BENSON FRANCIS

B. Tech Degree IV Semester Examination, April 2008

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 steps involved in the construction of Mohr's circle for strain measurement.

(b) State and explain St.Venant's Principle.

(c) Explain the relationship between stress components in rectangular co-ordinates and polar co-ordinates.

(d) Obtain the equations of equilibrium for a rotating discs.

(e) Explain the term stress ellipsoid.

(f) State and explain Castigliano's theorem with examples.

(g) Explain the term shear centre.

(h) Obtain the expression for twist of a thin tube.

PART – B

II. (a) For a stress function $\phi(r,\theta)$, the values of σ_r, σ_θ and $\tau_{r\theta}$ are given below. Show that, in the absence of body forces, these satisfies differential equations of equilibrium. $\sigma_r = \frac{1}{\gamma}\frac{\partial\phi}{\partial v} + \frac{1}{r^2}\partial^2\phi/\partial\theta^2$, $\sigma_\theta = \partial^2\phi/\partial r^2$,

$\tau_{r\theta} = -1/r\,\partial^2\phi/\partial r\partial\theta + \frac{1}{r^2}\cdot\partial\phi/\partial\theta$ (5)

(b) The displacement field is given by $Ux = K\left(x^2 + 2z\right), Uy = K\left(4x + 2y^2 + z\right), Uz = 4Kz^2$. K is a very small constant. What are the strains at $(2,2,3)$ in direction?

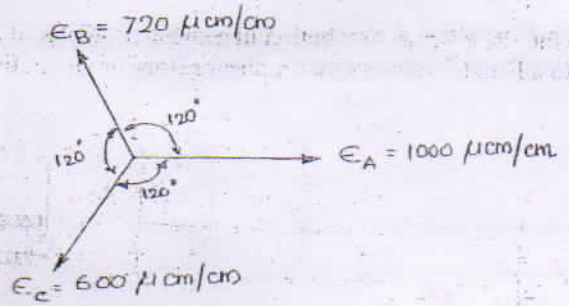
(i) $n_x = 0,\ n_y = 1/\sqrt{2}, n_z = 1/\sqrt{2}$

(ii) $n_x = 1\ \ n_y = n_z = 0$

(iii) $n_x = 0.6,\ n_y = 0, n_z = 0.8$ (10)

OR

III. (a) The arrangement of a 3 element delta rosette is given below. Find the principal strains. (5)



(b) The state of stress at a point for a given reference is given below. If a new set of axes $x'y'z'$ is formed by rotating $x\ y\ z$ through 60^0 about z axis, find the new stress tensor τns

$$\tau ij = \begin{Bmatrix} 200 & 100 & 0 \\ 100 & 0 & 0 \\ 0 & 0 & 500 \end{Bmatrix}$$ (10)

(Turn Over)

IV. (a) A steel shaft 100 mm in diameter has a 500 mm diameter steel disc shrunk on it. Permissible shrinkage strain is 0.0008. Find

(i) radial and tangential stresses at stand still

(ii) speed at which the disc will be loosened from shaft

(iii) shrinkage pressure at half the speed arrived above.

Given $E = 2\times10^6\ Kg/cm^2\ \ \mu = 0.3\ \ \delta = 8\ gm/cm^3$. (9)

(b) Derive the stress equilibrium equations in polar co-ordinates. (6)

OR

V. (a) Derive the expression for the radial and tangential stress components developed in a disk rotating at an angular velocity ω. (7)

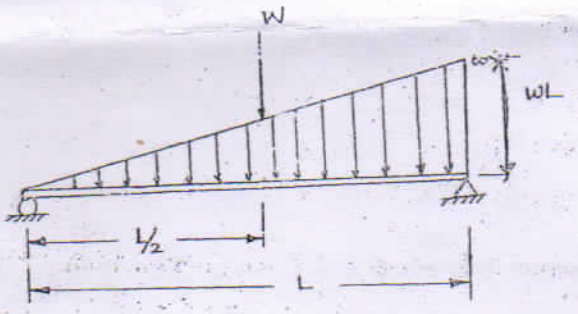
(b) Determine the radial and circumferential stress due to the internal pressure $p = 1.96\times10^5 kPa$ in a composite tube consisting of an inner copper tube of radii 10cm and 20cm and an outer steel tube of external radius 40 cm. $\nu_{st} = 0.3, \nu_{cu} = 0.34\ \ E_{st} = 1.96\times10^8 kPa,\ E_{st} = 0.98\times10^8 kPa$. Calculate these stresses at the inner and outer radius points of each tube. Determine the contact pressure also. (8)

VI. At a point P, the rectangular stress components are, $\sigma_x = 1,\ \sigma_y = -2,$ $\sigma_z = 4, \tau_{xy} = 2, \tau_{yz} = -3$ and $\tau_{zx} = 1$, all in units of kPa. Find the principal stresses and their directions. (15)

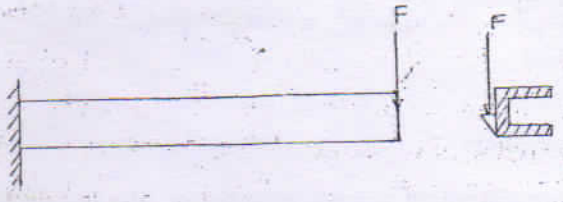
OR

VII. (a) An I beam has a depth d, width B, thickness of flange and web as t and b, and moment of inertia I. Find the total deflection due to bending and shear for simply supported span of L, loaded by a concentrated load of W at the centre by energy methods. (8)

(b) Find the central deflection of a simply supported beam of span with triangular loading as given below. (7)



VIII. Determine the shear stress distribution in a channel section of a cantilever beam subjected to a load F. Also locate the shear centre of the section. (15)



OR

IX. Derive the expression for maximum shear stress and angle of twist for an elliptical shaft. (15)

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