3 JUN 2023

BINDURA UNIVERSITY OF SCIENCE EDICATION

FACULTY OF SCIENCE EDUCATION

DEPARTMENT OF ENGINEERINGAND PHYSICS

Bachelor of Science Honours Degree in Electronic Engineering

EEE3205 - Control Engineering

Total Marks:100

Time Allowed: 3 Hours

Special Requirements: Scientific Calculator, rule, pen, pencil

INSTRUCTIONS

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

1(a) With the aid of a block diagram compare and contrast open loop to closed loop control Systems **[15]**

(b) What are the advantages and disadvantage open loop control system. **[5]**

2(a) A simple series voltage regulator closed loop control system is shown below. Discuss how it maintains the out voltage constant. **[10]**

(b) With the aid of a well-labelled block diagram design an Insulin delivery control system. The system must provide the insulin from a reservoir implanted within the diabetic person. The goal is to design a system to regulate the blood sugar concentration of a diabetic by controlled dispensing of insulin. The variable to be controlled is blood glucose concentration. The design specification is to provide a blood glucose level for the diabetic that closely approximates the glucose level of a healthy person. **[10]**

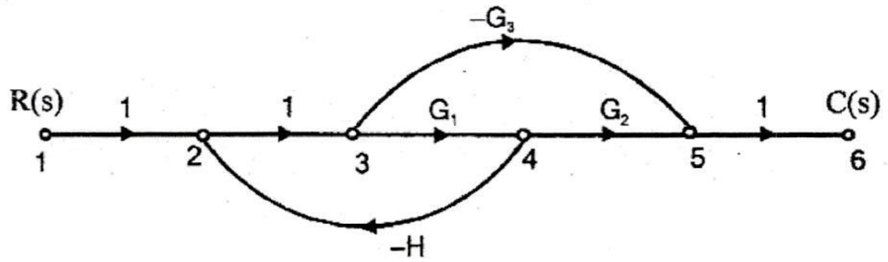
3(a)(i) What is the significance of standard test signals in control systems. **[2]**

(ii) With the aid of mathematical equations or waveform diagram, define step input test signal. **[3]**

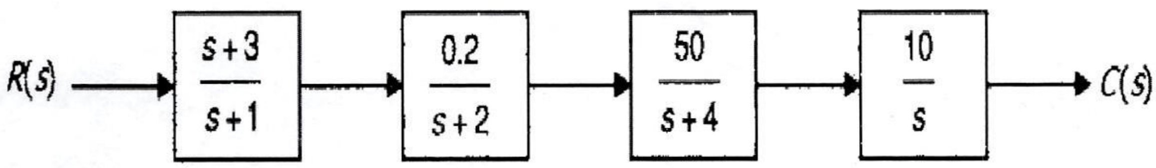
(b) Sketch then polar for the control system having the transfer function. **[15]**

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

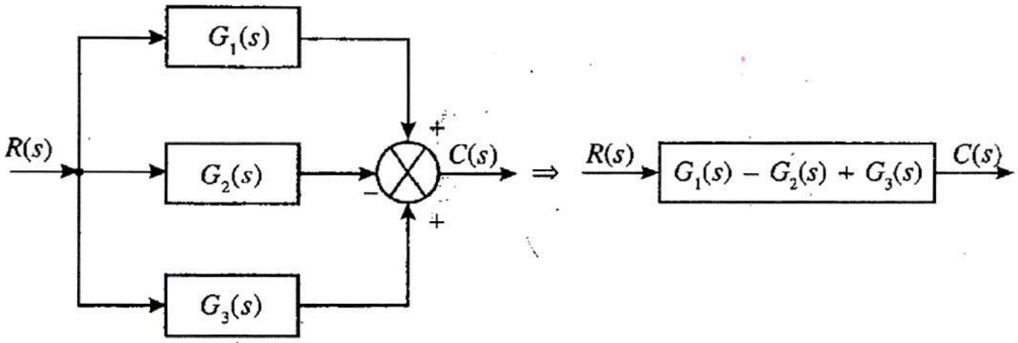
4(a) Find the transfer function of the system shown in Figure below using Mason's gain formula. **[8]**



(b) Determine the ratio $\frac{C(s)}{R(s)}$ of the block diagram shown below. **[2]**



(c) With the aid of a signal flow diagram, write the rule for three blocks in parallel. **[2]**



(d) Prove the above rule mathematically. **[3]**

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

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

5(a) Determine the characteristic equation of the following systems. **[2]**

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

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

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

(d) Find the Laplace transform of standard test signals below. **[2]**
Unit step signal
Unit ramp signal **[3]**

(e) Find the error coefficients of a system having $G(s)H(s) = \frac{(s+3)}{s(1+0.60s)(1+0.35s)}$ **[3]**

6(a) Calculate the frequency response of the following system over a frequency range of 0.01 to 10 rad/s.

$$G(s) = \frac{5\,(s+1)}{(s+2)(s+3)}$$ **[20]**

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]**
K_P - positional error constant
K_a -acceleration error constant
K_v - velocity error constant

(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]**

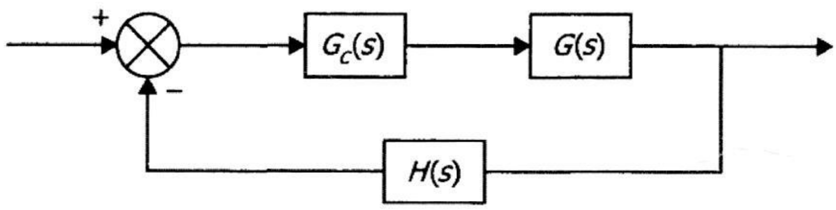
(d) Evaluate the significance of the following frequency response specifications.**[4]**

(i) Bandwidth

(ii) Resonant peak

(e) Briefly describe two scenarios when compensation can be required in closed loop control system. **[2]**

(ii) Identify the type of compensator below. **[1]**



(iii) Describe the effect of adding the compensator in the forward path as shown.**[3]**

The End