

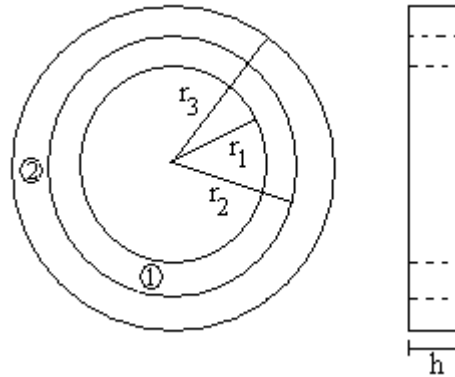
### Problem set: 4

1- Consider the assembly of two concentric thin rings:

Assume that we have a temperature change  $\Delta T$  and the rings are made of different materials. Find the thermal stresses  $\sigma_r$  and  $\sigma_\theta$  in the assembly.

a) Assume that both rings are circumferentially fiber reinforced (add any assumption that are necessary).

b) Assume that ring 1 is isotropic and ring 2 is circumferentially fiber reinforced (add any assumption that are necessary).



2- Repeat problem 1 by replacing the inside ring 1 by a solid disk.

In problem 1 and 2 use the following notations:

$$\begin{Bmatrix} \sigma_r \\ \sigma_\theta \end{Bmatrix} = \begin{bmatrix} Q_{rr} & Q_{r\theta} \\ Q_{r\theta} & Q_{\theta\theta} \end{bmatrix} \left( \begin{Bmatrix} \epsilon_r \\ \epsilon_\theta \end{Bmatrix} - \begin{Bmatrix} \alpha_r \\ \alpha_\theta \end{Bmatrix} \Delta T \right)$$

Where  $Q_{rr}=Q_{22}$ ,  $Q_{\theta\theta}=Q_{11}$ ,  $Q_{r\theta}=Q_{12}$ ,  $\alpha_r=\alpha_2$ ,  $\alpha_\theta=\alpha_1$

3- Plot  $\alpha_x$ ,  $\alpha_y$  and  $\alpha_{xy}$  versus  $\theta$ ,  $-90^\circ \leq \theta \leq 90^\circ$  for S-2 Glass/Epoxy and T300/5208 composites.

4- Consider a 50mm×50mm×50mm element of S-2 Glass/Epoxy material with its fibers oriented at  $45^\circ$  and constrained against deformation in the x direction. The element is heated  $50^\circ\text{C}$ . What is the stress  $\sigma_x$  required to enforce this constraint and what are the strains  $\epsilon_x$ ,  $\epsilon_z$ ,  $\gamma_{xy}$ ?