Exam 2 Equation Sheet

Strain energy in simple geometries

General

$$U = \frac{1}{2} V \sigma_{ij} \epsilon_{ij} \tag{1}$$

Rod

$$U = \int_0^L \frac{P^2}{EA} dx \tag{2}$$

Beam

$$U = \int_0^L \frac{M^2}{2EI} dx \tag{3}$$

Other Formulas

$$J = \int_\Gamma \left(W dy - T_i \frac{\partial u_i}{\partial x} \right) \tag{4}$$

$$G_I = \frac{1 - \nu^2}{E} K_I^2 \qquad \text{plane strain} \tag{5}$$

$$G_I = \frac{K_I^2}{E} \qquad \text{plane stress} \tag{6}$$

$$G_I = \frac{1}{2\Delta a} F_y^{(c)} \left(u_y^{(a)} - u_y^{(b)} \right) \tag{7}$$

$$G_{II} = \frac{1}{2\Delta a} F_x^{(c)} \left(u_x^{(a)} - u_x^{(b)} \right) \tag{8}$$

$$K_I \sin\theta_0 + K_{II} \cos(3\theta_0 - 1) = 0 \tag{9}$$

$$R_p = 2r_p = \frac{1}{\pi} \left(\frac{K_I}{\sigma_y^*} \right)^2 \qquad \text{Irwin} \tag{10}$$

$$R_p = \frac{\pi}{8} \left(\frac{K_I}{\sigma_y^*} \right)^2 \qquad \text{Dugdale} \tag{11}$$