CE 112 Exams Forumula Sheet

Axial Load

Max In-Plane Shear Stress	$\sigma_n = \frac{P}{A}$
Displacement	
$\sigma = E\epsilon$	$\delta = \int_0^L \frac{P(x)}{A(x)E}dx$
$\delta_{th} = \alpha \Delta TL$	$\delta = \frac{PL}{AE}$
Torsion	$\tau = G\gamma$
Shear Stress in a circular shaft	$\tau = \frac{Tp}{J}$
J for solid circle	$J = \frac{\pi}{2}C^4$
J for hollow circle	$J = \frac{\pi}{2}(C_o^4 - C_i^4)$
Angle of Twist	$\phi = \int_0^L \frac{T(x)}{J(x)G}dx$
	$\phi = \frac{TL}{JG}$

Bending

Normal Stress	$\sigma = -\frac{My}{I}$

Shear

Average Shear Stress	$\tau_{avg} = \frac{V}{A}$
Transverse (Bending) Shear Stress	$\tau = \frac{VQ}{It}$

Stress in Pressure Vessel

Cylinder	$\sigma_1 = \frac{Pr}{t}$
	$\sigma_2 = \frac{Pr}{2t}$
Sphere	$\sigma_1 = \sigma_2 = \frac{Pr}{2t}$

Stress Transformation

$$\sigma_{x'} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}cos2\theta + \tau_{xy}sin2\theta$$

$$\tau_{x'y'} = -\left(\frac{\sigma_x + \sigma_y}{2}\right)sin2\theta + \tau_{xy}cos2\theta$$

Principal Stress

$$tan2\theta_p = \frac{\tau_{xy}}{\frac{1}{2}(\sigma_x - \sigma_y)}$$

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

Max In-Plane Shear Stress

$$tan2\theta_s = -\frac{\frac{1}{2}(\sigma_x - \sigma_y)}{\tau_{xy}}$$

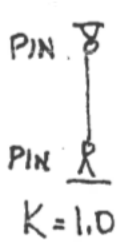
$$\tau_{max} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

Absolute Maximum Shear Stress

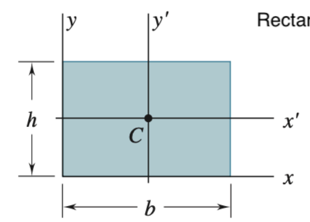
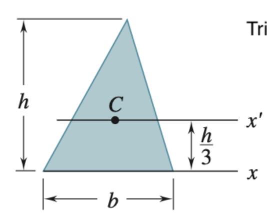
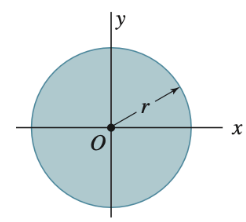
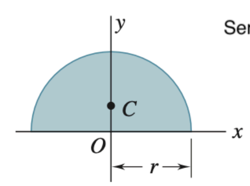
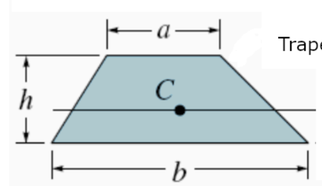
$$\tau_{|max|} = \frac{\sigma_x + \sigma_y}{2}$$

$$\sigma_{avg} = \frac{\sigma_{max} + \sigma_{min}}{2}$$

Shear Flow	$q = \dfrac{VQ}{I}$

Material Properties	
Poisson's Ratio	$\nu = -\dfrac{\epsilon_{tran}}{\epsilon_{long}}$
Relations between w, V, M	
$\dfrac{dV}{dx} = -w(x)$	$\dfrac{dM}{dx} = V$
Elastic Curve	$\dfrac{l}{\rho} = \dfrac{M}{EI}$
	$EI\dfrac{d^4\nu}{dx^4} = -\omega(x)$
	$EI\dfrac{d^3v}{dx^3} = V(x)$
	$EI\dfrac{d^2v}{dx^2} = M(x)$
Buckling	
Critical Axial Load	$P_{cr} = \dfrac{\pi^2 EI}{(KL)^2}$
Critical Stress	$\sigma_{cr} = \dfrac{\pi^2 E}{\left(\frac{KL}{r}\right)^2}$
Radius of Gyration	$r = \sqrt{\dfrac{I}{A}}$
Effective Length Factor, K	
	

Geometric Properties of Shapes

Rectangle 	$\bar{I}_{x'} = \frac{1}{12}bh^3$ $\bar{I}_{y'} = \frac{1}{12}b^3h$ $A = bh$
Triangle 	$\bar{I}_{x'} = \frac{1}{36}bh^3$ $A = \dfrac{1}{2}bh$
Circle 	$\bar{I}_x = \bar{I}_y = \frac{1}{4}\pi r^4$ $J_O = \frac{1}{2}\pi r^4$ $A = \pi r^2$
Semi-circle 	$I_x = I_y = \frac{1}{8}\pi r^4$ $J_O = \frac{1}{4}\pi r^4$ $A = \dfrac{\pi r^2}{2}$
Trapezoid 	$C_x = \dfrac{h}{2}$ $C_y = \dfrac{1}{3}\left(\dfrac{2a+b}{a+b}\right)h$ $A = \dfrac{1}{2}h(a+b)$

Parallel Axis Theorem

$I_{x'} = I_x + Ad^2$