Text Problems: 4.83 (30 pts)

Non-text Problems:

1. (10 pts) Derive simplified equations for sphere/plane contact and cylinder/plane contact.

2. (30 pts)

   (a) Derive the relation between load factor of safety ($n_L$) and the strength factor of safety ($n_s$) for spherical surface fatigue applications.

   (b) A spherical ball of $r = 10.0 \text{ mm}$ in a self-aligning bearing carries a load of $3.0 \text{ N}$, as in figure 1. The spherical seat has $r = 35 \text{ mm}$. Use a factor of safety for the surface fatigue stress of $n_s = 1.25$ and a factor of safety for the load of $n_L = 1.5$. All parts are made of steel ($E = 200 \text{ GPa, } \nu = 0.3$).

   **Determine what ultimate strength the steel needs to be in order to withstand a lifetime of $1 \times 10^9$ cycles.**

3. (30 pts) An experiment was performed using a cylindrical 1045 steel slider heat treated to a yield stress of $S_y = 128 \text{ ksi}$, pressed endwise against a steel disk with no lubricant. It was found that for a relative sliding velocity of $0.67 \text{ ft/sec}$, the 0.031 inch diameter slider, loaded by a 40 lb axial force, produced a slider wear volume of $5.8 \times 10^{-8} \text{ in}^3$ during a test of 40 minutes duration.

   (a) If the same material combination is to be used in a slider-bearing application at a sliding velocity of $3.0 \text{ ft/sec}$ under a bearing load of $P = 100 \text{ lb}$, and if the slider is to be square, what side dimension, $s$, should it have to assure a lifetime of 1000 hours, if a maximum wear depth of 0.050 inches can be tolerated? See figure 2 for a diagram of the slider to be designed. The experimental slider has the same setup, except it is a cylinder.

   (b) Check the design in 3a material against yielding.

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F = 3.0 \text{ N}
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![Figure 1: Figure for problem 2b](image-url)
Figure 2: Figure for problem 3