PROBLEM STATEMENT BUILDING UPON THE RESULTS OF 3-20, DETERMINE THE MINIMUM FACTOR OF SAFETY BASED ON INFINITE LIFE. ALL LOADS ARE CYCLED FROM ZERO TO THE DESIGNATED LOAD. THE MATERIAL USED IS 1045 STEEL.

GIVEN:

1. $\sigma_x = -6$ ksi, $\sigma_y = 18$ ksi, $\sigma_z = -12$ ksi, $\tau_{xy} = 9$ ksi, $\tau_{yz} = 6$ ksi, $\tau_{zx} = -15$ ksi
   $\sigma_1 = 21.04$ ksi, $\sigma_2 = 5.67$ ksi, $\sigma_3 = -26.71$ ksi
   $\sigma_{vm} = 43.09$ ksi
2. LOADS ARE CYCLED FROM ZERO TO MAXIMUM
3. 1045 STEEL (TABLE A-22: $S_y = 220$ ksi, $S_{ut} = 230$ ksi

ASSUMPTIONS:

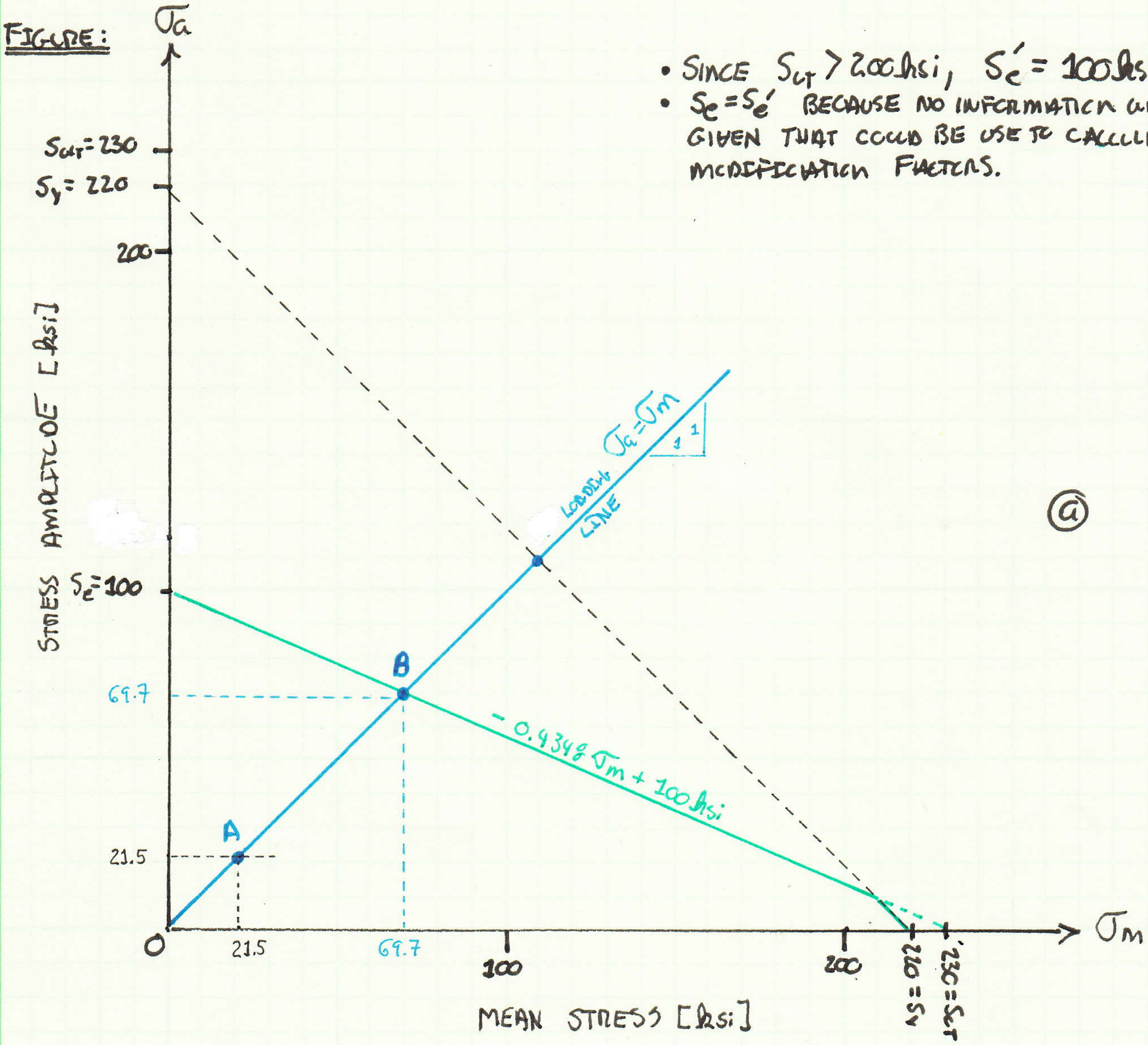
1. LINEAR-ELASTIC MATERIAL RESPONSE
2. LOADS ARE LOADED FROM ZERO, and UNLOADED FROM THEIR MAXIMUM IN PHASE.

