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ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. /B.Tech / B. Arch (Full Time) - END SEMESTER EXAMINATIONS, APR / MAY 2024

MECHANICAL ENGINEERING

III Semester

ML5352 MECHANICS OF MATERIALS

(Regulation 2019)

(Common to Mechanical E&T, Manufacturing, Material Science, Mining, Printing and Industrial Engineering)

Time:3 hrs Max.Marks: 100

CO1	1. To develop the understanding of the principle concepts behind stress, strain and deformation of solids for various engineering applications.
CO2	2. Analyzing the transverse loading on beams and stresses in beam for various engineering applications.
CO3	3. Analyzing the torsion principles on shafts and springs for various engineering applications.
CO4	4. Analyzing the deflection of beams for various engineering applications.
CO5	5. Analyzing the thin and thick shells and principal stresses in beam for various engineering applications

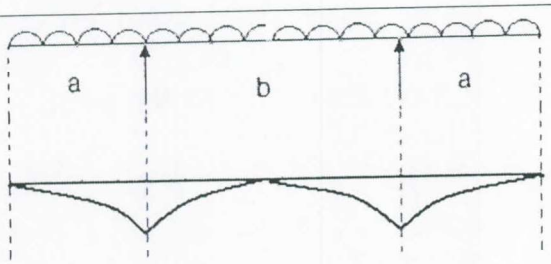
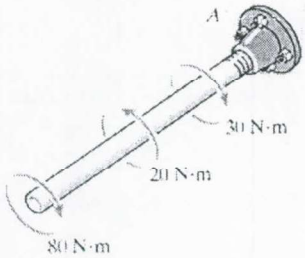
BL – Bloom's Taxonomy Levels

(L1-Remembering, L2-Understanding, L3-Applying, L4-Analysing, L5-Evaluating, L6-Creating)

PART- A (10x2=20Marks)

(Answer all Questions)

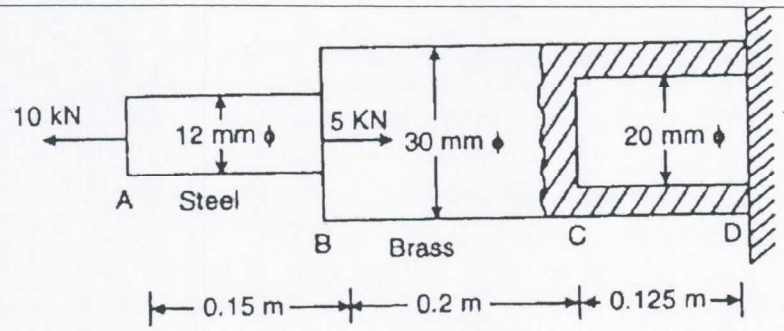
Q. No.	Questions	Marks	CO	BL
1	What is the safe static tensile load for a M36 × 4C bolt of mild steel having yield stress of 280 MPa and a factor of safety 1.5?	2	1	L2
2	A steel rail, rigidly fixed at its ends is assumed to be stress free at 20°C. If the stress required to cause the buckling of the rail is -75 MPa, at what temperature will the rail buckle? (E= 200 GPa and $\alpha = 12.5 \times 10^{-6}$/°C)	2	1	L2
3	A beam carrying a uniformly distributed load rests on two supports 'b' apart with equal overhangs 'a' at each end as shown in fig below. What is the ratio b/a for zero bending moment at mid-span?	2	2	L2

				
4	What is point of contraflexure?	2	2	L2
5	The copper pipe has an outer diameter of 40 mm and an inner diameter of 37 mm.If it is tightly secured to the wall at *A* and three torques are applied to it as shown, determine the absolute maximum shear stress developed in the pipe. 	2	3	L2
6	Define torsional rigidity and how it is related to stiffness.	2	3	L2
7	A cantilever beam of rectangular cross-section is subjected to a load W at its free end. If the depth of the beam is doubled and the load is halved, then what is the deflection at the free end? .	2	4	L2
8	What is a conjugate beam?.	2	4	L2
9	Differentiate between hoop and circumferential stress.	2	5	L1
10	Define slenderness ratio.	2	5	L2

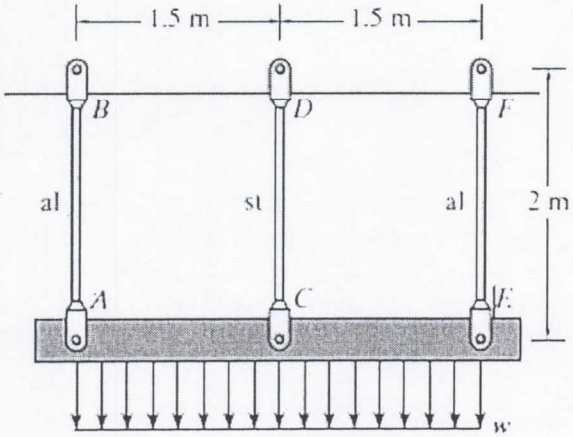
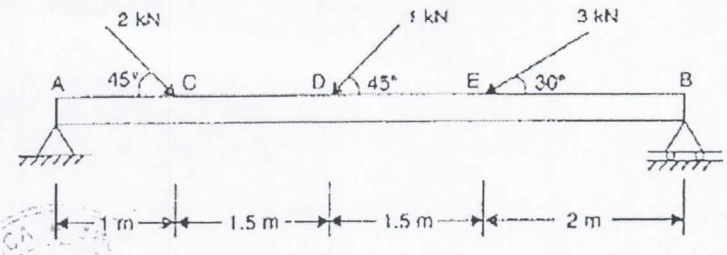
PART- B (5x 13=65Marks)

