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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S6 (S, FE) / S6 (PT) (S) Examination January 2024 (2019 Scheme)

Course Code: EET302

Course Name: LINEAR CONTROL SYSTEMS

Max. Marks: 100 Duration: 3 Hours

(Semi-log graph sheets and ordinary graph sheets will be provided)

PART A

Answer all questions, each carries 3 marks. Marks

1	Prove that negative feedback increases the system bandwidth.	(3)
2	List down any three characteristics of lag compensator.	(3)
3	The characteristic equation of a system is given by $s^3 + 20s^2 + 16s + 16k$. Using Routh's stability criteria, find out the range of *'k'* for which the system will be absolutely stable.	(3)
4	What is meant by bounded-input, bounded-output (BIBO) stability? Write down the condition for a system to be BIBO stable.	(3)
5	What are the effects of proportional controller on system performance?	(3)
6	How do you determine the angle of arrival of a root locus branch at an open loop zero?	(3)
7	What is meant by non-minimum phase systems? Give an example for a non-minimum phase system transfer function and sketch its pole-zero plot.	(3)
8	Define the following terminologies: (i) Gain margin. (ii) Phase margin. (iii) Phase cross-over frequency.	(3)
9	What is log magnitude vs. phase plot? What is its advantage?	(3)
10	State and explain Nyquist stability criteria.	(3)

PART B

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

Module I

11	Derive the transfer function of an armature-controlled D.C. motor and hence obtain its block diagram.	(14)

OR

12 Explain the principle of operation of the following control system components with the help of a neat sketch.

(i) A.C. servo motor. (7)

(ii) Synchro transmitter and receiver. (7)

Module II

13 a) Transfer function of a closed loop control system is given by $\frac{C(s)}{R(s)} = \frac{{\omega_n}^2}{s^2+2\xi\omega_n s+{\omega_n}^2}$, where $C(s)$ is the output and $R(s)$ is the input, in frequency domain. Derive an expression for the time response, *c(t)* of the system, if it is excited by a unit step signal. (10)

b) Plot the output, *c(t)* against time, *t* for (i) $\xi = 1$, and (ii) $0 < \xi < 1$ (4)

OR

14 The open loop transfer function of a unity feedback control system is given by $\frac{C(s)}{R(s)} = \frac{100}{s(s+10)}$.

a) Evaluate the static error constants of the system. (6)

b) Obtain the steady state error of the system, when excited by an input, $r(t) = 2 + 3t + 2t^2$. (8)

Module III

15 a) Sketch the root locus diagram of the system with open loop transfer function, $G(s) = \frac{K}{s(s+3)(s+6)}$ (10)

b) Find the value of *'K'*, which will make the above system critically damped. (4)

OR

16 a) A unity feedback control system has an open loop transfer function, $G(s) = \frac{K}{s(s+6)}$. Design a lead compensator to meet the following specifications: (10)

(i) Percentage peak overshoot = 9.5%. (ii) Natural frequency of oscillation, $\omega_n = 12\ rad/s$. (iii) Velocity error constant, K_v>10.

b) What are the general steps involved in the design of a lag compensator using root locus technique? (4)

Module IV

17 a) Sketch the polar plot of a unity feedback control system with open loop transfer function, $G(s) = \frac{K}{s(1+0.2s)(1+0.05s)}$, and hence determine the value of *'K'* so that the gain margin is 16 dB. (10)

b) For the above system, what will be the value of *'K'* if a phase margin of 40^0 is required? (4)

OR

18 a) Sketch the Bode plots for the transfer function, $G(s) = \frac{s^2}{(1+0.2s)(1+0.01s)}$ and hence find out the gain cross-over frequency. (10)

b) Find out the value of additional gain, *'K'* for the above system, that will make the gain cross-over frequency 10 rad/s? Also, draw the magnitude plot for this new gain cross-over frequency. (4)

Module V

19 The open loop transfer function of a unity feedback system is given by, $G(s) = \frac{K}{s(1+s)}$. Design a suitable lag compensator so that phase margin is 40^0 and steady state error for ramp input is less than or equal to 0.25. (14)

OR

20 a) The open loop transfer function of a unity feedback system is given by $G(s)H(s) = \frac{120}{s(s+2)(s+10)}$. Draw the Nyquist plot of the system. Determine the phase cross-over frequency and comment on the stability of the system. (10)

b) What is Nichol's chart? What is its significance? (4)

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