B. Tech Degree IV Semester Examination, April 2009

ME 403 ADVANCED MECHANICS OF SOLIDS

(2006 Scheme)

Time : 3 Hours Maximum Marks : 100

PART A

(Answer ***ALL*** questions)

(8 x 5 = 40)

I. (a) Explain the term 'stress function' with example.

(b) State and explain the compatibility equations for 2D problems.

(c) Explain the components of strain in 2D polar coordinates.

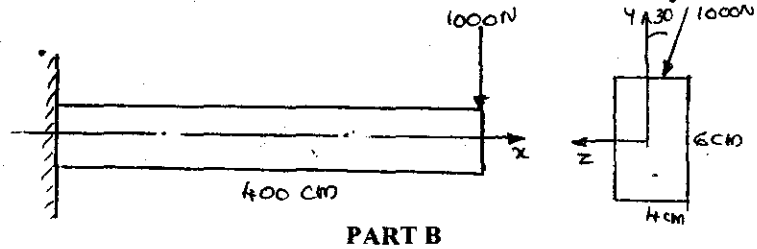
(d) A steel turbine disc is to be designed so that between radii of 25cm and 40 cm, the radial and circumferential stresses are to be constant and both equal to 600 Kg/cm^2 when running at 3000 rpm. If the axial thickness is 12mm at the outer edge of this zone, what should it be at inner edge. Assume wt/cm^3 = 8 gm.

(e) Obtain the differential equations of equilibrium of 3D problems.

(f) Define the term virtual work. Explain the principle of virtual work.

(g) Explain the term 'Membrane Analogy'.

(h) A cantilever beam of rectangular section is subjected to a load of 1000 N which is inclined at an angle of 30^0 to the vertical. What is the stress due to bending at point D near the built in end?



PART B

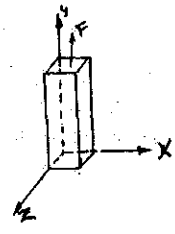
(4 x 15 = 60)

II. (a) A rectangular bar having a cross section 2 cm x 3 cm is subjected to a tensile force of 6000N. If the axes are chosen as shown in the figure. Determine the normal and shear stresses on plane whose normal has the following direction cosines:

(i) $n_x = n_y = 1/\sqrt{2}, n_z = 0$

(ii) $n_x = 0, n_y = n_z = 1/\sqrt{2}$

(iii) $n_x = n_y = n_z = 1/\sqrt{3}$.



(5)

(b) Derive the differential equations of equilibrium for plane stress condition. (10)

OR

III. (a) Investigate what problem solved by

$\phi = \frac{F}{d^3} xy^2 (3d - 2y)$ applied to the region included in $y = 0, y = d, x = 0$ on the side x positive. (7)

(b) The general displacement field in a body, in Cartesian coordinates, is given by

$$u = 0.015\ x^2 y + 0.03$$

$$v = 0.005\ y^2 + 0.03xz$$

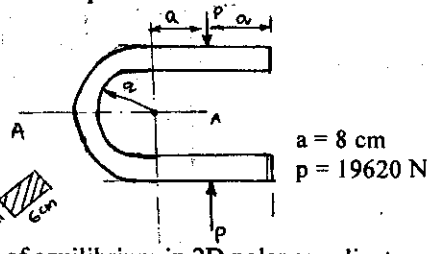
$$w = 0.003\ z^2 + 0.001\ yz + 0.005$$

Find the strain rotation tensors $\in ij$ and ωij for point $(1, 0, 2)$. (8)

(Turn Over)

IV. (a) The thick walled tube is subjected to an external pressure P_2. Its internal and external radii are 10cm and 15cm respectively. N = 0.3 and E = 2 x 10^5 MPa. If the maximum shear stress is limited to 2 x 10^5 kPa determine the value of P_2 and also the external radius. (8)

(b) Determine the maximum tensile and maximum compressive stresses across the section AA as shown in figure



(7)

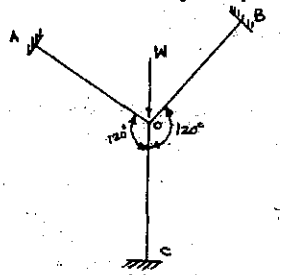
OR

V. Derive the expression for general equations of equilibrium in 2D polar coordinate system. (15)

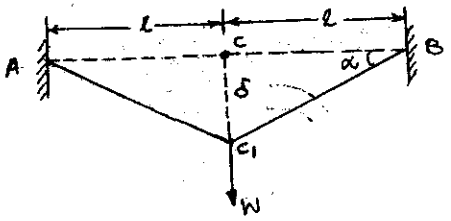
VI. The state of stress at a point is characterized by the components $\sigma_x = 12.31, \sigma_y = 8.96, \sigma_z = 4.34$, $\tau_{xy} = 4.20, \tau_{yx} = 5.27$, $\tau_{xz} = 0.84$. Find the principal stresses and their directions. (15)

OR

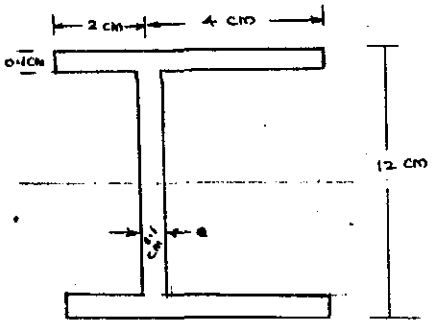
VII. (a) For a system shown in the figure, determine the load W necessary to cause a displacement δ in the vertical direction of point 0. 'a' is the cross sectional area and l is the length of each member. Use the principle of virtual work. (8)



b. The figure shows two identical bars hinged together, carrying a load of W. Check Castigliano's First theorem, using the elastic and complementary strain energy. (7)



VIII. For the section shown in the figure, locate the shear centre. For a vertical shear of 576 Kg, construct a shear flow diagram. (15)



OR

IX. Derive the expression for twist per unit length in thin walled tube subjected to torsion. (15)

***