B. Tech Degree V Semester (Supplementary) Examination June 2011

ME 503 ADVANCED MECHANICS OF SOLIDS

(2002 Scheme)

Time : 3 Hours Maximum Marks : 100

I. (a) The state of stress at a particular point relative to the xyz coordinate system is given by the stress matrix (12)

$$\begin{bmatrix} 15 & 10 & -10 \\ 10 & 10 & 0 \\ -10 & 0 & 40 \end{bmatrix} M\ Pa$$

Determine the normal stress and magnitude and direction of the shear stress on a surface intersecting the point and parallel to the plane given by the equation $2x - y + 3z = 9$.

(b) State and explain St.Venant's principle. (8)

OR

II. (a) A cantilever beam of rectangular cross section 40mm wide and 60mm thick is 800mm in length. It carries a load of 500N at the free end. Determine the stresses in the cantilever at the mid length. (12)

(b) Explain the term stress function. Determine the stress field that arise from the stress function $\phi = cy^2$. (8)

III. (a) A steel gun barrel is subjected to an internal pressure of 70 M Pa. The internal diameter of the barrel is 75mm and external diameter is of 225mm. A steel band 25mm thick and internal diameter 0.075mm smaller than external diameter of the gun barrel is shrunk on the gun barrel. Calculate: (12)

(i) the shrinkage of pressure on the gun barrel
(ii) max stress in the steel band
(iii) minimum temperature to which the band must be heated to make the assembly

For steel, $E = 200G\,Pa$, $\upsilon = 0.3$ and coefficient of thermal expansion = $10 \times 10^{-6}\ /^0 C$

(b) Obtain the equilibrium equations for plane stress problems in polar co-ordinates. (8)

OR

IV. (a) Derive the expressions for maximum stresses in a rotating disc. (10)

(b) A steel turbine rotor of 750mm outer diameter, 150mm inner diameter and 50mm thickness, has 100 blades 150mm long, each weighing 4N. It is shrink-fitted on a rigid shaft. Calculate the initial shrinkage allowance on the inner diameter of the rotor so that it just loosens on the shaft at 3000 rpm. Take $E = 200G\,Pa$ $\upsilon = 0.3$. The density of shaft rotor is 7500 kg/m^3. (10)

V. (a) Write short notes on (6)

(i) Stress ellipsoid
(ii) Stress Invariants

(b) Determine the principal stresses and their axes for the state of stress characterized by the given stress matrix. (14)

$$\left[\tau_{ij}\right] = \begin{bmatrix} 18 & 0 & 24 \\ 0 & -50 & 0 \\ 24 & 0 & 32 \end{bmatrix}$$

OR

VI. (a) Explain the term octahedral stress. (6)

(b) The state of stress at a point is characterized by the components (14)

$\sigma_x = 12.31 \quad \sigma_y = 8.96 \quad \sigma_z = 4.34$

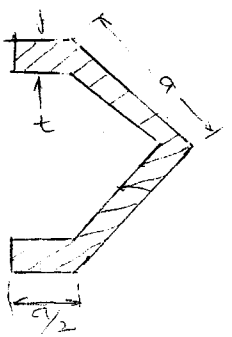
$\tau_{xy} = 4.2 \qquad \tau_{yx} = 5.27 \quad \tau_{zx} = 0.84$

Find the values of principal stress and their directions.

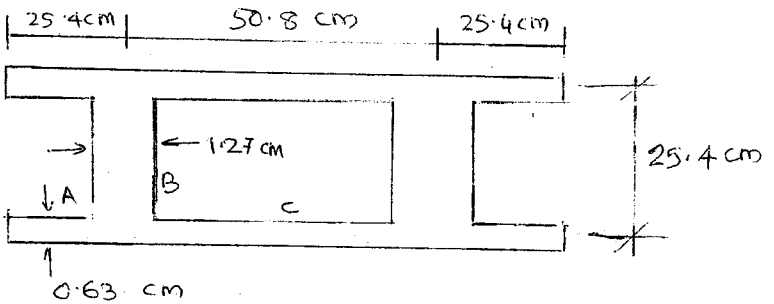
VII. Obtain the expressions for vertical displacements for a prismatic bar stretched by its own weight. (20)

OR

VIII. Locate the shear centre from CG for the section given below: (20)



IX. A section which is subjected to twisting is shown below. Determine the allowable twisting moment for a maximum shear stress of 68 950 k Pa. Calculate the shear stresses in different parts of section neglecting stress concentration. (20)



OR

X. Obtain the expression for maximum shear stress in an elliptical bar subjected to torsion. (20)

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