MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2020/2021 ACADEMIC YEAR

SECOND YEAR **FIRST** SEMESTER EXAMINATION FOR, DIPLOMA IN ELECTRICAL AND ELECTRONICS ENINEERING

EEE 068 – CONTROL ENGINEERING 1

DURATION: 2 HOURS

Instructions to candidates:

1. Answer question One and Any Other Two questions.

2. Mobile phones are not allowed in the examination room.

3. You are not allowed to write on this examination question paper.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

a) With the aid of well labelled block diagrams, distinguish between the following control systems

     i.   Open loop.

    ii.   Closed.   (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 a transfer function.

    ii) Determine the transfer function of the network shown in the following figure.
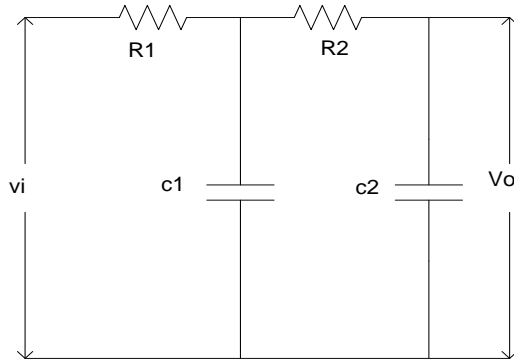
                                                                     (7 marks)

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.

$$G(s) = \frac{225}{s(s+15)}$$ (5 marks)

e) Using Routh Harwltz criterion, ascertain stability for each of the systems represented by the following characteristic equations.

    i) $2s^4 + 6s^3 + 3s^2 + 3s + 1 = 0$

ii) $s^6 + 2s^5 + 8s^3 + 5s^2 + 4s + 2 = 0$ (6 marks)

SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION
QUESTION TWO (20 MARKS)
a) Define Routh Harwltz criterion.
b) Explain any two Routh Harwltz criterion advantages and any two disadvantages.   (6 marks)
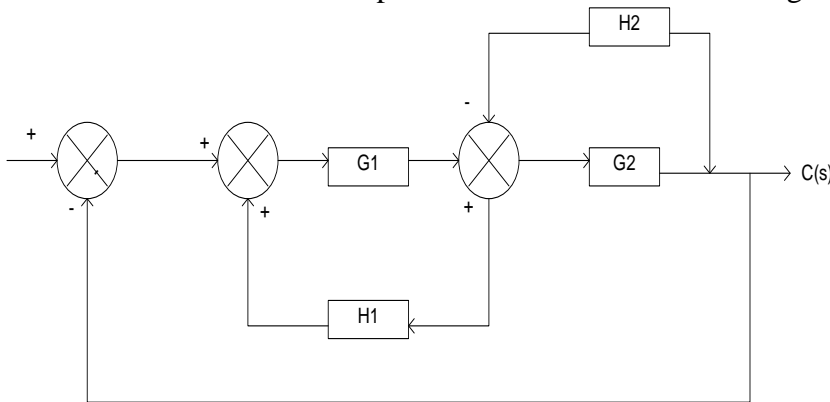c) An open loop transfer function of a unity feedback is given by

$$G(S)=\frac{k}{s(s2+s+1)(s+4)}$$

Determine
  i.   The characteristic equation
  ii.   The range of k for which the system remains stable using Routh Harwltz criterion.

(12 marks)

QUESTION THREE (20 MARKS)

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 the block diagram below

(14 marks)

QUESTION FOUR (20 MARKS)

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

$$G(s) = \frac{\beta}{(s+b1)(s+b2)}$$

Derive the expressions for
   i.   Closed loop transfer function.
   ii.   Undamped natural frequency.
   iii. Damped factor. (8 marks)
b) A second order position control system has a damped ratio of 0.5 and undamped natural frequency of 6 rad/sec. Determine for unity step input.
   i.   Output responses as a function of time.
   ii.   Value of the percentage peak overshoot.
   iii. Settling time. (12 marks)