INTI International College Penang
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FINAL
Examination Paper

(COVER PAGE)

Session	:	August 2016
Programme	:	Diploma In Electrical And Electronic Engineering (DEEI)
Course	:	EEE2108: Modern Control Systems Engineering
Date of Examination	:	13 December 2016 (Tuesday)
Time	:	2:00pm – 4:00pm
Duration	:	2 Hours Reading Time : Nil

Special Instructions :

This paper consists of SIX (6) questions. Answer any FOUR (4) questions in the answer booklet provided. All questions carry equal marks.

IMPORTANT NOTE : THIS PAPER SHOULD NOT BE TAKEN OUT OF THE EXAMINATION HALL BY THE STUDENTS.

Materials Permitted :

Scientific Calculator (Model fx570 Series)

Materials Provided :

Worksheet-Q4
Laplace Transform Table
Formula Sheet

Examiner(s)	:	Chan Tse Wei
Moderator	:	Dr. Ooi Beng Lee

This paper consists of 6 printed pages, including the cover page.

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
EEE2108: MODERN CONTROL SYSTEMS ENGINEERING
FINAL EXAMINATIONS: AUGUST 2016 SESSION

Instructions: This paper consists of SIX (6) questions. Answer any FOUR (4) questions in the answer booklet provided. All questions carry equal marks. Marks for each sub-question are shown in square brackets. Present your answers neatly and clearly. The assessor reserves the rights to ignore your answers if they are ambiguous.

Question 1

a. The unit impulse response of a certain system is a sinusoidal signal, $\sin(t)$. Determine the system transfer function and its differential equation. [6]

b. Figure-Q1(b) shows a circuit model of a voltage amplifier circuit. Derive the amplifier's voltage transfer function in factor form. From the derived voltage transfer function, identify the order of the system. [7]

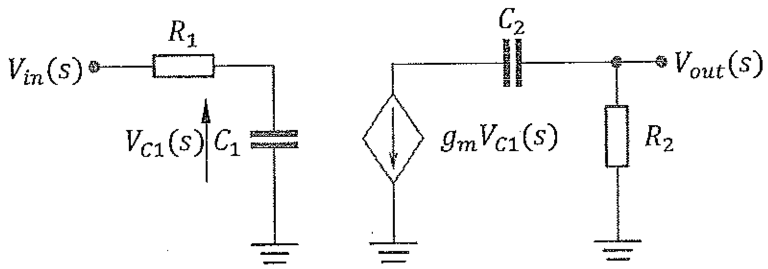

Figure-Q1(b)

c. Convert the block diagram in Figure-Q1(c) to a signal flow graph. Making use of the converted signal flow graph, determine the system transfer function. [12]

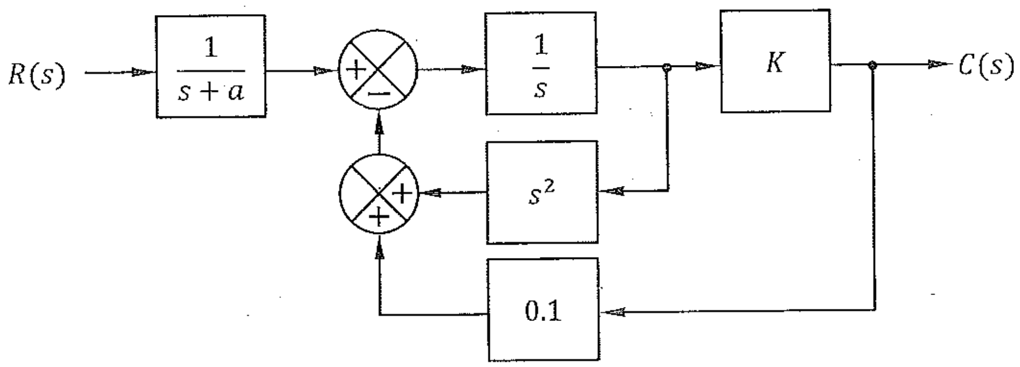

Figure-Q1(c)

Question 2

a. Figure-Q2(a) shows a negative unity feedback system with an open-loop transfer function, $G(s)$ given by,

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

K is the system gain value which is greater than 0.

