Machine Design Homework 4

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```
[1]: # Notebook Preamble
     import sympy as sp
     import numpy as np
     import matplotlib.pyplot as plt

     plt.style.use('maroon_ipynb.mplstyle')
```

Contents

1 Problem 6-1

1.1 Given

A 10-mm steel drill rod was heat treated and ground. The measured hardness was found to be 300 Brinell.

1.2 Find

Estimate the endurance strength in MPa if the rod is used in rotating bending.

1.3 Solution

Eq. 6-10 on p. 305,

$$S'_e = \begin{cases} 0.5S_{ut} & S_{ut} \leq 200\ ksi\ (1400\ MPa) \\ 100 & S_{ut} > 200\ ksi \\ 700\ MPa & S_{ut} > 1400\ MPa \end{cases}$$

The ultimate strength of steel comes from Eq. 2-36,

$$S_{ut} = 3.4H_B$$

```
[2]: H_B = 300
     S_ut = sp.S('3.4')*H_B

     if S_ut <= 1400:
         S_e_prime = 0.5*S_ut
     else:
         S_e_prime = sp.S(700)

     S_e_prime  # ksi
```

[2]: 510.0

This value is not the final value. The relationship for the refined value is,

$$S_e = k_a k_b k_c k_d k_e S'_e$$

The only necessary k values used for this analysis is k_a and k_b, whose equations are at 6-18 and 6-19 respectfully.

```
[3]: # See Table 6-2
     k_a = sp.S('1.58')*S_ut**-(sp.S('0.085'))
     d = 10
```

```
k_b = (d/sp.S('7.62'))**-(sp.S('0.107'))
S_e = k_a*k_b*S_e_prime
S_e   # MPa
```

[3]: 434.375608564977

The answer in the back of the book appears to be heavily rounded.