

END SEMESTER EXAMINATION

ST- 003 THEORY OF ELASTICITY AND PLASTICITY

THAPAR INSTITUTE OF ENGINEERING AND TECHNOLOGY, PATIALA

Time: 3 HRS.

MM: 100

- Attempt any five questions
- Assuming any missing data suitably

1. (i) Let x_1, x_2, x_3 be rectangular Cartesian co-ordinates and $\theta_1, \theta_2, \theta_3$ be spherical polar co-ordinates having the following relationship:

$$x_1 = \theta_1 \sin\theta_2 \cos\theta_3; x_2 = \theta_1 \sin\theta_2 \sin\theta_3; x_3 = \theta_1 \cos\theta_2$$

Get the components of Euclidian Metric tensor and the length of the line element. (12)

(ii) What do you understand by Cauchy's Stress Ellipsoid? Explain. (8)

2. (i) Derive the relation between the Lamé's Coefficient and the elastic constants. (10)

(ii) State the conditions under which the following is the possible system of strains:

$$\epsilon_{xx} = a + b(x^2 + y^2) + x^4 + y^4$$

$$\epsilon_{yy} = \alpha + \beta(x^2 + y^2) + x^4 + y^4$$

$$\gamma_{xy} = A + Bxy(x^2 + y^2 - C^2)$$

$$\gamma_{yz} = 0; \gamma_{xz} = 0; \epsilon_{zz} = 0 \tag{10}$$

3. As a result of measurements made on the surface of a machine component with strain gages oriented in various ways, it was established that the principal strains on the free surface are $\epsilon_a = +400 \times 10^{-6}$; $\epsilon_b = -50 \times 10^{-6}$.

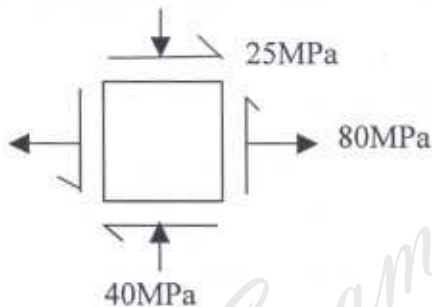
(i) Calculate the value of maximum in plane shearing strain.

(ii) Find absolute maximum shearing strain for the system (Given that $\sigma_c = 0$ for the free surface and Poisson ratio, $\nu = 0.3$). (20)

4. (i) Explain the development of Tresca Yield criteria. (10)

(ii) Write a short note on Plastic stress – strain relations. (10)

5. A state of plane stress shown in figure occurs at a critical point of a steel machine component.



- (i) Determine whether the machine will fail or not if the tensile yield strength is $\sigma_y = 250\text{MPa}$ for the grade of steel used by using maximum shearing stress criteria.
- (ii) Determine the factor of safety with respect to yield using both the maximum shearing stress criteria and maximum distortion energy criteria. (20)
6. (i) What is a Viscoelastic material. Explain the different ways to model its behaviour. (10)
- (ii) Explain the true Stress – strain curve for a ductile material. Also, illustrate the influence of Bauschinger Effect, strain rate and temperature on the curve. (10)