UNIVERSITY OF VICTORIA

FINAL EXAMINATIONS – DECEMBER 2004

ELEC 360 – CONTROL THEORY AND SYSTEMS I

SECTION F 01

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 6 PAGES, INCLUDING THIS COVER PAGE AND TWO ATTACHED FIGURES.

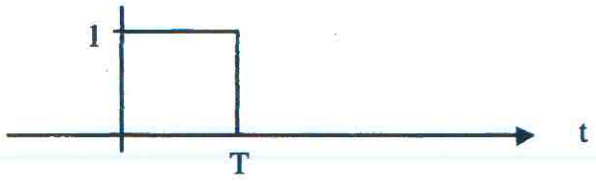
FOUR (4) PAGES OF HANDWRITTEN NOTES AND PHOTOCOPIES OF LAPLACE TRANSFORMS ARE PERMITTED.

DETACH PAGES 5 & 6 FROM THE EXAMINATION PAPER AND HAND IN WITH YOUR ANSWER BOOKLET.

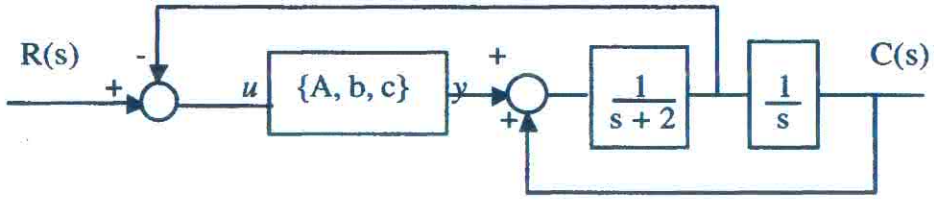
Marks

(5) 1. A system G(s) has
- two poles, one at -2 and one at -3
- one zero at +1

and the steady state value of the output with a unit step input is one.
Find the response of G(s) to an input signal given by:



(5) 2. Consider the system



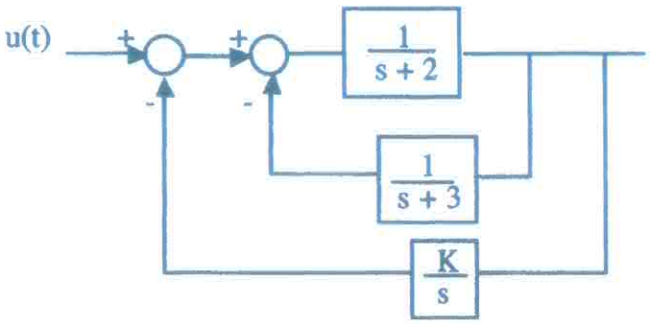
where {A, b, c} is given in state-space form as:

$$\dot{\underline{x}} = \begin{bmatrix} 1 & 2 \\ -1 & 1 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$$

$$y = \begin{bmatrix} 2 & 3 \end{bmatrix} \underline{x}$$

Find a state-space description for the complete system.

(5) 3. Consider the system given by:



a) Find for what values of K is the closed-loop system stable.

b) For what values of K is the steady state error for a unit step input as well as for a unit ramp input less than 0.3?

(6) 4. Sketch the root-locus of the system in question 3. Discuss the transient response performance of the closed-loop system when K goes from 0 to ∞.

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

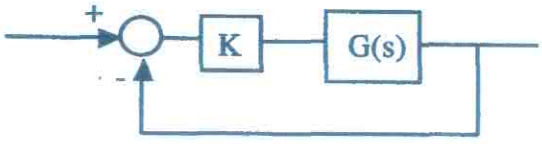
$$G(s) = \frac{K(s+2)}{s^2(s+10)}$$

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

i) $$G_1(s) = \frac{(s+1)}{s(s+0.5)(s+2)}$$

ii) $$G_2(s) = \frac{(s-1)}{(s+0.5)(s+1)}$$

(6) 7. Consider the Bode diagram of a system given on page 5. Based on this diagram, sketch the Nyquist plot and determine the stability of a closed loop system given by:



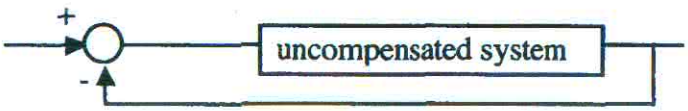
where the frequency response of G(s) is the one given on page 5.

