

**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

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

to the following input signal

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

- (5) 2. Find the transfer function for:

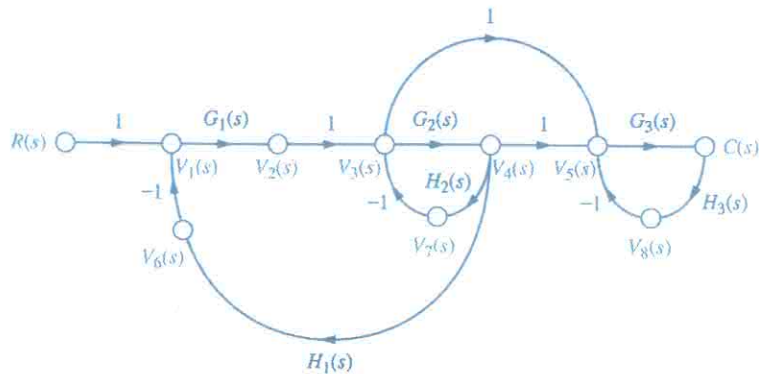
(a)

$$\begin{aligned} \dot{\underline{x}} &= A\underline{x} + \underline{b}u \\ y &= \underline{c}\underline{x} \end{aligned}$$

with

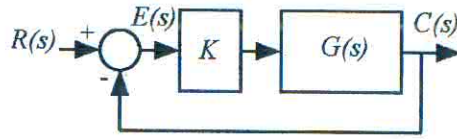
$$A = \begin{bmatrix} 0 & -2 \\ 1 & -3 \end{bmatrix} \quad b = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad c = [0 \quad 1]$$

(b)



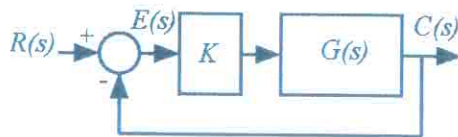
Marks

- (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.
- Sketch the root locus for the system for  $K$  between 0 and  $\infty$
  - Discuss the effect of changing  $K$  to the step response of the closed-loop system. Justify your answers.
  - 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 (dotted line).
- (a) For the uncompensated system, find:
- i) The type of the system.
  - ii) The error coefficient which is not 0 or  $\infty$  (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  $\infty$  (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.**