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

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FOURTH SEMESTER B.TECH DEGREE EXAMINATION (R), MAY 2024

(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. List out Cauchy's stress formula for an arbitrary plane.
2. Define stress invariants and write the expressions for stress invariants.
3. Define the term 'state of strain at a point' and represent it by the second order strain tensor.
4. Explain the physical significance of compatibility conditions.
5. List out the constitutive equations connecting components of stress to components of strain for isotropic material.
6. Define strain energy and complementary strain energy.
7. Explain the significance of theories of failure.
8. Explain stress concentration with a simple example.
9. Distinguish between torsion of circular and non circular sections.
10. Compare torsional stiffness of thin walled open and closed section.

PART B

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

MODULE I

11. a) Derive the differential equations of equilibrium. (7)

    b) The state of stress at a point is given by σ_x = 12.31MPa, σ_y = 8.96MPa, σ_z = 4.34MPa, τ_{xy} =4.20, τ_{yz} =5.27, τ_{zx} = 0.84. Determine the values of principal stresses. (7)

OR

12. a) Explain hydrostatic and deviatoric stresses. (6)

    b) The component of stress at a point are given by stress tensor $\begin{bmatrix} 5 & 2 & 1 \\ 2 & 3 & 4 \\ 1 & 4 & 2 \end{bmatrix}$ MPa. Determine the normal and shear stress components on an inclined plane whose direction cosines are $(\frac{1}{\sqrt{3}}, \sqrt{\frac{2}{3}}, 0)$ (8)

MODULE II

13. a) The displacement field in a body is given by U=$((x^2+y^3+2)i+(3x+4y^2)j+(2x^2+4z)k)\times 10^{-4}$. Determine the principal strains at (1, 2, -3). (9)

b) State and explain the compatibility equations for 2D problems. (5)

OR

14. a) Using the condition of compatibility, check whether the following system of plane strain is possible or not
$\varepsilon_{xx}=5+x^2+y^2+x^4+y^4$, $\varepsilon_{yy}=6+3x^2+3y^2+x^4+y^4$, $\gamma_{xy}=10+4xy(x^2+y^2+2)$. (8)

b) The strain components at a point are given by ε_x = 100, ε_y = 50, ε_z = 40 μ strains and γ_{xy} =20, γ_{yz} =10 γ_{zx} =15 μ radians. Calculate the normal and shearing strains on a plane whose normal has the direction cosines, $\frac{1}{\sqrt{3}}$, $\sqrt{\frac{2}{3}}$, 0. (6)

MODULE III

15. a) Explain the term boundary conditions. (6)

b) Derive the expression for strain energy due to gradually axial load and suddenly applied load. (8)

OR

16. For steel, the following data is applicable, E as 207 × 10^6 kPa and G = 80 × 10^6 kPa. The strain matrix at a point is given as $[\varepsilon_{ij}]=\begin{bmatrix}0.001 & 0 & -0.002\\ 0 & -0.003 & 0.0003\\ -0.002 & 0.0003 & 0\end{bmatrix}$. Determine the stress matrix. (14)

MODULE IV

17. a) Define fatigue stress and explain Palm Miner's Rule for fatigue analysis. (6)

b) A cylindrical bar is subjected to a torque of 3400Nm and a bending moment of 1080Nm. If the failure of the bar is governed by the maximum strain theory, determine the diameter of the bar. The elastic modulus of the material is 103 ×10^6kPa, Poisson's ratio = 0.25, tensile elastic limit for the material is 207MPa and the factor of safety to be used is 3. (8)

OR

18. a) Define fatigue stress and explain S N curve for fatigue analysis. (6)

b) Determine the diameter d of a circular shaft of subjected to a bending moment M and torque T, according to maximum shear stress criteria. (8)

MODULE V

19. a) Derive torsion formula for thin walled tube. (6)

b) A shaft of square section of outer side 55mm and inner side 50mm is subjected to a twisting moment such that the maximum shear stress developed is 250N/mm^2. What is the torque acting on the shaft and what is the angular twist if the shaft is 1.6m long and G=70000N/mm^2 (8)

OR

20. a) A square shaft of 50 mm × 50mm is subjected to a twisting moment of 4.905 × 10^{5}Nmm. Determine the maximum shear stress and the angle of twist per unit length. Assume G as 80GPa and values of constants α=0.208 and β=0.141. (6)

b) Derive the expression of the Poisson's torsion equation. (8)

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