

UNIVERSITY OF VICTORIA

FINAL EXAMINATIONS – DECEMBER 2015

ELEC 360 – CONTROL THEORY AND SYSTEMS I

SECTIONS A01 (CRN: 11255), A02 (CRN: 11256)

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.

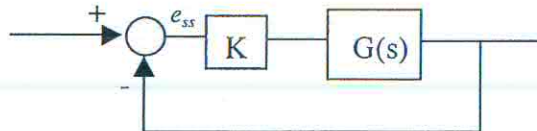
THIS QUESTION PAPER HAS 5 PAGES, INCLUDING THIS COVER PAGE.

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

- ✓ (5) 1. Consider a negative unity feedback system with feedforward transfer function $KG(s)$:



where $G(s)$ has

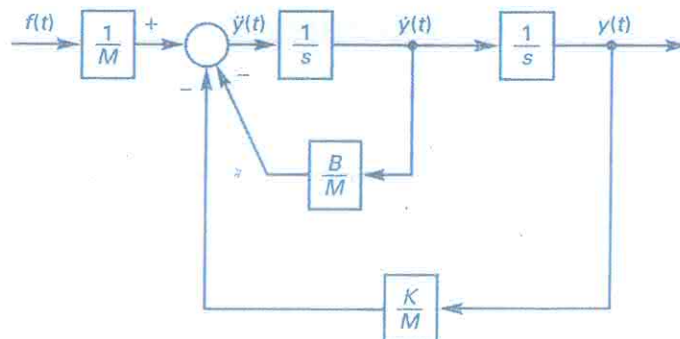
- an integrator
- a pole at -2

and e_{ss} , the steady state error to a unity ramp is 0.5

Find the response of the closed-loop system to the following input signal:

$$u(t) = \begin{cases} 0.5 & \text{for } 0 < t < 2 \\ 0 & \text{else} \end{cases}$$

- (4) 2. Find a state-space description for the following system :

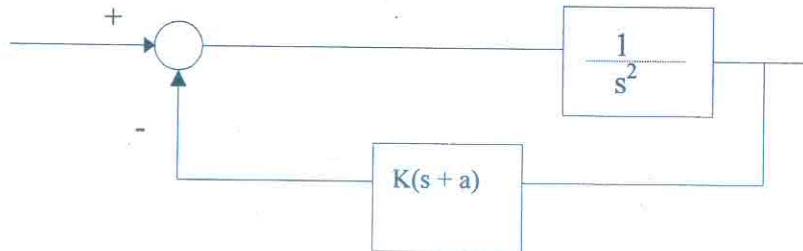


- (10) 3. Consider the closed-loop system with unity negative feedback and the following system in the feed forward path:

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

- ✓ (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) Sketch the Bode plot and the polar plot for the open-loop system.

- ✓ (5) 4. Consider the system given by:



Find K and a so that the closed-loop unit step response has a settling time of 4 sec and an overshoot of 0.13.

- ✓ (9) 5. Sketch the Bode plots and the polar plots for the following transfer functions:

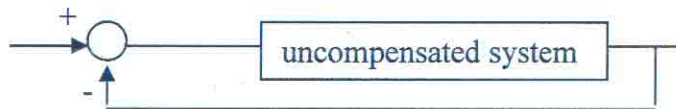
(a)
$$G_1(s) = \frac{10(s+0.5)}{s(s+2)(s^2+2s+5)}$$

✓ (b)
$$G_2(s) = \frac{K(s+1)}{s(s+2)(s+4)}$$

Using the Nyquist Stability Criterion, evaluate the stability of the negative unity feedback closed loop system with $G_2(s)$ as the feedforward transfer function. Consider a variable gain K changing from 0 to infinity.

- (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 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 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