SU

(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS 2023/2024 ACADEMIC YEAR

FOURTH YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE

OF

BACHELOR OF TECHNOLOGY EDUCATION IN ELECTRICAL AND ELECTRONIC ENGINEERING

COURSE CODE: TEE 422

COURSE TITLE: CONTROL SYSTEMS

DATE: FRIDAY, APRIL 12TH 2024 **TIME:** 11:30 AM - 13:30 PM

INSTRUCTIONS TO CANDIDATES

i) Question **ONE (1)** is compulsory
ii) Answer Any Other **TWO (2)** questions

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

QN 1 [30mks]

(a) *i)* Explain the difference between: [4mks]
   i) Gain margin and phase margin
   ii) Control signal and Controlled variable
   iii) Absolute and conditional stability
   iv) Bounded and unbounded signal
   ii) State TWO advantages and disadvantages of feedback systems. [2mks]
   iii) State THREE benefits of multi-position controllers. [3mks]

(b) By using Routh stability criterion, check the stability of the system whose characteristic equation is given by: [6mks]

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

(c) Obtain the transfer function model of the RC network in **Fig. 1** [6mks]

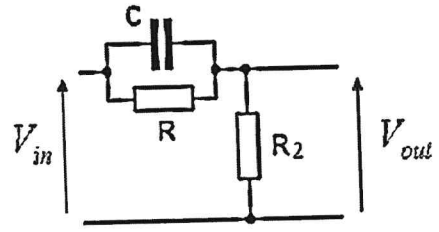


Fig. 1

(d) Consider the block diagram in **Fig. 2.**
   i) Reduce the block diagram to canonical form [6mks]
   ii) Write the overall closed loop transfer function [3mks]

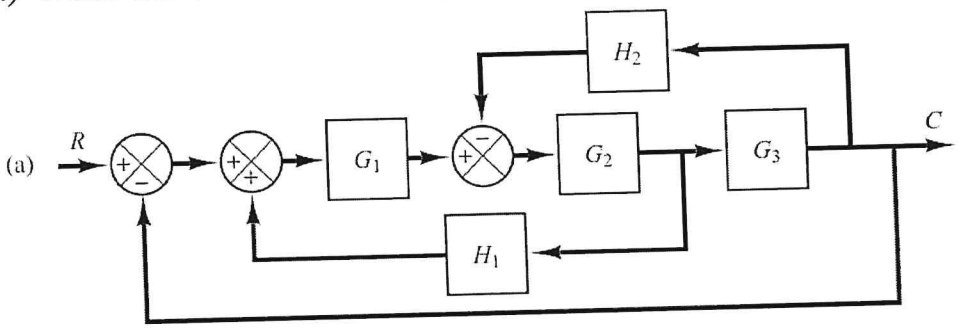


Fig. 2

QN 2 [20mks]

(a) A control system has an open-loop transfer function given by:

$$G(s)H(s) = \frac{K}{s(s+5)(s+10)}$$

   i) Poles and zeros [1mk]
   ii) Angles of Asymptotes and centroid [4mks]
   iii) Break away point [4mks]
   iv) Imaginary axis crossover point [2mks]
   v) The value of K for marginal stability [1mk]
   vi) Sketch the root locus [2mks]
   vii) Comment on stability [2mks]

(b) Explain the effects of the following on the root locus of a second order system:

i) Adding a zero to the open loop transfer function [2mks]
ii) Adding a pole to the open loop transfer function [2mks]

QN 3 [20mks]

(a) Determine the relationship between error signal $E(s)$ and output $U(s)$ for each of the following:

i) PI [1mk]
ii) PD [1mk]
iii) PID [1mk]

