ii. Determine the stability of the system using the Routh-Hurwitz criterion for the following equation- **7**

$$\frac{128}{s^8 + 3s^7 + 10s^6 + 24s^5 + 48s^4 + 96s^3 + 128s^2 + 192s^1 + 128}$$

Also find how many poles are there in LHS, RHS and on the imaginary axis jω.

OR iii. Determine the stability of the system using the Routh-Hurwitz criterion for the following equation- **7**

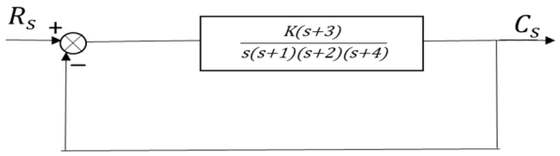
$$\frac{20}{s^8 + s^7 + 12s^6 + 22s^5 + 39s^4 + 59s^3 + 48s^2 + 38s^1 + 20}$$

Also find how many poles are there in LHS, RHS and on the imaginary axis jω.

Q.5 i. Explain the concept of root locus? Write the properties of root locus. **4**

ii. Compare and contrast the performance of PI, PD, and PID controllers in terms of stability, transient response, and steady-state error. **6**

OR iii. Sketch the root locus for the system shown in figure below **6**



Q.6 Attempt any two:

i. Describe how MATLAB facilitates system modeling in automatic control systems. What are the key functions or tools used for representing control systems mathematically? **5**

ii. How does MATLAB assist in stability analysis of control systems? Provide examples of stability analysis techniques available in MATLAB **5**

iii. Write advantages and limitations of using MATLAB in automatic control system applications **5**

******

Total No. of Questions: 6 *Total No. of Printed Pages:4*

Enrollment No.....

Faculty of Engineering
End Sem Examination May-2024
RA3CO31 Automatic Control Systems

Programme: B.Tech. Branch/Specialisation: RA

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1 i. In an elevator system where the position of the elevator is constantly monitored and adjusted based on the desired floor input, what type of control system does it represent? **1**

(a) Open-loop control system (b) Closed-loop control system
(c) Hybrid control system (d) None of these

ii. Steady-state error in a closed-loop system refers to: **1**

(a) The difference between the desired and actual output at a specific time
(b) The difference between the desired and actual output as time approaches infinity
(c) The speed at which the system responds to a change in input
(d) The deviation of the system's response from the desired output during transient conditions.

iii. If the stiffness of a spring element in a translational mechanical system increases, what happens to its impedance? **1**

(a) Impedance increases (b) Impedance decreases
(c) Impedance remains constant (d) Impedance becomes negative

iv. The aim of mathematical modeling in system analysis is- **1**

(a) To make systems more complex
(b) To provide a physical representation of a system using mathematical equations
(c) To eliminate the need for simulations
(d) To make systems less predictable

v. Total response of control system (C_t) in terms of stability is- **1**
(a) Natural response (C_n) + Forced response (C_f)
(b) 5 + Natural response (C_n) - Forced response (C_f)
(c) 5 - Natural response (C_n) × Forced response (C_f)
(d) Forced response (C_f) ÷ Natural response (C_n)

vi. A control system with a pole of multiplicity one and poles in the left half plane is- **1**
(a) Unstable
(b) Marginally stable
(c) Critically damped
(d) Oscillatory stable

vii. A break-in point in the root locus plot signifies: **1**
(a) A point where the root locus enters the region of interest
(b) A point where the root locus exits the region of interest
(c) The location of the controller poles
(d) The location of the controller zeros

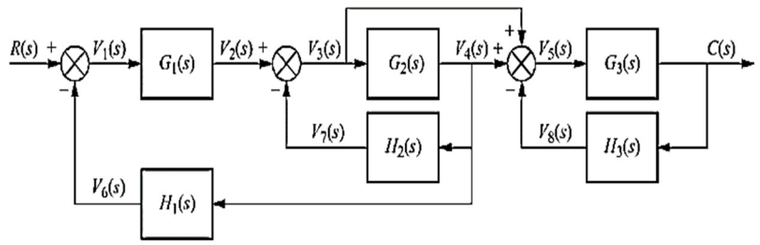
viii. A proportional-derivative (PD) controller is designed to: **1**
(a) Eliminate steady-state error
(b) Improve transient response and damping
(c) Provide high gain at low frequencies
(d) Increase stability margins

ix. MATLAB's Simulink is often used for: **1**
(a) Analyzing control systems in the time domain
(b) Implementing control algorithms on embedded hardware
(c) Analyzing control systems in the frequency domain
(d) Performing optimization of control system parameters

