Problem set: 5

1- Consider a [+45/-45] laminated cylinder subjected to an axial force F_z, a torque T_z, and an internal pressure P_I. There is no thermal effect. The cylinder is long and let:

$$\sigma_0 = \frac{F_z}{\pi(r_3^2 - r_1^2)} \qquad \text{and} \qquad \tau_0 = \frac{3T_z}{2\pi(r_3^3 - r_1^3)}$$

Where σ_0 and τ_0 are the average axial stress and the average shear stress, respectively. Also let *h* be the total thickness of the laminate and, furthermore, assume that the layers have the same thickness.

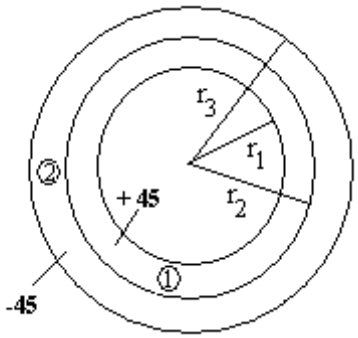
a) Impose all the boundary and continuity conditions and find analytical expression of σ_z, σ_θ, σ_r and $\sigma_{r\theta}$ within each layer.

Now for $r_1/h=75$ and $r_1/h=5$ use the properties of Graphite/Epoxy T300/5208 and do the followings:

b) For axial loading only plot $\frac{\sigma_z}{\sigma_0}$ and $\frac{\sigma_r}{\sigma_0}\left(\frac{r_1}{h}\right)^2$ vs. $\frac{r-r_1}{h}$.

c) For torque loading only plot $\frac{\sigma_{z\theta}}{\tau_0}$ and $\frac{\sigma_r}{\tau_0}\frac{r_1}{h}$ vs. $\frac{r-r_1}{h}$.

d) For internal pressure only plot $\frac{\sigma_\theta}{P_I}\frac{h}{r_1}$ and $\frac{\sigma_{z\theta}}{P_I}\frac{h}{r_1}$ vs. $\frac{r-r_1}{h}$.



2- Consider the problem we studied in section 3.6. assume that:

$$u_z = Z(r) + c_1 z$$
$$u_\theta = \Theta(r) + c_2 rz$$
$$u_r = R(r)$$

Where c_1 and c_2 are constants. Now solve the equilibrium equations (Eqs. (3.6-7)) without ever using the compatibility equations. Show your work and make sure that you obtain (3.6-30).