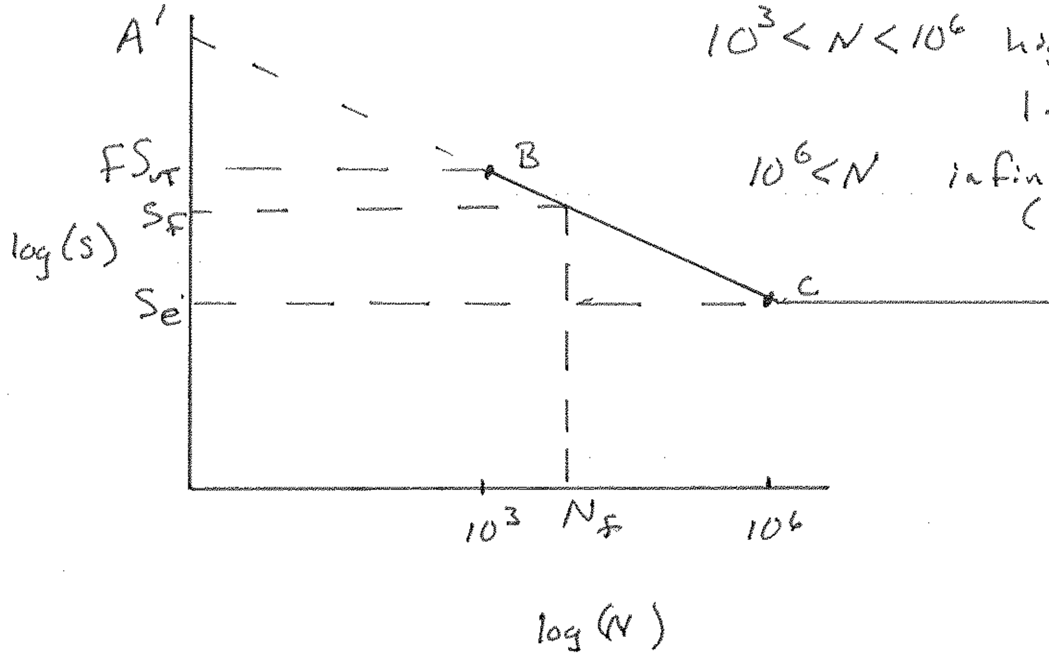

$N=1$ - single cycle failure

$1 < N < 10^3$ low cycle fatigue

$10^3 < N < 10^6$ high cycle, finite life

$10^6 < N$ infinite life (assumed)

S-N is "linear" on a log-log scale
Develop the S-N relationships for $10^3 < N < 10^6$ (high cycle, finite life).

At B : $x = \log(10^3)$ $y = \log(fS_{UT})$

At C : $x = \log(10^6)$ $y = \log(S_e)$

$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{\log(fS_{UT}) - \log(S_e)}{\log(10^3) - \log(10^6)} = -\frac{1}{3}\log\frac{fS_{UT}}{S_e}$$

Determine y-intercept for this line (A') at B: $x = \log(10^3)$ $\quad y = \log(fS_{UT})$

equation for a line

$$y = \text{slope} \cdot x + y\text{-intercept}$$

$$\log(fS_{UT}) = \text{slope} \cdot \log(10^3) + y\text{-intercept}$$

$$y \text{ intercept} = \log(fS_{UT}) - \text{slope} \cdot \log(10^3)$$

$$= \log(fS_{UT}) - \left(\left(-\frac{1}{3}\right)\log\frac{fS_{UT}}{S_e}\right)\log(10^3)$$

$$\log(10^3) = 3$$

$$y \text{ interc} = 2\log(fS_{UT}) - \log(S_e)$$

$$= \log\left(\frac{(fS_{UT})^2}{S_e}\right)$$

There, equation for the S-N relationship:
($y=mx+b$ form):

$$\log(S_f) = \text{slope} \cdot \log(N_f) + y\text{-intercept}$$

'b' = slope, 6-15 $\quad$ where $\text{slope} = -\frac{1}{3}\log\frac{fS_{UT}}{S_e}$

'a' 6-14 [illegible] $\quad$ $y\text{-int} = \log\left\{\frac{(fS_{UT})^2}{S_e}\right\}$

The textbook (Shigley):

$$\left(\text{slope} \Rightarrow\right) \quad b = -\frac{1}{3}\log\left(\frac{f S_{UT}}{S_e}\right) \qquad \text{eq } 6\text{-}15$$

$$\left(\text{y-intercept} \Rightarrow\right) \quad a = \frac{\left(f S_{UT}\right)^2}{S_e} \qquad \text{eq } 6\text{-}14$$

$$S_f = a N^b \qquad \text{eq } 6\text{-}13$$

$$N = \left(\frac{\sigma}{a}\right)^{1/b} \qquad \text{eq } 6\text{-}16$$

6-13 & 6-16 are the same eq'n except 6-13 determine "stress"* in terms of # of cycles (N), 6-16 solves N in terms of applied stress

* "stress" = "strength needed"