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

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FOURTH SEMESTER B.TECH DEGREE EXAMINATION (R), MAY 2023

(2020 SCHEME)

Course Code : 20CET292

Course Name: Advanced Mechanics of Solids

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

PART A

(Answer all questions. Each question carries 3 marks)

1. Differentiate between spherical and deviatoric stress tensors.
2. Define plane stress condition with examples.
3. Differentiate between principal strain and octahedral strain.
4. Write a short note on strain rosettes.
5. List out the six equations of compatibility for strain.
6. Define the following
   (a) strain energy density
   (b) complementary internal energy density
7. Enumerate the various modes of failure of engineering materials.
8. Differentiate between maximum shear stress criteria and maximum strain energy density criteria for failure.
9. Discuss the use of St Venants semi inverse method.
10. Explain Prandtl's membrane analogy.

PART B

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

MODULE I

11. a) Find the expression for the normal stress and shearing stress on a new coordinate system with X', Y' and Z' as the reference axes. X' axis is defined by $l_1i + m_1j + n_1k$, Y' axis is defined by $l_2i + m_2j + n_2k$ and Z' axis is defined by $l_3i + m_3j + n_3k$. (8)

    b) Derive the differential equations of motion of a deformable body. (6)

OR

12. Given a state of stresses at a point with respect to a convenient coordinate system (x, y, z) be σ_x =100 MPa, σ_y= −60 MPa, σ_z = 40 MPa , τ_{xy} = 80 MPa, $\tau_{yz} = \tau_{xz}$ = 0 MPa. Determine (14)

i) principal normal stresses and their direction cosines

ii) principal shear stresses.

iii) octahedral normal stresses and octahedral shearing stresses considering X,Y,Z co-ordinate system

iv) mean and deviatoric stress tensors

MODULE II

13. a) The strain components at a point are given by (10)

$\varepsilon_x = 5xy+6z$; $\gamma_{xy} = 2xy^2$

$\varepsilon_y = 2xy^2 + yz$; $\gamma_{yz} = yz^2$

$\varepsilon_z = x^2z + y$; $\gamma_{xz} = xz^2$

Verify whether the compatibility equations are satisfied or not at the point (1, -1, 2).

b) Enumerate different types of strains. (4)

OR

14. a) Explain strain invariants. (4)

b) The strain components at a point with respect to xyz co-ordinate system are ε_x = 0.02, ε_y = 0.03, ε_z = 0.01, $\gamma_{xy} = \gamma_{yz} = \gamma_{xz}$ =0.02. If the coordinate axes are rotated about the z-axis through 30° in the anticlockwise direction, determine the new strain components. (10)

MODULE III

15. For a shear modulus of 80×10^6 kPa and an Elastic Modulus of 200×10^6 kPa, compute the strain tensor for the following state of stress: (14)

σ_x = 100 , σ_y = 50, σ_z = -200 , τ_{xy}=-500, τ_{yz}=50, τ_{xz}=0 MPa.

OR

16. a) Determine whether the following displacement field satisfies the equilibrium equations or not at the point (3,5,-8). Assume body forces to be zero and Poisson's ratio as 0.3. (10)

$u_x = 5x^2y + 6xz$, $u_y = 3y^2z + 2xy$, $u_z=xyz + 2yz^2$

b) List out the equilibrium equations in Cartesian co-ordinates in terms of displacements. (4)

MODULE IV

17. A solid shaft as shown in figure given below has a radius of 12.7mm and is made of steel having σ_y= 250MPa. Determine whether the loadings cause the shaft to fail according to the maximum shearing stress criterion and the maximum distortion energy criterion. (14)

OR

18. A circular cylindrical shaft is made of steel with a yield stress 700MPa. The shaft is subjected to a static bending moment of 13kNm and a static torsional moment of 30kNm. Assume modulus of elasticity as 200GPa and Poisson's ratio as 0.29. Employing a factor of safety of 2.60, determine the minimum required safe diameter for the shaft. (14)

MODULE V

19. a) Distinguish between torsion of circular and non-circular sections. (4)

b) A thin-wall brass tube (G = 27.6GPa) has an equilateral triangular cross section. The mean length of one side of the triangle is 25.4 mm and the wall thickness 2.54mm. Determine the maximum shear stress and angle of twist per unit length of the tube. (10)

OR

20. A hollow circular torsion member has an outside diameter of 22.0 mm and inside diameter of 18.0 mm, with mean diameter D = 20.0 mm and t/D = 0.10. (14)

i) Determine T and θ when shear stress at the mean diameter is 70MPa and compare these values with values obtained using the elasticity theory. G = 77.5GPa.

ii) Determine T and θ if a cut is made through the wall thickness along the entire length of the torsion member and the maximum shear stress in the resulting torsion member is 70MPa.

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