AMERICAN UINVERSITY OF BEIRUT
FACULTY OF ENGINEERING AND ARCHITECTURE
EECE 460 Control Systems
Spring 2005-2006. Quiz I
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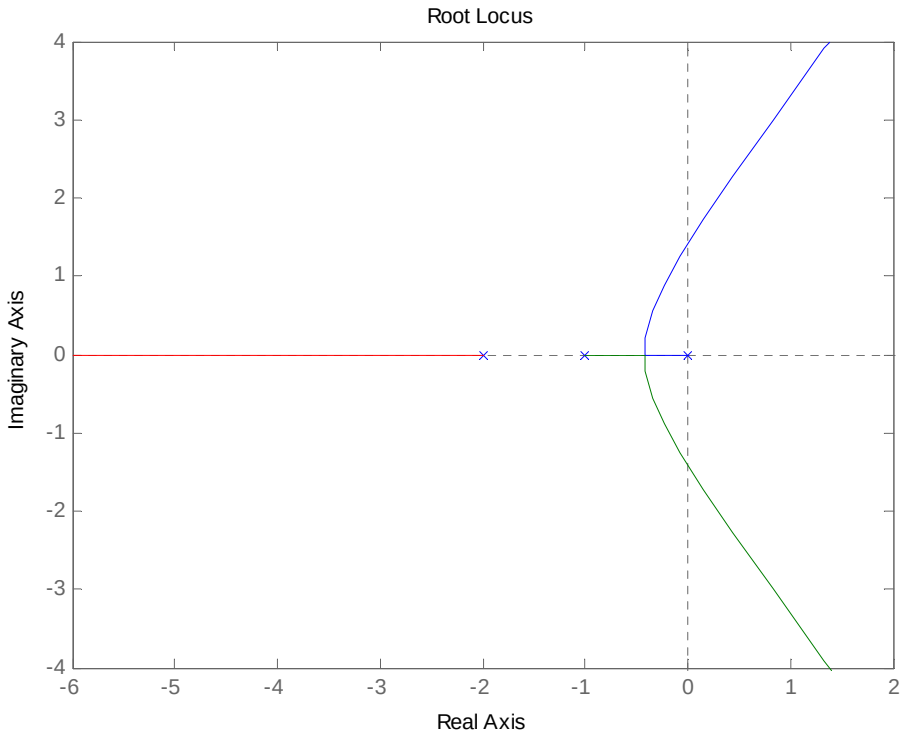
Name:

1.5 hours. March 16, 2006
Total of 100 points. Open Book Exam, 2 pages
YOU MUST RETURN THIS EXAM WITH YOUR ANSWER BOOKLET

Question I (50 points):

A unity feedback control system compensated by a series P controller with positive gain K has the following root locus:



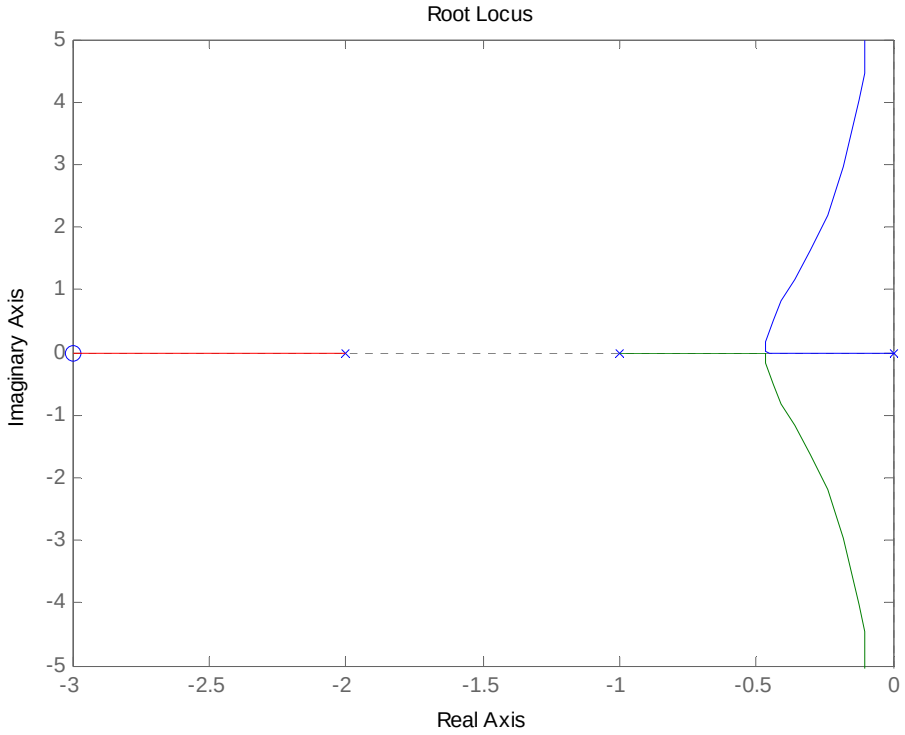
+10 a) Based on the graph, approximate the open loop transfer function $\left[\frac{k}{s(s+1)(s+2)}\right]$

+10 b) Characterize the stability of the closed loop transfer function *[conditionally stable]*

+10 c) Find the P controller gain K that makes the closed loop system dominated by a critically damped second order system. $[k=0.38]$

+10 d) Find the range of the P controller gain that makes the system dominated by an overdamped 2nd order behavior. $[0<k<0.38]$

A substitute series PD controller is proposed for the same system K(s+3), the following new root locus was obtained



+5 e) Based on the plot, supply the range of the gain K that makes this controlled process stable. [$k>0$ always]

+5 f) Based on plot approximate the value of the double location of the closed loop transfer function. [≈ -0.45]

Question II (50 points):

A unity feedback system of a DC motor whose transfer function is

$$G(s) = \frac{K}{s(s+6)}$$

+10 a) Approximate the root locus of the system

+10 b) Derive a valid state model of the open loop system

+10 c) Supply the closed loop transfer function

+10 d) Supply the natural frequency and damping ratio of the closed loop transfer function when K = 672

+10 e) Based on part d, approximate 2% settle time and maximum overshoot in the system response to a step input.

b) $A = \begin{bmatrix} 0 & 1 \\ 0 & -6 \end{bmatrix}, B = \begin{bmatrix} 0 \\ k \end{bmatrix}, C = \begin{bmatrix} 1 & 0 \end{bmatrix}$, not unique

c) $\dfrac{k}{s^2 + 6s + k}$

d) $\omega_n \approx 26, \varsigma \approx 0.116$

e) $\mu_p \approx 69\%, t_s \approx 1.33 \sec$