Exam 2 Equation Sheet

Residual strength formulas

$$K_I = \sigma\sqrt{\pi a}\beta \tag{1}$$

$$r_p = \frac{1}{I\pi}\left(\frac{K_I}{\sigma_{YS}}\right)^2 \tag{2}$$

$$I = 6.7 - \frac{1.5}{t}\left(\frac{K_I}{\sigma_{YS}}\right)^2 \tag{3}$$

$$2 < I < 6 \tag{4}$$

Stress based fatigue

$$\Delta\sigma = \sigma_{max} - \sigma_{min} \tag{5a}$$

$$\sigma_m = \frac{\sigma_{max} + \sigma_{min}}{2} \tag{5b}$$

$$\sigma_a = \frac{\sigma_{max} - \sigma_{min}}{2} \tag{5c}$$

$$R = \frac{\sigma_{min}}{\sigma_{max}} \tag{6}$$

$$A = \frac{\sigma_a}{\sigma_m} \tag{7}$$

$$\Delta\sigma = 2\sigma_a = \sigma_{max}(1 - R) \tag{8a}$$

$$\sigma_m = \frac{\sigma_{max}}{2}(1 + R) \tag{8b}$$

$$R = \frac{1 - A}{1 + A} \tag{8c}$$

$$A = \frac{1 - R}{1 + R} \tag{8d}$$

$$\sigma_a = C + D\log N_f \tag{9}$$

$$\sigma_a = \sigma_f'\left(2N_f\right)^b \tag{10}$$

$$\frac{N_1}{N_{f1}} + \frac{N_2}{N_{f2}} + \frac{N_3}{N_{f3}} + ... = \sum\frac{N_i}{N_{fi}} = 1 \tag{11}$$

$$\frac{\sigma_a}{\sigma_{ar}} + \frac{\sigma_m}{\sigma_u} = 1 \tag{12}$$

$$\frac{\sigma_a}{\sigma_{ar}} + \left(\frac{\sigma_m}{\sigma_u}\right)^2 = 1 \tag{13}$$

$$\frac{\sigma_a}{\sigma_{ar}} + \frac{\sigma_m}{\sigma'_f} = 1 \tag{14}$$

$$\sigma_{ar} = \sqrt{\sigma_{max}\sigma_a} \tag{15}$$

$$\bar{\sigma}_a = \frac{1}{\sqrt{2}}\sqrt{(\sigma_{xa} - \sigma_{ya})^2 + (\sigma_{ya} - \sigma_{za})^2 + (\sigma_{za} - \sigma_{xa})^2 + 6(\tau_{xy}^2 + \tau_{yz}^2 + \tau_{zx}^2)} \tag{16}$$

$$\bar{\sigma}_m = \bar{\sigma}_{xm} + \bar{\sigma}_{ym} + \bar{\sigma}_{zm} \tag{17}$$

$$k_f = \frac{\sigma_{ar}}{S_{ar}} \tag{18}$$

$$q = \frac{k_f - 1}{k_t - 1} \tag{19}$$

$$q = \frac{1}{1 + \frac{\alpha}{\rho}} \tag{20}$$

Strain based fatigue

$$\epsilon_a = \frac{\sigma'_f}{E}(2N_f)^b + \epsilon'_f(2N_f)^c \tag{21}$$

$$\epsilon_a = \frac{\sigma'_f}{E}\left(1 - \frac{\sigma_m}{\sigma'_f}\right)(2N_f)^b + \epsilon'_f\left(1 - \frac{\sigma_m}{\sigma'_f}\right)^{\frac{c}{b}}(2N_f)^c \tag{22}$$

$$\epsilon_a = \frac{\sigma'_f}{E}\left(1 - \frac{\sigma_m}{\sigma'_f}\right)(2N_f)^b + \epsilon'_f(2N_f)^c \tag{23}$$

$$\sigma_{max}\epsilon_a = \frac{\left(\sigma'_f\right)^2}{E}(2N_f)^{2b} + \sigma'_f\epsilon'_f(2N_f)^{b+c} \tag{24}$$

Fracture mechanics based fatigue

$$\frac{da}{dN} = C(\Delta K)^n \tag{25}$$

$$\frac{da}{dN} = 10^{-4}\left(\frac{1}{m_T}\right)^p [K_{max}(1-R)^q]^p \tag{26}$$

$$\sum_i (z\sigma_{max})_i^p N_i = (S)^p \tag{27}$$