Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Sixth Semester B.Tech Degree Examination June 2022 (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		Explain the effect of feedback on overall gain, sensitivity and noise for a closed loop control system.	(3)
2		Explain the role of compensators in automatic control systems.	(3)
3		What is meant by bounded input bounded output stability?	(3)
4		Using Routh's stability criterion determine the stability of the given system whose characteristic equation is $s^4 + 10s^3 + 30s^2 + 100s + 25 = 0$	(3)
5		Compare the performance characteristics of PI and PD controllers.	(3)
6		Explain the effect of adding poles and zeros to the nature of root locus.	(3)
7		Explain how phase margin and gain margin can be detected from the polar plot.	(3)
8		Draw the approximate polar plot for the open loop transfer function, $G(s) = \frac{1}{s(1+sT_1)(1+sT_2)}$	(3)
9		State and explain Nyquist stability criterion.	(3)
10		Explain the significance of Nichols chart.	(3)

PART B

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

Module I

11	a)	Derive the transfer function for the armature controlled DC motor and hence draw the block diagram representation of the system.	(7)
	b)	Obtain the transfer function of lag compensators using R-C circuit components and bring out the characteristics of lag compensators.	(7)
		OR	
12	a)	Derive the transfer function of a lag-lead compensator.	(7)

b) Derive the transfer function for the field controlled DC motor and hence draw the block diagram representation of the system. (7)

Module II

13 a) The forward path transfer function of a unity feedback control system is given by (7)

$$G(s) = \frac{2}{s(s+3)}$$

Obtain the unit step response of the system.

b) Derive the error coefficient and steady state error for a type 1 system applied with unit step and unit ramp input. (7)

OR

14 a) The open loop transfer function of a unity feedback control system is given by (8)

$$G(s) = \frac{25}{s(s+5)}$$

Determine the natural frequency of oscillation, damped frequency of oscillation, damping ratio and maximum overshoot for a unit step input.

b) Obtain the unit step response of a standard first order system. Draw the response curve and comment on the effect of time constant on the speed of response of the system. (6)

Module III

15 a) A unity feedback control system has an open loop transfer function (10)

$$G(s) = \frac{K}{s(s+4)}$$

Draw the root locus and determine the value of K if the damping ratio is 0.707.

b) Explain the Ziegler Nichols method of tuning the PID controllers. (4)

OR

16 a) A unity feedback control system has an open loop transfer function (10)

$$G(s) = \frac{K}{s(s+1)(s+3)}$$

Draw the root locus for the system and determine the value of K for marginal stability.

b) Explain the function of PID controllers in any closed loop control system. (4)

Module IV

17 a) For the given open loop transfer function (10)

$$G(s) = \frac{10}{s(1 + 0.4s)(1 + 0.1s)}$$

Draw the bode plot using asymptotic approach; determine the phase cross over frequency, gain cross over frequency and comment on the stability of the system.

b) Define minimum phase and non-minimum phase systems with examples. (4)

OR

18 a) Sketch the polar plot of a unity feedback control system having an open loop transfer function (10)

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

Determine the gain margin and phase margin of the above system and comment on the stability of the system.

b) What is the relationship between phase cross over frequency and gain cross over frequency for a stable system? How does the gain margin and phase margin values vary with these frequencies? (4)

Module V

19 a) Explain the general steps involved in the design of lead compensator using bode plot. (4)

b) Design a phase lead compensator for a unity feedback system given by the open loop transfer function (10)

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

to meet the following specifications

(i) phase margin of the system > 40 deg (ii) velocity error constant is 15/sec

OR

20 a) The open loop transfer function of a unity feedback system is given by (10)

$$G(s)H(s) = \frac{5}{s(s + 1)(s + 2)}$$

Draw the Nyquist plot and comment about the stability of the system.

b) What is a log magnitude Vs phase plot? (4)