(b) Consider the block diagram in **Fig. 3**

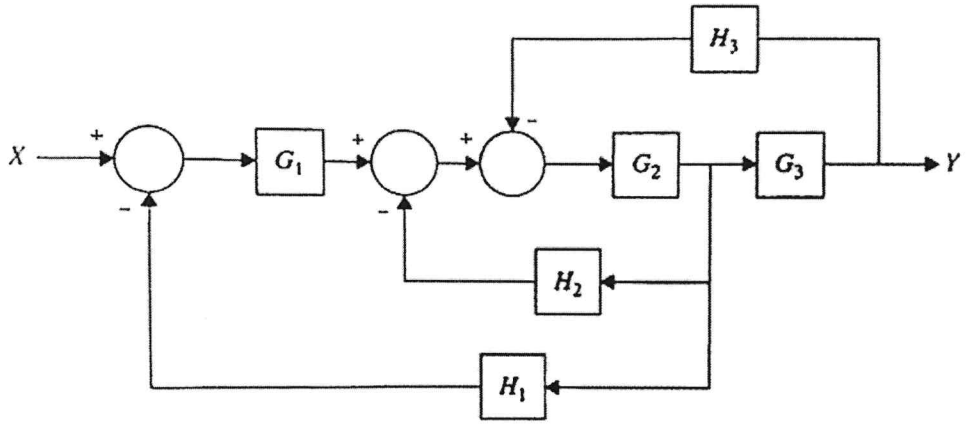


Fig. 3

i) Reduce the block diagram to canonical form [5mks]
ii) Write the overall closed loop transfer function [2mks]

(c) Obtain the transfer function model of the mechanical system shown in **Fig. 4** if u is the input and y_2 is the output. [10mks]

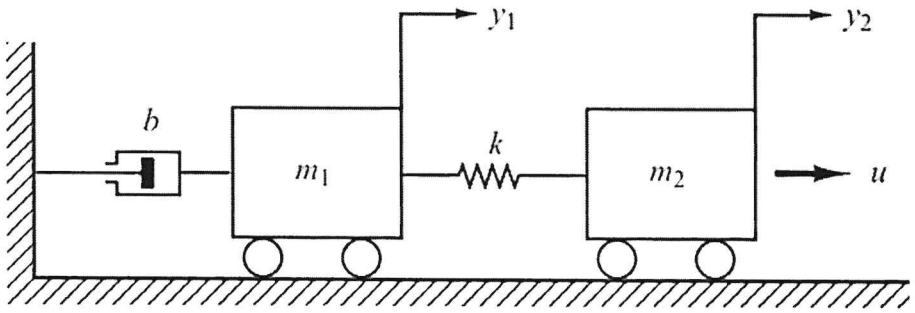


Fig. 4

QN 4 [20mks]

(a) **i)** Outline FIVE design requirements of an effective control system. [3mks]

ii) The **Fig.5** shows an example of servomechanism.

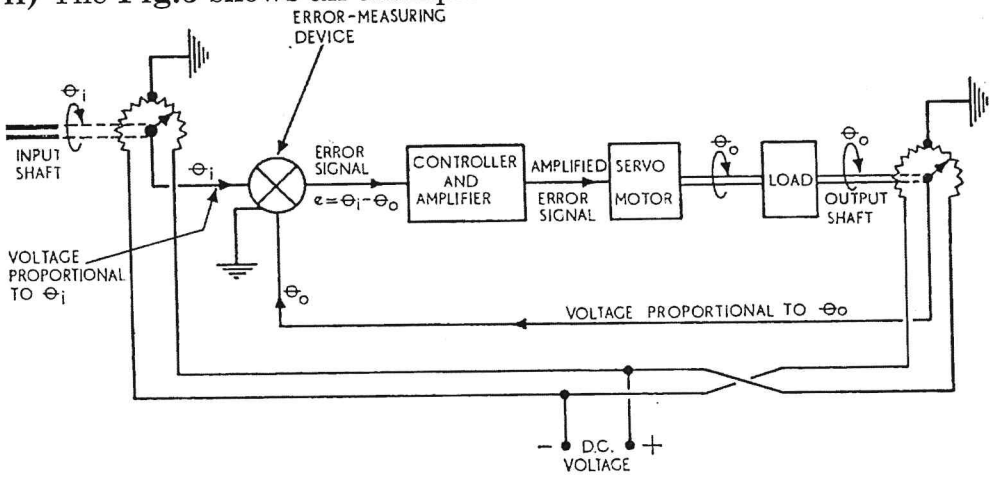


Fig.5

i) State TWO features of servomechanism. [2mks]

ii) Explain how control of the angular position of output shaft of a motor is achieved. [5mks]

(b) Construct the Nyquist diagram for the control system given below with $H(s) = 1$, over the frequency range provided in the table. [10mks]

$$G(s) = \frac{100}{s\,(s^2 + 2s + 4)}$$

$\omega(rads/s)$	0	1	2	4	8	10	8	∞
Gain								
Phase								

Determine:

i) Open loop on stability [3mks]

ii) Closed loop stability [3mks]

iii) Gain margin [2mks]

iv) Phase margin [2mks]