ESE 406/505 & MEAM 513 - SPRING 2011
HOMEWORK #8
DUE 6-Apr-2011 (Monday, 11-Apr-2011 with late pass)

1. Work problem 4.26 in the textbook.

   Answers:

   a. $\dfrac{1}{1+10k_p}$, $k_p \geq 9.9$

   b. $\omega_n = \sqrt{2020} \simeq 45$, $\zeta = \dfrac{12}{2\sqrt{2020}} \cong 0.13$

   c. $\sigma \geq 46$, $\zeta \geq 0.7$

   d. On Your Own.

   e. Integral feedback eliminates steady errors for step disturbances.

2. Work problem 4.29 in the textbook.

   Answers:

   a. $\dfrac{Y(s)}{W(s)} = \dfrac{-1500s}{s^2+60(1+10k_p)s+600k_I}$

   b. $k_I = 12$, $k_p = 0.1$

3. Work problem 4.30 in the textbook.

   Answers:

   a. 0

   b. $\dfrac{1}{K_v} = \dfrac{1}{10k_I} = \dfrac{1}{120}$

   c. 0

d. $-\frac{5}{24}$

4. Work problem 4.33 in the textbook. Note that for part (a), you should use the tuning rules in Table 4.2, while for part (b), you should use table 4.3. Please submit closed-loop step command responses for both controllers (pretty plots with both responses on the same axis, please.)

   Note that equation 4.89 in the explanation of the Ziegler-Nichols rules is incorrect. It should be $\frac{Y(s)}{U(s)} = \frac{Ae^{-t_d s}}{\tau s + 1}$, which is precisely the form of transfer function you are given here. For part (b), you should be able to compute the gain, K_u, at which the system will reach neutral stability by making a bode plot of the loop transfer function. You don't have to submit this analysis, but please be sure you know how to do it.

   Answers:

   a. $K = \frac{1.2}{RL} = 1.8 \quad T_I = 2L = 4 \; T_D = 0.5L = 1.0$

   b. $K \;=\; 0.6K_u = 1.82 \quad T_I = \frac{1}{2}P_u = 3.5 T_D = \frac{1}{8}P_u = 0.875$