MACHAKOS UNIVERSITY

University Examinations for 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

THIRD YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)

EEE 310 CONTROL SYSTEMS

DATE: 24/4/2019 **TIME:8:30 – 10:30 AM**

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Discuss any TWO advantages of closed loop over open loop systems. (4 marks)

b) State the Routh Stability criteria. (3 marks)

c) A unity feedback system has an open loop transfer function:

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

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

(10 marks)

d) Define the term transfer function. (3 marks)

e) A second order system is represented by the differential equation:

$$2\frac{d^2\theta_o}{dt^2} + 4\frac{d\theta_o}{dt} + 8\theta_o = 8\theta_i$$

Where θo=output, θi= input. For the system determine:

(i) Natural frequency.

(ii) Damping factor.

(iii) Damped frequency

(10 marks)

QUESTION TWO (20 MARKS)

a) State the need for system modeling. (3 marks)

b) A system has a transfer function:

$$T_{(S)} = \frac{10}{S(1+0.2S)(1+0.02S)}$$

Draw the Bode plots and hence determine the phase and gain margins. (10 marks)

c) Use Mason's rule to determine the transfer function for fig.1. (7 marks)

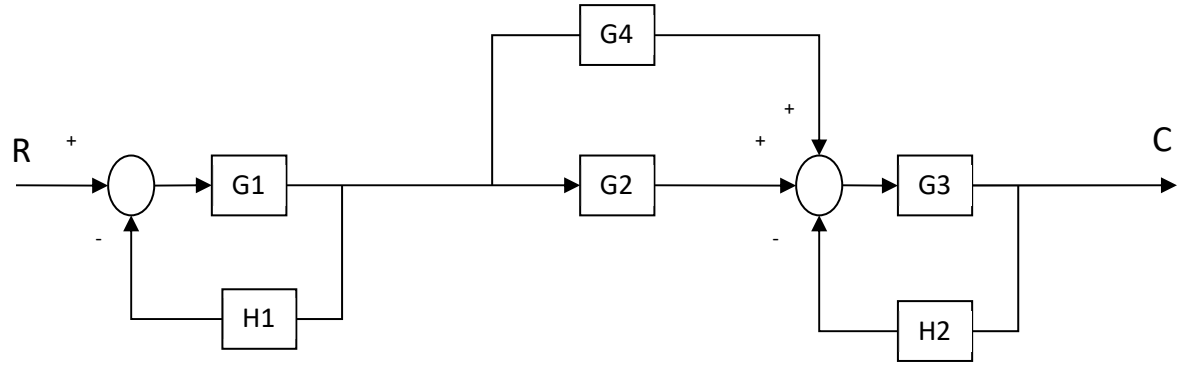

Fig.1

Question three (20 marks)

a) State Nyquist stability criteria. (2 marks)

b) A system open loop transfer function is given by:

$$G_{(S)}H_{(s)} = \frac{120}{S(S+2)(S+10)}$$

(i) Calculate the phase cross over frequency and gain margin.

(ii) Sketch the Nyquist plot. (8 marks)

c) The Open loop frequency response of a control system is given by:

ω(rad/sec)	0.1	0.5	1	1.5	2.5	3.5	4.5	5.5
GH(dB)	34	19.7	12.6	7.8	0.7	-4.72	-9	-12.7
Phase(°)	94	109	127	140	160	174	184	192

Use Nichols chart to determine:

(i) Gain margin

(ii) Phase margin

(iii) Band width

(iv) Whether the system is stable or unstable. (10 marks)

QUESTION FOUR (20 MARKS)

a) With aid of diagrammatical representation briefly describe any THREE standard test signals and give their Laplace transform representation. (6 marks)

b) Determine transfer function of the system shown in fig.2. (8marks)

