

Exam 2 Equation Sheet

Residual strength formulas

$$K_I = \sigma \sqrt{\pi a} \beta \quad (1)$$

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

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

$$2 < I < 6 \quad (4)$$

Stress based fatigue

$$\Delta\sigma = \sigma_{max} - \sigma_{min} \quad (5a)$$

$$\sigma_m = \frac{\sigma_{max} + \sigma_{min}}{2} \quad (5b)$$

$$\sigma_a = \frac{\sigma_{max} - \sigma_{min}}{2} \quad (5c)$$

$$R = \frac{\sigma_{min}}{\sigma_{max}} \quad (6)$$

$$A = \frac{\sigma_a}{\sigma_m} \quad (7)$$

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

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

$$R = \frac{1 - A}{1 + A} \quad (8c)$$

$$A = \frac{1 - R}{1 + R} \quad (8d)$$

$$\sigma_a = C + D \log N_f \quad (9)$$

$$\sigma_a = \sigma'_f (2N_f)^b \quad (10)$$

$$\frac{N_1}{N_{f1}} + \frac{N_2}{N_{f2}} + \frac{N_3}{N_{f3}} + \dots = \sum \frac{N_i}{N_{fi}} = 1 \quad (11)$$

$$\frac{\sigma_a}{\sigma_{ar}} + \frac{\sigma_m}{\sigma_u} = 1 \quad (12)$$

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

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

$$\sigma_{ar} = \sqrt{\sigma_{max}\sigma_a} \quad (15)$$

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

$$\bar{\sigma}_m = \bar{\sigma}_{xm} + \bar{\sigma}_{ym} + \bar{\sigma}_{zm} \quad (17)$$

$$k_f = \frac{\sigma_{ar}}{S_{ar}} \quad (18)$$

$$q = \frac{k_f - 1}{k_t - 1} \quad (19)$$

$$q = \frac{1}{1 + \frac{\alpha}{\rho}} \quad (20)$$

Strain based fatigue

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

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

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

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

Fracture mechanics based fatigue

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

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

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