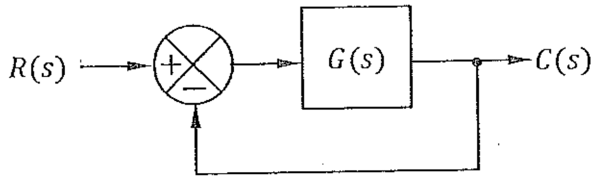

Figure-Q2(a)

a. Determine if the system can be unstable. [6]

b. State the general name of the input signal to the $G(s)$ block. [2]

c. State the type number of the system. [2]

d. Determine the steady-state error of the system if a unit step input is applied to the system with $K = 5$. [4]

e. If an integral block is included in the feedback path of the system, determine the new steady-state error if a unit step input is applied to the system. [5]

f. From the result of part (e), determine the steady-state value of the output signal. [3]

g. Suggest a proper approach to eliminate the steady-state error of the system in response to a unit step input. Justify your suggestion. [3]

Question 3

a. A closed-loop system has an open-loop transfer function given by,

$$G(s)H(s) = \frac{1 + \beta s}{\beta s(1 + \alpha s)^3}$$

i. Determine the conditions of α and β for the system to subject for Routh-Hurwitz stability test. [5]

ii. Determine the relationship of α and β for the system to be marginally stable. [5]

b. A closed-loop system has a closed-loop transfer function given by,

$$\frac{C(s)}{R(s)} = \frac{50}{s+50}$$

In response to a unit step input,

i. Derive the expression of the output signal, $c(t)$. [4]

ii. Determine the steady-state value of the output signal. [2]

iii. Calculate the system's time constant, τ. [3]

iv. Calculate the system's settling time, t_s (assume 2% accuracy) [3]

v. Calculate the system's rise time, t_r [3]

Question 4

Identify the pole locations and sketch the unit step response for each of the following system. Also, state the instantaneous expression for each of the output signal, $c(t)$. Present your answers using "Worksheet-Q4".

a. $R(s) = \frac{1}{s} \longrightarrow \boxed{9} \longrightarrow C(s)$ [2]

b. $R(s) = \frac{1}{s} \longrightarrow \boxed{\frac{9}{s^2+9}} \longrightarrow C(s)$ [5]

c. $R(s) = \frac{1}{s} \longrightarrow \boxed{\frac{9}{s^2+2s+9}} \longrightarrow C(s)$ [6]

d. $R(s) = \frac{1}{s} \longrightarrow \boxed{\frac{9}{s^2+6s+9}} \longrightarrow C(s)$ [6]

e. $R(s) = \frac{1}{s} \longrightarrow \boxed{\frac{9}{s^2+9s+9}} \longrightarrow C(s)$ [6]

Question 5

Figure-Q5 shows a root locus plot of a negative feedback closed-loop system. The system has a general characteristic equation expressed as,

