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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)

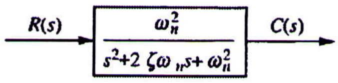

Figure 1

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 (10)

$$G(s)H(s) = \frac{10e^{-0.2s}}{s+1}.$$

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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