TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION FOR:

DIPLOMA IN MECHANICAL ENGINEERING (PLANT OPTION)

DIPLOMA IN MECHANICAL AND AUTOMATION ANGINEERING

ECI 2205: CONTROL SYSTEMS

END OF SEMESTER EXAMINATION

SERIES: AUGUST 2019

TIME: 2 HOURS

DATE: Pick DateSelect MonthPick Year

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of FIVE questions. Attempt any THREE **Questions**

Do not write on the question paper.

QUESTION ONE

a)

i) Define the term "Control System" as used in control engineering

ii) State any ONE objective of control system

iii) Differentiate between the following control schemes

I) Open-loop

II) Closed-loop

iv) Give and explain operation of ONE example of a control in iii (I)

(10marks)

b)

i) Use block diagram algebra to obtain the closed loop transfer function of the control system of fig.Q1(b)(i)

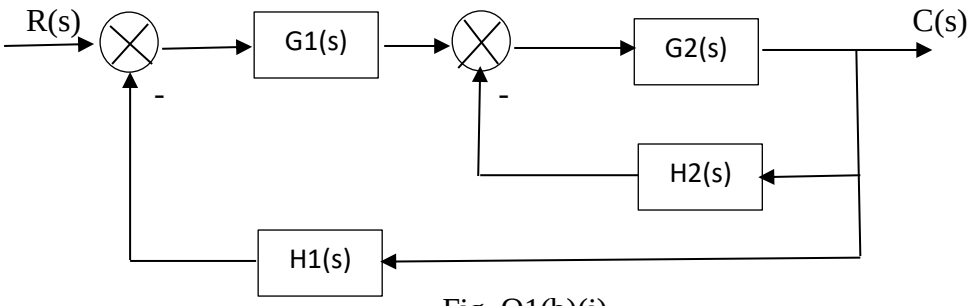

Fig. Q1(b)(i)

ii) For the system shown in fig. Q1(b)(ii) obtain the expression for the output C(s).

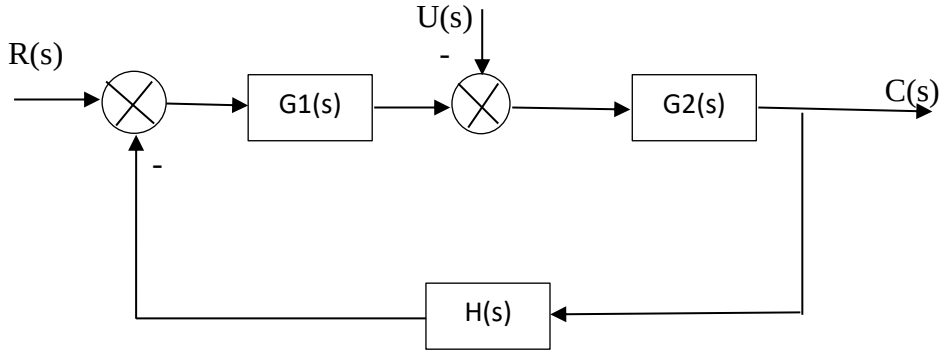

Fig. Q1(b)(ii)

(10marks)

QUESTION TW0

a)

i) Define the following terms as used in signal flow graphs

I) Node

II) Path

III) Branch

ii) Obtain the transfer $\frac{Y(s)}{X(s)}$ function of the signal flow graph in fig. Q2(a)

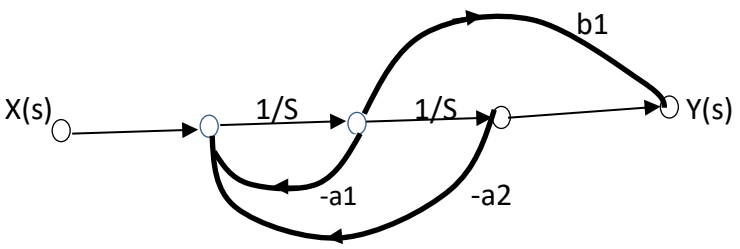

Fig. Q2(a) (9mrks)

b) Determine the step, ramp and parabolic error coefficients for unity feedback systems with the following transfer function.

$$\frac{10\,(S+3)}{(S+1)\,(S^2+2S+2)}$$ (5marks)

a) i) Define the following terms as used in feedback control systems

I. Actuating signal

II. Feedback signal

ii) Explain how a feedback control system maintains its output at a prescribed value

(6marks)

QUESTION THREE

a)

i) State the Routh stability criterion

ii) A unity feedback has open-loop transfer function

$$G(s) \quad \frac{K}{S^4 + 2S^3 + 6S^2 + 10S}$$

I) Determine the characteristics equation of the system

II) Use the Routh array to determine the range of values of K for which the system is stable

III) Given that K = 5, determine the oscillating frequency of the system (10marks)

a)

i) Define with aid of sketches the following input signals used for testing control systems. Give their mathematical representation.

I) Step

II) Sinusoidal

III) Ramp

IV) Parabolic

ii) Distinguish between time response and frequency response (10marks)

QUESTION FOUR

a)

i) State the Nyquist stability criterion

ii) With respect to the Nyquist polar plot, define the following

I) Gain cross over frequency

II) Phase cross- over frequency (8marks)

b) The open loop transfer function of a system is:

$$G_{(s)} = \frac{50}{S\,(1 + 0.1S)\,(1 + 0.5S)}$$

i) Plot the polar curve of the system

ii) Find the gain and phase margin

iii) Deduce from the values found in b(ii) whether the system is stable or not. State reasons for your answer. (12marks)

QUESTION FIVE

a) Define the Nichols chart with reference to control system

b) The open-loop transfer function of a control system is given below

$$G(s) = \frac{2}{S(1 + S)(1 + S/3)}$$

Construct the response on a Nicholas chart and determine:-

I) Phase Margin

II) Gain Margin

III) Peak magnitude (12marks)

c)

i) State any THREE advantages of Bode over the Nyquist diagrams

ii) In a test on a servomechanism the following open – loop response was obtained

W(rad/s)	0.1	0.3	0.5	1.0	2.0	3.0	5.0	10	20
Gain(dB)	30	21	17	1.0	0	-8	-2.0	-39	-57
Phase angle (deg)	-98	-110	-120	-145	-186	-208	-230	-250	-260

Plot the response on a Bode diagram and determine:-

I) Gain margin

II) Phase margin

III) If the system is stable or unstable (8marks)