FIND:

1. MINIMUM FACTOR OF SAFETY BASED ON INFINITE FATIGUE LIFE.

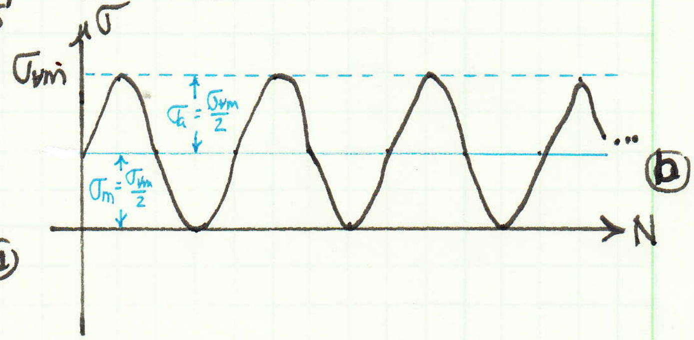
FIGURE:

- SINCE $S_{ut} > 200$ ksi, $S_e' = 100$ ksi
- $S_e = S_e'$ BECAUSE NO INFORMATION WAS GIVEN THAT COULD BE USE TO CALCULATE MODIFICATION FACTORS.



SOLUTION:

USING THE PREVIOUS STATE OF STRESS, THE CALCULATED PRINCIPLE STRESSES, AND THE VON MISSES STRESS FROM PROBLEM 3-20 THE MEAN VON MISSES AND AMPLITUDE OF THE FLUCTUATING VON MISSES STRESS CAN BE CALCULATED.



$$\sigma_{m,vm} = \frac{43.1\text{ ksi}}{2} = 21.5\text{ ksi} \quad (1)$$

$$\sigma_{a,vm} = \frac{43.1\text{ ksi}}{2} = 21.5\text{ ksi} \quad (2)$$

(a) ILLUSTRATES THE MODIFIED GOODMAN LINE. USING THIS ILLUSTRATION THE FACTOR OF SAFETY FOR FATIGUE IS

$$n = \frac{OB}{OA} \quad (3)$$

$$OA = \sqrt{(21.5\text{ ksi})^2 + (21.5\text{ ksi})^2} = 30.4\text{ ksi} \quad (4)$$

BEFORE THE FACTOR OF SAFETY CAN BE CALCULATED, POINT B NEEDS TO BE LOCATED. CALCULATING THE EQUATION OF THE LINE THAT STARTS AT $\sigma_a = S_e$ AND ENDS AT $\sigma_m = S_{ut}$

$$\sigma_a = m\cdot\sigma_m + b = -0.4348\cdot\sigma_m + 100\text{ ksi} \quad (5)$$

$$m = -\frac{100\text{ ksi}}{230\text{ ksi}} = -0.4348$$

$$b = 100\text{ ksi}$$

THE EQUATION OF THE LOADING LINE IS $\sigma_a = \sigma_m$, SETTING THIS EQUAL TO (5) @ B

$$\sigma_a^{(B)} = \sigma_m^{(B)} \rightarrow \sigma_a^{(B)} = -0.4348\cdot\sigma_m^{(B)} + 100\text{ ksi}$$

$$\sigma_m^{(B)} = -0.4348\cdot\sigma_m^{(B)} + 100\text{ ksi} \Rightarrow 1.4348\cdot\sigma_m^{(B)} = 100\text{ ksi}$$

$$\sigma_m^{(B)} = \frac{100\text{ ksi}}{1.4348} = \underline{\underline{69.7\text{ ksi}}} \quad (6) \qquad \Rightarrow OB = \sqrt{2(69.7\text{ ksi})^2} = 98.6\text{ ksi} \quad (7)$$

CALCULATING THE FACTOR OF SAFETY

$$n = \frac{98.6\text{ ksi}}{30.4\text{ ksi}} = \boxed{3.24} \quad (8)$$

SUMMARY: FOR THIS PROBLEM THE ACTUAL MACHINE ELEMENT WAS NOT SPECIFIED, THEREFORE THE ENDURANCE LIMIT COULD NOT BE MODIFIED.