ST5103- Theory of Elasticity and Plasticity

Important 13 Marks Questions

Part-B

Unit- I

1. The three stress components at a point are given by $\begin{bmatrix} 10 & 5 & 6 \\ 5 & 8 & 10 \\ 6 & 10 & 6 \end{bmatrix}$ MPa calculate the principal stresses and principal planes?
2. Derive the compatibility equations for plane stress problem and plane strain problem in cartesian coordinate considering the body forces. Also show that when the body forces are constant or zero, the compatibility equations for plane stress problem and plane strain problem reduces to the same?
3. Using Fourier integral method, determine the solution of biharmonic equation in Cartesian coordinates?
4. Following unit elongations were measured with a rectangular strain rosette $\epsilon_0 = 3 \times 10^{-4}, \epsilon_{45} = -4 \times 10^{-4}\ and\ \epsilon_{90} = 5 \times 10^{-4}$ Determine the principal strains and their directions?
5. Derive the Elastic Stress – Strain relationship by the understanding of Hook's law for isotropic and homogeneous materials.

Unit- II

1. Discuss the use of polynomials in the solution of structural problems?
2. Show that the Airy's stress function $\emptyset = A\left(xy^3 - \left(\frac{3}{4}\right)xyh^2\right)$ represents the stress distribution in a cantilever beam loaded at the free end with load P. find the value of A, if $r_{xy} = 0\ at\ y = \pm h/2$ where b and h are width and depth respectively of the cantilever beam cross section?
3. The following stress function is proposed for a long cantilever carrying a point load at the free end. Determine the stress components and verify the same.
4. Show that Ψ = C (Constant) solves the torsion problem of a solid circular shaft using warping function approach. Evaluate the maximum shear stress and torsional moment, in terms of torsional rigidity, and verify the results are in agreement with those given by the strength of materials approach.

5. State the plain stress and plain strain. Discuss the plain stress and plain strain for two dimensional problems with illustration.

Unit- III

1. A 300mm steel I beam with flanges and web 12.5mm thick is subjected to a torque of 4kNm. Find the maximum shear stress and angle of twist per unit length. Assume G = 100GPa.
2. An I section with flanges 50mm × 5mm and web 140mm × 3mm is subjected to a twisting moment of 200Nm. Find the maximum shearing stress and twist per unit length. Assume G=80Gpa. If the I section is stiffened by welding two steel plates of size 140mm × 5mm, find the stress due to the same torque.
3. A thin-walled closed tube of non-circular section is subjected to a torque T. Derive the expression for shear stress and angle of twist.
4. Discuss the design method analysis of torsion on thin walled open and closed section.
5. Write short notes on the following i) Analogy by St. Venant's Approach ii) Analogy by Prandit's Approach.

Unit- IV

1. What are the two types of elastic foundations? Explain them briefly.
2. Derive the governing differential equation for the elastic line of a beam resting on an elastic foundation.
3. The foundation for a machine base comprises of standard I beams of overall depth 75mm and 8m long supported on coil springs spaced at 120N/mm. The machine transmits a concentrated load of 10KN acting at the mid-point of the beam. Estimate the maximum deflection and the bending stress in the beam, assuming the modulus of elasticity of the materials of the beam is 70kN/mm^2 and second moment of area of the beam is 1×10^6 mm^4.
4. Illustrate the Rayleigh Ritz method of analysis in the application to beams and columns.
5. State and prove energy theorems and also explain the applications of theorem to beams and columns.

Unit- V

1. Discuss the various yield criteria and its use to predict the onset of yielding in metals.

2. The state of stress in a material is given by σ_x=75 *MPa*, σ_y=95 *MPa* and τ_{xy} = 55 *MPa*. If the yield strength of the material is 120 MPa, determine whether yielding will occur or not.
3. Explain the sand heap analogy for solving plastic torsion problems. What are the limitations of this analogy?
4. Briefly explain about elastic plastic problems in bending and torsion with a typical idealized stress-strain diagram.
5. Explain the various failure Theories adopted in elastic-plastic analysis with necessary sketches.