Justify your answers.

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

From the plot of the uncompensated system, determine:

a) The stability of the closed-loop system



b) The type of 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 compensator used

b) The new phase and gain margins

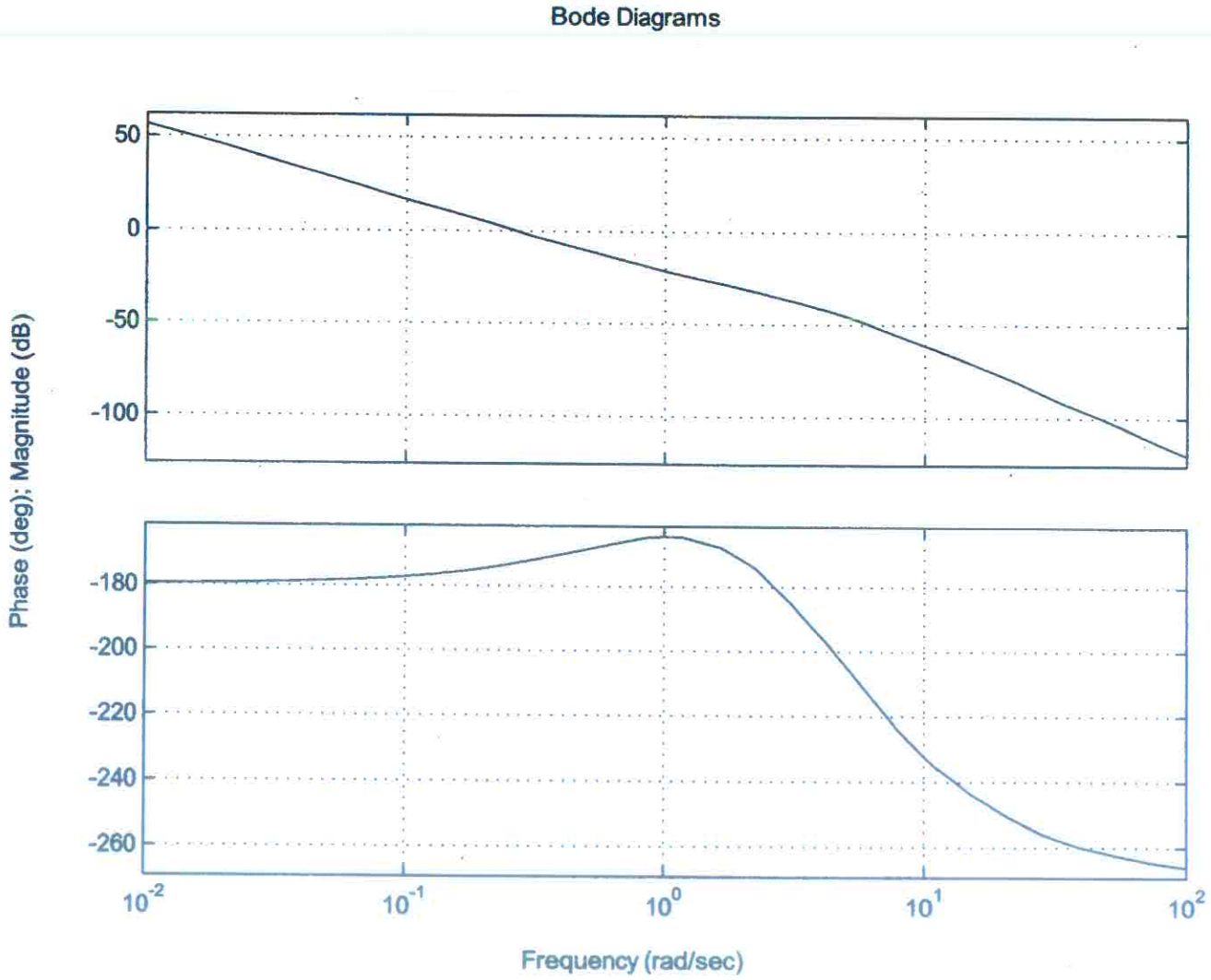
c) Discuss the effects of using a compensator – what has been improved and how?

