Reg. No.: 

**Question Paper Code: 18074**

M.E. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

First Semester

Structural Engineering

ST 7103 — THEORY OF ELASTICITY AND PLASTICITY

(Regulations 2013)

Time: Three hours

Maximum: 100 marks

Answer ALL questions.

**PART A — (10 \times 2 = 20 marks)**

1. State generalized Hooke's law.
2. Define shear strain.
4. Express the stress compatibility equation for plane strain case.
6. Write the equation for calculating torsion of elliptical cross section bar.
7. Write the equations for calculating slope and deflection of a infinite beam subjected to single concentrated load.
8. Define semi infinite beam.
9. What are the assumptions made in yield line theory?
10. What is meant by yield line?

**PART B — (5 \times 13 = 65 marks)**

11. (a) The state of stress at a particular point relative to xyz coordinate system is given by stress matrix \[
\begin{bmatrix}
15 & 10 & -10 \\
10 & 10 & 0 \\
-10 & 0 & 40
\end{bmatrix}
\] kg/cm². Determine the normal stress and the magnitude and direction of the shear stress on a surface intersecting the point and parallel to the plane given by the equation \(4x - y + 3z = 11\).

Or
(b) For the stress tensor given below, determine the principal stresses and the direction cosines associated with the normal to the surfaces of each principal stress.

\[
\begin{bmatrix}
15 & 10 & -10 \\
10 & 10 & 0 \\
-10 & 0 & 40
\end{bmatrix}
\]

12. (a) Using Fourier integral method, determine the solution of biharmonic equation in Cartesian coordinates.

Or

(b) A cantilever beam of rectangular cross section 5 cm wide and 6 cm thick is 1 m in length. It carries a load of 5 kN at the free end. Determine the stresses in the cantilever at mid length.

13. (a) Derive the equations for torsion of elliptical cross-section bar.

Or

(b) A 300 mm x 300 mm angle section with 15 mm thickness is subjected to a torque of 250000 Nmm. Find the maximum shear stress induced in the section and the angle of twist per unit length. Assume \( G = 0.8 \times 10^5 \text{ N/mm}^2 \).

14. (a) (i) What are the different types of elastic foundation? Give examples.

(ii) Derive the differential equation for the elastic line of a beam resting on an elastic foundation.

Or

(b) A semi infinite beam with free ends is resting on an elastic foundation. The beam is 6 cm wide and 8 cm thick. It carries a uniformly distributed load of 6 kN/m over a length of 50 cm at one end. Determine the maximum deflection and the stresses in the beam. Assume \( E = 2 \times 10^4 \text{ N/mm}^2 \), \( \mu = 0.30 \) and modulus of elastic foundation as 63 N/mm².

15. (a) Discuss in detail about the various failure theories of plasticity with its limitations.

Or

(b) Derive the expression showing plastic stress strain relationship.
PART C — (1 × 15 = 15 marks)

16. (a) A circular disc of uniform thickness has external radius of 25 cm and internal radius of 5 cm. It is rotated at 750 rpm. Determine the maximum circumferential radial and shear stresses in the disc. Assume density of the material is 7.8 gm/cm³ and \( \mu = 0.28 \).

Or

(b) The state of stress at a point is given by \( \sigma_x = 20 \text{MPa}, \sigma_y = -10 \text{MPa}, \sigma_z = 5 \text{MPa}, \tau_{xy} = 4 \text{MPa}, \tau_{xz} = 5 \text{MPa}, \tau_{yz} = 6 \text{MPa} \). If \( E = 2 \times 10^6 \text{N/mm}^2, \ G = 0.84 \times 10^6 \text{N/mm}^2 \), Determine the strain components.