ME 323: Mechanics of Materials
Exam 03 - Equation sheet

USEFUL EQUATIONS

$$\sigma_{avge} = \frac{F_N}{A}$$
$$\tau_{avge} = \frac{V}{A}$$

Generalized Hooke's Law

$$\varepsilon_x = \frac{1}{E}\left[\sigma_x - \nu\left(\sigma_y + \sigma_z\right)\right] + \alpha\Delta T$$
$$\varepsilon_y = \frac{1}{E}\left[\sigma_y - \nu\left(\sigma_x + \sigma_z\right)\right] + \alpha\Delta T$$
$$\varepsilon_z = \frac{1}{E}\left[\sigma_z - \nu\left(\sigma_x + \sigma_y\right)\right] + \alpha\Delta T$$

$$\gamma_{xy} = \frac{1}{G}\tau_{xy} \quad \gamma_{xz} = \frac{1}{G}\tau_{xz} \quad \gamma_{yz} = \frac{1}{G}\tau_{yz}$$
$$G = \frac{E}{2(1+\nu)}$$

$$\sigma_x = \frac{E}{(1+\nu)(1-2\nu)}\left[(1-\nu)\epsilon_x + \nu(\epsilon_y + \epsilon_z) - (1+\nu)\alpha\Delta T\right]$$
$$\sigma_y = \frac{E}{(1+\nu)(1-2\nu)}\left[(1-\nu)\epsilon_y + \nu(\epsilon_x + \epsilon_z) - (1+\nu)\alpha\Delta T\right]$$
$$\sigma_z = \frac{E}{(1+\nu)(1-2\nu)}\left[(1-\nu)\epsilon_z + \nu(\epsilon_x + \epsilon_y) - (1+\nu)\alpha\Delta T\right]$$

Axial Deformations

$$e_{AB} = u_B - u_A \qquad e = \int_0^L \frac{F}{AE}dx + \int_0^L \alpha\,\Delta T\;dx, \qquad e = \frac{F\,L}{A\,E} + \alpha\,\Delta T\,L$$

$$e = u\cos(\theta) + v\sin(\theta)$$

Torsional Deformations

$$\phi_{AB} = \phi_B - \phi_A \qquad \phi = \int_0^L \frac{T(x)}{G(x)\,I_P(x)}dx \qquad \phi = \frac{T\,L}{G\,I_P}$$

$$\gamma = \rho\frac{d\phi}{dx} \qquad \tau = G\,\rho\frac{d\phi}{dx} \qquad \gamma = \frac{\rho\,T}{G\,I_p} \qquad \tau = \frac{\rho\,T}{I_p}$$

with $I_p = \int_A \rho^2\,dA$, $I_p = \frac{\pi r^4}{2}$ (solid), $I_p = \frac{\pi}{2}\left(r_0^4 - r_i^4\right)$ (hollow)

Shear force and Bending moment relationships

$$V(x) = V_{1^+} + \int_{x_1}^{x} p(\xi)d\xi \qquad \frac{dV(x)}{dx} = p(x)$$

$$M(x) = M_{1^+} + \int_{x_1}^{x} V(\xi)d\xi \qquad \frac{dM(x)}{dx} = V(x)$$

$$\Delta V = P_0$$
$$\Delta M = -M_0$$