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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; July / August - 2022

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.*

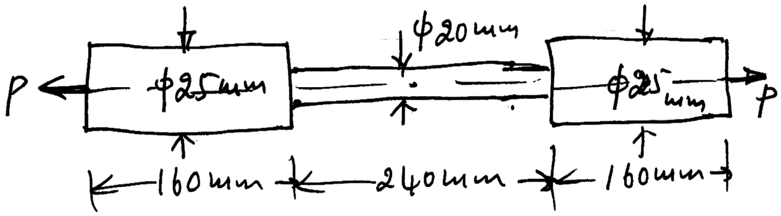
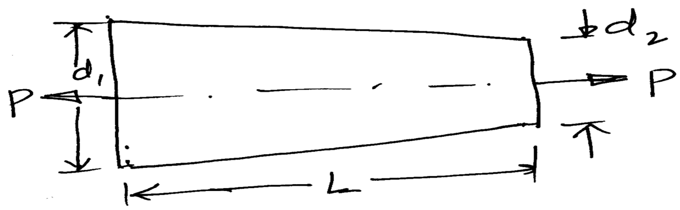
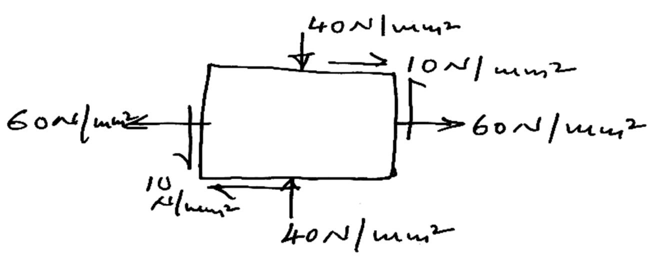
*CO3: **Draw** Shear Force Diagrams and Bending Moment Diagrams for uniform beams for different types of loads and support conditions.*

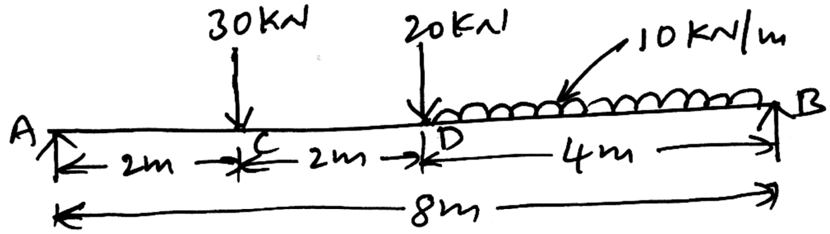
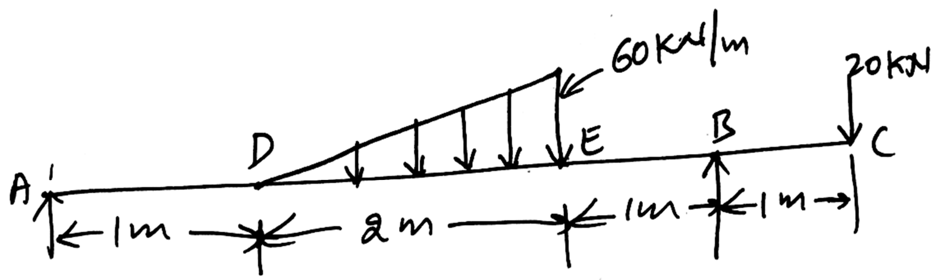
*CO4: **Compute** and **analyze** bending and shear stresses and deflections induced in beams.*

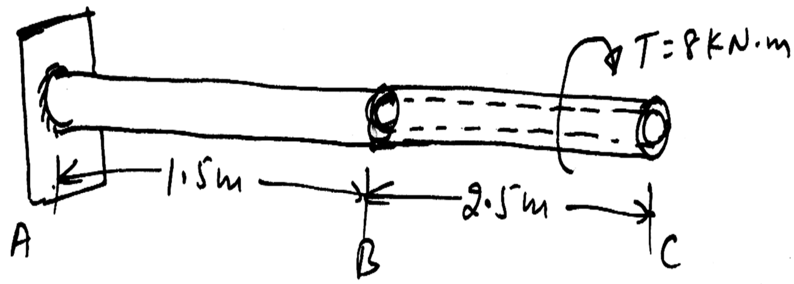
*CO5: **Estimate** torsional stresses in circular shafts; **Analyze** columns under buckling load; **Analyze** perfect frames under loads.*

