Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering
End Sem Examination Dec-2023
EE3CO34 / EX3CO34 Control Systems

Programme: B.Tech. Branch/Specialisation: EE/EX

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. The output of the feedback control system must be a function of- **1**
(a) Output and feedback signal
(b) Input and feedback signal
(c) Reference input
(d) Reference output

ii. Which of the following is an open loop control system? **1**
(a) Field controlled D.C. motor
(b) Ward leonard control
(c) Metadyne
(d) Stroboscope

iii. The time required for the response curve to reach and stay within the specified 2-5% of its final value referred as: **1**
(a) Peak time (b) Rise time
(c) Setting time (d) Peak overshoot time

iv. If the characteristic polynomial for a second order system is given by $S^2 + 2S + 1 = 0$, then the system is: **1**
(a) Underdamped (b) Overdamped
(c) Critically Damped (d) Undamped

v. Which of the following method is the strongest tool to determine the stability and transient response of the system? **1**
(a) Bode plot (b) Nyquist Plot
(c) Root Locus (d) Rowth-Hurwitz criterion

vi. For a stable system: **1**
(a) Gain margin Positive & Phase margin negative
(b) Gain margin Positive & Phase margin positive
(c) Gain margin negative & Phase margin negative
(d) Gain margin negative & Phase margin positive

vii. A phase lag compensation will- **1**
(a) Improve relative stability (b) Increase the speed of response
(c) Increase bandwidth (d) Increase overshoot

viii. Addition of zeros in transfer function causes which of the following: **1**
(a) Lead compensation (b) Lag compensation
(c) Lead - Lag compensation (d) None of these

ix. Which mechanism in control engineering implies an ability to measure the state by taking measurements at output? **1**
(a) Controllability (b) Observability
(c) Differentiability (d) Adaptability

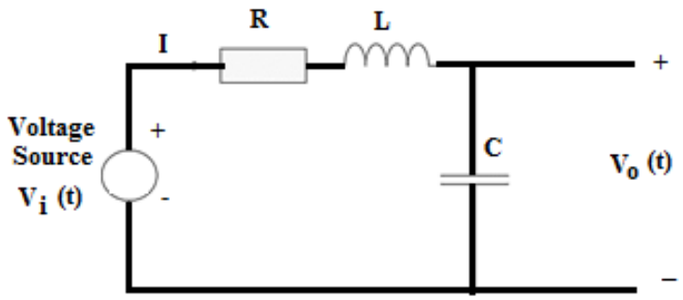
x. State space analysis is applicable even if the initial conditions are: **1**
(a) Zero (b) Non-zero
(c) Equal (d) Not equal

Q.2 i. State the Mason's Gain formula. **2**

ii. Describe open loop and close loop control systems. **3**

iii. Derive the transfer function of a close loop control system. **5**

OR iv. Derive the transfer function of the following electrical system; **5**



Q.3 i. Define the following terms: **2**
(a) Stable system (b) Unstable system

ii. Derive and plot the response of a second order critically damped system when subjected to unit step input. **8**

OR iii. A unity feedback control system has an open loop transfer function **8**

$$G(S) = \frac{10}{s(s+2)}$$

Find the rise time, percentage overshoot, peak time, delay time and setting time.

Q.4 i. What do you mean by Gain margin & Phase margin? **3**

ii. Construct the Bode plot for the system having open loop transfer function: **7**

$$G(S) = \frac{80}{S\,(S+2)(S+20)}$$

From the Bode plots determine Gain margin and phase margin. Also comment on the stability of the system.

OR iii. Draw the complete Nyquist plot for a unity feedback control system whose open loop transfer function is **7**

$$G(S)\,H(S) = \frac{K}{S\,(S^2 + 2S + 2)}$$

Find the maximum value of K for which the system is stable.

Q.5 i. What is compensation? Explain the different types of compensation. **4**

ii. Derive expression for the transfer function of a phase lead compensator. What are the effects of phase lead compensator to the system? **6**

OR iii. Obtain the transfer function of lag-lead compensator and draw the pole zero plot. **6**

Q.6 Attempt any two:

i. What is meant by state transition matrix? List the properties of state transition matrix. **5**

ii. Define the following terms with respect to state space approach: **5**
(a) State Variables (b) State Vector

iii. Explain the concept of controllability & observability. **5**

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Marking Scheme

EE3CO34 Control Systems

Q.1	i)	b) Input and feedback signal		1
	ii)	(a) Field controlled D.C. motor		1
	iii)	(c) Setting time		1
	iv)	(c) Critically Damped		1
	v)	(c) Root Locus		1
	vi)	b) Gain margin Positive & Phase margin positive		1
	vii)	a) Improve relative stability		1
	viii)	b) Lag compensation		1
	ix)	b) Observability		1
	x)	b) Non-zero		1
Q.2	i.	State the Mason's Gain formula	(As per explanation)	2
	ii.	Open loop	1.5 Marks	
		Close loop control systems.	1.5 Marks	
	iii.	Transfer function of a close loop control system.	(As per explanation)	5
OR	iv.	Transfer function	(As per explanation)	5
Q.3	i.	a) Critically stable system	1 Mark	
		b) Conditionally stable system	1 Mark	1
				1
	ii.	Response of a second …..input.	6 Marks	6 Marks
		Response ……. System	2 Marks	2 Marks
OR	iii.	Find the rise time, percentage overshoot, peak time, delay time and setting time		

Ans. rise time = 0.628s, percentage overshoot = 36% , Peak time = 1.05s, delay time = 0.3849 s , Setting time = 4s.
(3 marks for close loop transfer function and damping ratio. 1 Marks each for t_r, M_p, $t_{p,}$ t_d and $t_{s)}$

Q.4	i.	Gain margin	1.5 Marks	
		MarksPhase margin	1.5 Marks	
	ii.	**Ans.** Gain margin = +21 dB, Phase margin = $+38^0$		
		(4 Marks for bode plot. 1.5 marks each for gain & phase margin)		
OR	iii.	**Ans.** For stability K<4		
		(4 Marks for Nyquist plot. 3 Marks to find the value of K.)		
Q.5	i.	Compensation	2 Marks	2
		The different types of compensation.	2 Marks	2
	ii.	Transfer function of a phase lead compensator.	4 Marks	4
		Effects of phase lead compensator to the system	2 Marks	2
OR	iii.	Obtain the transfer function	4 Marks	4
		Pole zero plots	2 Marks	2
Q.6		Attempt any two:		
	i.	What is meant by state transition matrix	2.5 Marks	2.5
		List the properties of state transition matrix.	2.5 Marks	2.5
	ii.	a) State Variables	2.5 Marks	
		b) State Vector	2.5 Marks	2.5
				2.5
	iii.	Controllability	2.5 Marks	
		Observability.	2.5 Marks	2.5
				2.5

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