UNIVERSITY OF VICTORIA

FINAL EXAMINATION – DECEMBER 2013

ELEC 360 – CONTROL THEORY AND SYSTEMS I

SECTIONS A01/CRN 11210, A02/CNR 11211

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

(3) 1. Find the output of a system having an impulse response given by

$$g(t) = \begin{cases} e^{-t} - e^{-2t} & \text{for } t \geq 0 \\ 0 & else \end{cases}$$

to the following input signal

$$u(t) = \begin{cases} 1 \; for \; 0 \leq t \leq 1 \\ 0 \quad else \end{cases}$$

(5) 2. Find the transfer function for:

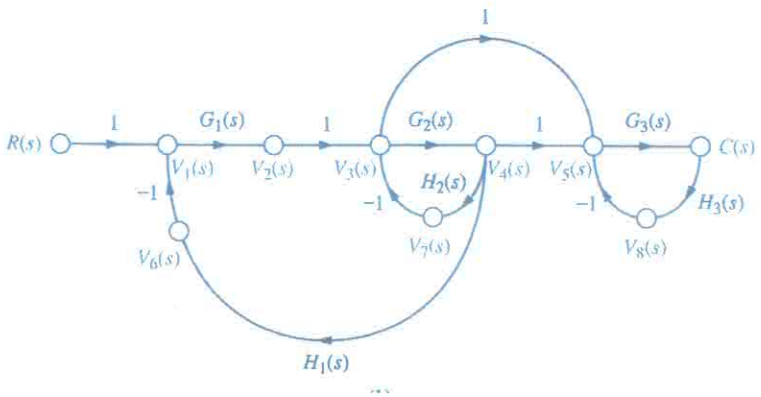
(a)

$$\dot{\underline{x}} = A\underline{x} + \underline{b}u$$
$$y = \underline{c}\underline{x}$$

with

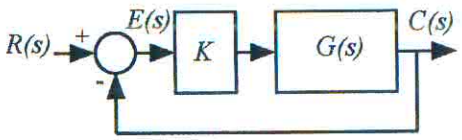
$$A = \begin{bmatrix} 0 & -2 \\ 1 & -3 \end{bmatrix} \quad b = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad c = [0 \quad 1]$$

(b)



Marks

(3) 3. Find for what values of K is the following system stable:



with $$G(s) = \frac{1}{s(s^2 + 6s + 11)}$$

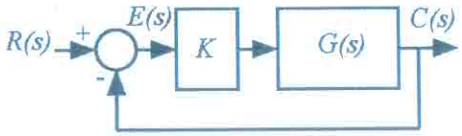
(6) 4. Consider the system in question 3.

(a) Sketch the root locus for the system for K between 0 and ∞

(b) Discuss the effect of changing K to the step response of the closed-loop system. Justify your answers.

(c) For what values of K will you have a steady state error of less than 0.5 for a unit step and a unit ramp.

(8) 5. Consider the following two systems:



where

(a) $$G(s) = \frac{1}{(s+1)(s+2)(s+5)}$$

(b) $$G(s) = \frac{(s-1)}{s(s+3)}$$

Sketch the Bode and Polar plots of the open-loop system and discuss the stability of the closed-loop system using the Nyquist stability criterion for both (a) and (b).

Marks

(7) 7. The figure in page 5 is the frequency response of the open-loop system without compensator (solid line) and the open-loop system with the compensator (doted line).

(a) For the uncompensated system, find:

i) The type of the system.

ii) The error coefficient which is not 0 or ∞ (give the value)

iii) The phase and the gain margins.

(b) For the compensated system, find:

i) The type of compensator used.

ii) The error coefficient which is not 0 or ∞ (give the value)

iii) The phase and gain margins.

(c) What is the effect of using this compensator on the closed loop response of the system?

Justify your answers. Indicate in the figure the corresponding quantities!

WRITE your NAME and STUDENT ID NUMBER on the attached sheet for Question 7. Include this sheet with your booklet.