UNIVERSITY OF VICTORIA

FINAL EXAMINATIONS – DECEMBER 2016

ELEC 360 – CONTROL THEORY AND SYSTEMS I

SECTIONS A01 (CRN: 11243), A02 (CRN: 11244)

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 IT IN WITH YOUR ANSWER BOOKLET.

Marks

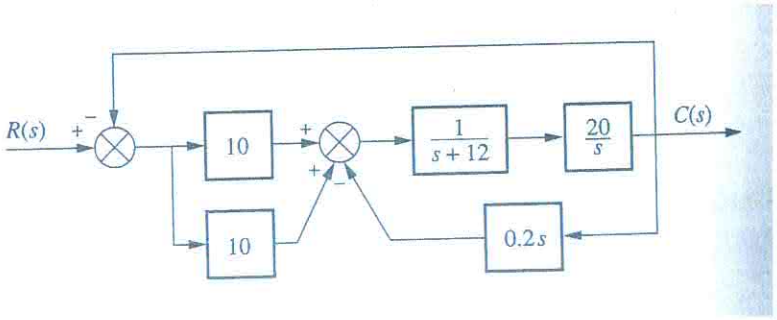
(4) 1. Consider a system described by:

$$\ddot{y} + 5\dot{y} + 6y = u$$

Find $y(t)$ for $y(0) = \dot{y}(0) = 0$ and an input signal $u(t)$ given by:

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

(4) 2. Find the transfer function G(s) = C(s)/R(s) of the following system :



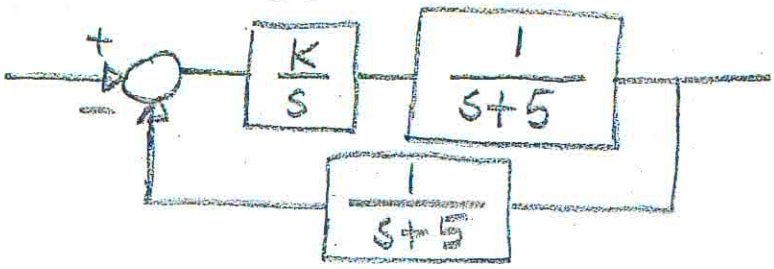
(3) 3. Consider a system given by:

$$\dot{\underline{x}} = \underbrace{\begin{bmatrix} -1 & 2 \\ -1 & b \end{bmatrix}}_{A} \underline{x} + \underbrace{\begin{bmatrix} 0 \\ 1 \end{bmatrix}}_{B} u$$

$$y = \underbrace{\begin{bmatrix} 1 & 1 \end{bmatrix}}_{C} \underline{x}$$

For what values of the parameter b will the system be stable?
Jystify your answer.

(10) 4. Consider the following system:



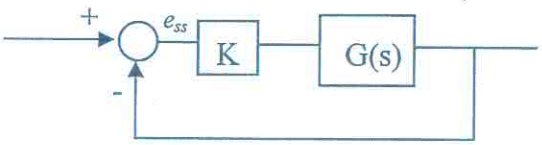
(a) Sketch the root-locus for the above system.

(b) Discuss the transient response performance of the closed-loop system when K goes from 0 to ∞.

(c) For what values of K is the closed-loop system stable

(d) Find K so that the steady state error is less than 0.4 for a unit step and a unit ramp.

(8) 5. Consider a system given by:



where G(s) is given by:

(i) $$G_1(s) = \frac{(s+1)}{s(s+2)(s^2+2s+9)}$$

or

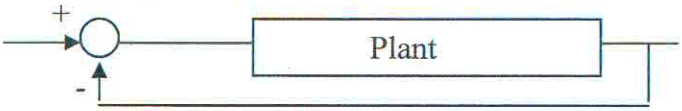
(ii) $$G_2(s) = \frac{(s-1)}{s(s+3)}$$

(a) Sketch the Bode and Polar plots for $G_1(s)$ and $G_2(s)$

(b) Using the Nyquist Stability Criterion, evaluate the stability of the two closed-loop systems with negative unity feedback, Proportional Control (i.e variable gain K changing from 0 to infinity in the numerator) and feedforward transfer function $G_1(s)$ or $G_2(s)$ respectively.

(6) 6. The Bode plots of the open loop compensated and open loop uncompensated systems are given in page 5 (both are minimum phase).

From the open-loop Bode plot of ***the uncompensated system***



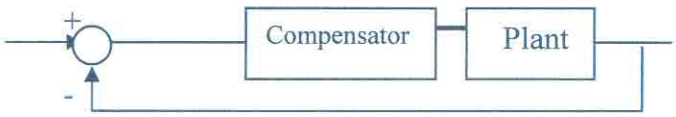
determine:

a) The stability of the closed-loop system

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

c) The phase and gain margins.

From the open-loop Bode plot of the ***compensated system***



determine:

a) The type of compensator used

b) The new phase and gain margins

c) Discuss the effects of using this compensator on the response of the closed-loop system, i.e, what has been improved (with respect to the uncompensated system) and why?

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

END