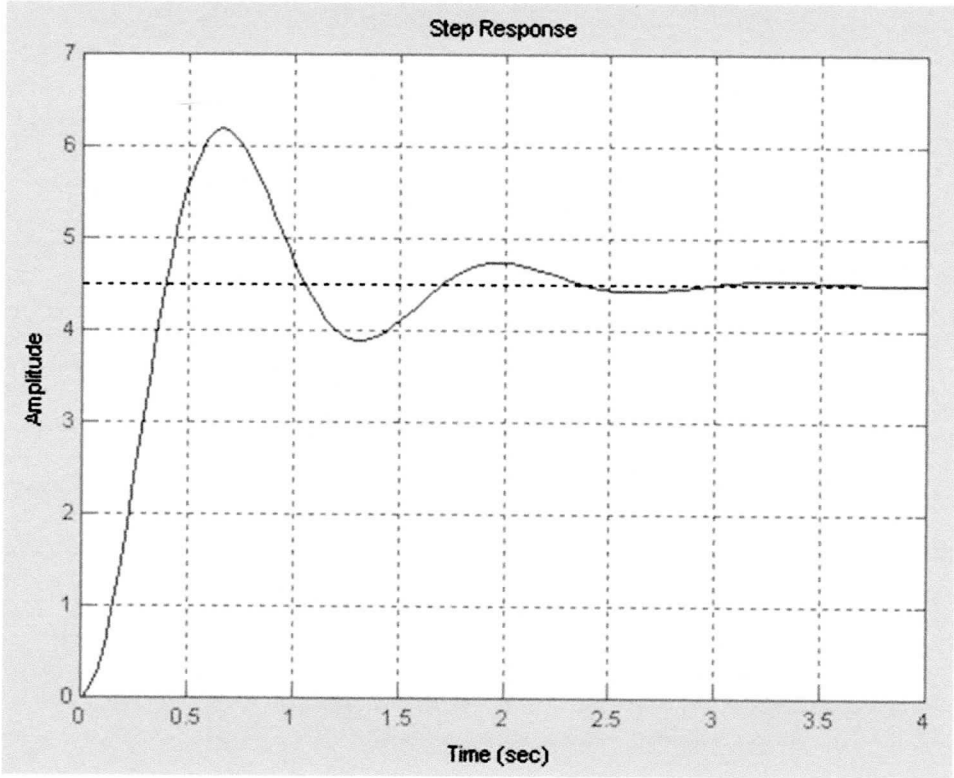
Name _____ Circle one: Section 1510 1610

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.

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



a) Find the response parameters of the system.

(2) $\%OS = (6.2 - 4.5)/4.5 = 0.378$

(2) $\zeta = -\ln(0.378)/\sqrt{\pi^2 + \ln^2(0.378)} = 0.296$

(2) $T_d = 1.95 - 0.68 = 1.27$ sec

(2) $\omega_d = \frac{2\pi}{T_d} = 4.95 = \omega_n\sqrt{1-\zeta^2}$

(2) $\omega_n = 4.95/\sqrt{1-0.296^2} = 5.18$ rad/sec

(2) K_{ss}: 3 gives 4.5, $K_{ss} = 1.5$

b) What is the transfer function of the system?

(3) $G(s) = \dfrac{1.5\,(5.18)^2}{s^2 + 2(0.296)(5.18)s + 5.18^2} = \dfrac{40.25}{s^2 + 3.07s + 26.8}$

c) What is the percent overshoot of the response?

(1) $\%OS = 37.8\%$

d) What is the system's settling time?

(2) $T_{s\text{-}2\%} = \dfrac{4}{\zeta \omega_n} = \dfrac{4}{0.296(5.18)} = 2.61\,sec$

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

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

(2) For necessary condition, $K < 0$.

Sufficient condition for 4th order

(4) $a_0 \cdot a_3^2 + a_4 \cdot a_1^2 - a_1 \cdot a_2 \cdot a_3 < 0$

$20 \cdot (2^2)^2 + 18 \cdot 4^2 - 4 \cdot (-k) \cdot 2 < 0$

$80 + 288 + 8K < 0$

$8K < -368$

(2) $\boxed{K < -46}$

└ That necessary condition is superfluous