MACHAKOS UNIVERSITY

University Examinations for 2019/2020Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EEE 311: CONTROL SYSTEMS II

DATE: 24/11/2020 **TIME: 2.00-4.00 PM**

INSTRUCTIONS

Answer Question One and Any Other Two Questions

Requirements

Bode plot graph paper

QUESTION ONE (30 MARKS)

a) A system has a transfer function given below. Design a phase lead network to ensure the phase margin is 45 degrees. (10 marks)

$$G(s) = \frac{17.783}{S(1 + 0.5S)(1 + 0.05S)}$$

b) Discuss the functions of the following controllers PI, PD and PID. (6 marks)

c) For the system shown in fig.1, choose v1(t) and v2(t) as the state variables. Determine the state equations in the vector matrix form. (7 marks)

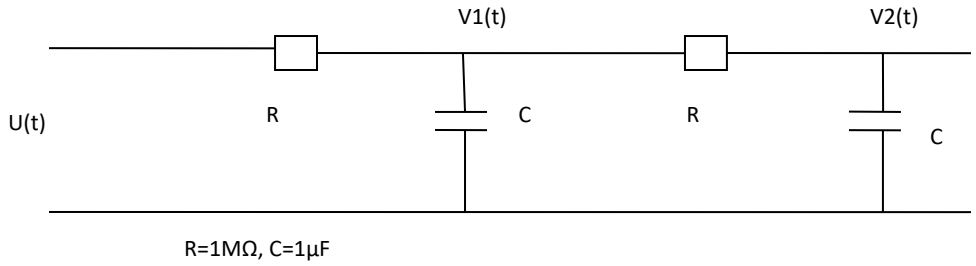

Fig. 1

d) Name three areas of application for two position controller can be used. (3 marks)

e) Briefly explain what is meant by 'the state of a dynamic system'. (4 marks)

QUESTION TWO (20 MARKS)

a) Derive the transfer function of the electrical network in fig.2. If the network is used as lead-lag compensator, give the general transfer function and sketch its magnitude and phase bode plots. (10 marks)

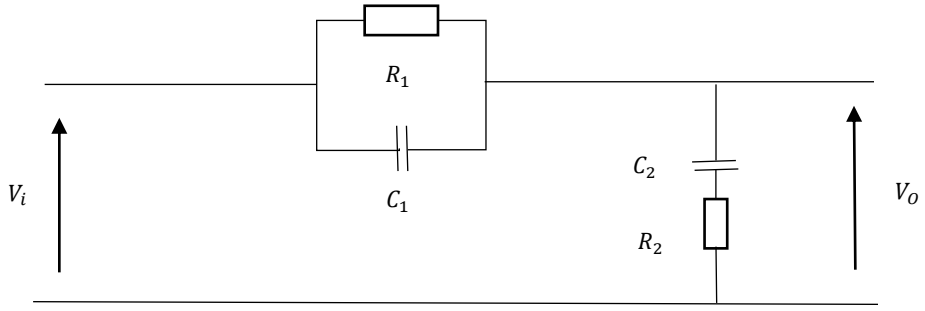

Fig. 2

b) With aid of a diagram describe proportional band. (4 marks)

c) Draw the canonical block diagram representation for the system whose transfer function is given below. (6 marks)

$$T(s) = \frac{S^2+1}{(S+1)(S+2)(S-3)}$$

QUESTION THREE (20 MARKS)

a) The Bode plots for a certain electrical network is shown in fig. 3. The network is used as a lag compensator. Discuss the steps used when using the network to compensate a controlled system. (10 marks)

