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Total No. of Questions: [09]

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B. Tech. (Aerospace Engg) (Semester –3rd)
STRENGTH OF MATERIALS
Subject Code: BASES-1304
Paper ID: [19113005]

Time: 03 Hours

Maximum Marks: 60

Instruction for candidates:

1. Section A is compulsory. It consists of 10 parts of two marks each.
2. Section B consist of 5 questions of 5 marks each. The student has to attempt any 4 questions out of it.
3. Section C consist of 3 questions of 10 marks each. The student has to attempt any 2 questions.

Section – A

(2 marks each)

Q1. Attempt the following:

- a. Draw a stress strain curve for mild steel.
- b. Define Hooke's law. Explain Mohr's circle of stress?
- c. Define shear force and bending moment in the context of beams?
- d. How do you calculate the maximum shear force in a beam subjected to a concentrated load?
- e. What is the point of contra-flexure, and how is it identified in a bending moment diagram?
- f. State the torsion equation for a circular shaft and define its terms.
- g. Describe the relationship between internal pressure and changes in diameter and volume of a thin sphere.
- h. How does the thickness-to-diameter ratio impact the stress distribution in thin cylinders??
- i. What does Johnson's empirical formula predict for axially loaded columns?
- j. State the relationship between bending moment, slope, and deflection in beams.

Section – B

(5 marks each)

- Q2. How are temperature stresses calculated in compound bars subjected to axial loads with Varying temperatures?
- Q3. A steel column with a length of 2.5 m, hinged at both ends, has a cross-sectional area of 2000 mm² and a moment of inertia of $I=4.5 \times 10^6$ mm⁴. The modulus of elasticity for steel is $E=200$ GPa.
1. Calculate the critical load using Euler's formula.
 2. If the actual load is 80% of the critical load, determine whether the column will remain stable.
- Q4. Derive the expression for shear stress in a circular shaft subjected to Torsion.
- Q5. A thin-walled pressure vessel is a cylindrical shell with an internal diameter of $D=200$ and the internal pressure is $p=2$ MPa. The thickness of the shell is $t=10$ mm. The vessel is subjected to internal pressure, Calculate a) Hoop Stress and b) Longitudinal Stress
- Q6. A spherical pressure vessel has an internal diameter of $D=1$ m and is subjected to an internal pressure of $p=10$ MPa. The material has a Young's Modulus $E=200$ GPa and Poisson's ratio $\nu=0.3$. The vessel is made from a thin material with a thickness of $t=50$ mm.
1. Calculate the change in diameter of the sphere.
 2. Calculate the change in the internal volume of the sphere.

Section – C

(10 marks each)

- Q7. Explain how the bending moment (BM) diagram is different from the shear force (SF) diagram. How do you calculate the maximum shear force in a beam subjected to a concentrated load? For a simply supported beam with a uniformly distributed load over its entire span, describe the shape of the shear force and bending moment diagrams.
- Q8. A compound bar is made up of two different materials: Steel and Copper. The steel section is of length $L_1=2$ m, and the copper section is of length $L_2=3$ m. The cross-sectional areas of both sections are the same, $A=100\text{ mm}^2$, and the bar is subjected to an axial load $P=50$ kN. The following material properties are given:
- For Steel: Young's modulus, $E_1=200$ GPa
Poisson's ratio, $\nu_1=0.3$
Coefficient of thermal expansion, $\alpha_1=12\times 10^{-6}/^\circ\text{C}$
- For Copper: Young's modulus, $E_2=110$ GPa
Poisson's ratio, $\nu_2=0.34$
Coefficient of thermal expansion, $\alpha_2=16\times 10^{-6}/^\circ\text{C}$ If the temperature of the bar is raised by $\Delta T=40^\circ\text{C}$, calculate:
1. The total elongation of the compound bar due to the axial load and the temperature change.
 2. The stress in each material (Steel and Copper) after temperature rise.
 3. The strain in each material (Steel and Copper) after temperature rise.
- Q9. A cantilever beam of length $L=6$ m carries a uniformly distributed load $w=2$ kN/m along its entire span and a concentrated load $P=10$ kN at the free end. The modulus of elasticity is $E=200$ GPa, and the moment of inertia of the beam's cross-section is $I=2.4\times 10^{-6}\text{ m}^4$.
- a) Calculate the slope at the free end using the Moment Area Method.
 - b) Calculate the deflection at the free end using the Method of Integration.