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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Sixth Semester B.Tech Degree Supplementary Examination May 2023 (2019 Scheme)

Course Code: EET302

Course Name: LINEAR CONTROL SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks. Marks

1		Compare open loop and closed loop systems. Give an example for each	(3)
2		Obtain the transfer function of a lead compensator with the help of an electrical network.	(3)
3		Draw the unit step response of an under damped system and mark various time domain specifications	(3)
4		State and explain Routh- Hurwitz stability criterion.	(3)
5		Write the design steps of lag compensator using root locus.	(3)
6		Explain the effect of adding poles and zeros to the nature of root locus.	(3)
7		What is the relationship between phase cross over frequency and gain cross over frequency for a stable system.	(3)
8		Point out the difference between minimum phase systems and non-minimum phase systems	(3)
9		State and explain Nyquist Stability Criterion.	(3)
10		Write procedure for designing a lead compensator design using Bode plot	(3)

PART B

Answer one full question from each module, each carries 14 marks.

Module I

11	a)	Derive the transfer function of an armature controlled DC motor and represent the system in block diagram form.	(7)
	b)	Derive the transfer function of a lag-lead compensator.	(7)

OR

12	a)	Explain the following control system components (i) Sychro-transmitter (ii) AC tachogenerator	(8)

b) Obtain the transfer function of lag compensators using R-C circuit components and hence explain the characteristics of the lag compensators (6)

Module II

13 a) Derive the expression for unit step response of an under damped second order system. (8)

b) A unity feedback control system is characterized by an open loop transfer function given below. Determine the value of K so that its damping ratio of the closed loop system is 0.5. (6)

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

OR

14 a) Derive the expression for rise time and peak time of an under damped second order system. (8)

b) Using Routh – Hurwitz Criterion ascertain the stability of the system whose characteristic equation is. (6)

$$s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0$$

Module III

15 a) Sketch the root locus of the system having open loop transfer function $G(s)H(s) = \frac{K}{s(s+2)(s+4)}$. Find the value of K so that the damping ratio of the closed loop system is 0.5. (14)

OR

16 a) Design a phase lag compensator for a system whose open loop transfer function is $G(s)H(s) = \frac{K}{s(s+4)(s+5)}$ to meet the following specifications (14)

(i) Damping ratio = 0.707 (ii) $K_v \geq 5$ (iii) ω_n =2 rad/sec.

Module IV

17 a) Determine the gain cross over frequency, phase cross over frequency, gain margin and phase margin for the system with open loop transfer function (10)

$$G(s) = \frac{1}{s(2s+1)(1+s)}$$

b) What is resonant frequency and resonant peak for a second order system? What is the relation between resonant peak of a system with the damping factor, η ? (4)

OR

18 Draw Bode Plot for a system whose open loop transfer function is $G(s)H(s) = \frac{10}{s(1+s)(1+0.02s)}$. Also Determine (14)

i. Gain Margin
ii. Phase Margin
iii. Closed Loop Stability

Module V

19 Draw the Nyquist plot for the system whose open loop transfer function is (14)

$G(s) = \frac{K}{s(s+2)(s+10)}$. Determine the range of K for which the system is stable

OR

20 A unity feedback system has an open loop transfer function (14)

$$G(s) = \frac{K}{s(1+2s)}$$

Design a suitable lag compensator so that phase margin is 45 degree and velocity error constant is 5.

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