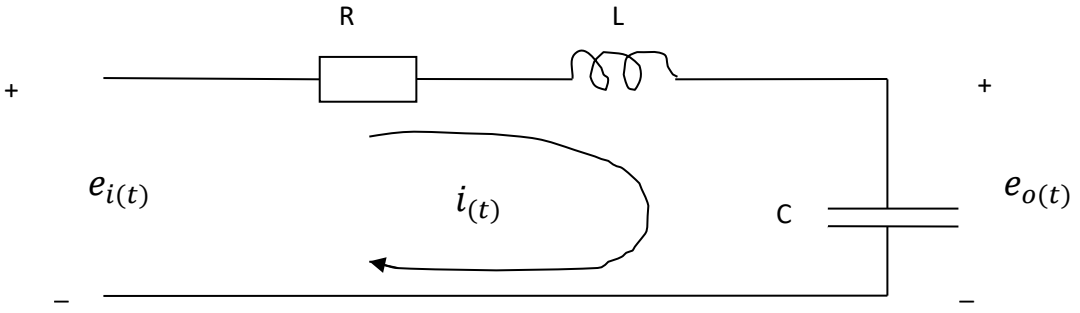

Fig. 2

c) Using block diagram reduction techniques to derive the transfer function of the block diagram in fig.3. (6 marks)

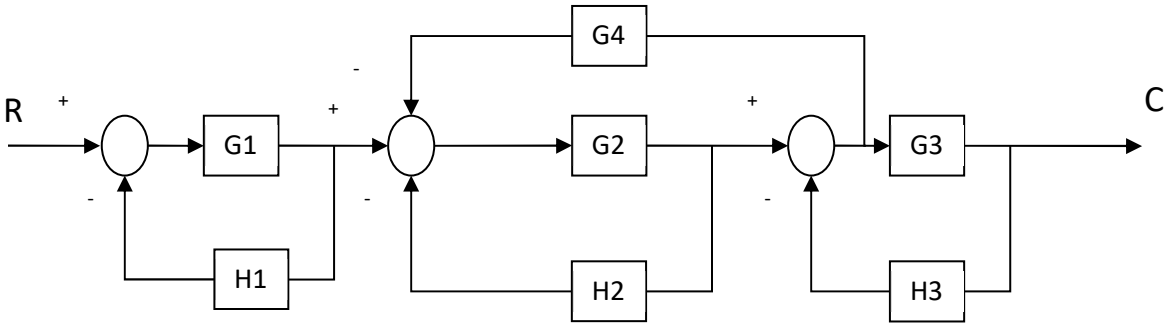

Fig. 3

QUESTION FIVE (20 MARKS)

a) For the network in fig.4:

(i) Derive the expression for the transfer function $\frac{V_{O(S)}}{V_{i(S)}}$

(ii) For a step input determine the expression for $v_{o(t)}$

(iii) Sketch the curve for $v_{o(t)}$.

(iv) Determine the expression for the error signal.

(v) Determine value of the steady state error. (10 marks)

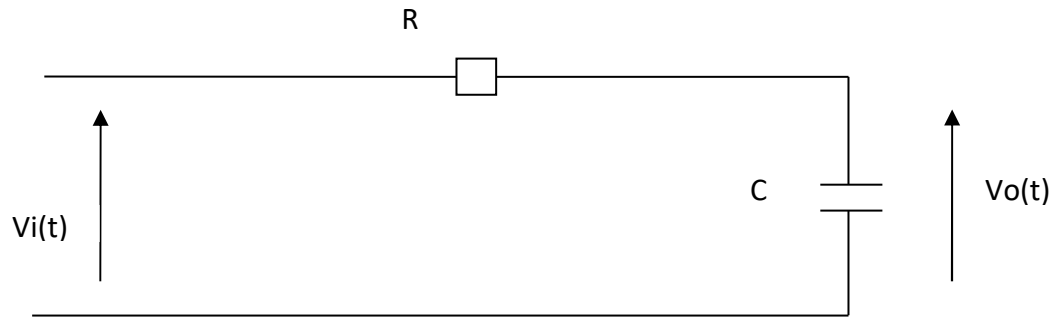

Fig. 4

b) Define the following terms with reference to signal flow graphs:
   (i) Forward path
   (ii) Forward path gain (3 marks)

c) The transfer function of a given network is given by $\frac{C_{(s)}}{R_{(s)}} = \frac{1}{S^2+10S+50}$

   i) Sketch the roots in the complex s plane and comment on the stability of the system. (4 marks)

ii) If 10S is replaced by zero so that the new transfer function is $\frac{C_{(s)}}{R_{(s)}} = \frac{1}{S^2+50}$ sketch the new roots on the complex s plane and comment on the stability of the system. (3 marks