

STRUCTURAL MECHANICS Revision Examples

1. An element of material is subject to the following stresses in the x-y plane: $\sigma_x = 20$ MN/m²; $\sigma_y = 30$ MN/m²; $\tau_{yx} = 25$ MN/m².

- Sketch the element, showing the directions of the components of stress. (4 marks)
- Find the principal stresses. (5 marks)
- Sketch the Mohr circle. (7 marks)
- 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/m²; $\sigma_y = 0$; $\tau_{yx} = 50$ MN/m².

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

Data Sheet for Structural Mechanics

Hooke's Law

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

etc.

Thin cylinder

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

Bending

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

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

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

Stress transformations

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

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