MACHAKOS UNIVERSITY

University Examinations for 2021/2022

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

DIPLOMA IN ELECTRICAL ENGINEERING

CONTROL SYSTEMS

DATE: TIME:

Instructions

Answer question ONE and any other TWO questions

1. (a)   Define the following terms with respect to control systems
   - Controlled variable
   - Manipulated variables   (6 marks)

   (b)   State THREE merits of a closed loop control system   (6 marks)

   (c)   With the aid of a labelled block diagram describe an open loop control system

                                                                     (8 marks)

   (d)   The closed loop transfer function of a given system is

$$\frac{600}{s^2 + 70s + 600}$$

   obtain

   - undamped natural frequency
   - Natural frequency
   - And damping ratio of the system   (10 marks)

2.   A unity feedback system subjected to a unit step input has an open loop transfer
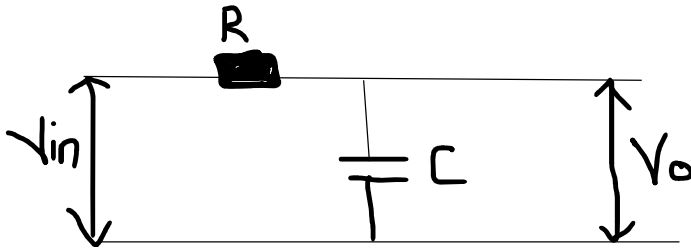   function

$$GS = \frac{k}{S(S+10)}$$

Determine

- Characteristic equation
- Gain K so that the system will have a damping ratio of 0.5
- Settling time
- Percentage overshoot   (20 marks)

3. (a)   Define each of the following in relation to signal flow graphs
   - Feedback path
   - Self loop
   - Path
   - Path gain   (10 marks)

   (b)   the figure below shows an R-C circuit diagram, derive its transfer function

                                                                              (10 marks)

4.   a)   State TWO demerits of stability analysis using Nyquist method   (4 marks)

      b)   The table below shows the open loop frequency response of a control system.

            Draw Nyquist diagram for the system and determine the

            - Gain margin
            - Phase margin
            - Comment on the stability of the system   20marks

ꞷ rad/sec	1	2	3	4	5
GH(dB)	4.5	1.6	0.8	0.5	0.3
Phase angle 0°	-127	-152	-168	-180	-188

5.   (a)   define the ROUTH stability criterion   (5 marks)

      (b)   Consider a 4th order system with the following characteristics equation

             $s^4 + 8s^3 + 18s + 16s + 5 = 0$ using Routh stability criterion determine
             whether the system is stable or not   (15 marks)