BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR

First Semester Master of Engineering (Engineering Mechanics) Final Examination 2013

Subject: Theory of Elasticity and Plasticity I (AM 903)

Full Marks: 70 **Time: 3 hours**

(i) Answer any FIVE questions taking at least TWO from each group.
(ii) All notations have their usual meanings unless specified otherwise.
(iii) Marks will be deducted for unclear writings and diagrams.

Group A

1 (a) Define plane stress and plane strain.

(b) Under plane stress condition, show that the boundary conditions can be expressed by:

$$\hat{X} = l\sigma_x + m\tau_{xy}$$
$$\hat{Y} = m\sigma_y + l\tau_{xy}$$

(c) A circular disk having uniform thickness t and mass density ρ is rotating about its centroidal vertical axis at a uniform angular velocity of ω. Show that the potential function can be expressed as $V = 0.5\rho\,\omega^2(x^2 + y^2)$ [4 + 4 + 6]

2 (a) Derive the following equation of compatibility:

$$\frac{\partial^2 \varepsilon_x}{\partial y^2} + \frac{\partial^2 \varepsilon_y}{\partial x^2} = \frac{\partial^2 \gamma_{xy}}{\partial x\,\partial y}$$

(b) Find the principal strains and their directions from the following rosette measurements:

$$\varepsilon_\varphi = 3x10^{-6}; \quad \varepsilon_{\varphi+\alpha} = 2.5x10^{-6}; \quad \varepsilon_{\varphi+\alpha+\beta} = 0.85x10^{-6};$$

$$where, \quad \alpha = 30^0 \quad and \quad \beta = 45^0$$

[5+9]

3 (a) Derive the following differential equation of equilibrium in polar coordinates:

$$\frac{\partial \sigma_r}{\partial r} + \frac{1}{r}\frac{\partial \tau_{r\theta}}{\partial \theta} + \frac{\sigma_r - \sigma_\theta}{r} + R = 0$$
$$\frac{1}{r}\frac{\partial \sigma_\theta}{\partial \theta} + \frac{\partial \tau_{r\theta}}{\partial r} + 2\frac{\tau_{r\theta}}{r} + S = 0$$

(b) Derive the expressions for the strain components ε_r, ε_θ and $\gamma_{r\theta}$ in polar coordinates in terms of u, v, r and θ. [8+6]