TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

DIPLOMA IN TECHNOLOGY
ELECTRICAL POWER ENGINEERING (DEPE 4)
ELECTRICAL POWER ENGINEERING (DEPE 4 Evening)
INSTRUMENTATION AND CONTROL ENGINEERING (DICE 4)

ECI 2205
CONTROL SYSTEMS I

SPECIAL/SUPPLEMENTARY EXAMINATIONS

SERIES: MARCH, 2014

TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. You should have the following for this examination:
   - Answer Booklet
   - Scientific Calculator
   - Laplace Table

2. This paper consists of **FIVE** Questions.
3. Answer **ANY THREE** Questions.
4. This paper consists of **FIVE** printed pages.

Question ONE

(a) Define the following terms:

(i) A control system
(ii) Controller
(iii) Servomechanism

(6 marks)

(b) List important features for each of the following control system:

(i) Open loop control system
(ii) Closed loop control system

(6 marks)

(c) State, giving reasons whether the following are open loop or closed loop control systems:

(i) The room heater
(ii) Maintenance of normal body temperature of a human being

(4 marks)

(d) Differentiate between the following types of control system:

(i) Deterministic control system and stochastic control system
(ii) Linear and nonlinear control systems

(4 marks)

Question TWO

(a) (i) Define the term 'Transfer function'. **(2 marks)**

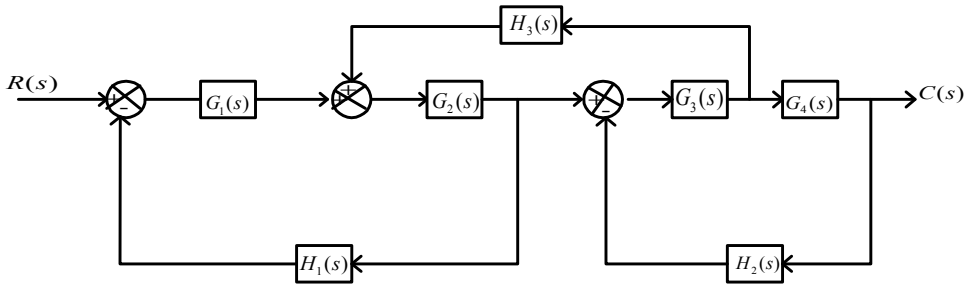

Fig. 2a

(8 marks)

(ii) From the diagram above (Figure 2a). Obtain the control ratio $C(s)/R(s)$. **(8 marks)**

(b) Consider Figure 2b below:

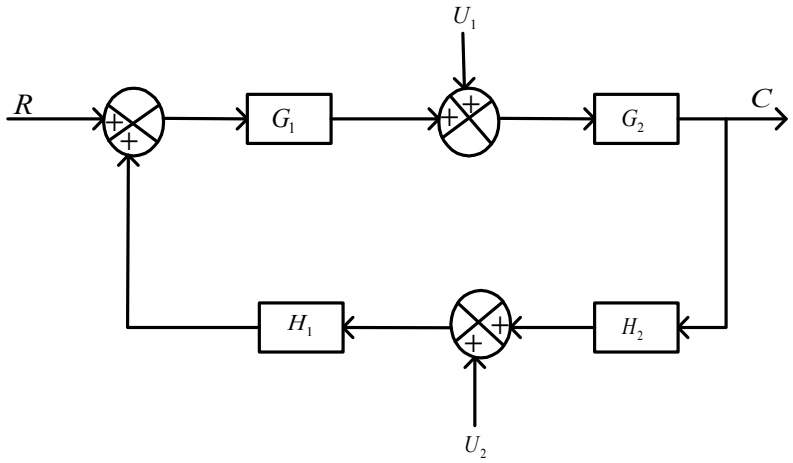

Fig. 2b

Determine the response C due to inputs R, V_1, V_2 using the superposition method.