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

END

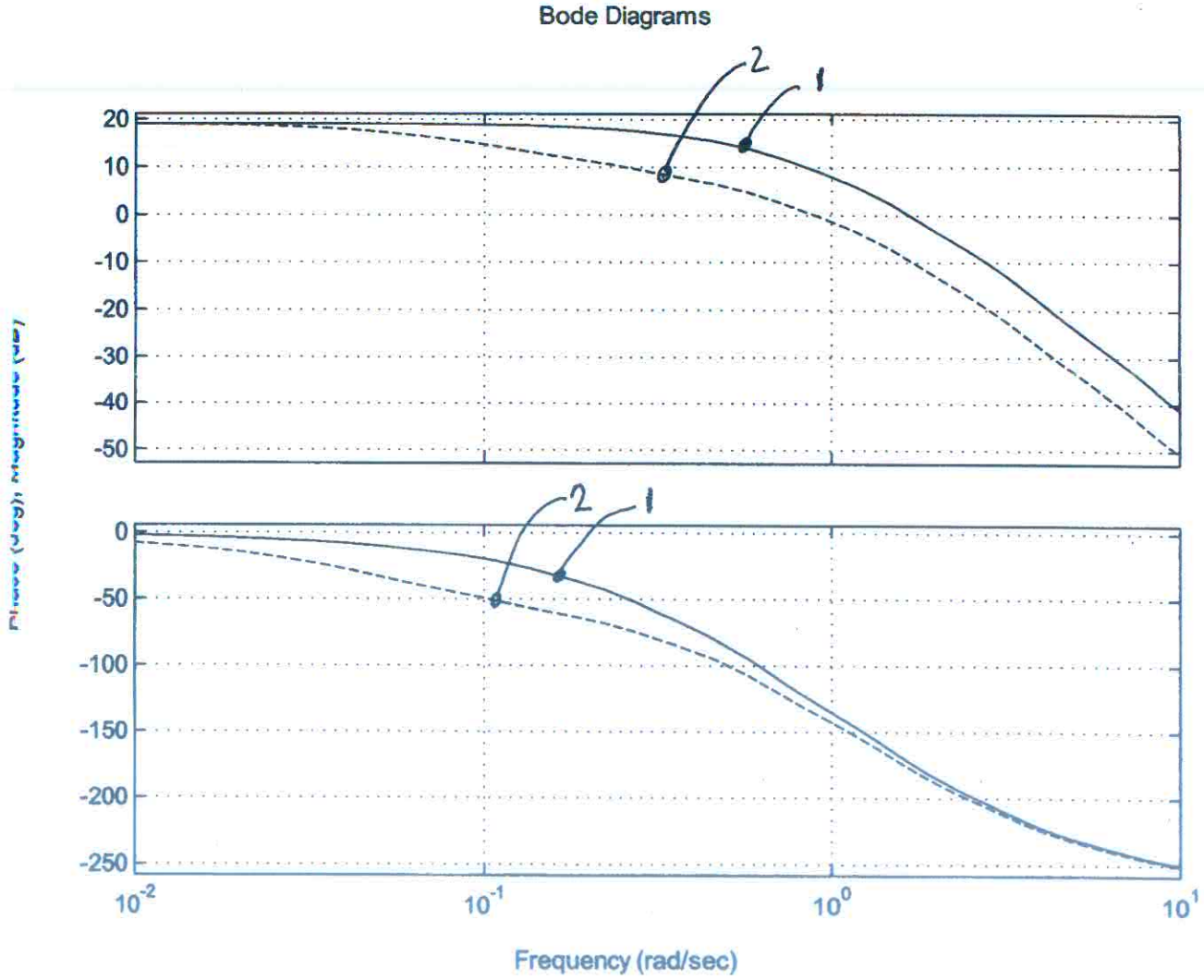
Name: _____ **Student No.:** _____

Figure for Question 7



Name: _____ **Student No.:** _____

Figure for Question 8



1. Uncompensated system

2. Compensated system