

Name :

Roll No. :

Invigilator's Signature :

CS/M.Tech(SE)/SEM-2/SE-203/2013

2013

THEORY OF ELASTICITY AND PLASTICITY

Time Allotted : 3 Hours

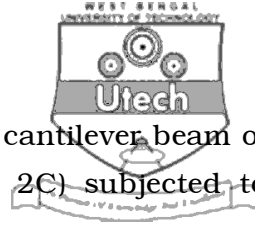
Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer any *five* of the following. $5 \times 14 = 70$

1. a) Using basic principles of theory of elasticity, prove that
$$e = \frac{1-2\nu}{E} \theta, \text{ where } e = \varepsilon_x + \varepsilon_y + \varepsilon_z \text{ and } \theta = \sigma_x + \sigma_y + \sigma_z.$$
 E and ν are modulus of elasticity and Poisson's ratio of the material. 7
- b) From the above expression, find modulus of volume expansion. 3
- c) Develop the expression of stress components i.e. $\sigma_x, \sigma_y, \sigma_z$ in terms of $\varepsilon_x, \varepsilon_y$ and ε_z . 4
2. a) What is the difference between a plane stress problem and plane strain problem ? 2
- b) Derive the differential equation of equilibrium for two-dimensional problems. 4
- c) Derive the condition of compatibility in plane-stress situation. 3
- d) Find the general equation combining (b) and (c). 5



3. Find the equation of deflection curve for a cantilever beam of length l cross-sectional dimension ($1 \times 2C$) subjected to concentrated load P at the free end.

4. a) Derive the differential equation of equilibrium of two-dimensional problem in polar co-ordinates. 7

- b) Using the following expressions of σ_r , σ_θ , $\tau_{r\theta}$ in terms of stress function ϕ , find the stress distribution in a hollow circular cylinder having inner and outer radii as a and b subjected to internal and external pressure p_i and p_o respectively.

$$\sigma_r = \frac{1}{r} \left(\frac{\partial \phi}{\partial r} + \frac{1}{r^2} \frac{\partial^2 \phi}{\partial \theta^2} \right)$$

$$\sigma_\theta = \frac{\partial^2 \phi}{\partial r^2}$$

$$\tau_{r\theta} = \frac{1}{r^2} \left(\frac{\partial \phi}{\partial \theta} \right) - \frac{1}{r} \frac{\partial^2 \phi}{\partial r \partial \theta}. \quad 7$$

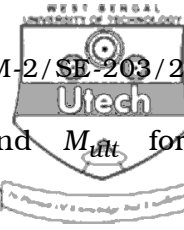
5. a) What do you mean by principal stress and principal plane ? 2

- b) A square element of a thin plate is subjected to following stress components :

$$\sigma_x = -50 \text{ N/mm}^2, \quad \sigma_y = +150 \text{ N/mm}^2, \quad \tau_{xy} = 100 \text{ N/mm}^2.$$

Draw Mohr's circle and find the magnitude and direction of principal stresses. 5

- c) Derive the expression from which the magnitude of principal stresses can be calculated in three dimensional problems. 7



6. a) Derive the expression of M_y , M_{ep} and M_{ult} for a rectangular beam cross-section ($b \times d$). 7
- b) Derive an expression relating torsion, twist and shear stress for a circular shaft. 7
7. a) What do you mean by yield criteria ? 3
- b) Explain Trescas and Von Mises yield criteria. 8
- c) What is the difference between Trescas' and Von Mises' yield criteria ? 3
8. a) What do you mean by stress tensor? 2
- b) Write short notes on the following :
- (i) Stress invariants
- (ii) Stress deviator. 6
- c) The state of stress at a point is given by
- $$\sigma_{ij} = \begin{bmatrix} 30 & 45 & 60 \\ 45 & 20 & 50 \\ 60 & 50 & 10 \end{bmatrix}$$
- Determine the stress invariants I_1 , I_2 , I_3 and J_2 . 6

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