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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S6 (R,S) (FT/WP/PT) Examinations April 2026 (2019 Scheme)

Course Code: EET302

Course Name: LINEAR CONTROL SYSTEMS

Max. Marks: 100 Duration: 3 Hours

Provide normal graph sheets and semi log graph sheets if necessary.

PART A

Answer all questions, each carries 3 marks. Marks

1 What is synchro? Mention its application in position control. (3)

2 Define transfer function. Derive transfer function of a series RLC circuit with the applied voltage across the series circuit as input and the voltage across resistor as output. (3)

3 Derive the unit impulse response of a unity feedback system with forward transfer function $G(s) = \frac{1}{s}$ and determine settling time. (3)

4 For a unity feedback system with open loop transfer function $G(s) = \frac{K(s+2)}{s(s^3+7s^2+12s)}$, determine the Type & order of the system and static position, velocity and acceleration error coefficients. (3)

5 Sketch the real axis loci and asymptotes of a positive feedback system open loop transfer function $G(s) = \frac{k}{(s+1)(s+2)(s+3)}$. (3)

6 Explain the function of PID controllers in any closed loop control system. (3)

7 Sketch the approximate shape of polar plot for the system with open loop transfer function $G(s) = \frac{1}{s(1+sT_1)(1+sT_2)}$. (3)

8 Define gain margin and phase margin and explain how stability can be determined from GM and PM? (3)

9 State and explain Nyquist stability criterion. (3)

10 Explain the need for compensation in control system. (3)

PART B

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

Module I

11 a) Derive the transfer function of a lag-lead compensator using RC circuit components and draw its pole zero plot. (8)

b) Compare the working and performance of AC and DC servomotor (6)

OR

12 a) With relevant characteristics, explain the operation of stepper motor and AC tacho generator. (8)

b) Derive the transfer function of a field-controlled DC servomotor and draw its block diagram. (6)

Module II

13 a) The open loop transfer function of unity feedback control system is $G(s) = \frac{k}{s(s+10)}$. Determine the gain k so that the system will have a damping ratio of 0.5. For this value of k, determine the settling time, peak overshoot and peak time for a unit step input. (8)

b) Pole locations affect system stability. Explain how? (6)

OR

14 a) The open loop transfer function of a servo system with unity feedback is $G(s) = \frac{k}{s(0.1s+1)}$. Evaluate the static error coefficients(K_p, K_v, K_a) for the system. Obtain the steady state error of the system when subjected to an input given by the $r(t) = a_0 + a_1 t + \frac{a_2}{2} t^2$. Also evaluate the dynamic error using the dynamic error coefficients. (8)

b) Determine the stability of the system with characteristic equation $s^5 + s^4 + s^3 + s^2 + 2s + 1 = 0$ (6)

Module III

15 a) Sketch the root locus of the system with open loop transfer function $G(s)H(s) = \frac{K}{s(s+1)(s+2)(s+3)}$ and comment on stability. (10)

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

OR

16 a) Sketch the root locus for a system with unity feedback system and having open loop transfer function $G(s) = \frac{K}{s(s+1)(s+4)}$ (6)

b) Design a suitable compensator for the above system to meet the specifications 1) Damping ratio ζ=0.5 and 2) Undamped natural frequency $\omega_n = 2\, rad/sec.$ Determine the steady state error for unit ramp input after the addition of compensator. (8)

Module IV

17 a) Sketch the Bode plot for the system with open loop transfer function $G(s)H(s) = \frac{2000}{s(s+2)(s+100)}$. Determine the gain cross over frequency, phase cross over frequency, gain margin and phase margin. Also determine the value of K and the corresponding phase margin for a gain cross over frequency 10 rad/sec. (10)

b) Define resonant peak and resonant frequency. Draw the frequency response of a standard second order underdamped system and mark resonant peak and resonant frequency. (4)

OR

18 a) Draw the Bode plot for the system with open loop transfer function given below $G(s)H(s) = \frac{48(s+10)}{s(s+20)(s^2+2.4s+16)}$ and comment on stability. (10)

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

Module V

19 a) For the system with open loop transfer function $G(s)H(s) = \frac{s+1}{s^2-4}$ sketch the Nyquist plot and determine the stability. (10)

b) What is Nichol's chart? Explain the use of Nichol's chart. (4)

OR

20 a) For a unity feedback system with open loop transfer function $G(s) = \frac{0.025}{s(1+0.5s)(1+0.05s)}$, design a suitable compensator to give velocity error coefficient = 20 sec -1, Phase margin = 40° at 1.5rad/s. (10)

b) What are the advantages of Nichol's chart? (4)

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