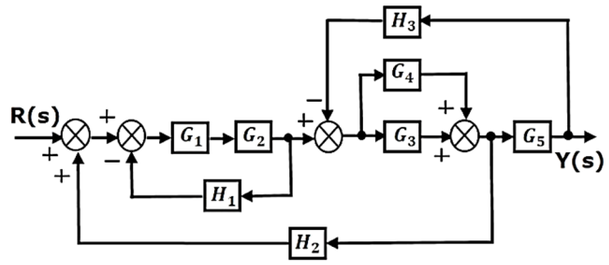
x. Which MATLAB command is used to obtain the step response of a linear time-invariant (LTI) system? **1**
(a) 'step' (b) 'bode'
(c) 'pzmap' (d) 'ltiinfo'

Q.2 i. Compare and contrast the performance of the open-loop control system with the closed-loop control system with the help of practical examples. **3**

ii. Solve the block diagram shown in figure below- **7**

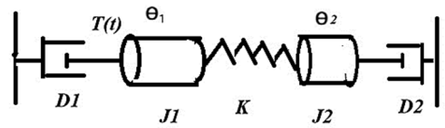


OR iii. Solve the block diagram shown in figure below- **7**



Q.3 i. What is the transfer function $H(s)$ of an RL (resistor-inductor) and LR (inductor-resistor) circuit with a resistance R and inductance L. Also explain why RL and LR circuit called low-pass filter and high-pass filter? **4**

ii. Find the transfer function G(s) for the rotational mechanical system as shown below- **6**



OR iii. Write the differential equations for a translational mechanical system-two equation of motion (spring-mass) and also find a transfer function solving these differential equations. **6**

Q.4 i. Explain the concept of steady-state error in control systems. Discuss how it relates to the system's response to step, ramp, and parabolic input signals **3**

Marking Scheme

RA3CO31 (T) Automatic Control Systems

Q.1	i.	B	**1**
	ii.	B	**1**
	iii.	A	**1**
	iv.	B	**1**
	v.	A	**1**
	vi.	A	**1**
	vii.	A	**1**
	viii.	B	**1**
	ix.	A	**1**
	x.	A	**1**

Q.2	i.	Compare and contrast the performance of the open-loop control system with the closed-loop control system the open-loop control -1.5 mark the closed loop control system -1.5 mark	**3**
	ii.	Solve the block diagram shown in figure below block diagram reduction rule -1 mark solution step by step -6 marks	**7**

	iii.	Solve the block diagram shown in figure below block diagram reduction rule -1 mark solution step by step -6 marks	**7**

Q.3	i.	What is the transfer function $H(s)$ of an RL (resistor-inductor) and LR (inductor-resistor) circuit with a resistance R and inductance L. Also explain why RL and LR circuit called low-pass filter and high-pass filter? Transfer function of RL and LR circuit -2 marks Reason for low and high pass filter -2 marks	**4**
	ii.	Find the transfer function G(s) for the rotational mechanical system as shown below Differential equation -1 mark Forces and their direction -2 marks Trasfer function determination -3 marks	**6**
OR	iii.	Write the differential equations for a translational mechanical system-two equation of motion (spring-mass) and also find a transfer function solving these differential equations. Differential equation -1 mark Forces and their direction -2 marks Trasfer function determination -3 marks	**6**

Q.4	i.	Explain the concept of steady-state error in control systems. Discuss how it relates to the system's response to step, ramp, and parabolic input signals Explain steady-state error -1 mark Relation with different input -2 marks	**3**
	ii.	Determine the stability of the system using the Routh-Hurwitz criterion for the following equation. Also find how many poles are there in LHS, RHS and on the imaginary axis jω Solution -4 marks Stable or Unstable -1 mark Location of poles -2 marks	**7**

OR	iii.	Determine the stability of the system using the Routh-Hurwitz criterion for the following equation. Also find how many poles are there in LHS, RHS and on the imaginary axis jω Solution -4 marks Stability or unstabilty -1 mark Location of poles -2 marks	**7**
Q.5	i.	Explain the concept of root locus? Write the properties of root locus. Definition root locus 1 mark Properties of root locus 3 marks	**4**
	ii.	Compare and contrast the performance of PI, PD, and PID controllers in terms of stability, transient response, and steady-state error. PI -2 marks PD -2 marks PID -2 marks	**6**
OR	iii.	Sketch the root locus for the system shown in figure below Calculating the asymptotes -1 mark Explanation with root locus sketch -5 marks	**6**
Q.6	i.	Describe how MATLAB facilitates system modeling in automatic control systems. What are the key functions or tools used for representing control systems mathematically? Description -2 marks Key functions -3 marks	**5**

	ii.	How does MATLAB assist in stability analysis of control systems? Provide examples of stability analysis techniques available in MATLAB Description -2 marks Examples - 3 marks	**5**
	iii.	Write advantages and limitations of using MATLAB in automatic control system applications Advantages -2.5 marks Disadvantages -2.5 marks	**5**

******