Name:

Exam 2

1. Estimate the cycles (using stress-based fatigue) to failure for a notched part made from Aluminum 2024-T4 with $\sigma'_f = 131$ ksi, $b = -0.102$ and $E = 10.6$ Msi. The notch has a stress concentration factor of $K_t = 2.5$, a radius of $\rho = 0.5$ in and $\alpha = .02$ in. If the part is subjected to a loading block with 10 cycles of fully reversed 10 ksi, 5 cycles of $\sigma_{max} = 25$, $\sigma_{min} = 5$ ksi and 10 cycles of $\sigma_{max} = 20$, $\sigma_{min} = 0$ ksi per block, find the total number of blocks it can sustain. (20 pts.)

2. A part made from 7075-T6 aluminum has material properties of $E = 10.3$ (Msi), $\sigma'_f = 213$ (ksi), $b = -0.143, \epsilon'_f = 2.62, c = -0.619$. Find the transition life and comment on the appropriateness of fatigue analysis methods above and below this point. What is the meaning of the transition life? (20 pts.)

3. Briefly describe the Boeing method for variable amplitude loads. Is it appropriate to use this method when you anticipate crack growth retardation to be important to model? Why or why not? (20 pts.)

4. A wide, edge-cracked specimen ($\beta = 1.122$) with Paris law parameters $C = 10^{-9}$ and $n = 4$ has fracture toughness of $K_c = 120$ ksi$\sqrt{\text{in}}$. The specimen is subjected to an $R = 0$ cyclic stress such that $\sigma_{max} = 20.0$ ksi. Assuming an initial crack of $a = 0.5$ in, how many cycles can this sustain before failure? (20 pts.)

5. Use the Boeing method to approximate the following variable amplitude load cycle for a material with $m_T = 25.8$, $p = 3.9$, $q = 0.6$, and $\mu = 0.1$. Recall that

$$Z = (1 - R)^q \qquad \text{for} R \geq 0$$
$$Z = (1 - \mu R)^q \qquad \text{for} R < 0$$

Would you expect crack retardation to be an important effect when modeling this load cycle? Why or why not? (20 pts.)