B. Tech Degree V Semester Examination November 2010

ME 503 ADVANCED MECHANICS SOLIDS

(2002 Scheme)

Time : 3 Hours Maximum Marks : 100

I. (a) Let $\sigma_x = -5C, \sigma_y = C, \sigma_z = C, \lambda_{xy} = -C, \lambda_{yz} = \lambda_{zx} = 0$, where C=1000KPa. Determine the principal stresses, stress deviators, principal axes, greatest shearing stress and octahedral stresses. (7)

(b) If the value of Modulus of elasticity E and the shear modulus G for an alloy are 200 GPa and 80GPa, find the Lame's constant λ. Hence find the components of the stress tensor λ_0 if the strain tensor is given by $\sum ij = \begin{pmatrix} 1 & 0 & -2 \\ 0 & -3 & 0.5 \\ -2 & 0.5 & 0 \end{pmatrix} x\, 10^{-3}$.

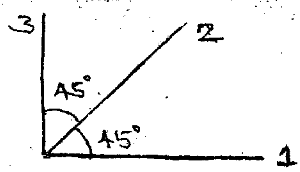
Express the stress tensor in the matrix form. (7)

(c) Derive the equation of equilibrium in Cartesian co-ordinates for 2D-field. (6)

OR

II. (a) Derive the compatibility condition for strain in a 2D field. (6)

(b) A rectangular rosette shown in figure gives the following results on the surface of a body. Gauge 1 = 0.002, gauge 2=0.001, gauge 3 = -0.004. What are the principal strains at the point. Take the modulus of elasticity as 200 GPa and poisson ratio 0.3. (7)



(c) An element in plane stress is subjected to stresses $\sigma_x = 15000pa, \sigma_y = 5000Pa$ and $\lambda_{xy} = 4000Pa$ using Mohr's circle, determine

(i) the stresses acting on an element rotated through an angle $\theta = 40^0$.
(ii) the principal stresses
(iii) the maximum shear stresses. (7)

III. (a) The radial displacement at the outside of a thick cylinder subjected to an internal pressure P_a is $\frac{(2p_a r_b r_a)^2}{E(r_b^2 - r_a^2)}$. By Maxwell's reciprocal theorem, find the inward radial displacement at the inside of a thick cylinder subjected to external pressure. (10)

(b) Derive expression 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 ω. (10)

OR

IV. (a) A disk of thickness *t* and outside diameter *2b* is shrunk on a steel shaft of diameter *2a*, producing a radial interference pressure *p* in the non-rotating condition. It is then rotated with an angular velocity ω rad/s. If *f* is the co-efficient of friction between disk and shaft and ω_0 is the value of the angular velocity for which the interface pressure falls to zero, show that

(i) the maximum horsepower is transmitted when $\omega = \omega_0 / \sqrt{3}$.
(ii) this maximum horsepower is equal to $0.000366\, a^2 tfp\omega_0$, where the dimensions are in inches and pounds. (10)

(P.T.O)

(b) Derive expression for bending of curved beams (Winkler-Bach Formula) (10)

V. (a) Derive the strain displacement relations in a 3D stress field in Cartesian co-ordinates. (7)

(b) Discuss generalized Hook's law. (6)

(c) Find the principal stresses and principal directions for the following 3D stress field.

$$\begin{bmatrix} 10 & 5 & 8 \\ 5 & 15 & 7 \\ 8 & 7 & 20 \end{bmatrix} MPa.$$

(7)

OR

VI. (a) At a point in a stressed material, the principal stresses acting are given as $\sigma_1 = 120pa, \sigma_2 = 60pa$ and $\sigma_3 = 20pa$. Find the normal and shear stress on a plane whose normal is inclined at an angle of 40^0 to the σ_1 axis in the plane containing the σ_1 & σ_3 stresses and 50^0 to the σ_1 axis in the plane containing the σ_1 and σ_2 stresses. Find also the normal and shear stresses on the octahedral planes. (10)

(b) Show that Lame's ellipsoid and the stress –director surface together completely define the state of stress at a point. (10)

VII. (a) Define a shear centre. Discuss it's practical applications. (6)

(b) Explain Castigliano's theorem. (7)

(c) Derive the transformation equations for moments of inertia v_{nn}, v_{yy} and v_{xy} in the content of unsymmetrical bending. (7)

OR

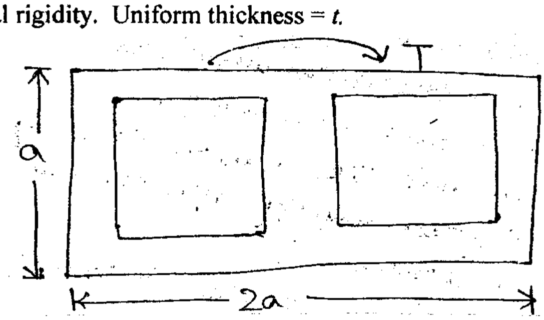
VIII. (a) Briefly describe the theorem of virtual work. (8)

(b) A curved beam is having a circular cross section of radius a. If the inner radius is P_1 and outside radius is P_2, derive an expression for the radius of curvature of the neutral surface when bending moment is applied in the plane of it's curvature. (12)

IX. An elliptical section is subjected to a torque T. Derive the expression for (i) Shear stresses (ii) Warping (iii) Torsional rigidity. Show the deflection contours. (20)

OR

X. Using the membrane analogy analyze the following section for torsional shear stresses and torsional rigidity. Uniform thickness = *t*. (20)



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