$$1 + K\frac{\prod_{i=1}^{i=\infty}(s+z_i)}{\prod_{j=1}^{j=\infty}(s+p_j)} = 0$$

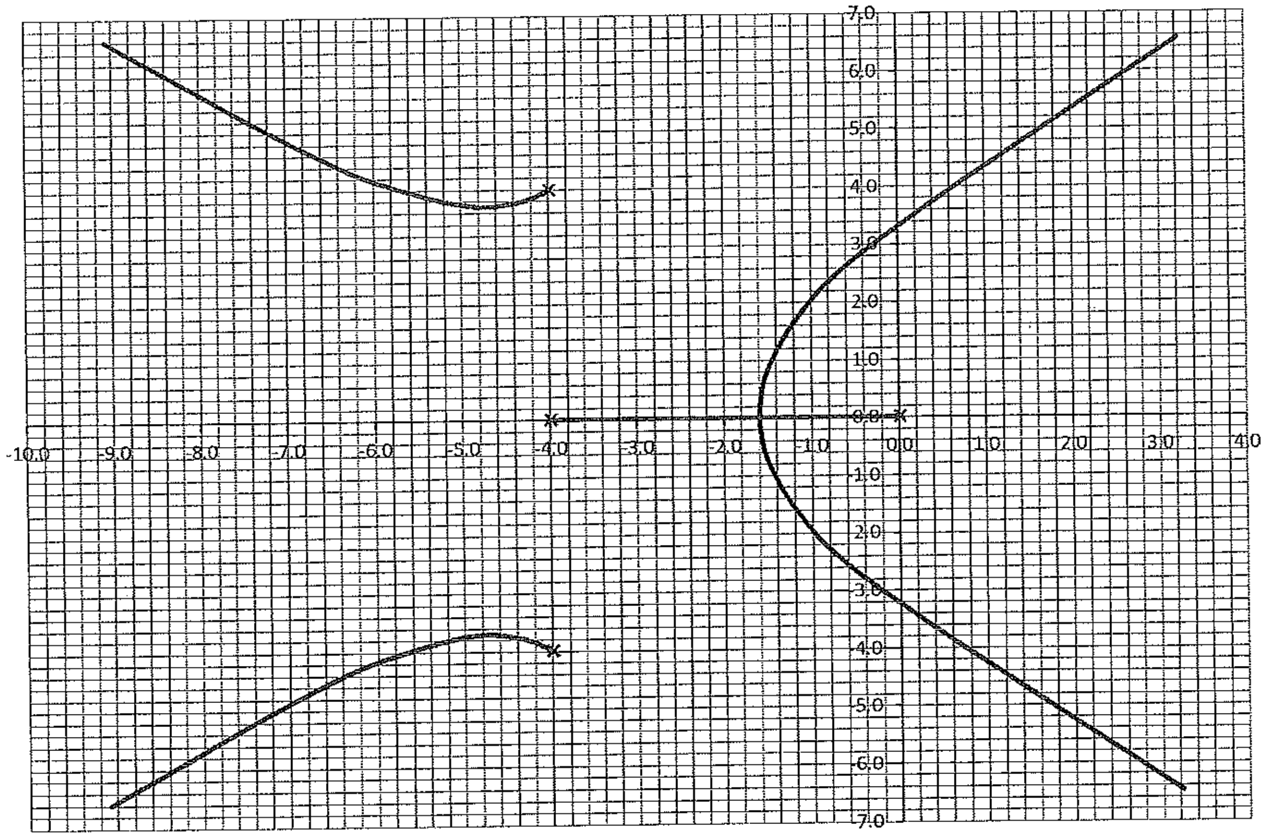

Figure-Q5

a. In general, state if the system is stable for all value of gain K. Justify your answer. [4]

b. Derive the characteristic equation of the system in terms of s and K. Express the characteristic equation in polynomial form. [5]

c. Determine the value of gain K if a closed-loop pole of $s = -1$ is desired. [4]

d. Make use of the root locus graph to estimate the system's dominating poles if it's damping factor is 0.4472. [5]

e. Make use of the root locus graph to estimate the value of gain K that causes the system to oscillate indefinitely in response to an impulse input. [4]

f. Make use of the root locus graph to estimate the value of gain K that generate two real overlapping closed-loop poles. [3]

Question 6

A control system with unity negative feedback has an open-loop transfer function given by,

$$G(s) = \frac{K}{s(1 + Ts)}$$

a. i. Derive an expression for the peak value of the modulus of the closed-loop frequency response M_p in terms of K and T. [8]

ii. If the time constant T is 0.01 s, determine the value of open-loop gain K that will give an M_p value of 1. [4]

b. i. Derive an expression for the phase-margin of the open-loop frequency response in terms of K and T. [8]

ii. Using the value of KT which correspond to the value of K determine in part (a)(ii), find the value of the phase margin in degrees, which will give an M_p value of 1. [5]

~ The End ~