UNIVERSITY OF VICTORIA

FINAL EXAMINATIONS – DECEMBER 2011

ELEC 360 – CONTROL THEORY AND SYSTEMS I

SECTIONS A01/CRN 11066 A02/CRN 10186

TO BE ANSWERED IN BOOKLETS

DURATION: 3 hours

INSTRUCTOR: Dr. P. Agathoklis

STUDENTS MUST COUNT THE NUMBER OF PAGES IN THIS EXAMINATION PAPER BEFORE BEGINNING TO WRITE, AND REPORT ANY DISCREPANCY IMMEDIATELY TO THE INVIGILATOR.

THIS QUESTION PAPER HAS 5 PAGES, INCLUDING THIS COVER PAGE.

FOUR (4) PAGES OF NOTES AND PHOTOCOPIES OF LAPLACE TRANSFORMS ARE PERMITTED.

DETACH PAGE 5 FROM THE EXAMINATION PAPER AND HAND IN WITH YOUR ANSWER BOOKLET.

Marks

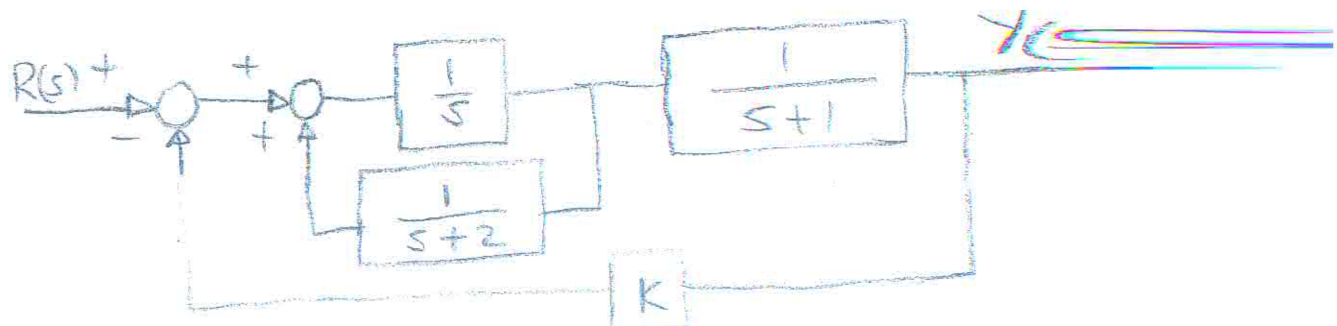
(4) 1. Consider a system G(s), where G(s) has

- one integrator,
- a pole at -.5
- a pole at -10 and
- a phase cross-over frequency of 5 rad/sec

Find the response of G(s) to an input signal given by:

$$u(t) = \begin{cases} 2 & for\ t > 1 \\ 0 & else \end{cases}$$

(8) 2. Consider the system



a) Find the transfer function G(s)=Y(s)/R(s).
b) Sketch the root-locus of the system for K between 0 and infinity.
c) Discuss the transient response performance of the closed-loop syste
K goes from 0 to ∞.
d) Find for what values of K is the closed-loop system stable.

(10) 3. Consider the unity negative feedback system with feed-forward transfer function given by:

$$G(s) = \frac{K}{5(s^3 + 2s^2 + 3s)}$$

(a) Find for what values of K does the closed-loop system have a steady state error of less than 0.7 for unit step and unit ramp inputs.
(b) Sketch the root-locus for the above system.
(c) Sketch the Bode and polar plots for the open-loop system.
(d) Find a state-space description for the closed-loop system.

(6) 4. Consider the unity negative feedback system with the same feed forward transfer function as in question 3, given by:

$$G(s) = \frac{K}{5(s^3 + 2s^2 + 3s)}$$

(a) Use the Polar plot of G(s) and evaluate the stability of the closed-loop system with Proportional Control (i.e variable gain K changing from 0 to infinity in the numerator) using the Nyquist Stability Criterion.

(b) Replace Proportional Control K with Proportional-Derivative Control so that

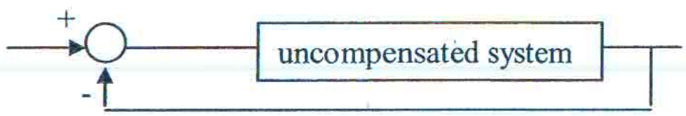
$$G(s) = \frac{K(s+1)}{5(s^3 + 2s^2 + 3s)}$$

and use the Nyquist Stability Criterion to evaluate the stability of the closed-loop system when K is changing from 0 to infinity.

(6) 5. The Bode plots of the open loop compensated and uncompensated system are given in page 5.

From the plot of the uncompensated system, determine:

a) The stability of the closed-loop system



b) The type of open-loop system and the value of the corresponding static error constant.

c) The phase and gain margins.

From the plot of the compensated system, determine:

a) The compensator used

b) The new phase and gain margins

c) Discuss the effects of using a compensator – what has been improved and how?

Justify your answers and indicate in the attached figure (page 5) the corresponding quantities.

END