Note: *i) **PART-A** is compulsory. One question from each unit for maximum of 2 marks.*
*ii) **PART-B** Answer any **TWO** sub questions (from a, b, c) from each unit for a Maximum of 18 marks.*

Q. No.	Questions	Marks	BLs	COs	POs
	I: PART - A	**10**			
I.	Define the following,				
	a. Normal stress	2	L1	CO1	
	b. Coefficient of thermal expression	2	L1	CO2	
	c. Shear force	2	L1	CO3	
	d. Neutral layer	2	L1	CO4	
	e. Pure torsion	2	L1	CO5	
	PART - B	**90**			
	UNIT - I	**18**			
1 a.	A specimen of steel 25 mm diameter with a gauge length of 200 mm is tested to destruction. It has an extension of 0.16 mm under a load of 80 kN and the load at elastic limit is 160 kN. The maximum load is 180 kN. The total extension at fracture is 56 mm and the diameter at the neck is 18 mm. Find; i) The stress at elastic limit ii) Young's modulus iii) Percentage elongation iv) Percentage reduction in area v) Ultimate tensile stress	9	L3	CO1	
b.	The bar shown in Fig. Q1(b) is tested in a universal testing machine. It is observed that at a load of 40 kN, the total extension of the bar is 0.285 mm. Determine the young's modulus of the material.	9	L3	CO1	

	 Fig. Q1(b).				
c.	A tapering rod has diameter d_1 at one end and it tapers uniformly to a diameter d_2 at the other end in a length L as shown in Fig. Q1(c). If modulus of elasticity of the material is E, find its change in length when subjected to an axial force of P.  Fig. Q1(c).	9	L3	CO1	
	UNIT - II	**18**			
2 a.	A compound bar of length 500 mm consists of a strip of aluminum 50 mm wide × 20 mm thick and a strip of steel 50 mm wide × 15 mm thick rigidly joined at ends. If the bar is subjected to a load of 50 kN, find the stresses developed in each material and the extension of the bar. Take elastic modulus of aluminum and steel as 1×10^5 N/mm^2 and 2×10^5 N/mm^2 respectively.	9	L3	CO2	
b.	A plane element is subjected to stresses as shown in Fig. Q2(b). Determine principal stresses, maximum shear stress and their planes.  Fig. Q2(b).	9	L4	CO2	
c.	The state of stress at a point is a strained member is given below, P_x = 180 N/mm^2, P_y = 120 N/mm^2, q = 80 N/mm^2. Draw Mohr's circle and determine; i) Direction of the principal planes ii) The magnitude of principal stresses, and	9	L4	CO2	

	UNIT – III	**18**			
3 a.	The simply supported beam shown in Fig. Q3(a) carries two concentrated loads and a uniformly distributed load, Draw shear force diagram and bending moment diagram.  Fig. Q3(a)	14	L4	CO3	
b.	Draw the bending moment and shear force diagrams for the overhanging beam shown in Fig. Q3(b). Indicate all the values including point of contra flexure.  Fig. Q3(b)	14	L4	CO3	
c.	Draw space diagram, SFD and BMD (only indicative) for a cantilever beam subjected to a concentrated load at free end.	4	L4	CO3	
	UNIT - IV	**18**			
4 a.	A circular pipe of external diameter 70 mm and thickness 8 mm is used as a simply supported beam over an effective span 2.5 m. Find the maximum concentrated load that can be applied at the centre of the span if permissible stress in tube is 150 N/mm^2.	9	L3	CO4	
b.	The diameter of a concrete flag post varies from 200 mm at base to 100 mm at top. If the length of post is 8 m and horizontal load acting at top is 500 N, find the section at which stress is maximum.	9	L2	CO4	
c.	Determine the cross-section of a rectangular beam of uniform strength for a simply supported beam of 6m span subjected to a central concreted load of 30 kN. i) By keeping depth of 300mm throughout ii) By keeping width of 200 mm throughout	9	L3	CO4	

	UNIT - V	**18**			
5 a.	Obtain general torsional equation with assumptions.	9	L3	CO5	
b.	The shaft shown in Fig. Q5(b) is securely fixed at A and is subjected to a torque of 8 kNm. If portion AB is solid shaft of 100 mm diameter and portion BC is hollow with external diameter 100 mm and internal diameter 75 mm, find the maximum stress and maximum angle of twist. Take G = 80 kN/mm^2. Fig.Q.5(b) 	9	L2	CO5	
c.	Obtain Rankine's formula for crippling load P_{cr}.	9	L3	CO5	

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