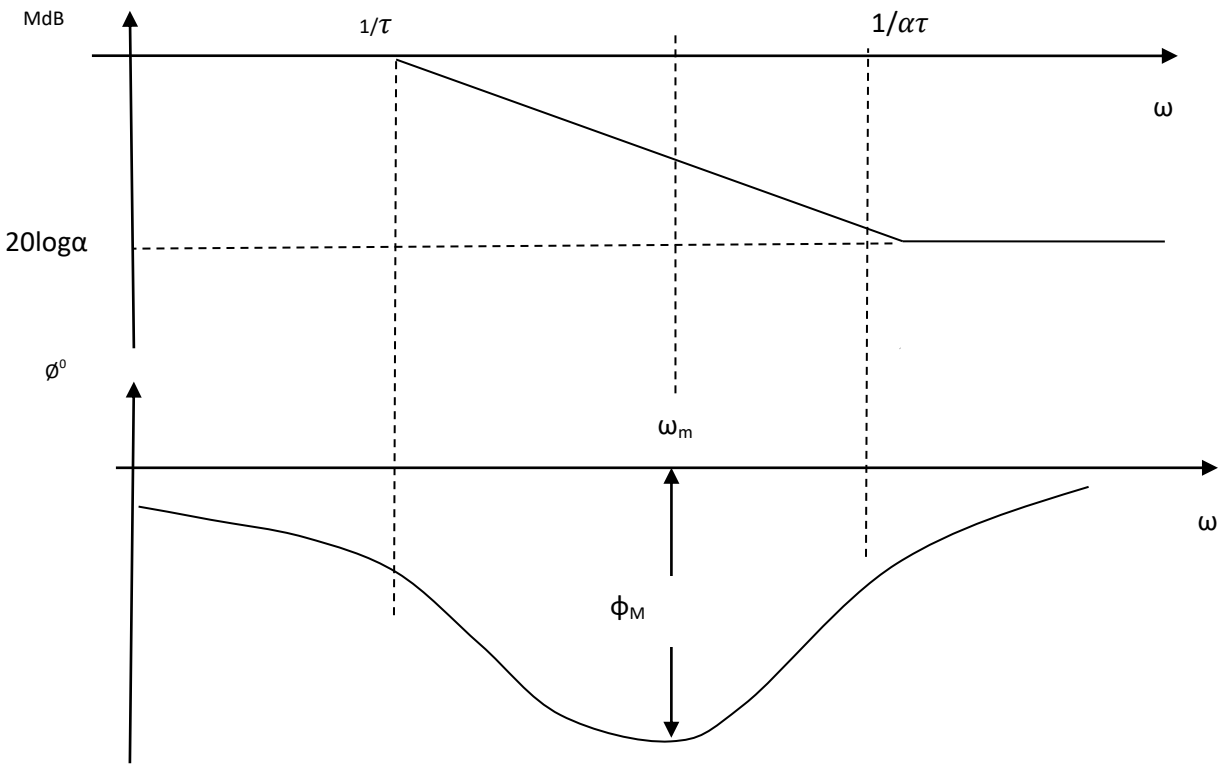

Fig. 3

b) With aid of well labelled diagram, derive the expression showing the relationship between the input and output signal of a proportional plus integral controller. (6 marks)

c) Describe the following terms:

i. Controllability

ii. Observability (4 marks)

QUESTION FOUR (20 MARKS)

a) When using canonical state model, diagonalization of matrix is necessary. This is facilitated by use of eigenvectors. Let $A = \begin{pmatrix} 10 & -8 \\ 4 & -2 \end{pmatrix}$. Find all eigenvalues of A. (8 marks)

b) With aid of diagrams, discuss three ways in which a compensator can be introduced into a controlled system. (6 marks)

c) A PI controller has proportional gain of 4 and an integral action of 40. It was subjected to a continuous error signal of 1.0 millivolt. Determine the controller output after 20 seconds. (6 marks)

QUESTION FIVE (20 MARKS)

a) For the controller in fig. 4:

i. Derive the time domain expression of its output signal.

ii. Sketch the output waveform from the given input waveform. (10 marks)

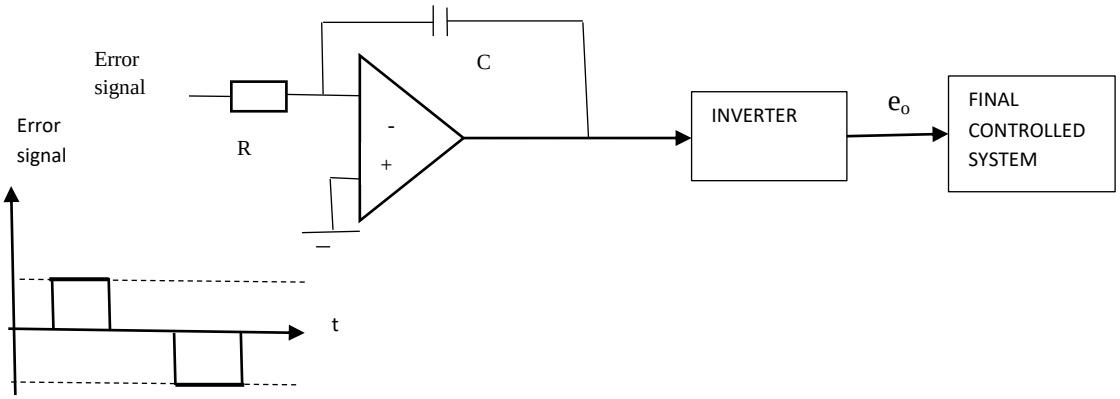

Fig.4

b) State any THREE effects of phase lead network. (4 marks)

c) Construct the state model for a system characterized by the differential equation below and give the block diagram representation. (6 marks)

$$\frac{d^3y}{dt^3} + 4\frac{d^2y}{dt^2} + 8\frac{dy}{dt} + 4y = 20u$$