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

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FIRST SEMESTER M.TECH DEGREE EXAMINATION (R), DECEMBER 2023

STRUCTURAL ENGINEERING AND CONSTRUCTION MANAGEMENT

(2021 Scheme)

Course Code: **21SC104-B**

Course Name: **Theory of Elasticity**

Max. Marks: **60** **Duration: 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1. Explain Octahedral stresses.
2. With neat sketch explain the strain displacement relations.
3. For a material E= 210 GPa, ν= 0.3, find Lame's constant, shear modulus, and bulk density.
4. Elaborate Airy's Stress function.
5. Explain Semi inverse solution for torsion.
6. Derive the expression for the angle of twist for a thin-wall hollow section.
7. Illustrate the various failure theories of plasticity.
8. Define yield line.

PART B

(Answer one full question from each module; each question carries 6 marks)

MODULE I

9. The state of stress at a given point is given by

$\sigma = \begin{bmatrix} 20 & -32 & 7 \\ -32 & 35 & -11.5 \\ 7 & -11.5 & 39 \end{bmatrix} MPa$. Find the principal stresses and its orientation. (6)

OR

10. Derive the equilibrium equations in Cartesian coordinates. (6)

MODULE II

11. The strain components at a point with respect to x y z co-ordinates system are $\varepsilon_x = 0.10$ $\varepsilon_y = 0.80, \varepsilon_z = 0.9, \gamma_{xy} = 0.24, \gamma_{yz} = \gamma_{xz} = 0.20$. If the co-ordinates axes are rotated about the z- axis through 45° in the anticlockwise direction, determine the new strain components. (6)

OR

12. Compose the compatibility equation in 3-D Cartesian co-ordinates. (6)

MODULE III

13. Consider an isotropic material that is subjected to uniform stress. Show that there are only two elastic constants using generalized Hooke"s law. (6)

OR

14. a) Explain St. Venant's Principle with example. (3)

b) At a point in a stressed material, the principal stresses are as follows. $\sigma_1 = 200\ N/mm^2$, $\sigma_2 = 150\ N/mm^2$, $\sigma_3 = 120\ N/mm^2$. Calculate the volumetric strain and Lame's constants if $E = 2 \times 10^5\ N/mm^2$ and Poisson's ratio 0.3. (3)

MODULE IV

15. Obtain the expressions for deflection of cantilever beam of with length l and rectangular cross-sectional area (b x d), with concentrated load at free end. Also, compare the same with strength of materials approach. (6)

OR

16. Show that $\phi = \frac{P}{\pi} r\theta \cos\theta$ is a stress function. Determine the stresses $\sigma_r, \sigma_\theta, \tau_{r\theta}$. (6)

MODULE V

17. Explain the use of membrane analogy in torsion analysis. (6)

OR

18. Determine the maximum torque that can be applied on the section shown in Figure 1 if the allowable shear is 300 N/mm^2. Calculate the angle of twist per unit length of the shaft under the above torque. Also determine the shear in various parts of the section. The wall thickness is uniform and has a value of 15 mm. Given modulus of rigidity is $2 \times 10^4\ N/mm^2$. (6)

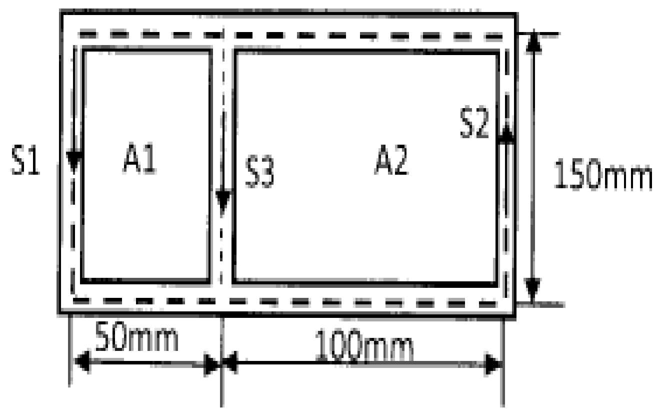

Figure 1

MODULE VI

19. a) Explain strain hardening. (3)

 b) Explain Bauschinger's effect? (3)

OR

20. The state of stress at a point is given by $\sigma_x = 75\ MPa, \sigma_y = -125\ MPa\ and\ \tau_{xy} = 40\ MPa$. If the yield strength of the material is *190 MPa*, find if yielding occurs according to (a) Tresca's failure criteria (b) Von Mises Hencky yield criteria. (6)

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