Formula Sheet

$$\sigma_{avg} = \boldsymbol{N}/A \qquad \tau_{avg} = \boldsymbol{V}/A \qquad \sigma_{ij} = \lim_{\Delta A_i \to 0}\left(\frac{\Delta F_j}{\Delta A_i}\right)$$

$$\varepsilon = \frac{L_f - L_o}{L_o} \qquad \varepsilon = \frac{\delta}{L_o} \qquad \varepsilon = \frac{u_B - u_A}{x_B - x_A} \qquad \gamma = \pi/2 - \alpha \qquad \varepsilon_{xx} = \frac{du}{dx}(x)$$

$$\varepsilon_{xx} = [\sigma_{xx} - \nu(\sigma_{yy} + \sigma_{zz})]/E \qquad \gamma_{xy} = \tau_{xy}/G \qquad G = \frac{E}{2(1+\nu)}$$

$$\sigma_{xx} = [\varepsilon_{xx} + \nu\varepsilon_{yy}]\frac{E}{(1-\nu^2)} \qquad \varepsilon_{zz} = -\left(\frac{\nu}{1-\nu}\right)(\varepsilon_{xx} + \varepsilon_{yy})$$

$$\frac{du}{dx} = \frac{\boldsymbol{N}}{EA} \qquad u_2 - u_1 = \frac{\boldsymbol{N}(x_2 - x_1)}{EA} \qquad \delta = \frac{\boldsymbol{N}L}{EA} \qquad \sigma_{xx} = \frac{\boldsymbol{N}}{A}$$

$$\frac{d\phi}{dx} = \frac{\boldsymbol{T}}{GJ} \qquad \phi_2 - \phi_1 = \frac{\boldsymbol{T}(x_2 - x_1)}{GJ} \qquad \tau_{x\theta} = \frac{\boldsymbol{T}\rho}{J}$$

$$\boldsymbol{M}_z = EI_{zz}\frac{d^2v}{dx^2} \qquad \sigma_{xx} = -\left(\frac{\boldsymbol{M}_z y}{I_{zz}}\right) \qquad \tau_{xs} = -\left(\frac{\boldsymbol{V_y} Q_z}{I_{zz} t}\right)$$

$$\sigma_{xx} = -\left(\frac{\boldsymbol{M}_y z}{I_{yy}}\right) \qquad \tau_{xs} = -\left(\frac{\boldsymbol{V_z} Q_y}{I_{yy} t}\right)$$

$$\boldsymbol{V_y} = -\boldsymbol{V} \qquad \frac{d\boldsymbol{V}}{dx} = p \qquad \frac{d\boldsymbol{M_z}}{dx} = \boldsymbol{V} \qquad \boldsymbol{V_2} = \boldsymbol{V_1} + \int_{x_1}^{x_2} p\,dx \qquad \boldsymbol{M_2} = \boldsymbol{M_1} + \int_{x_1}^{x_2} \boldsymbol{V}\,dx$$

$$\sigma_{nn} = \sigma_{xx}\cos^2\theta + \sigma_{yy}\sin^2\theta + 2\tau_{xy}\sin\theta\cos\theta \qquad \tau_{nt} = -\sigma_{xx}\cos\theta\sin\theta + \sigma_{yy}\sin\theta\cos\theta + \tau_{xy}(\cos^2\theta - \sin^2\theta)$$

$$\tan 2\theta_p = \frac{2\tau_{xy}}{(\sigma_{xx} - \sigma_{yy})} \qquad \sigma_{1,2} = \frac{(\sigma_{xx} + \sigma_{yy})}{2} \pm \sqrt{\left(\frac{\sigma_{xx} - \sigma_{yy}}{2}\right)^2 + \tau_{xy}^2} \qquad \tau_{max} = \left|\max\left(\frac{\sigma_1 - \sigma_2}{2}, \frac{\sigma_2 - \sigma_3}{2}, \frac{\sigma_3 - \sigma_1}{2}\right)\right|$$

$$\varepsilon_{nn} = \varepsilon_{xx}\cos^2\theta + \varepsilon_{yy}\sin^2\theta + \gamma_{xy}\sin\theta\cos\theta \qquad \gamma_{nt} = -2\varepsilon_{xx}\sin\theta\cos\theta + 2\varepsilon_{yy}\sin\theta\cos\theta + \gamma_{xy}(\cos^2\theta - \sin^2\theta)$$

$$\tan 2\theta_p = \frac{\gamma_{xy}}{(\varepsilon_{xx} - \varepsilon_{yy})} \qquad \varepsilon_{1,2} = \frac{(\varepsilon_{xx} + \varepsilon_{yy})}{2} \pm \sqrt{\left(\frac{\varepsilon_{xx} - \varepsilon_{yy}}{2}\right)^2 + \left(\frac{\gamma_{xy}}{2}\right)^2} \qquad \frac{\gamma_{max}}{2} = \left|\max\left(\frac{\varepsilon_1 - \varepsilon_2}{2}, \frac{\varepsilon_2 - \varepsilon_3}{2}, \frac{\varepsilon_3 - \varepsilon_1}{2}\right)\right|$$

$$P_{Cr} = \frac{\pi^2 EI}{L^2}$$

$$\eta_C = \frac{4r}{3\pi} \qquad I = \frac{1}{12}ab^3 \qquad I = \frac{1}{4}\pi r^4 \qquad J = \frac{1}{2}\pi r^4$$