ME 422 – Quiz 2
Winter 2011

In giving your answer, the answer alone is not enough. Make sure you clearly give your rationale for arriving at the answer. It must be clear to me how you arrive at your answer.
Weights: 1 = 60%, 2 = 40%

1. The plot below shows the output from a step response of a system where the input is $3\cdot u(t)$.

   ![Step Response Plot]

   a) Find the response parameters of the system.
b) What is the transfer function of the system?

c) What is the percent overshoot of the response?

d) What is the system’s settling time?

2. For the system shown, find for what values of $K$ the system is stable.

$$G_{cl} = \frac{16 \cdot (s + 3)}{18 \cdot s^4 + 2 \cdot s^3 - K \cdot s^2 + 4 \cdot s + 20}$$
Formulae:

\[ G_1(s) = \frac{K_{ss}}{\tau \cdot s + 1} \]

\[ G_2(s) = \frac{K_{ss} \cdot \omega_n^2}{s^2 + 2 \cdot \zeta \cdot \omega_n \cdot s + \omega_n^2} \]

\[ \zeta = \frac{-\ln(\%\text{ OS}/100\%)}{\sqrt{\pi^2 + \ln^2(\%\text{ OS}/100\%)}}, \]

\[ T_{s-2\%} = \frac{4}{\zeta \cdot \omega_n} \]

Sufficient Hurwitz conditions for stability:

- \( n = 3 \): \( a_0 \cdot a_3 - a_1 \cdot a_2 < 0 \)
- \( n = 4 \): \( a_0 \cdot a_3^2 + a_4 \cdot a_1^2 - a_1 \cdot a_2 \cdot a_3 < 0 \)
- \( n = 5 \): \( a_2 \cdot a_5 - a_3 \cdot a_4 < 0 \) and \( (a_0 \cdot a_3 - a_1 \cdot a_2)^2 - (a_3 \cdot a_4 - a_3 \cdot a_5) \cdot (a_1 \cdot a_2 - a_0 \cdot a_3) < 0 \)