is fitted into a copper tube of inner diameter 50 mm and 10 mm thick. They are connected by using 20 mm diameter pins at the ends. If the length of compound bar is 600 mm, find the stresses produced in the tubes and pins when temperature is raised by 25°C. Take: α_s = 12 x 10^{-6} / °C, α_c = 17.5 x 10^{-6}/ °C, $E_s = 2x10^5$ N/mm^2 and E_c= 1.2 x 10^5 N/mm^2. — 9 L3 CO2 PO1,2

c. A plane element is subjected to stresses as shown in Figure 3(c). Determine principal stresses, maximum shear stress and their planes using Mohr's circle method. — 9 L3 CO2 PO1,2

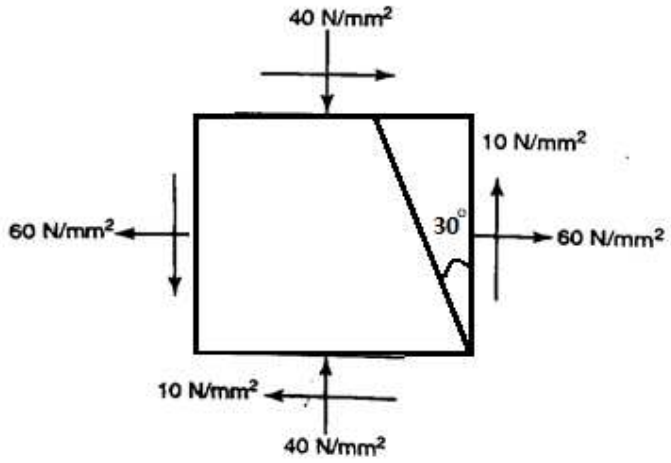

Figure 3(c)

UNIT - III **18**

4 a. Draw shear force and bending moment diagrams for the simply supported beam shown in Figure 4(a). — 9 L3 CO3 PO1,2

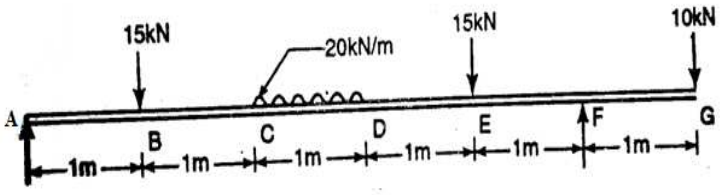

Figure 4(a)

Contd…3

b. Draw shear force and bending moment diagrams for the simply supported beam shown in Figure 4(b).

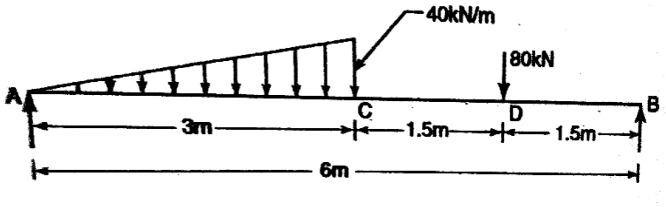

Figure 4(b)

9 L3 CO3 PO1,2

c. Draw shear force and bending moment diagrams for the cantilever beam shown in Figure 4(c).

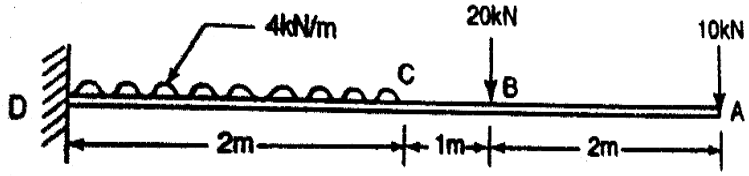

Figure 4(c)

9 L3 CO3 PO1,2

UNIT - IV **18**

5 a. Derive the relationship between bending stresses and radius of curvature in bending of beams and mention assumptions. 9 L2 CO4 PO1

b. A symmetrical I-section with flange 250 mm x 230 mm has a web 160 mm x 10 mm, if the shear force acting in the section is 80 kN. Find the maximum shear stress developed in the section and draw shear stress distribution diagram. 9 L3 CO4 PO1,PO2

c. A simply supported beam of 6 m span is subjected to a concentrated load of 18 kN at 4 m from left support. Calculate the position and the value of maximum deflection and deflection at the load point using Macaulay's method. 9 L3 CO4 PO1,2

UNIT - V **18**

6 a. Derive the torsional equation and write the assumptions made. 9 L2 CO5 PO1

b. Determine the diameter of solid shaft which will transmit 440 kW at 280 rpm. The angle of twist must not exceed one degree per meter length and the maximum torsional shear stress is to be limited to 40 N/mm^2. Assume G = 84 kN/mm^2. 9 L3 CO5 PO1,2

c. Derive the Euler's equation for critical load in a column with both ends hinged and mention the assumptions made. 9 L2 CO5 PO1

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