

Two dimensional Stress and Strain – Tutorial

1. A material is subjected to mutually perpendicular tensile direct stresses of 40 MPa and 30 MPa together with a shear stress of 20 MPa, the shear stress being clockwise on the face carrying the 40 MPa tensile stress.

Determine:

- i) the stresses on a plane making an angle of 40° counter-clockwise to the plane of the 40 MPa stress;
- ii) the principal stresses and their planes;
- iii) the maximum shear stress and its plane.

2. The state of strain at a point in a stressed component is as follows:

$$\epsilon_x = -500 \times 10^{-6}, \quad \epsilon_y = 140 \times 10^{-6} \quad \text{and} \quad \gamma_{xy} = 360 \times 10^{-6}.$$

Determine:

- i) the principal strains and the principal axes, and
- ii) the extensional strain ϵ_A whose direction makes 50° with the x-axis, the strain ϵ_B at right angles to ϵ_A and the shear strain γ_{AB} .

3. A thin cylinder 120 mm mean diameter, 400 mm long and 2.5 mm thick is subjected simultaneously to an internal pressure of 2.4 MPa and an axial twisting moment of 1.2 kN/m.

Determine:

- i) the components of stress on a rectangular element of the cylinder wall;
- ii) the magnitudes and directions of the principal stresses.

4. At a given point in a transmission shaft the bending stress and torsional shear stress are 20 MN/m^2 and 40 MN/m^2 respectively.

Determine:

- i) the principal stresses and their directions;
- ii) the maximum shear stress and the plane on which it acts.

5. The following strains were measured by a 45° strain gauge rosette on the surface of a stressed component:

$$\varepsilon_A = 320 \text{ microstrain,}$$

$$\varepsilon_B \text{ (} 45^\circ \text{ anticlockwise from A)} = -240 \text{ microstrain, and}$$

$$\varepsilon_C \text{ (} 45^\circ \text{ anticlockwise from B)} = 160 \text{ microstrain.}$$

Determine the magnitudes of the principal strains at the location of the rosette, and the directions of the principal planes relative to gauge A.

Assuming that there is no stress perpendicular to the surface at the measurement site, determine the magnitudes and directions of the principal stresses.

Take E as 207 GPa and $\nu = 0.28$.