MURANG'A UNIVERSITY COLLEGE

(A Constituent College of Jomo Kenyatta University of Agriculture and Technology)

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

University Ordinary Examinations 2015/2016

THIRD YEAR **FIRST** SEMESTER EXAMINATION FOR THE DIPLOMA IN ELECTRICAL POWER ENGINEERING

UNIT CODE: SEE 1302

UNIT TITLE: CONTROL ENGINEERING I

TIME: 2 HOURS

DATE: 21ST APRIL 2016

INSTRUCTION:

Answer ALL the questions in section A and any other two questions from section B.

SECTION A (30 MARKS)

QUESTION 1

a) With the aid of well labeled block diagrams distinguish between the following control systems;
   (i). Open Loop
   (ii).Closed Loop (6 marks)

b) With the aid of a canonical block diagram of a closed-loop control system, derive

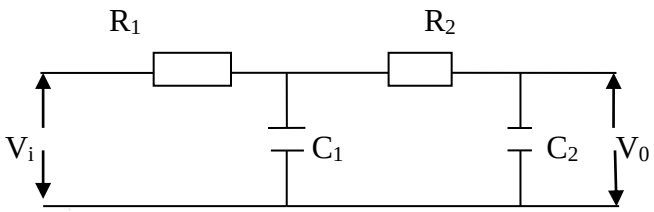
   (i). The closed loop transfer function
   (ii).The error -ratio

(6 marks)

c) i) Define transfer function

   ii) Determine the transfer function of the network shown in the following figure

(7 marks)



d) A control system with unity feedback has the following forward transfer function
   i. Draw the block diagram of the system
   ii. Determine the natural frequency and damping ratio (5 marks)

$$G(s) = \frac{225}{s(s+15)}$$

e) Using Routh Hurwitz criterion, ascertain stability for each of the systems represented by following characteristics equations.
   i. $2s^4 + 6s^3 + 3s^2 + 3s + 1 = 0$
   ii. $s^6 + 2s^5 + 6s^4 + 8s^3 + 5s^2 + 4s + 2 = 0$ (6 marks)

SECTION B (40 MARKS)

QUESTION TWO

a) Define Routh-Hurwitz criterion (2 marks)

b) Explain for Routh Hurwitz criterion any TWO limitations and their remedies. (6 marks)

c) An open loop transfer function of a unity feedback is given by

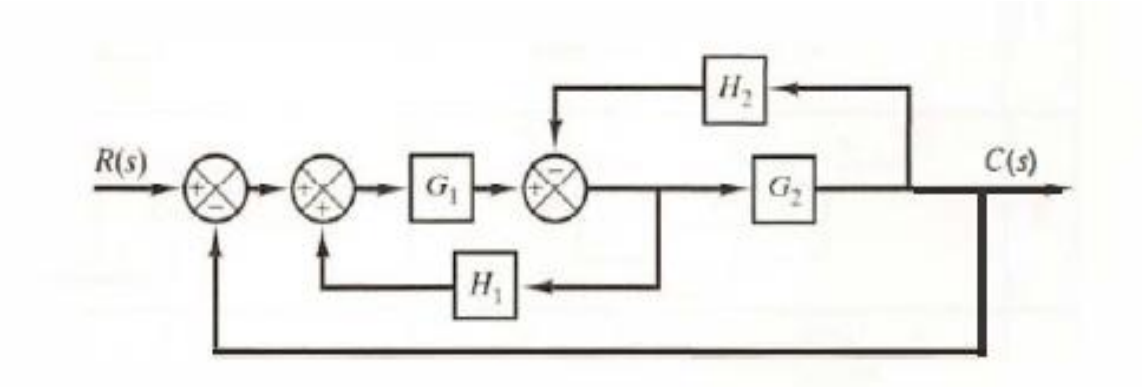
$$G(s) = \frac{K}{s(s^2+s+1)(s+4)}$$

Determine

(i). The characteristic equation
(ii). The range of K for which the system remains stable using Routh Hurwitz criterion (12 marks)

QUESTION THREE

a) State the Mason's gain formula with respect to signal flow graphs (2 marks)
b) With the help of a diagram describe the 'superposition' theorem as applied to multiple input control systems (4 marks)
c) For the following block diagram;
   (i). Draw its signal flow graph
   (ii). Determine the closed loop transfer function by mason's gain formula and block diagram algebra technique



(14 marks)

QUESTION FOUR

a) A unity feedback control system has a forward transfer function.

$$G(s) = \frac{\beta}{(s + b_1)(s + b_2)}$$

Derive the expressions for
   i. Closed loop transfer function
   ii. Undamped natural frequency
   iii. Damping factor (8 marks)

b) A second order position control system has a damping ratio of 0.5 and undamped natural frequency of 6 rad/sec. Determine for a unity step input
   i. Output responses as a function of time
   ii. Value of the percentage peak overshoot
   iii. Settling time (12 marks)