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

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FOURTH SEMESTER B.TECH DEGREE EXAMINATION (Regular), JULY 2022

(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. Define the term 'state of stress at a point' and represent it by the second order stress tensor.
2. Explain 'state of pure shear' with the necessary condition to exist it.
3. Describe strain invariants and write down the expression of strain invariants in terms of principal strains.
4. Distinguish between rectangular strain rosette and equiangular strain rosette.
5. Define generalised Hook's law and express the stress –strain- stiffness matrix relationship in matrix form.
6. Define strain energy density and represent it in terms of strain and modulus of elasticity.
7. Explain stress concentration factor.
8. Explain any two failure theories.
9. Prove that shear flow is constant throughout the tube.
10. Distinguish between torsion of circular and non circular sections.

PART B

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

MODULE I

11. a) The state of stress at a point is given by σ_x = 100MPa, σ_y = -40MPa, σ_z = 80MPa, $\tau_{xy} = \tau_{yz} = \tau_{zx} = 0$. Determine the octahedral shear stress and its associated normal stress. (5)

b) Derive the equilibrium equation for plane stress state. (9)

OR

12. a) The state of stress at a point is given by stress tensor $\begin{bmatrix} 70 & -40 & 20 \\ -40 & 10 & 20 \\ 20 & 20 & -20 \end{bmatrix}$. Determine the principal stresses, maximum shear stress and maximum principal stress direction. (9)

b) Explain the hydrostatic and deviatorial parts of stress and its function. (5)

MODULE II

13. a) The strain components at a point are given by $\varepsilon_x = 100$, $\varepsilon_y = 50$, $\varepsilon_z = 40$ µ strains and $\gamma_{xy} = 20$, $\gamma_{yz} = 10$ $\gamma_{zx} = 15$ µ radians. Calculate the normal and shearing strains on a plane whose normal has the direction cosines, $\frac{1}{\sqrt{3}}, \sqrt{\frac{2}{3}}, 0$. (7)

b) The displacement field in a body is given by U=$(x^2 + y)i + (3 + z)j + (x^2 + 2 - y)k$. Determine the principal strains at (3, 2, -1) and the direction of maximum principal strain. (7)

OR

14. a) Derive the St. Venant's equations of compatibility. (7)

b) The strain components at a point with respect to xyz co-ordinate system are $\varepsilon_x = 0.15$, $\varepsilon_y = 0.16$, $\varepsilon_z = 0.35$, $\gamma_{xy} = \gamma_{yz} = \gamma_{xz} = 0.170$. If the coordinate axes are rotated about the z-axis through 45° in the anticlockwise direction, determine the new strain components. (7)

MODULE III

15. 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. Take value of E as 207 x 10^6 kPa and G = 80 x 10^6 kPa. (14)

OR

16. The stress components at a point in a body are given by $\sigma_x = 5xy^2z + 2x$, $\sigma_y = 3xyz + 3y$, $\sigma_z = x^2y + y^2z$, $\tau_{xy} = 0$, $\tau_{yz} = \tau_{zx} = 2xy^2z + 2xy$. Determine whether these components of stress satisfy the equilibrium equations or not at the point (1,-1, 2). If not then determine the suitable body force required at this point so that these stress components are under equilibrium. (14)

MODULE IV

17. a) Explain Von Mises criteria. (6)

b) Discuss S N curve and Palmgren Miner's Rule for fatigue analysis. (8)

OR

18. a) Explain stress concentration factor and its significance in structural analysis. (6)

b) A cylindrical bar of 70mm diameter is subjected to a torque of 3400Nm and a bending moment M. If the bar is at the point of failing in accordance with the maximum principal stress theory, determine the maximum bending moment it can support in addition to the torque. The tensile elastic limit for the material is 207 MPa and the factor of safety to be used is 3. (8)

MODULE V

19. a) Prove that the warping function is harmonic and it satisfies Laplace equation. (7)

b) A shaft of 600mm long, 30mm wide and 10mm thick is subjected to twisting. If the maximum allowable stress is 50MPa, determine the largest value of torque that can be applied to the shaft. Also determine the corresponding angle of twist. Modulus of rigidity is 40MPa. The coefficients 'α' and 'β' for b/h corresponding to 3 for rectangular shafts in torsion may be taken as 0.267 and (7)

0.263 respectively.

OR

20. a) An elliptical shaft of semi axes a = 0.05m, b = 0.025m and G = 80GPa is subjected twisting moment of 1200 N.m. Determine the maximum shear stress and angle of twist per unit length. (7)

b) A hollow section of length 150mm and width 75mm (both dimensions along median line) is designed for a maximum shear stress of 40 MPa neglecting stress concentration. Find the twisting moment that can be taken up by the section and the angle of twist. Take wall thickness 't' as 7 mm. (7)

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