Register No.: ..... Name: .....

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

THIRD SEMESTER B.TECH DEGREE EXAMINATION (Regular), DECEMBER 2022
MECHANICAL ENGINEERING
(2020 SCHEME)

Course Code : 20MET201

Course Name: Mechanics of Solids

Max. Marks : 100 **Duration: 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1. What do you mean by method of sections?
2. Write stress tensor of plane stress condition
3. Define thermal stress and strain
4. Write down the two relationships among elastic constants **E,G,K & ν**
5. Enumerate the assumptions while deriving torsion equation
6. Define the term point of contraflexure
7. How strain energy method is useful in stress analysis?
8. Write the procedure followed for Macaulay's method
9. Explain the term effective length of a column
10. Explain Rankines theory of failure.

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) Explain (i) Principal stress and (ii) Principal plane (5)
    b) The stress tensor at a point is given by

$$\begin{bmatrix} 3 & 1 & 1 \\ 1 & 0 & 2 \\ 1 & 2 & 0 \end{bmatrix} \text{MPa} \quad (9)$$

Find the principal stresses.

OR

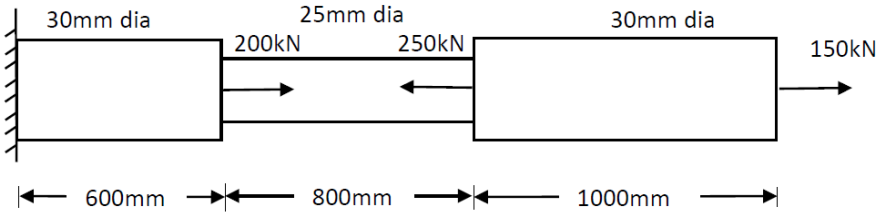
12. a) Write the strain displacement relations (5)
    b) Determine the strain components for the following displacement field. (9)

$U_X = K (x^2 + y^2)$, $U_y = K (4x + 2 y^2 + 3)$, $U_z = 4 K z^2$

MODULE II

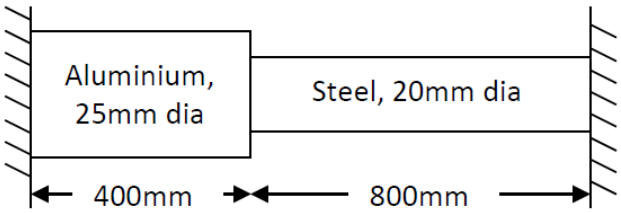
13. a) A steel bar of 10mm diameter is subjected to an axial load of 12kN. If the change in diameter is found to be 0.0022mm, determine the Poisson's ratio and the modulus of elasticity. Take G=78GPa. (7)

b) Find the total elongation of the composite bar shown below. The bar segment diameters are of 30mm, 25mm and 30mm respectively, and the bar lengths are 600mm, 800mm and 1000mm respectively. Take E=200GPa. (7)



OR

14. a) A composite bar made of aluminum and steel is rigidly attached to the end supports at 60°C as shown in figure. Evaluate the stresses in the two portions of the bar when the temperature of the system falls to 20°C. The modulus of elasticity of steel and aluminum are 200GPa and 70GPa respectively. The coefficient of thermal expansion of steel and aluminum are 11.7×10^{-6}/°C and 23.4×10^{-6}/°C respectively. (9)



b) Draw a typical stress-strain curve for mild steel subjected to tensile load and explain the salient points. (5)

MODULE III

15. a) Find the maximum bending stress induced in a simply supported beam of length 4m, acted upon by a load of 100N at the mid-span. The beam has a rectangular cross-section 10mm wide and 20mm deep. (7)

b) A hollow circular shaft of 6 m length and inner and outer diameter of 75 mm and 100 mm is subjected to a torque of 10 kN-m. If G=80GPa, determine the shear stress produced and the total angle of twist (7)

OR

16. a) Derive the relation among load intensity and shear force (5)
    b) A simply supported beam has a total span of 2.5 m. It is subjected to uniform distributed load of magnitude 2 kN/m for 1 m length from left end. It is also subjected to a point load of 2kN at a point 1.5 m from left end. Draw the SFD & BMD and mark the salient points. (9)

MODULE IV

17. a) Classify different types of beams subjected to support and loading conditions (5)
    b) A simply supported beam having length 2m is subjected to a point load of 4 kN, acting at 0.5 m away from the left end A. An uniform distributed load of magnitude 5 kN/m is acting at the last 1m. Find the deflection at the midpoint of the beam using Macaulay's method. Take **E** = 200GPa; **I** = 15 x 10^6 mm^4. (9)

OR

18. a) Derive an expression for the strain energy stored in an element subjected to an axial load of **P** having length **L** and area of cross-section **A** and modulus of elasticity **E** (5)
    b) A cantilever beam supports a udl 4kN/m and a concentrated load 6kN at the free end. Total span is 2m. Determine the deflection at the free end. Given EI = 5000kNm^2. (9)

MODULE V

19. a) Derive an expression for Euler's Buckling load for a column of which both ends are hinged. (5)
    b) A hollow steel tube of 200 mm external diameter and 25 mm thick is 4m long and is used as a column. If one end is fixed and the other end is hinged, find the load the column can carry. Use Euler's formula and factor of safety as TWO. (9)

OR

20. a) Explain the Maximum shear stress theory (5)
    b) The principal stresses at a point in an elastic material are 100MPa tensile, 25MPa tensile and 50MPa compressive. Determine the factor of safety against failure based on i) maximum principal stress theory, ii) maximum shear stress theory, and iii) maximum strain energy theory. The elastic limit in simple tension is 220MPa and Poisson's ratio is 0.3 (9)

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