Ref. No. : Ex/CE/PE/B/T/415B/2025

Name of the Examinations: B.E. CIVIL ENGINEERING FOURTH YEAR FIRST SEMESTER – 2025

Subject : ADVANCED SOLID MECHANICS **Time : 3 hours** **Full Marks :100**

Part I (50 Marks)

Instructions : Use Separate Answer scripts for each part

Question 1. Establish the relationship between octahedral shear stress and stress invariants of deviatoric components of stress tensor. (CO1) (5)

Question 2. The state of stress shown in Figure 1 is in a component made of a ductile material with a yield strength of σ_Y = 250 MPa. Does the maximum shear stress theory predict failure for the material? Does the maximum distortion energy predict failure for the material? (CO3) (10)

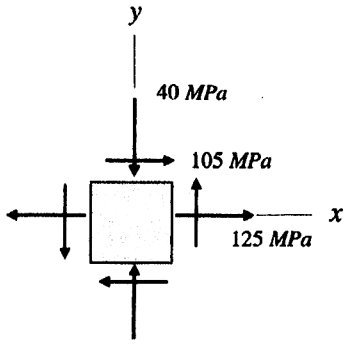

Figure 1

Question 3. Plot the failure boundary based on (i) Rankine (ii) Tresca (iii) St. Venant (iv) Haigh and (v) von Mises failure theories for ductile material subjected to 2-D stress. (CO3) (5)

Question 4. Develop the bi-harmonic equation in polar coordinate in terms of Airy's Stress Function for a 2-D continuum. (CO4) (10)

Question 5. An annular plate with inner diameter d_i and outer diameter d_o is loaded axi-symmetrically as shown in Figure 2. Obtain the expression for stresses within the plate. Assume any other relevant data required. (CO4) (10)

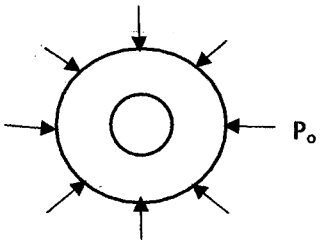

Figure 2

Question 6. The stress state at a point is described by the stress components: σ_{11} = 14, σ_{22} = 10, σ_{33} =35, σ_{12} = 7, σ_{13}= -7, σ_{23} = 0 (MPa). Find the normal and resultant shear stresses acting upon a plane whose normal is defined by the direction cosines: $l = 2/\sqrt{14}, m = -1/\sqrt{14}, n = 3/\sqrt{14}$

(CO1) (10)

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(Use Separate Answer scripts for each Part)

Part- II (Marks 50)

1. Starting from anisotropic material, show that the independent elastic constants for isotropic material are only two. 30
2. Starting from equilibrium equation, find the Bi-harmonic equation i.e. $\frac{\partial^4 \phi}{\partial x^4} + 2\frac{\partial^4 \phi}{\partial x^2 \partial y^2} + \frac{\partial^4 \phi}{\partial y^4} = 0$ for plane strain problem. Use this Bi-harmonic equation to obtain stress and displacement field for uniaxial tension problem. 20