LIST OF EQUATIONS

Note: Not all of these equations are required for the examination.

$$\sigma_{x'} = \sigma_x \cos^2 a + \sigma_y \sin^2 a + \tau_{xy} \sin 2a$$

$$\sigma_{y'} = \sigma_x \sin^2 a + \sigma_y \cos^2 a - \tau_{xy} \sin 2a$$

$$\tau_{x'y'} = \left(\frac{\sigma_y - \sigma_x}{2}\right) \sin 2a + \tau_{xy} \cos 2a$$

$$\varepsilon_{x'} = \varepsilon_x \cos^2 \alpha + \varepsilon_y \sin^2 \alpha + \frac{\gamma_{xy}}{2} \sin 2\alpha$$

$$\frac{\gamma_{x'y'}}{2} = \frac{\varepsilon_y - \varepsilon_x}{2} \sin 2\theta + \frac{\gamma_{xy}}{2} \cos 2\theta$$

$$\varepsilon_{1,2} = \varepsilon_{\max,\min} = \frac{\varepsilon_x + \varepsilon_y}{2} \pm \sqrt{\left(\frac{\varepsilon_x - \varepsilon_y}{2}\right)^2 + \left(\frac{\gamma_{xy}}{2}\right)^2} \qquad \tan 2\alpha = \frac{2\left(\frac{\gamma_{xy}}{2}\right)}{\varepsilon_x - \varepsilon_y}$$

$$\frac{\gamma_{\max}}{2} = \frac{\varepsilon_1 - \varepsilon_2}{2}$$

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

$$\tau_{\max} = \frac{\sigma_1 - \sigma_2}{2}$$

General Constitutive Equations;

$$\varepsilon_x = \frac{1}{E}\left[\sigma_x - \nu\left(\sigma_y + \sigma_z\right)\right] \qquad \tau_{xy} = G\gamma_{xy}$$

$$\varepsilon_y = \frac{1}{E}\left[\sigma_y - \nu\left(\sigma_x + \sigma_z\right)\right] \qquad \tau_{xz} = G\gamma_{xz}$$

$$\varepsilon_z = \frac{1}{E}\left[\sigma_z - \nu\left(\sigma_x + \sigma_y\right)\right] \qquad \tau_{yz} = G\gamma_{yz}$$

$$\sigma_x = \lambda\varepsilon_v + 2G\varepsilon_x$$

$$\sigma_y = \lambda\varepsilon_v + 2G\varepsilon_y$$

$$\sigma_z = \lambda\varepsilon_v + 2G\varepsilon_z$$

$$\lambda = \frac{\upsilon E}{(1+\upsilon)(1-2\upsilon)} \qquad \mathrm{G} = \frac{E}{2(1+\upsilon)}$$

$$\varepsilon_v = \varepsilon_x + \varepsilon_y + \varepsilon_z$$

Constitutive Equations
(Plane Stress conditions):

$$\sigma_x = \frac{E}{(1-\upsilon^2)}\left[\varepsilon_x + \upsilon\varepsilon_y\right]$$

$$\sigma_y = \frac{E}{(1-\upsilon^2)}\left[\varepsilon_y + \upsilon\varepsilon_x\right]$$

$$\tau_{xy} = G\gamma_{xy}$$

$$G = \frac{E}{2(1+\nu)}$$

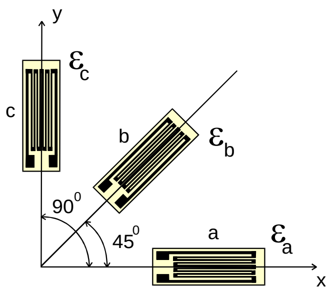
Spherical Pressure Vessels $\sigma_1 = \sigma_2 = \dfrac{pr}{2t}$

Cylindrical Pressure Vessels $\sigma_1 = \dfrac{pr}{t}; \sigma_2 = \dfrac{pr}{2t}$

Von Mises Failure Criteria (plane stress) $\sigma_1{}^2 + \sigma_2{}^2 - \sigma_1\sigma_2 < \sigma_{Yield}^2$

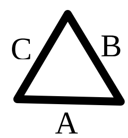
Tresca Failure Criteria (plane stress) $\tau_{\max} \le \dfrac{\sigma_{yield}}{2}$

Maximum Principle stress Failure criteria $\sigma_{\max} < \sigma_{ult}$



$$\gamma_{xy} = 2\varepsilon_b - \varepsilon_c - \varepsilon_a\,,\ \varepsilon_x = \varepsilon_a\,,\ \varepsilon_y = \varepsilon_c$$

For 60° rosette $\gamma_{xy} = \dfrac{2}{\sqrt{3}}(\varepsilon_C - \varepsilon_B)$ and $\varepsilon_y = \dfrac{2}{3}\left(\varepsilon_B + \varepsilon_C - \dfrac{\varepsilon_A}{2}\right)$ and $\varepsilon_x = \varepsilon_a$



$$\tau = \frac{VA\bar{y}}{Ib} \qquad \sigma = \frac{My}{I} \qquad I_{\text{rectangle}} = \frac{bh^3}{12} \qquad I_{xx} = I_{11} + A\bar{y}^2 \qquad EI\frac{d^2y}{dx^2} = M$$

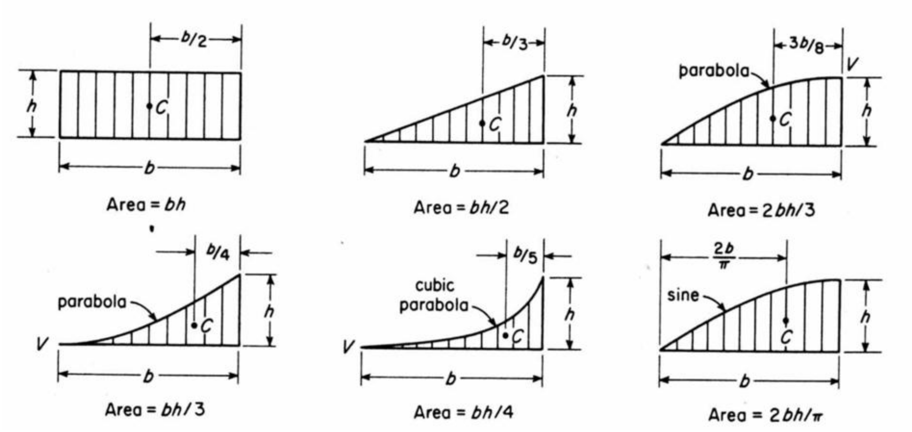
First Yield Moment: $M_y = Zf_y$ $Z = \dfrac{I}{y}$

Fully Plastic Moment: $M_p = Sf_y$

Shape Factor: $\eta = \dfrac{M_p}{M_y} = \dfrac{S}{Z}$

Moment area Theorem 1: $\theta_B - \theta_A = Area\ \dfrac{M}{EI}$

Moment area Theorem 2: If a vertical line is drawn at any location D, and tangents are produced from A and B to intersect this line, the distance between the points of intersection is equal to the first moment of area of that portion of the M/EI diagram between A and B, taken with respect to that line.



Centroids and Areas of some common BMD shapes