ME323: Mechanics of Materials
Exam 1 – Equation sheet

USEFUL EQUATIONS

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

Generalized Hooke's Law

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

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

Axial Deformations

$$e_{AB} = u_B - u_A \qquad e = \int_0^L \frac{F(x)}{E(x)A(x)}dx + \int_0^L \alpha\Delta T\, dx \qquad e = \frac{FL}{EA} + \alpha\Delta TL$$
$$e = u\cos(\theta) + v\sin(\theta)$$

Torsional Deformations

$$\phi_{AB} = \phi_B - \phi_A \qquad \phi = \int_0^L \frac{T(x)}{G(x)I_p(x)}dx \qquad \phi = \frac{TL}{GI_p}$$
$$\gamma = \rho\frac{d\phi}{dx} \qquad \tau = G\rho\frac{d\phi}{dx} \qquad \gamma = \frac{T\rho}{GI_p} \qquad \tau = \frac{T\rho}{I_p}$$

with $I_p = \int_A \rho^2 dA$ $\qquad I_p = \frac{\pi r^4}{2}$ (solid) $\qquad I_p = \frac{\pi}{2}(r_o^4 - r_i^4)$ (hollow)

Flexural and Shear Stress

$$\sigma(x,y) = -\frac{Ey}{\rho} = -\frac{M_{zz}y}{I_{zz}} \qquad I_{zz} = \frac{bh^3}{12}\text{ (rectangle)} \qquad I_{zz} = \frac{\pi}{4}R^4\text{ (circle)}$$

$$\tau(x,y) = \frac{VQ}{I_{zz}t} = \frac{VA^*y^*}{I_{zz}t} \qquad I_{zz} = \frac{bh^3}{36}\text{ (triangle)} \qquad I_{zz} = (\frac{\pi}{8} - \frac{8}{9\pi})R^4\text{ (semi-circle)}$$

$\tau_{max} = \frac{3V}{2A}$ (rectangle)

$\tau_{max} = \frac{4V}{3A}$ (circle)