BINDURA UNIVERSITY OF SCIENCE EDICATION

FACULTY OF SCIENCE EDUCATION

DEPARTMENT OF ENGINEERING AND PHYSICS

Bachelor of Science Honours Degree in Electronic Engineering

EEE2209/EEE3205 - CONTROL ENGINNERING [ ]

Time Allowed: 3 Hours **Total Marks: 100**

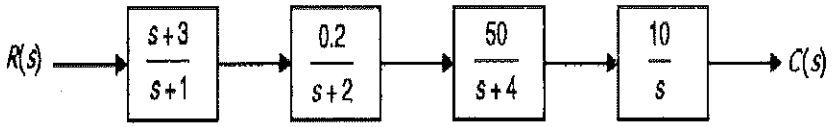
Special Requirements: Scientific Calculator, rule, pen, pencil

INSTRUCTIONS

1. Answer any **FIVE (5) questions**
2. The question paper **contains SEVEN (7)** questions
2. Each question carries 20 marks

1(a) What is feedback. What type of feedback is employed in control system. [2]
(b) With the aid of a block diagram state the components of a closed loop control system. [4]
(c) State the function of each component in (a) above. [4]
(d) Explain why negative feedback is invariably preferred in a closed loop control system. [3]
(e) Compare and contrast open loop control system to closed loop control system.[7]

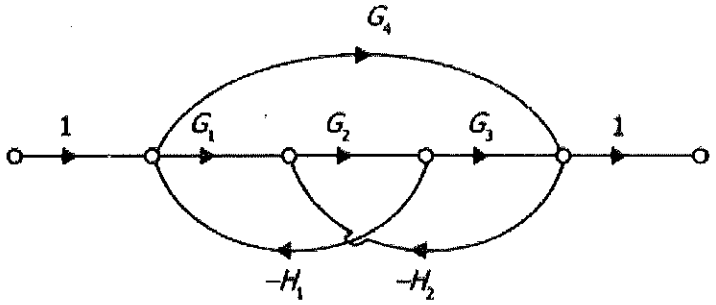
2(a)(i) What is the significance of standard test signals in control systems. [2]
(ii)With the aid of mathematical equations or waveform diagram, define step input test signal. [3]
(b) Determine the ratio $\frac{C(s)}{R(s)}$ of the block diagram shown below. [3]



(c) Sketch then polar for the control system having the transfer function. [12]

$$G(s) = \frac{1}{(1+0.1s)}$$

3(a) Find the transfer function of the system shown in Fig. below using Mason's gain formula. [8]

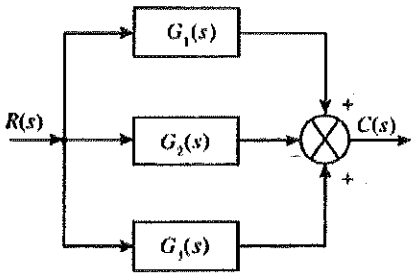


(b)With the aid of diagrams define the following Signal Flow Rules
(i)Addition Rule [2]
(ii)Transmission rule [2]
(iii)Multiplication Rule [2]
(c)Find Laplace Transform of $Sin\ \omega t$ [6]

4(a)Discuss the following basic elements of Signal Flow graph (SFG) with the aid of diagrams
(i)Feedback loop [2]
(ii) Self-loop [2]

(iii)Path gain [2]
(iv)Non Touching loops [2]

(b)(i) For the three connected as shown below, show that $\frac{C(s)}{R(s)} = G_1(s) - G_2(s) + G_3(s)$. **[4]**

