STRUCTURAL MECHANICS Revision Examples

1. An element of material is subject to the following stresses in the x-y plane: $\sigma_x = 20$ MN/m^2; $\sigma_y = 30$ MN/m^2; $\tau_{yx} = 25$ MN/m^2.

(i) Sketch the element, showing the directions of the components of stress. (4 marks)
(ii) Find the principal stresses. (5 marks)
(iii) Sketch the Mohr circle. (7 marks)
(iv) Calculate the maximum shearing stress. (4 marks)

2. An element of material is subject to the following stresses in the x-y plane: $\sigma_x =$ 100 MN/m^2; $\sigma_y = 0$; $\tau_{yx} = 50$ MN/m^2.

(i) Sketch the element, showing the directions of the components of stress. (5 marks)
(ii) Find the principal stresses. (5 marks)
(iii) Find the angles of the principal stresses to the x direction. (5 marks)
(iv) Calculate the maximum shearing stress. (5 marks)

Data Sheet for Structural Mechanics

Hooke's Law

$$\varepsilon_x = \frac{1}{E}\left\{\sigma_x - \nu(\sigma_y + \sigma_z)\right\} + \alpha(T - T_0)$$

etc.

Thin cylinder

Axial stress $\sigma_x = \dfrac{pr}{2t}$; hoop stress $\sigma_\theta = \dfrac{pr}{t}$.

Bending

$$\frac{\sigma}{y} = \frac{M}{I} = \frac{E}{R}$$

Second moments: rectangle $I = \dfrac{bd^3}{12}$; solid cylinder $I = \dfrac{\pi R^4}{4}$.

Slope and deflection: $EI\dfrac{d^2v}{dx^2} = -M$.

Stress transformations

Principal stresses $\sigma_{1,2} = \dfrac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left[\left(\dfrac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2\right]}$

Angle of principal stresses to x axis $\tan 2\theta = \dfrac{2\tau_{xy}}{\sigma_x - \sigma_y}$.