PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Final Examination: Semester 2   Academic Year: 2006
Date: February 24, 2007   Time: 9:00-12:00
Subject: 226-331: Industrial Automatic Control   Room: R300

ทุจริตในการสอบ โทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

Instructions

- There are 5 questions in 4 pages.
- Attempt all questions and write the answer in the answer book.
- Dictionaries, calculators, all notes, books and materials are allowed. (Open-book exam.)
- Total score is 75.

Name:	Student
....	ID.........................

| Question #	Full Score	Assigned Score
1	25	
2	10	
3	15	
4	13	
5	12	
Total	**75**	

Assoc. Prof. Somchai Chuchom

Question 1 (25 marks)
Briefly answer the following questions.

1.1 How can you tell from the root locus if a system is unstable?

1.2 Describe how the zeros of the open-loop system affect the root locus and the transient response.

1.3 Explain how to improve the transient response by making use of the root locus.

1.4 How the control system can be designed to meet the transient and the steady-state error specifications simultaneously?

1.5 What is a PID controller? How is it useful? Why?

1.6 What are the Peak time (T_p), Percent overshoot (%OS), Settling time (T_s), and Rise time (T_r) of the underdamped second-order system? Show them graphically.

1.7 There are 2 parts of the time response for the first-order control system, what are they? Explain.

1.8 Compare the advantages of applying hydraulic controller to pneumatic controller (as a plant of the control system).

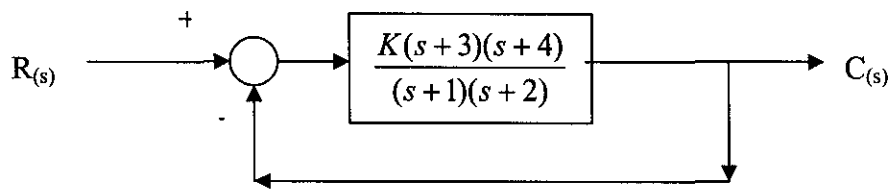## Question 2 (10 marks)
For the stable system shown below
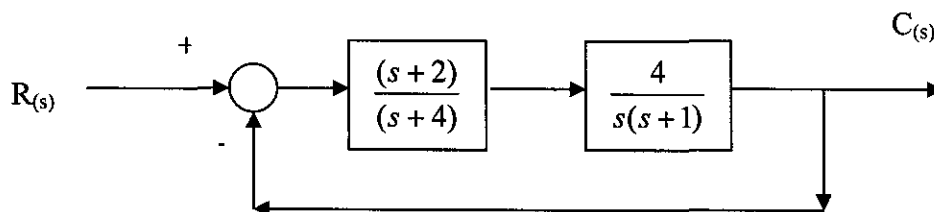
2.1 Find the position, velocity and acceleration error constants.

2.2 Find the steady-state error for
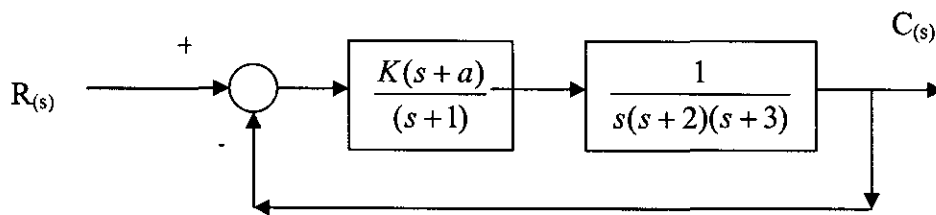   a) a unit-step input
   b) a unit-ramp input

Question 3 (15 marks)
Sketch the root locus of the system shown below


```
        +
R(s) ----→( )----→| K(s+3)(s+4) |----→ C(s)
          -↑      | ---------- |
           |      | (s+1)(s+2) |
           |_____|
```

Question 4 (13 marks)
A block diagram of a welding head positioning system is shown below. What are the ranges of **K** and **a** for which the system is stable?


```
        +                                        C(s)
R(s) ----→( )----→| K(s+a) |----→|     1      |----→
          -↑      | ------ |     | ---------- |
           |      | (s+1)  |     | s(s+2)(s+3)|
           |_____|
```

Question 5 (12 marks)

Find the step response of each of the transfer functions shown in equation 5-1 through 5-3 and compare them graphically in the time domain.

$$T_{1(s)} = \frac{24.542}{s^2 + 4s + 24.542} \qquad \ldots\ldots\ldots\ldots\ldots 5\text{-}1)$$

$$T_{2(s)} = \frac{245.42}{(s+10)(s^2 + 4s + 24.542)} \qquad \ldots\ldots\ldots\ldots\ldots 5\text{-}2)$$

$$T_{3(s)} = \frac{73.626}{(s+3)(s^2 + 4s + 24.542)} \qquad \ldots\ldots\ldots\ldots\ldots 5\text{-}3)$$

Hint: The step response, $C_i(s)$, for a transfer function, $T_i(s)$, is the response of the transfer function $T_i(s)$ and a unit step input.