NATIONAL INSTITUTE OF TECHNOLOGY, KURUKSHETRA

THEORY EXAMINATION

Question Paper

Month and Year of Examination: May, 2025

Programme: B. Tech. (Mechanical)

Subject: **Strength of Materials - II** Semester: Fourth

Time Allotted : 3 Hrs. Course No.: MEPC 209

Maximum Marks: 50

Note: Attempt Any Five questions out of Eight questions. In case of over attempt, first Five attempted questions will be considered. Each question carries 10 marks.

Questions *Assume suitably and state, additional data required, if any.*

		Marks
I. (a).	A cast iron column of a hollow circular section with an external diameter of 250 mm and a wall thickness of 45 mm is subjected to an axial compressive load P. The column is 7 m long with both ends hinged. Taking factor of safety as 8, determine safe Rankine's bucking load P. Rankine's constants are, σ_c = 56 kN/cm²; α (for hinged ends) = 1/1600.	5
(b).	A column of length L and flexural rigidity EI is fixed at both the ends. Derive the expression of Euler's buckling load and state the assumptions made.	5
II.	The ends of a thin cylindrical shell are closed by flat plates. It is subjected to an internal fluid pressure, but the ends of the cylinder are rigidly stayed and no axial movement is permitted. Determine the increase in the volume of the shell. Take Poisson's ratio as 0.3.	10
III.	A compound cylinder is formed by shrinking one outer steel cylinder over bronze cylinder. The final dimensions are internal diameter 100 mm, external diameter 200 mm and junction diameter 160 mm, and the shrinkage pressure at the common surface is 12 N/mm².	
	a) Calculate the necessary difference in radii of two cylinders at the common surface.	4

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b) If the compound cylinder is subjected to an internal pressure 50 N/mm^2, what are the hoop stresses at inner and outer radii of both the cylinders?

For Modulus of elasticity of steel and bronze, take 200 GPa and 100 GPa, respectively. For Poisson's ratio of steel and bronze, take 0.3 and 0.32, respectively.

IV. (a) A close-coiled helical spring made of round steel wire is required to carry an axial load of 800 N for a maximum stress not to exceed 150 N/mm^2 in shear. Determine the wire diameter if the stiffness of the spring is 10 N/mm and diameter of helix is 80 mm and also, calculate the number of turns required in the spring. Neglect the correction due to spring index. Given G_{steel} = 84 kN/mm^2.

(b) An open-coiled helical spring made of 5 mm diameter steel wire, 25 mm mean coil radius, and 23° angle of helix is subjected to an axial moment of 2 Nm. Determine

(a) angular rotation of one end with respect to the other end; and

(b) axial deflection, if number of coils in the spring is 15.

Given E_{steel} = 210 GPa, G_{steel} = 82 GPa.

V. (a) A flanged coupling has n bolts of a diameter of 19 mm arranged symmetrically along a bolt circle of diameter of 300 mm. If the diameter of the shaft is 80 mm and it is stressed up to 80 N/mm^2, determine the value of n if the shear stress in bolts is not to exceed 35 N/mm^2.

(b) A composite shaft is made by joining an 80 cm long solid steel shaft with 80 cm long hollow copper shaft as shown in Figure 1. The diameter of solid shaft is 40 mm, while internal and external diameters of hollow shaft are 25 mm and 50 mm, respectively. Determine the maximum shear stresses developed in steel and copper shafts, if torque T applied at junction is 4 kN-m. What is the angular twist at the junction? Given G_{steel} = 82 GPa and G_{copper} = 41 GPa.

VI. A built-in beam AB has a clear span L and carries a concentrated load P at a distance 'a' and 'b' from two ends. Estimate the fixing moments and the reactions

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at the supports. Also, determine the magnitude and the position of the maximum deflection. 10

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A horizontal beam ABCD is 15 m long and is simply supported at A, B and C. Span AB is 5 m long and carries a uniformly distributed load of 2 kN/m. Span BC is 8 m long and does not carry any load whereas overhanging span CD is 2 m long and carries a point load of 3 kN at the free end D. The moment of inertia of spans AB, BC and CD are 2I, 3I and I, respectively. Draw the bending moment and shear force diagrams for the entire beam. 10

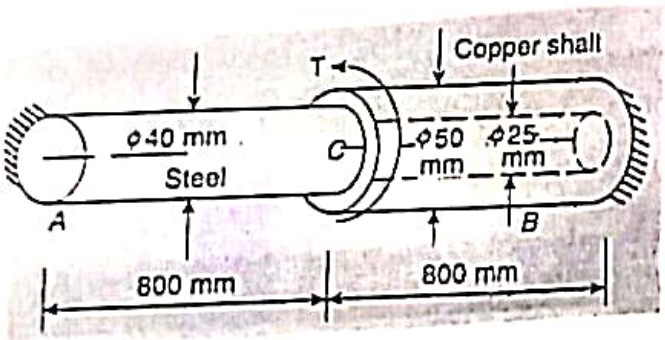
I. (a) A thin disc of uniform thickness is of 80 cm outer diameter and 5 cm inner diameter. It rotates at 3000 rpm. Density of the disc material is 7800 kg/m^3. Poisson ration is 0.25. Determine the maximum values of the radial, hoop and shear stresses. 5

(b) A rotor disc of a turbine is of 800 mm diameter at the blade ring and is fixed to a 60 mm shaft. If the minimum thickness of the disc is to be 8 mm, find the thickness of the disc at the shaft for a uniform stress of 210 MPa at 7500 rpm. Density of the disc material is 7800 kg/m^3. 5

I. A ring of T-section with a saw cut is subjected to a tensile load of 80 kN as shown in Figure 2. Take $E_{steel} = 2.03 \times 10^{11}$ N/m^2. Find 6

(a) stresses at points P and Q, and 4

(b) deflection of the ring along the load line.



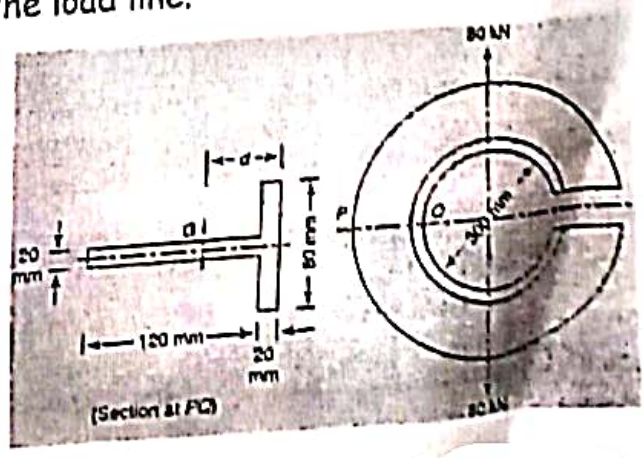


Figure 2