

UNIVERSITY OF VICTORIA

FINAL EXAMINATIONS –December 2023

ECE 360 – CONTROL THEORY AND SYSTEMS I

SECTION A01 CRN: 11032

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 AND AN ATTACHED FIGURE.

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

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

Marks

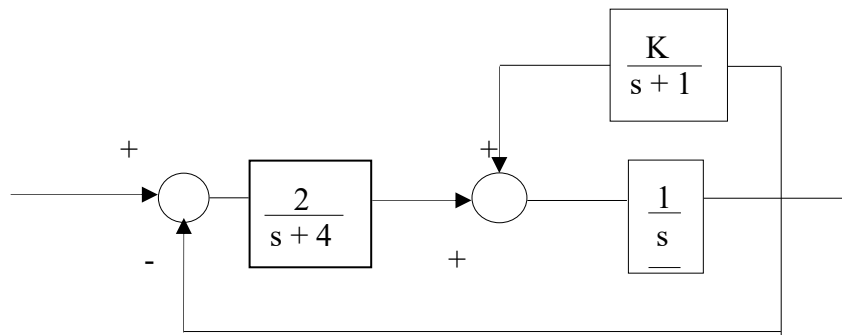
- (4) 1. Consider a system described by the following differential equation:

$$\ddot{x}(t) + 6\dot{x}(t) + 8x(t) = u(t)$$

Find the response of the system to initial conditions $x(0)=0$, $\dot{x}(0) = 0$ and an input signal $u(t)$ given by:

$$u(t) = \begin{cases} e^{-2t} & \text{for } 0 \leq t \leq 1 \\ 0 & \text{else} \end{cases}$$

- (5) 2. Consider the system given by:



Find a state-space representation for this system.

- (4) 3. Consider a *negative unity feedback system* with the following feedforward transfer function

$$G(s) = \frac{K}{(s-1)(s+3)(s+4)}$$

Find for what values of K is the *closed loop system* stable.

Justify your answers.

- (6) 4. a) Sketch the root-locus of a system with the following open-loop transfer function:

$$G(s) = \frac{K(s+1)}{(s^2-4s+13)}$$

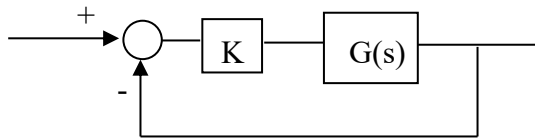
- b) Discuss the transient response of the closed loop system when K goes from 0 to infinity.
 c) Discuss the steady state response of the closed loop system for unit step, unit ramp and unit parabola inputs.

- (6) 5. Sketch the Bode and Nyquist plots of

i) $G_1(s) = \frac{1}{s(s+2)(s+5)}$

ii) $G_2(s) = \frac{s-1}{s^2(s+5)}$

- (4) 6. Consider the Bode and Nyquist plots of the systems in question 5. Determine the stability of the two closed loop systems given by:

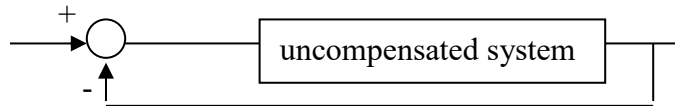


where $G(s)$ is equal to $G_1(s)$ and $G_2(s)$ respectively

Justify your answers.

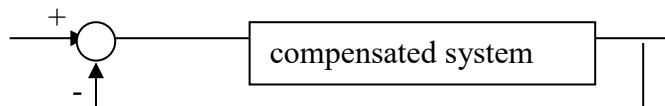
- (6) 7. The Bode plots of the open loop compensated and uncompensated system are given in page 5

From the plot of the system without compensator (uncompensated system), determine:



- The phase and gain margins
- The stability of the closed-loop system
- The type of open-loop system and the value of the corresponding static error constant.

From the plot of the system with compensator (compensated system), determine:



- The compensator used
- The new phase and gain margins
- Discuss the effects of using a compensator – what has been improved and how?

Justify your answers and indicate in the attached figure (page 6) the corresponding quantities.

END

Name: _____

Student No.: _____

Figure for Question 7**Solid Line:** System **without** compensator**Dashed Line:** System **with** compensator

Solid line: uncompensated;

Dotted line: compensated

Bode Diagram