NETTING:

$\sigma_f = \frac{pr}{2\,t\,cos^2\theta}$ Where t = thickness / 2

$\sigma_f = \frac{pr}{t\,sin^2\theta}$ Where t = thickness/ 2

Transverse Averages

$$\bar{\sigma}_{ij} = \int_{Vol} \sigma_{ij} dv \rightarrow \frac{\int \sigma_2 dx2}{\int dx3}$$

Same for Strain

ISOTROPIC HOOKE'S LAW

$$\varepsilon_z = -\frac{\nu * (\varepsilon_x + \varepsilon_y)}{1-\nu}$$

$$\varepsilon_z = -\frac{\nu * (\sigma_x + \sigma_y)}{E}$$

SPECIALLY ORTHOTROPIC LAMINA

$$\nu_{ij} = -\frac{\varepsilon_j}{\varepsilon_i}$$

$$\frac{\nu_{ij}}{E_i} = \frac{\nu_{ji}}{E_j}$$

$$G_{23} = \frac{E_2}{2(1+\nu_{23})}$$

$$\{\varepsilon\} = [S]\{\sigma\}$$

$$\boldsymbol{S_{11}} = \frac{\boldsymbol{1}}{\boldsymbol{E_1}} \quad \boldsymbol{S_{22}} = \frac{\boldsymbol{1}}{\boldsymbol{E_2}} \quad \boldsymbol{S_{12}} = \frac{\boldsymbol{-\nu_{12}}}{\boldsymbol{E_1}} \quad \boldsymbol{S_{66}} = \frac{\boldsymbol{1}}{\boldsymbol{G_{12}}}$$

$$\{\sigma\} = [C]\{\varepsilon\} \quad [C] = Q \; if \; 2D$$

$$\boldsymbol{Q_{11}} = \frac{\boldsymbol{E_1}}{(\boldsymbol{1-\nu_{12}\nu_{21}})} \quad \boldsymbol{Q_{12}} = \frac{\boldsymbol{\nu_{12}E_2}}{(\boldsymbol{1-\nu_{12}\nu_{21}})} \quad \boldsymbol{Q_{22}} = \frac{\boldsymbol{E_2}}{(\boldsymbol{1-\nu_{12}\nu_{21}})} \quad \boldsymbol{Q_{66}} = \boldsymbol{G_{12}}$$

GENERALLY ORTHO LAMINA

$\sigma_1 = \sigma_x \cos^2\theta + \sigma_y \sin^2\theta + 2\tau_{xy} \cos\theta \sin\theta$ *ϑ = angle from principle*

$$\sigma_2 = \sigma_x \sin^2\theta + \sigma_y \cos^2\theta - 2\tau_{xy} \cos\theta \sin\theta$$

$$\tau_{12} = -\sigma_x \cos\theta \sin\theta + \sigma_y \cos\theta \sin\theta + \tau_{xy}(\cos^2\theta - \sin^2\theta)$$

$$[T] = \begin{bmatrix} c^2 & s^2 & 2cs \\ s^2 & c^2 & -2cs \\ -cs & cs & c^2 - s^2 \end{bmatrix}$$

$$\{\sigma_{xyz}\} = [T]^{-1}\{\sigma_{123}\}$$

Same for strains

$$\begin{Bmatrix} \sigma_x \\ \sigma_y \\ \tau_{xy} \end{Bmatrix} = [T]^{-1}[Q_{Tensor}][T]\begin{Bmatrix} \varepsilon_x \\ \varepsilon_y \\ \varepsilon_{xy} \end{Bmatrix}$$

$$[\bar{Q}]_{Tensor} = [T]^{-1}[Q_{Tensor}][T]$$

$$[\bar{S}]_{Tensor} = [T]^{-1}[S_{Tensor}][T]$$

See Lecture 6 for Ex, Ey, Gxy, and Averages

RULE OF MIXTURES

$$\upsilon_f = \frac{A_f}{A_{total}}$$

$$E_1 = \sum_i E_i \upsilon_i$$

$$E_2 = \frac{\upsilon_f}{E_{f2}} + \frac{\upsilon_m}{E_m}$$

$$\nu_{12} = \nu_{f12}\upsilon_f + \nu_m \upsilon_m$$

$$G_{12} = \frac{\upsilon_f}{G_{f12}} + \frac{\upsilon_m}{G_m}$$

IMPROVED MICROMECHANICS

HOPKINS AND CHAMIS SPENCER ADAMS AND DONER HALPIN TSAI (BEST)	SEE LECTURE 9

Failure Criterion

Max Stress

$|\sigma_1| \geq S_L^{(-)}$ *if* σ_1 *is* $(-)$ *or* $\sigma_1 \geq S_L^{(+)}$ *if* σ_1 *is* $(+)$

$|\sigma_2| \geq S_T^{(-)}$ *if* σ_2 *is* $(-)$ *or* $\sigma_2 \geq S_T^{(+)}$ *if* σ_2 *is* $(+)$

$|\tau_{12}| \geq S_{LT}$

Max Strain

$|\varepsilon_1| \geq e_L^{(-)}$ *if* ε_1 *is* $(-)$ *or* $\varepsilon_1 \geq e_L^{(+)}$ *if* ε_1 *is* $(+)$

$|\varepsilon_2| \geq e_T^{(-)}$ *if* ε_2 *is* $(-)$ *or* $\varepsilon_2 \geq e_T^{(+)}$ *if* ε_2 *is* $(+)$

$|\gamma_{12}| \geq e_{LT}$

$S_L^{(+)} = E_1 e_L^{(+)}$

$S_L^{(-)} = E_1 e_L^{(-)}$

$S_T^{(+)} = E_2 e_T^{(+)}$

$S_T^{(-)} = E_2 e_T^{(-)}$