B. Tech Degree V Semester (Special Supplementary) Examination, July 2005

ME 503 ADVANCED MECHANICS OF SOLIDS

(2002 Admissions)

Time : 3 Hours — Maximum Marks : 100

I. (a) Distinguish between plane stress and plane strain conditions citing suitable examples. (6)

(b) During static test of an air plane wing, the following readings were obtained from a 60° strain rosette with gauge 'a' horizontal :

$$\epsilon_a = 1000\times10^{-6}, \epsilon_b = 2000\times10^{-6}, \epsilon_c = 1200\times10^{-6}.$$

Calculate -
- (i) the principal strains
- (ii) the maximum shear strain
- (iii) the principal stresses
- (iv) the maximum shear stress
- (v) orientation of the principal directions

The modulus of elasticity of the material = 80 GPa and Poisson's ratio = 0.35. (14)

OR

II. (a) Show that $\phi = A(xy^3 - \frac{3}{4}xyh^2)$ is an Airy's stress function, where 'A' and 'h' are constants. Also show that it represents the stress distribution in a cantilever beam loaded at the free end with a load. (6)

(b) Using the stress-strain relations, strain compatibility equation, and equations of equilibrium, derive the relation for plain strain $\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}\right)(\sigma_x+\sigma_y) = \frac{-1}{1-\nu}\left(\frac{\partial X}{\partial x}+\frac{\partial Y}{\partial y}\right)$ where X and Y are the components of body force per unit volume along the x & y directions and ν is the Poisson's ratio. (14)

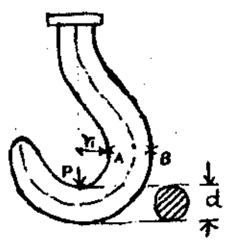
III. (a) Obtain the expressions for the strain components in terms of the displacement components in polar co-ordinates. (6)

(b) Determine the stress at points A & B of a crane hook having a circular cross section and carrying a load P. (14)

$r_1 = 5\,cm$

$P = 30\,KN$

$d = 4\,cm$



OR

IV. (a) Derive the expressions for the radial and tangential stress components developed in a disk rotating at an angular velocity ω. Neglect the weight of the disk. (10)

(b) A gas turbine steel disk of 76 cm outer diameter and 16 cm internal diameter is shrunk on to a steel shaft. The shrink allowance is 0.008 cm on radius. Calculate the speed at which the shrink fit will loosen up, considering the shaft as a solid disk. Take the Elasticity Modulus = 200 GPa, Poisson's ratio = 0.3, Density of steel = 8000 Kg/m³. (10)

V. (a) Explain the following : (i) Octahedral shear stress (ii) Lame's stress ellipsoid. (6)

(b) At a point in a given material, the state of the stress is given by $\tau_{ig} = \begin{pmatrix} 10 & 20 & 10 \\ 20 & 10 & 10 \\ 10 & 10 & 10 \end{pmatrix} N/mm^2$.

(Turn Over)

Compute the following :

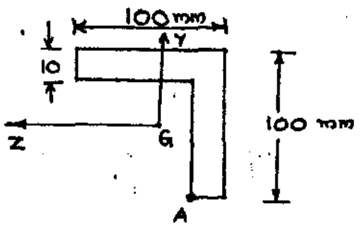
- (i) Principal stresses
- (ii) Orientation of the principal planes
- (iii) Maximum shear stresses
- (iv) Octahedral shear stress
- (v) Octahedral normal stress. (14)

OR

VI. (a) Derive the differential equations of equilibrium for 3D stress system. (10)

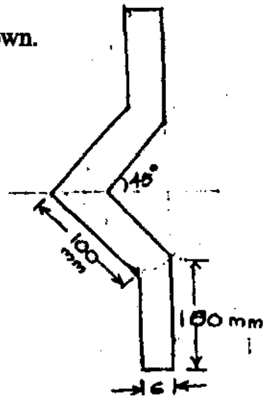
(b) The state of stress at a point is given by the matrix $\begin{pmatrix} \sigma & 2 & 1 \\ 2 & 0 & 2 \\ 1 & 2 & 0 \end{pmatrix} MPa$. Determine the value of σ such that there is at least one plane passing through the point in such a way that the resultant stress on that plane is zero. Determine the direction cosines of the normal to the plane. (10)

VII. A cantilever beam of equal leg angle section $100 \times 100 \times 10\, mm$ is carrying a uniformly distributed load of 1000 N/m. If the span of the beam is 3 m, determine the stress at point A near the built-in end. Also calculate the orientation of the neutral axis. (20)



OR

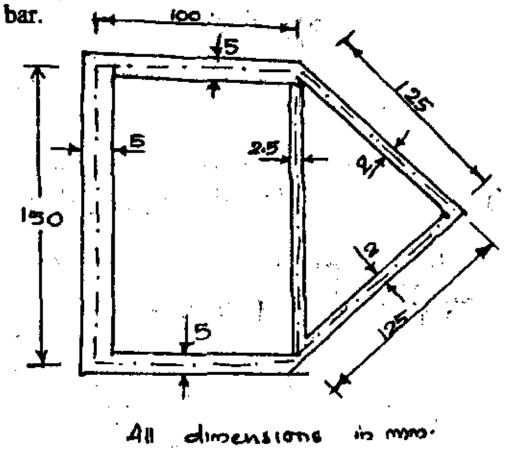
VIII. Locate the shear centre for the section shown. (20)



IX. An elliptical bar is subjected to a twisting moment T. The semi major and minor axes of the ellipse is 'a' & 'b'. Determine the shear stresses developed in the bar. Also calculate the twist per unit length of the bar. (20)

OR

X. A double celled tube is as shown. If the tube is subjected to a torque of 10 KNm, calculate the shear stress in each part and the angle of twist per metre length. Take the modulus of rigidity of the material of the tube is 80 KN/mm^2. (20)



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