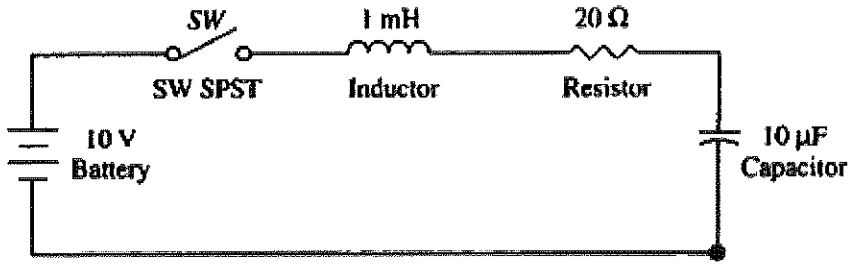


(i) Draw the equivalent block diagram. **[2]**

(c) A resistor, capacitor, and inductor are connected in series. A dc voltage of 10 V is applied through a battery with low internal impedance. The current i in the circuit is given by the following differential equation:

$$v = L\frac{di}{dt} + Ri + \frac{1}{C}\int_0^1 idt$$

All initial conditions are zero; that is, at time t =0, there is no magnetic field across the inductor, no charge on the capacitor, and no current through the resistor. Determine a general expression for current, which is valid for all values of time greater than or equal to 0 s. Below is the circuit diagram. **[6]**



5(a) Determine the poles and zeros of the closed-loop system. **[5]**

$$G_1(s) = \frac{0.1s+1}{s}, \quad G_2(s) = \frac{s+1}{s^2 + 2s + 4}$$

(b) Determine the characteristic equation of the following system: **[2]**

$G(s) = \frac{12}{s(s^2+4s+2)}$ and $H(s) = 0.5$

(c) State Routh Stability Criterion. **[2]**

(d) Examine the stability of $s^5 + 6s^4 + 3s^3 + 2s^2 + s + 1 = 0$ using Routh Stability Criterion. **[8]**

(e) Find the Laplace transform of a unit step signal. **[3]**

6 (a) Find the error coefficients of a system having $G(s)H(s) = \frac{(s+3)}{s(1+0.6s)(1+0.3s)}$ **[3]**

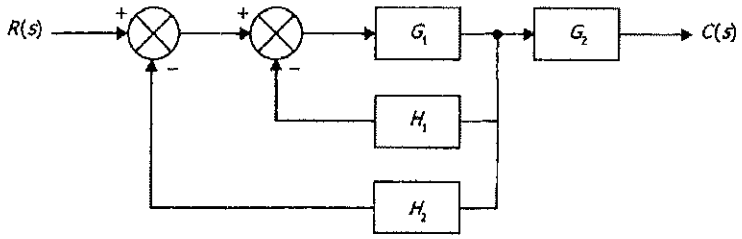
(b) Calculate the frequency response of the following system over a frequency range of 0.01 to 10 rad/s. **[17]**

7(a)If the transfer function of a system and applied input to it are e^{-3t} and e^{-4t}, find the response of the system. **[3]**

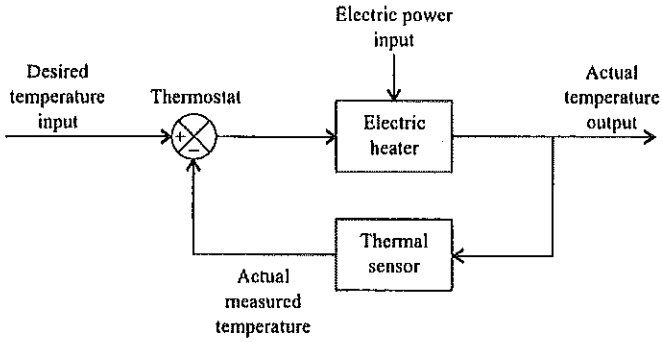
(b) What are static error constants with reference to Time Domain response. **[3]**

(c) A unity feedback system has an open loop transfer function of $G(s) = \frac{10}{(s+1)(s+2)}$
Determine steady state error for unit step signal input. **[4]**

(d) Find ***C(s)/R(s)*** of the block diagram shown **[6]**



(e) A closed loop thermostatically controlled electric oven in the kitchen of a house is shown below. Describe its operation. **[4]**



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