(10 marks)

Question THREE

(a) Consider Figure 3a:

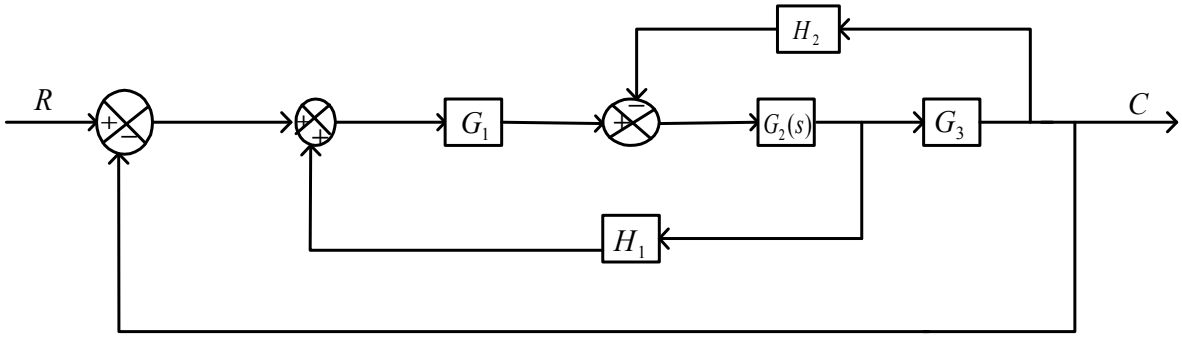

Fig. 3a

(i) Construct the signal flow graph. **(4 marks)**

(ii) Evaluate the transfer function for the constructed signal flow graph in ai above using Mason's gain formula. **(7 marks)**

(b) (i) Define the term mathematical modeling as used in control systems. **(2 marks)**

(ii) What is the significance of developing mathematical models for systems. **(2 marks)**

(c) Obtain the transfer function on an electrical network shown in Figure 3(b) below:

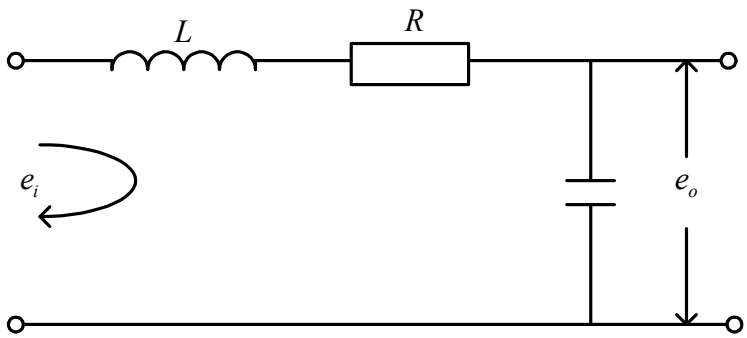

Fig. 3b

(5 marks)

Question FOUR

(a) Consider the mechanical system shown below:

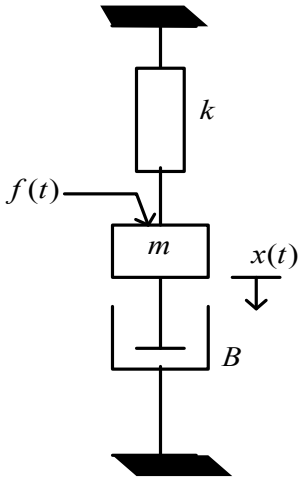

Fig. 4a

Where:

m = Is the mass
k = Is the spring constant
B = Is the damping coefficient
f(t) = Is the external force applied
x(t) = Is the displacement undergone by mass

(i) Develop a mathematical model

(ii) Obtain the transfer function

(4 marks)

(b) (i) Describe with aid of sketches **FIVE** standard test signals used in control systems. **(10 marks)**

(ii) Explain why the signals in (bi) above are used in evaluating the performance of a control system. **(2 marks)**

(c) Define:

(i) Steady state response
(ii) Transient response

(4 marks)

Question FIVE

(a) Define the following terms as used in system response:

(i) Time constant
(ii) Rise time
(iii) Settling time

(6 marks)

(b) The transfer function of a control system is given by $\frac{50}{S+50}$. For a unit step input determine:

(i) Time response
(ii) Time constant (T)
(iii) Settling time (T_s)
(iv) Rise time (T_r)

(8 marks)

(c) For a second order system with a damping ratio of 0.4, natural frequency of 10Hz, gain k = 1. Determine:

(i) The transfer function
(ii) The time response when it is subjected to a unit step input

(6 marks)