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S6 (R, S) / S6 (PT) (R) Examination June 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	How does closed-loop system differ from open-loop system in its function?	(3)
2	Give a comparison between lead and lag compensator.	(3)
3	Name the time domain performance specification for first-order systems and define it.	(3)
4	What pole locations characterize (1) the underdamped system, (2) the overdamped system, and (3) the critically damped system?	(3)
5	What are two ways to find where the root locus crosses the imaginary axis?	(3)
6	Write the magnitude and angle conditions for the root locus of positive feedback systems.	(3)
7	Discuss how to obtain the frequency response of a system analytically.	(3)
8	Define gain margin and phase margin of a system.	(3)
9	State the Nyquist criterion. What does the Nyquist criterion tell us?	(3)
10	Explain the importance of Nichols chart.	(3)

PART B

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

Module I

11	a)	Obtain the transfer function of lead compensators using R-C circuit components and bring out the characteristics of lead compensators.	(7)
	b)	An automobile driver uses a control system to maintain the speed of the car at a prescribed level. Sketch a block diagram to illustrate this feedback system.	(7)
		OR	
12	a)	Derive the transfer function for the armature-controlled DC motor using the block diagram representation of the system.	(6)
	b)	List the control applications of (i) Tacho Generator and (ii) Synchro	(8)

Module II

13 a) A unity negative feedback control system has the loop transfer function $G(s) = \frac{K}{s(s+\sqrt{2K})}$. (i) Determine the percent overshoot and settling time (using a 2% settling criterion) due to a unit step input. (ii) For what range of K is the settling time, $T_s \leq 1$ sec? (8)

b) A system with unity feedback is having an open loop transfer function $G(s) = \frac{20}{s^2+14s+50}$, determine the steady-state error for a step and a ramp input. (6)

OR

14 a) The system shown in Figure 1 has a unit step input. Find the output response as a function of time. Assume the system is underdamped. (7)

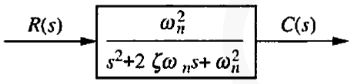

Figure 1

b) A system has a characteristic equation $s^5 + s^4 + 2s^3 + s^2 + s + K = 0$. Determine the range of K for stability. (7)

Module III

15 a) A unity feedback system has the loop transfer function $G(s) = \frac{K(s+2)}{s(s+1)}$. Sketch the root locus and find the gain when the closed loop poles of the system are located at $s_{1,2} = -2 \pm \sqrt{2}j$. (10)

b) Explain the effect of adding poles and zeros to the nature of root locus. (4)

OR

16 a) Sketch the root locus for the unity feedback system with open loop transfer function $G(s) = \frac{K(s^2+1)}{s^2}$. Comment on the stability of closed loop system from root locus. (10)

b) Explain the steps involved in the design of lag compensator using root locus method. (4)

Module IV

17 a) Sketch Bode Plot for the system with open loop transfer function $G(s) = \frac{100}{s(s+10)^2}$. From Bode plot, determine GM and PM of the system and assess the stability of the system. (10)

b) Describe the change in the magnitude and phase plot of the system if time delay is added to the system. (4)

OR

18 a) Sketch Polar Plot for the following Open Loop Transfer Function given below $G(s)H(s) = \frac{10e^{-0.2s}}{s+1}$. (10)

b) Define resonant frequency, resonant peak, Bandwidth and cut off rate for a standard second order system. (4)

Module V

19 a) Draw Nyquist plot for the system whose open loop transfer function is $G(s) = \frac{6}{s(1+s)(2+s)}$. Determine the number of right-hand side poles of the system and assess the stability. (10)

b) Explain the design constrains on the selection of corner frequencies of lag compensator. (4)

OR

20 a) Compare the Nyquist plots of $(i)\ G(s) = \frac{K}{sT_1+1}$, $(ii)\ G(s) = \frac{K}{s(sT_1+1)}$, $(iii) G(s) = \frac{K}{s^2(sT_1+1)}$ and comment about stability of the system. (9)

b) Explain the steps involved in the design of lead compensator using bode plot. (5)

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