MEEG 4103 Quiz 6.1.081 (Closed book, closed notes)

1. ② Define 1 pound (lb) in terms of pound-mass (lbm) and the *value* of the standard gravitational acceleration in SI.

2. ③ Using the chain-link conversion technique and the exact relations 1 lbm = 0.453 592 37 kg, 1 ft = 0.3048 m, as well as the definitions of 1 lb and 1 N, convert a stress of $\sigma = 100$ kpsi into MPa to *five* significant digits of precision.

3. ⑤ For a polished rotating beam made of AISI 1050 CD steel with $S_{ut} = 100$ kpsi and $H_B < 500$, estimate *(a)* the endurance limit S'_e, *(b)* the fatigue strength S'_f at $N = 10^4$ cycles, *(c)* the expected life N under a completely reversed stress of 55 kpsi.

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1. $1\text{ lb} = (1\text{ lbm}) \times (9.806\,65\text{ m/s}^2)$ ②

2.
$$\sigma = 100\text{ kpsi} = 10^5\text{ psi} \cdot \frac{\text{lb/in}^2}{\text{psi}} \cdot \frac{1\text{ lbm} \cdot 9.806\,65\text{ m/s}^2}{1\text{ lb}} \cdot \frac{0.453\,592\,37\text{ kg}}{1\text{ lbm}} \cdot \frac{(12)^2\text{ in}^2}{1^2\text{ ft}^2} \cdot \frac{1\text{ N}}{1\text{ kg} \cdot \text{m/s}^2} \cdot \frac{1^2\text{ ft}^2}{(0.3048)^2\text{ m}^2} \cdot \frac{1\text{ Pa}}{1\text{ N/m}^2} \cdot \frac{1\text{ MPa}}{10^6\text{ Pa}} = 689.4757\text{ MPa}$$ ②

$\sigma = 689.48$ MPa ①

3. $S'_e = 0.5 S_{ut}$: $S'_e = 50$ kpsi ① $\sigma'_F = S_{ut} + 50\text{ kpsi} = 150\text{ kpsi}$ ①

$(S'_f)_N = \sigma'_F (2N)^b$: $50 = 150(2 \cdot 10^6)^b$ $\therefore\ b = -0.07572$ ①

$S'_f = 150(2 \cdot 10^4)^{-0.07572} = 70.86$ $S'_f = 70.9$ kpsi ①

$55 = 150(2N)^b$ $N = 284 \times 10^3$ $N = 2.84 \times 10^5$ cycles ①