B. Tech Degree V Semester (Supplementary) Examination July 2010

ME 503 ADVANCED MECHANICS OF SOLIDS

(2002 Scheme)

Time : 3 Hours Maximum Marks : 100

I. (a) What is stress function? Explain how the stress function in 2D problems are solved using a third degree polynomial. (10)

(b) In a rectangular rosette, the recorded strains are $E_{0^o} = 110\times10^{-6}$, $E_{45^o} = 60\times10^{-6}$, $E_{90^o} = 110\times10^{-6}$. Find the principal strains. (10)

OR

II. (a) The stresses at a point are $\sigma_x = 8MPa$, $\sigma_y = 2MPa$ and $\lambda_{xy} = -4MPa$. Find the principal stresses using Mohr's Circle Method. (8)

(b) Derive the transformation equations for strain when a body is in a state of plain strain. (12)

III. (a) Derive the expressions for the radial and tangential stresses developed in a disk of uniform thickness with inner radius 'a' and outer radius 'b' rotating with an angular velocity 'w'. (10)

(b) Evaluate the outer radius 'b' for a cylinder subjected to an internal pressure $p = 500$ atm with a factor of safety z. The yield point for the material (in tension as well as in compression) is $\sigma_{yp} = 5000\,\text{kgf/cm}^2$ (490000 kPa). The inner radius is 5 cm. Assume that the ends of the cylinder are closed. (10)

OR

IV. (a) Derive the strain components in polar co-ordinates. (10)

(b) A flat steel disk of 750 mm outer diameter with a 150 mm dia hole is shrunk around a solid steel shaft. The shrink fit allowance is 0.0075 cm in radius. At what speed will the shrink fit loosen up as a result of rotation. Assume that the same equations of disk are applicable to the shaft also. Take the modules of elasticity as 214 GPa and poisson ratio 0.3. (10)

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

(b) At a point in a given material, the state of stress is given by

$$\lambda_{ij} = \begin{bmatrix} 10 & 20 & 10 \\ 20 & 10 & 10 \\ 10 & 10 & 10 \end{bmatrix} \text{N/mm}^2$$

Compute - (i) Principal stresses
(ii) Orientation of the principal planes. (10)

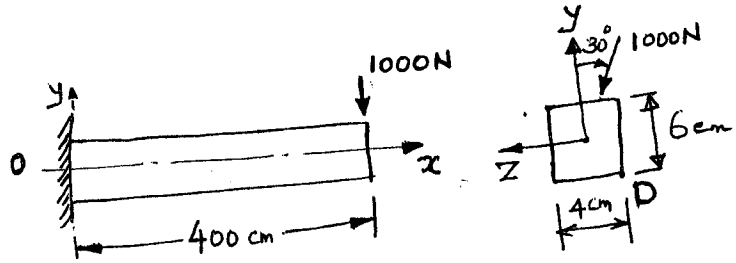
OR

VI. (a) Explain the following :
(i) Stress invariants (ii) Compatibility conditions. (10)

(P.T.O.)

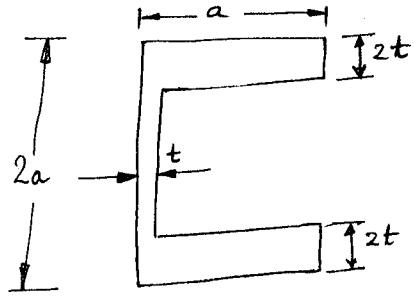
(b) The state of stress at a point is given by the matrix $\begin{bmatrix} \sigma & 2 & 1 \\ 2 & 0 & 2 \\ 1 & 2 & 0 \end{bmatrix}$ MPa. Determine the value of σ such that there is at least one plane passing through the point in such a way that the resultant stress on that plane is zero. Determine the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

VII. A cantilever beam of rectangular section is subjected to a load of 1000 N which is inclined at an angle of 30° to the vertical. What is the stress due to bending at point D near the built – in – end (20)

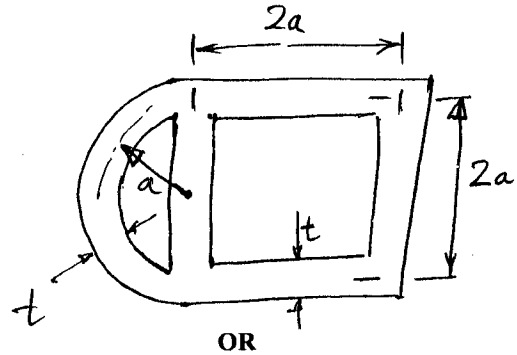


OR

VIII. A channel section shown in figure is subjected to a transverse shear force. Determine the location of the shear centre. (20)



IX. A thin-walled box shown in figure is subjected to a torque T. Determine the shear stresses in the walls and the angle of twist per unit length of the box. (20)



OR

X. Derive the expressions for stresses in a bar of elliptical cross section subjected to a torque T, using stress function $\phi = K\left[\frac{x^2}{a^2}+\frac{y^2}{b^2}-1\right]$ where K is a constant. Also determine its torsional rigidity. (20)

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