M.E. (Civil) 1st Semester Examination, 2011

Engineering Elasticity and Plasticity (CE-902)

Time: 3 hours | Full Marks: 70

Answer **Question No. 1** and any **FOUR** from the rest.

1. Write short notes on the following: (any four)
   i) Stress deviator
   ii) Stress invariants
   iii)Lame's coefficient
   iv) Plane strain problem
   v) Airy's stress function

2. a) What do you mean by a yield criterion? Explain Trescas' and Von Mises' yield criteria. Also, give the graphical representations.

   b) The state of stress at a point is given by

$$\sigma_{ij} = \begin{bmatrix} 30 & 45 & 60 \\ 45 & 20 & 50 \\ 60 & 50 & 10 \end{bmatrix} \text{ MPa}$$

   Determine the stress invariants I_1, J_2, J_3 and θ

3. What do you mean by 'equations of plasticity'? Explain Mises equations of plasticity and Prandtl-Rouss equations of plasticity, clearly stating the assumptions.

4. Derive an expression relating torsion and twist in a circular shaft stating the assumptions and explain what you mean by torsion constant. Hence, derive expressions for shear stress for a circular shaft subjected to torsion T.

5. What is meant by plane stress problem? Show that for plane stress, the compatibility equation may be expressed as

$$\nabla^2(\sigma_x + \sigma_y) = (1+\nu)\left(\frac{\partial X}{\partial x} + \frac{\partial Y}{\partial y}\right)$$ where X and Y are the body forces.

6. a) Define Kronecker Delta and permutation symbol.
   b)Distinguish between covariant tensor and contravariant tensor.
   c) Explain principal stress using tensor notation.

7. a) The given state of stress is: $\sigma_x = 12$, $\sigma_y = 8.96$, $\sigma_z = 4.3$, $\tau_{xy} = 4.2$, $\tau_{yz} = 5.25$, $\tau_{zx} = 0.8$. Resolve the state of stress into hydrostatic and pure shear case. Calculate normal and shear stress for hydrostatic and pure shear case separately.

   b) For the following plane strain distribution, verify whether the compatibility condition is satisfied

$$\varepsilon_x = 3x^2y \qquad \varepsilon_y = 4y^2x + 10^{-2} \qquad \gamma_{xy} = 2xy + 2x^3\,\sigma_y$$