

**ME 5339**  
**HOMEWORK SET NO. 12**

**Due Apr. 29, 2008**  
**All of the problems will be graded.**

**Problem 12.1**

An infinite plate of unit thickness contains a center crack with a length of 0.5 inch. The plate has  $K_{IC} = 80 \text{ ksi}\sqrt{\text{in}}$ ,  $E=10E6 \text{ psi}$  and  $\nu=0.3$ .

The plate is subjected to a fatigue loading with  $\sigma_{\max} = 60 \text{ ksi}$  and  $R = 0.1$ . and a crack growth law as

$$\frac{da}{dN} = 1.6 \times 10^{-12} (\Delta K)^4 \quad \text{where } \Delta K \text{ is in term of } \text{ksi}\sqrt{\text{in}}$$

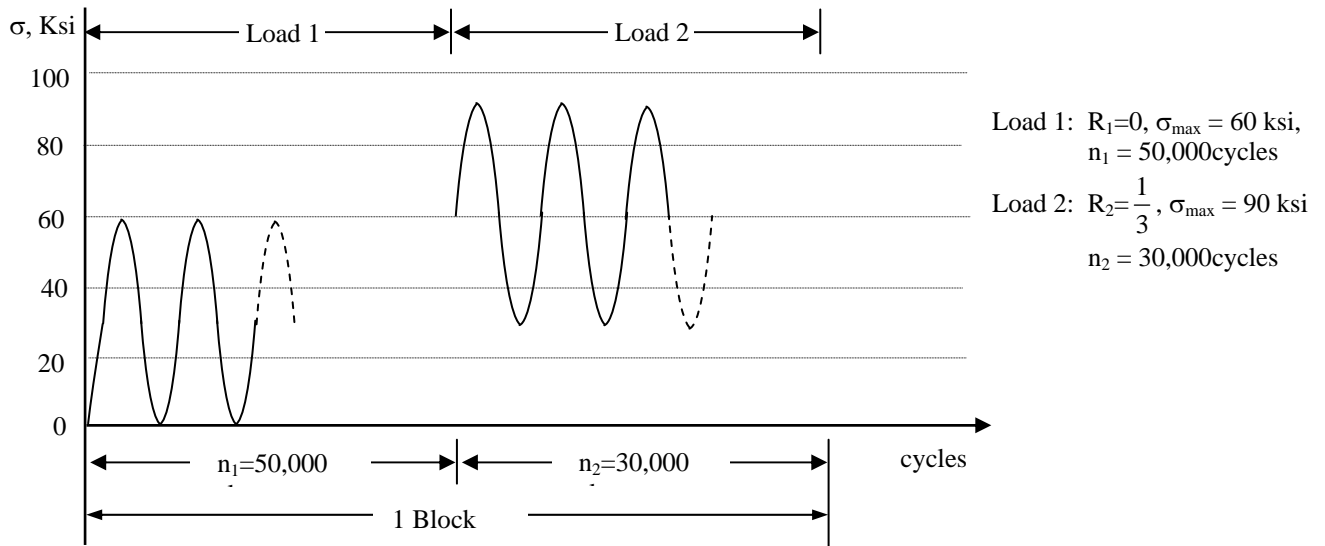
Determine:

- How long (in term of cycles) the plate will take to the total failure.
- The maximum crack opening displacement at the time of the failure.
- The residual strength of the plate after being subjected to a  $4 \times 10^3$  fatigue life
- Repeat all of the problems if the initial crack size is 1.0 inch long.

**Problem 12.2**

A material has the following properties: the ultimate strength of  $150 \text{ ksi}$ , endurance limit of  $50 \text{ ksi}$ , and a fully reversed stress at 1000 cycles,  $S_{1000}=100 \text{ ksi}$ , a true fracture strength of  $175 \text{ ksi}$ ,

The coupon of this material is under a block sequence of fatigue loading as shown below:



Determine

- The cycles to failure for each segment of constant load by using the Goodman relationship.
- The fatigue damage at end of the first block of loading.
- The fatigue life if the block loading is repeated.

### Problem 12.3

A stress-time history is shown as below. Count the corresponding cycles by lever-crossing, peak value, simple range and rainflow methods and **show the stress range of each cycle.**

