Mechanics of Materials I:

Fundamentals of Stress & Strain and Axial Loading

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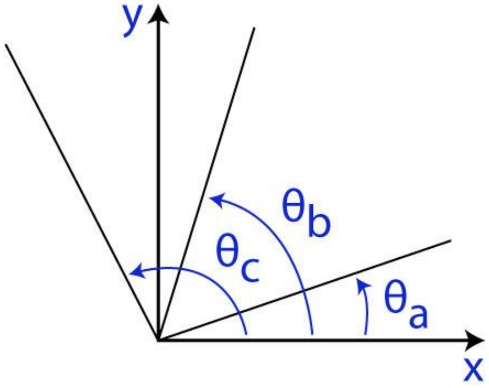
Module 36 Learning Outcome

- Calculate in-plane strains based on strain gage rosette measurements

Strain gage rosettes



$$\varepsilon_a = \varepsilon_x \cos^2\theta_a + \varepsilon_y \sin^2\theta_a + \gamma_{xy} \sin\theta_a \cos\theta_a$$

measured

$$\varepsilon_b = \varepsilon_x \cos^2\theta_b + \varepsilon_y \sin^2\theta_b + \gamma_{xy} \sin\theta_b \cos\theta_b$$

$$\varepsilon_c = \varepsilon_x \cos^2\theta_c + \varepsilon_y \sin^2\theta_c + \gamma_{xy} \sin\theta_c \cos\theta_c$$

Solve 3 equations
For 3 unknowns

$$\varepsilon_x, \ \varepsilon_y, \ \gamma_{xy}$$

Now we can solve for in-plane principal strains/planes and max in-plane shear stress

Example

A 45° strain rosette was placed on the surface of a critical point on an engineering part. The following were measured:

$$\varepsilon_a = 350\,\mu\frac{mm}{mm}$$

$$\varepsilon_b = 400\,\mu\frac{mm}{mm}$$

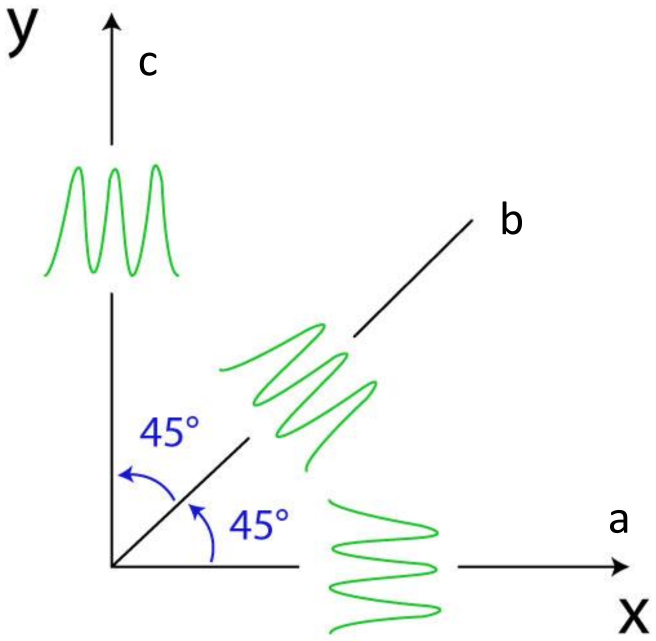
$$\varepsilon_c = 600\,\mu\frac{mm}{mm}$$

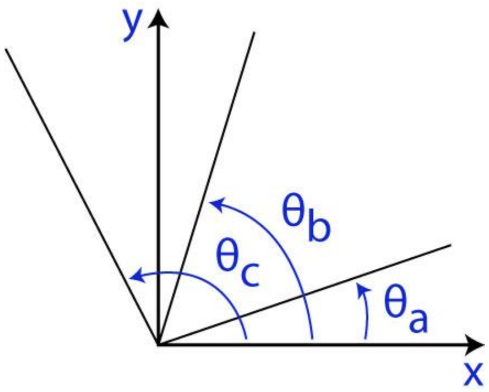
Gage a was aligned with the x-axis.

a) Determine the in-place stresses

$$\varepsilon_x,\ \varepsilon_y,\ \gamma_{xy}$$

b) Using Mohr's Circle, find the principal strains and the maximum shear strain at that point, and find the orientation of the principal planes from the given x-y axes.





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a) Determine the in-place stresses

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$$\varepsilon_a = \varepsilon_x \cos^2\theta_a + \varepsilon_y \sin^2\theta_a + \gamma_{xy}\sin\theta_a\cos\theta_a$$

$$\varepsilon_b = \varepsilon_x \cos^2\theta_b + \varepsilon_y \sin^2\theta_b + \gamma_{xy}\sin\theta_b\cos\theta_b$$

$$\varepsilon_c = \varepsilon_x \cos^2\theta_c + \varepsilon_y \sin^2\theta_c + \gamma_{xy}\sin\theta_c\cos\theta_c$$

$$\varepsilon_c = 600\,\mu\frac{mm}{mm}$$

$$\theta_c = 90^\circ$$

$$\varepsilon_b = 400\,\mu\frac{mm}{mm}$$

$$\theta_b = 45^\circ$$

$$\varepsilon_a = 350\,\mu\frac{mm}{mm}$$

$$\theta_a = 0^\circ$$