Finding steel fatigue strength for $10^3 < N < 10^6$:

$S_N = ?$ Given: $S_{10^3} = .9 S_u$, $S_{10^6} = S_n'$

(Note - $S_{N>10^6} = S_n'$ also)

Logarithmic interpolation:

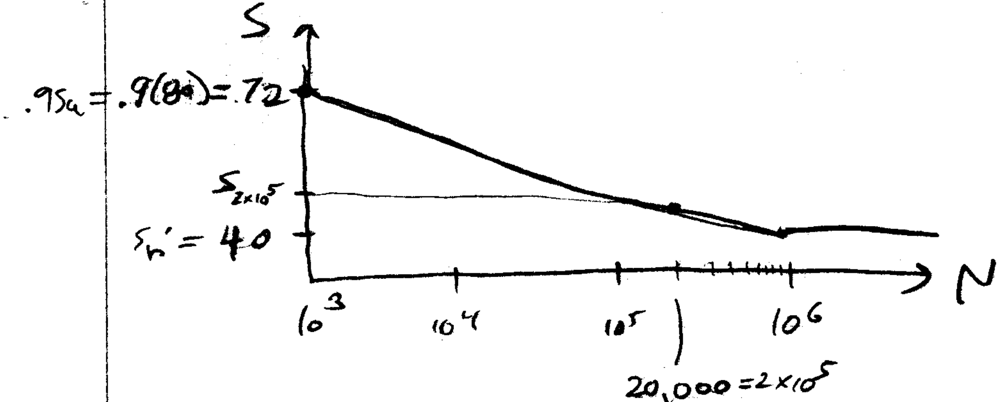
$$\log S_N = \underbrace{\log(.9S_u)}_{A} - \frac{(\log N - \log 10^3)}{(\log 10^6 - \log 10^3)}\left[\overbrace{\log(.9S_u)}^{A} - \log(S_n')\right]$$

(Base 10 or nat. log)

$$S_N = 10^{\left\{A - \frac{1}{3}[A - \log(S_n')](\log N - 3)\right\}}$$

Ex) Given: steel w/ $S_u = 80$ ksi, $S_n' = 40$ ksi

Find: plot S-N diagram & find fatigue strength at 200,000 cycles



$A = \log(.9S_u) = 1.857$

$$S_{2\times10^5} = 10^{\left\{A - \frac{1}{3}[A - \log(40)][\log(2\times10^5) - 3]\right\}}$$

$$= 10^{1.662}$$

$$= \boxed{45.9 \text{ ksi}}$$

⇒ if $\sigma_a < S_{2\times10^5}$, part won't fail by 20,000 cycles

> Note - linear interp.
>
> $\Rightarrow S_N = A - \frac{(N - 10^3)}{10^6 - 10^3}(A - S_n')$
>
> where $A = .9S_u = 72$
>
> @ $N = 2\times10^5$
>
> $S_{2\times10^5} = 65.6$ ksi
>
> way off!!