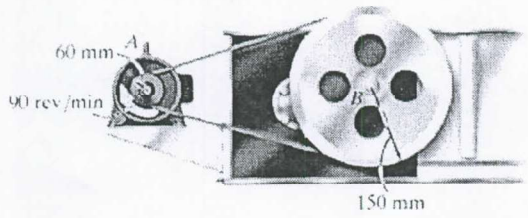
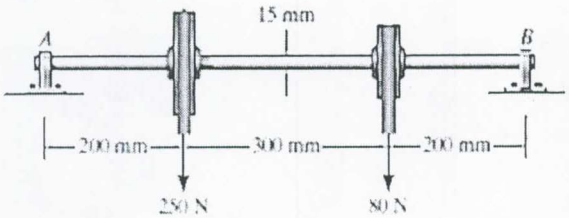
(Restrict to a maximum of 2 subdivisions)

Q. No.	Questions	Marks	CO	BL
11 (a)	The diameters of the brass and steel segments of the axially loaded bar shown in figure are 30 mm and 12 mm respectively. The diameter of the hollow section of the brass segment is 20 mm. Determine: (i) The maximum normal stress in the steel and brass (ii) The displacement of the free end ; Take E_s = 210 GN/m^2 and E_b = 105 GN/m^2	13	1	L3



OR

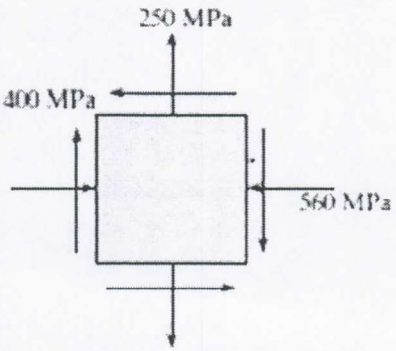
11 (b)	The distributed loading is supported by the three suspender bars. AB and EF are made of aluminum and CD is made of steel. If each bar has a cross-sectional area of 450 mm^2determine the maximum intensity w of the distributed loading so that an allowable stress of (σ_{allow}) st=180 MPa in the steel and (σ_{allow}) al=940 MPa in the aluminum is not exceeded. Est = 200 GPa, Eal = 70 GPa.Assume ACE is rigid. 	13	1	L3
12 (a)	A beam is loaded as shown in the figure below. Draw the shear force bending moment and thrust diagrams. Determine the max shear force, and max Bending Moment. . 	13	2	L5

	OR			
12 (b)	A Simply supported beam AB of span length 4 m supports a uniformly distributed load of intensity q = 4 kN/m spread over the entire span and a concentrated load P = 2 kN placed at a distance of 1.5 m from left end A. The beam is constructed of a rectangular cross-section with width b = 10 cm and depth d = 20 cm. Determine the maximum tensile and compressive stresses developed in the beam to bending..	13	2	L5
13 (a)	The motor *A* develops a power of 300 W and turns its connected pulley at 90 rev/min.Determine the required diameters of the steel shafts on the pulleys at (60mm) *A* and *B (150 mm)* if the allowable shear stress is ζallow = 85 MPa.  	13	3	L4
	OR			
13 (b)	A hollow shaft of diameter ratio 3/8 internal dia. to outer dia) is to transmit 375 kW power at 100 rpm. The maximum torque being 20% greater than the mean. The shear stress is not to exceed 60. N /mm^2 and twist in a length of 4 m not to exceed 2 degrees. Calculate its external and internal diameters which would satisfy both the above conditions. Assume modulus of rigidity, C = 0.85x 10^5 *N / mm ^{2}.	13	3	L5
14 (a)	The shaft is made of steel and has a diameter of 15 mm. Determine its maximum deflection. The bearings at A and B exert only vertical reactions on the shaft. E_{st} = 200 GPa.  	13	4	L4
	OR			

14 (b)	A simply supported beam AB of span 4m carries a point of 100 kN at its centre C. The value of I for the left half is 1 X 10^8 m m^4 and for the right half portion 2 X 10^8 mm^4 Find the slopes at the two supports and deflection under the load using conjugate beam method .E=200GN/m^2	13	4	L4
15 (a) (i)	Obtain an expression for circumferential and longiditional stress in an thin cylinder and also find an expression for maximum shear stress. (7)	13	5	L4
ii).	A boiler shell is to be made of 15 mm thick plate having a limiting tensile stress of 120N /mm^2 If the efficiencies of the longitudinal and circumferential joints are 70% and 30% respectively determine the maximum permissible diameter of the shell for an internal pressure of 2 N/mm^2 (6)			
	OR			
15 (b) (i)	Obtain an expression for the crippling load of a column when both ends are hinged. (7)	13	5	L4
(ii).	A solid round bar 3 m long and & 5 cm in diameter is used as a strut.. Determine the crippling (or collapsing) load when used as both ends hinged and both ends fixed. Take E = 2 x10^5 N /m^2			

PART- C (1x 15=15Marks)

(Q.No.16 is compulsory)

Q. No.	Questions	Marks	CO	BL
16	Determine the equivalent state of stress for an element oriented 60° counterclockwise from the element shown. Show the result on the element. Draw the Mohr circle and confirm the result analytically 	15	CO5	L6