(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS 2022/2023 ACADEMIC YEAR

FOURTH YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF TECHNOLOGY EDUCATION IN ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE CODE: TEE 422

COURSE TITLE: CONTROL SYSTEMS

DATE: 14TH APRIL 2023 **TIME: 12:00 NOON - 2:00 PM**

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.
QUESTION ONE CARRIES 30 MARKS AND ALL OTHERS 20 MARKS EACH.

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

QUESTION ONE (COMPULSORY) (30 MARKS)

a. For each of the following control systems, state with a reason whether it an open loop or closed loop system.

   a) A bread toaster

   b) A man walking on the road

   c) A photocell -controlled street lighting system

[6 Marks]

b. State three essential features of a servo mechanism. **[3 marks]**

c. Define the following controller

   a) Proportional controller

   b) Integral controller

   c) Derivative controller

[3 marks]

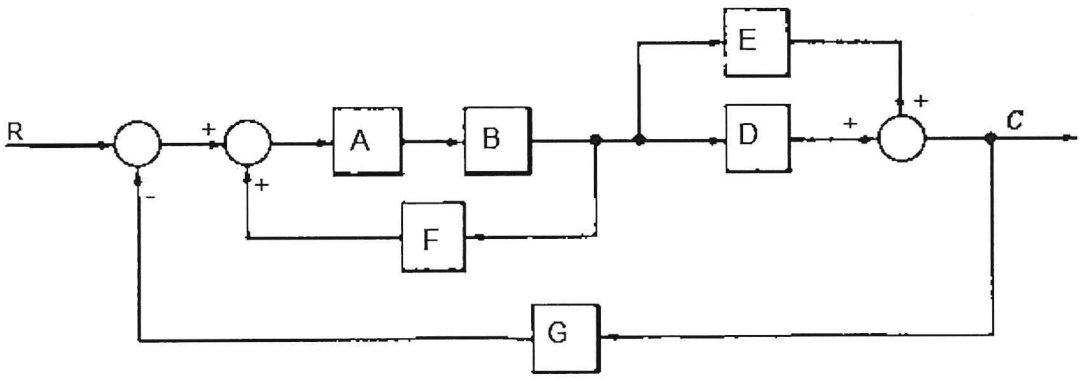
d. Discuss the impact of introducing integral controller in series with the system for a unity negative feed system.

[2 marks]

e. state four requirements of a good control system **[4 marks]**

f. State three types of compensating network. **[3 marks]**

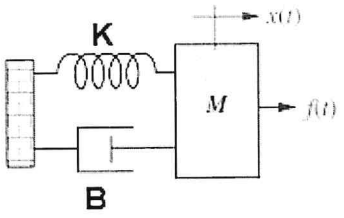
g. Mention four importance of servo mechanism **[4 marks]**



[5 marks]

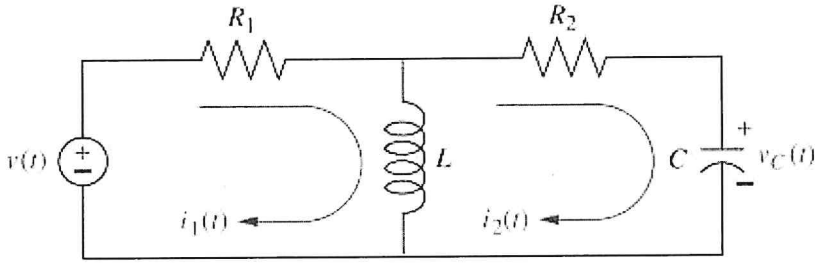
QUESTION TWO

a. Find the transfer function, X(s)/F(s), for the system



[5 Marks]

b. Find the transfer function relating the capacitor voltage $V_c(s)$ to the input voltage V(s)



[5 MARKS]

c. Draw the root-locus of the feedback system whose open-loop transfer functions are given by.

$$G(s)H(s) = \frac{k}{s(s+1)(s+2)(s+3)}$$

[10 Marks]

QUESTION THREE

a. State the Routh-Hurwitz stability criterion. **[2 marks]**

b. State two necessary conditions for a system to be stable with reference to Routh's stability criterion

[2 marks]

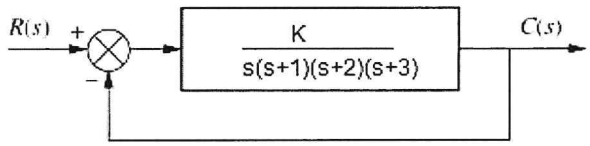
c. Find the stability of the control system having characteristic equations below using Routh-Hurwitz Stability Criterion.

i. $s^5 + 2s^4 + 2s^3 + 4s^2 + 4s + 8 = 0$

ii. $s^4 + 5s^3 + 2s^2 + 3s + 1 = 0$

[6 Marks]

d. A unity negative feedback control system has an open loop transfer function given as shown in the figure below.



For the system, determine

i. The characteristic equation.

ii. The range of K within which the system remains stable using Routh-Hurwitz Stability Criterion

[10 Marks]

QUESTION FOUR

a. State two effects of a negative feedback on a control system. **[2 marks]**

b. Draw a block diagram showing the mode of connection of the following types of compensation.

i. Series compensation
ii. Feedback compensation
iii. Load compensation

[6 marks]

c. A system has an open loop transfer function of $G(s) = \frac{50}{s(1+0.25s)(1+0.1s)}$

Draw a bode diagram and hence determine the;

i. Gain crossover frequency
ii. Phase cross over frequency
iii. Gain margin
iv. Phase margin.

[12 Marks]

QUESTION FIVE

a. State Four effects of a phase-lead compensator to a control system **[4 marks]**

b. State the Nyquist stability criterion. **[2 marks]**

c. State two merits and demerits of using Nyquist method when analyzing system stability. **[4 marks]**

d. Table below shows the frequency response of an open loop control system:

i. Plot the Nyquist diagram
ii. Determine the stability margins
iii. Comment on the stability of the system.

ω(rad/sec)	2	3	4	5	6	8	10	30
Gain (dB)	2.8	1.9	1.3	0.9	0.68	0.4	0.26	0.12
Phase angle (^{0})	-120^0	-130^0	-140^0	-149^0	-157^0	-170^0	-180^0	-200^0

[12 marks]