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

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

THIRD SEMESTER B.TECH DEGREE EXAMINATION (S), MAY 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. Define principal planes and principal stresses. Write down the stress matrix for a 3D state of stress involving only principal stresses.
2. Write down the six strain displacement relations
3. Draw and label the stress-strain diagram for ductile material.
4. Define the following a) Poisson's ratio, b) Bulk modulus, c) Rigidity modulus
5. With suitable examples define point of contraflexure and inflexion in BMD.
6. Define torsional rigidity and polar moment of inertia.
7. Explain proof resilience and modulus of resilience.
8. State Maxwell's reciprocal theorem with example.
9. Define slenderness ratio and mention the criteria for classification of column based on slenderness ratio.
10. Brief on the importance of theories of failures

Part B

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

Module I

11. (a) At a point 'P' in a body $\sigma_{xx} = 100$ MPa, $\sigma_{yy} = 50$ MPa, $\sigma_{zz} = -50$ MPa, $\tau_{xy} = \tau_{yz} = \tau_{xz} = 100$ MPa. Determine the normal and shear stress on a plane with direction cosines given by $\left\{\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}\right\}$ (7)

(b) For the given 2D state of stress, $\sigma_{xx} = 10$ MPa, $\sigma_{yy} = -30$ MPa, $\tau_{xy} = -15$ MPa. Determine the principal stress, maximum shear stress and orientation of maximum principal stress using Mohr's circle method. (7)

OR

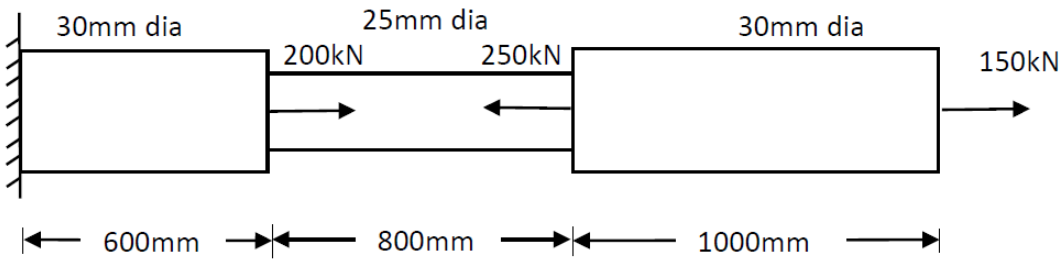
12. (a) Determine the stress invariants and maximum and minimum principal stresses if $\sigma_{xx} = 5$ MPa, $\sigma_{yy} = 5$ MPa, $\sigma_{zz} = 5$ MPa, $\tau_{xy} = \tau_{yz} = 3$ MPa and $\tau_{xz} = 2$ MPa. (9)

(b) If the displacement field is $(2x^2+y)\,\mathbf{i} + (3y^2+z)\,\mathbf{j} + (4z^2+x)\,\mathbf{k}$, obtain the strain tensor at (1,2,1). (5)

Module II

13. (a) A circular shaft 30 mm diameter and 500 mm long is subjected to a tensile force of 10 kN. Determine the modulus of rigidity, bulk modulus and change in volume if the poisson's ratio is 0.3 and E = 2.1×10^5 N/mm^2. (5)

(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. (9)



OR

14. (a) A concrete column (250×250) mm in section is reinforced by a longitudinal steel rod of 15 mm diameter. The column carries a compressive load of 300 kN. Calculate the load carried and compressive stress produced in steel rod and concrete. Take E_{steel} = 200 GN/m^{2}and $E_{concrete}$ = 15 GN/m^2. (7)

(b) Draw a typical stress-strain curve for mild steel subjected to tensile load and explain the salient points. (7)

Module III

15. (a) Derive torsion equation stating all the assumptions. (5)

(b) A hollow shaft is to transmit a uniform torque of 30 kNm. The total angular twist in 2.5 m length of shaft is not to exceed 2° and the allowable shearing stress is 85 MPa. Determine the external and internal diameter of the shaft. Take modulus of rigidity of shaft material as 80 GPa. (9)

OR

16. (a) A simply supported beam AB of span 7 m carries two point loads of magnitude 5 kN located 1 m away from the support provided at A and B. another UD load of magnitude 3 kN/m length is acting over a span of 2 m. The UD load is placed in such a way that it is in the middle of the beam and 1.5 m apart from the point load also. Draw the sketch of the beam and make calculations for SFD and BMD. Also determine the maximum value of bending moment and its location. (9)

(b) Derive the differential equation between load, shear force and bending moment. (5)

Module IV

17. (a) A simply supported beam of 4m span is subjected to a concentrated point load of 16 kN and UD load of 8 kN/m length. The point load is located 1 m away from the left support and UD load is located over a length of 2 m starting from the right support. Distance between point load and UD load is 1 m. Using the Macaulay method, determine the slope at A and deflection at centre C of the beam and maximum deflection. (9)

(b) List the steps involved in determining the deflection of beams using Macaulay's method. (5)

OR

18. (a) Determine the maximum deflection of a simply supported beam of span 'L' carrying a load of 'w' per unit length using strain energy method. (7)

(b) A cantilever beam of span 10 m carries a udl of 5 kN/m at a distance of 3 m from the free end. Calculate the slope and deflection at the free end. (7)

Module V

19. (a) Derive an expression for critical load for a column when both ends are pinned. State the assumptions in Euler's column theory. (6)

(b) State and explain the following failure theories: (8)
(i) Rankine's Theory
(ii) Saint Venant's Theory

OR

20. (a) Find the crippling load for a hollow steel column of external diameter 50mm and internal diameter 40mm. The column is 2.5m long and pinned at both ends. Use Rankine's formula with Rankine's constant as 1/7500 and crushing stress as 335MPa. (6)

(b) State and explain the following failure theories: (8)
(i) Guest's Theory
(ii) Hencky-von Mises Theory

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