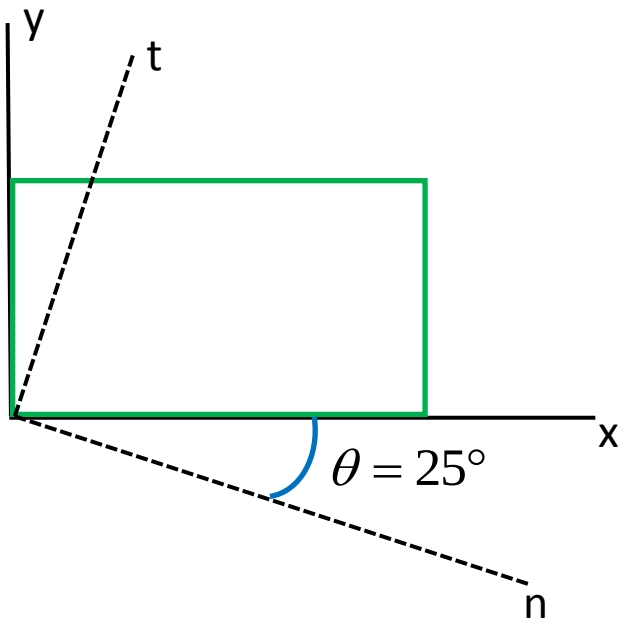
MOOC – "Mechanics of Materials I"
Week Four Quiz Solution

Problem 1) For an engineering structural member under loading, the strain components at a point are found to be:

$$\varepsilon_x = -500\,\mu\frac{mm}{mm} \qquad \varepsilon_y = 1250\,\mu\frac{mm}{mm} \qquad \gamma_{xy} = 1900\,\mu rad$$

Find the strain components ε_n and γ_{nt} for the n-t axes oriented as shown below.



$$\epsilon_n = \frac{\epsilon_x + \epsilon_y}{2} + \frac{\epsilon_x - \epsilon_y}{2}\cos 2\theta + \frac{\gamma_{xy}}{2}\sin 2\theta$$

$$\epsilon_n = \frac{-500 + 1250}{2} + \frac{-500 - 1250}{2}\cos[2(-25°)] + \frac{1900}{2}\sin[2(-25°)]$$

$$\epsilon_n = -915\,\mu\frac{mm}{mm}$$ ANS

$$\gamma_{nt} = -(\epsilon_x - \epsilon_y)\sin 2\theta + \gamma_{xy}\cos 2\theta$$

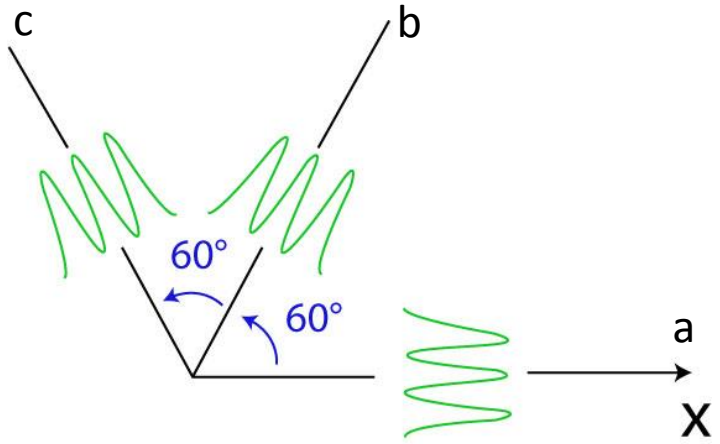
$$\gamma_{nt} = -(-500 - 1250)\sin[2(-25°)] + 1900\cos[2(-25°)]$$

$$\gamma_{nt} = -119\,\mu\,rad$$ ANS

Problem 2) The strain rosette shown below was used to measure the following strain data on the free surface of a stressed body at a point.

$$\varepsilon_a = 750\,\mu\frac{mm}{mm} \qquad \varepsilon_b = 1250\,\mu\frac{mm}{mm} \qquad \varepsilon_c = -50\,\mu\frac{mm}{mm}$$

Find the strain components $\varepsilon_x, \varepsilon_y, \gamma_{xy}$ at the point



$\theta_a = 0°$

$\theta_b = 60°$

$\theta_c = 120°$

$$\epsilon_a = \epsilon_x \cos^2\theta_a + \epsilon_y \sin^2\theta_a + \gamma_{xy} \sin\theta_a \cos\theta_a$$

$$750\mu = \epsilon_x \cos^2 0° + \epsilon_y \sin^2 0° + \gamma_{xy} \sin 0° \cos 0°$$

$$\epsilon_x = 750\,\mu\,\frac{mm}{mm} \quad \text{ANS}$$

$$\epsilon_b = \overset{750}{\epsilon_x} \cos^2\theta_b + \epsilon_y \sin^2\theta_b + \gamma_{xy} \sin\theta_b \cos\theta_b$$

$$1250 = 750 \cos^2 60° + \epsilon_y \sin^2 60° + \gamma_{xy} \sin 60° \cos 60°$$

$$\epsilon_y = 1417 - 0.577\,\gamma_{xy} \quad (*)$$

$$\epsilon_c = \overset{750}{\epsilon_x} \cos^2\theta_c + \epsilon_y \sin^2\theta_c + \gamma_{xy} \sin\theta_c \cos\theta_c$$

$$-50 = 750 \cos^2 120° + \epsilon_y \sin^2 120° + \gamma_{xy} \sin 120° \cos 120°$$

$$0.75\,\epsilon_y = 0.433\,\gamma_{xy} - 237.5 \quad (**)$$

SOLVING SIMULTANEOUSLY

$$\epsilon_y = 550\,\mu\,\frac{mm}{mm} \quad \text{ANS}$$

$$\gamma_{xy} = 1500\,\mu\,\text{rad} \quad \text{ANS}$$

Problem 3) Show a Mohr's Circle plot depicting the principal strains and the maximum in-plane shear strain for the strain condition below acting at a point in an engineering structural member.

$$\varepsilon_x = -500\,\mu\frac{mm}{mm}$$

$$\varepsilon_y = 1250\,\mu\frac{mm}{mm}$$

$$\gamma_{xy} = 1900\,\mu rad$$

a)