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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2018

Course Code: EE304

Course Name: ADVANCED CONTROL THEORY (EE)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 5 marks. Marks

1		What is a lag compensator? Draw its pole-zero plot and the frequency response characteristics.	(5)
2		Explain the effects of adding PID controller to a system.	(5)
3		Selecting $i_1(t) = x_1(t)$ and $i_2(t) = x_2(t)$as sate variables obtain state equation and output equation of the network shown in Fig.1	(5)

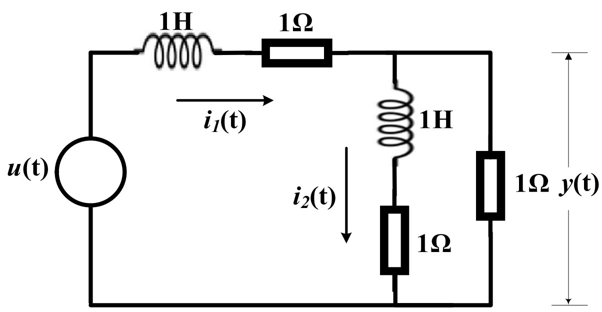

Fig.1

4		The characteristic polynomial of certain sampled data system is given by $P(z) = z^4 - 1.2z^3 + 0.07z^2 + 0.3z - 0.08 = 0$, test the stability of the system using Jury's stability test.	(5)
5		Explain different non linearities with diagram.	(5)
6		What is limit cycle? How will you determine stable and unstable limit cycle using phase portrait?	(5)
7		What are singular point? Explain the types of singular point.	(5)
8		Determine given quadratic form is positive definite or not $V(x) = 10x_1^2 + 4x_2^2 + x_3^2 + 2x_1x_2 - 2x_2x_3 - 4x_1x_3$	(5)

PART B

Answer any two full questions, each carries10 marks.

9	a)	For a feedback system shown in Fig. 2, design suitable compensator so that phase margin is $40^o$and steady state error for ramp input ≤ 0.2	(10)

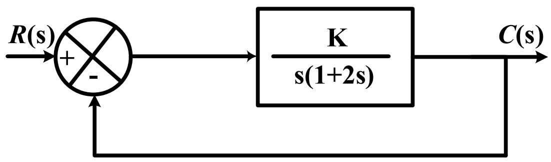

Fig. 2

10 Design a suitable compensator for the system with open-loop transfer function $G(s)H(s)=\frac{1}{s(s+1)(s+2)}$ so that the over shoot to a unit step input to be limited to 20% and the transient to be settled with in 3s. (10)

11 a) Briefly explain Ziegler – Nichol's PID tuning rules. (6)

b) Write the design steps of lead compensator based on frequency domain approach. (4)

PART C

Answer any two full questions, each carries 10 marks.

12 Find the complete response of the system (10)

$$\dot{x}=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}x+\begin{bmatrix}2 & 1\\ 0 & 1\end{bmatrix}U(t), x(0)=\begin{bmatrix}0\\ 0\end{bmatrix}$$

and $y(t)=\begin{bmatrix}1 & 0\\ 1 & 1\end{bmatrix}x$ to the following input, $U(t)=\begin{bmatrix}u(t)\\ e^{3t}u(t)\end{bmatrix}$ where *u(t)* is the unit step input.

13 a) Transform the system in to controllable canonical form (7)

$$\dot{x}=\begin{bmatrix}-1 & 1\\ 0 & 2\end{bmatrix}x+\begin{bmatrix}2\\ 1\end{bmatrix}u \text{ and } y=\begin{bmatrix}1 & 2\end{bmatrix}x$$

b) State and explain sampling theorem (3)

14 a) Consider a system defined by (7)

$$\dot{x}=\begin{bmatrix}0 & 1\\ -3 & 1\end{bmatrix}x+\begin{bmatrix}0\\ 2\end{bmatrix}u \text{ and } y=\begin{bmatrix}1 & 0\end{bmatrix}x$$

Using state feedback control $u=-Kx$, it is desired to have the closed loop poles at s = −3 and , s =−4, determine the state feedback gain matrix *K*.

b) What is pulse transfer function? (3)

PART D

Answer any two full questions, each carries 10 marks.

15 Obtain the describing function of saturation non-linearity (10)

16 A common form of an electronic oscillator is represented as shown in Fig. 3. For what value of *K,* the possibility of limit cycle predicted? If *K*=3, determine amplitude and frequency of limit cycle. Also find the maximum value of *K* for the (10)

system is stable.

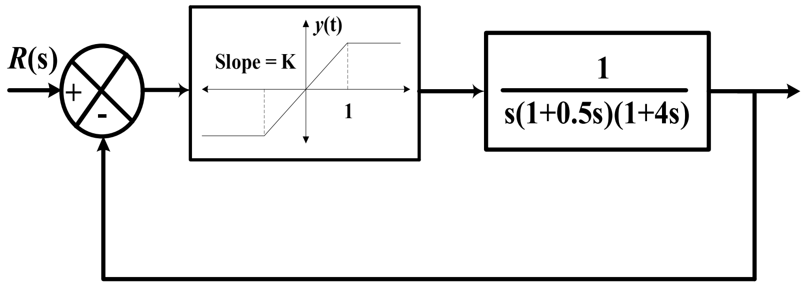

Fig. 3

17 A second order system is represented by $\dot{x} = Ax$ where (10)

$$A = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix}$$

Assuming matrix Q to be identity matrix, solve for matrix P in the equation $A^T P + PA = -Q$. Use Lyapunov theorem and determine the stability of the system. Write the Lyapunov function $V(x)$

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), MAY 2019

Course Code: EE304

Course Name: ADVANCED CONTROL THEORY

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 5 marks. Marks

1		Compare the effects of P, PI and PID controllers on the closed loop system performance in terms of rise time, peak overshoot, settling time, steady state error and stability.	(5)
2		What are the effects of Lag and Lead compensators on the system performance?	(5)
3		Explain the terms (i) state (ii) state variables (iii) state vector (iv) state space (v) state trajectory of a system.	(5)
4		What is pulse transfer function? Derive the transfer function of a ZOH circuit.	(5)
5		State any five characteristics of Nonlinear systems.	(5)
6		Define Describing function. Explain how describing function can be used for stability analysis of nonlinear systems.	(5)
7		Define Singular point. Explain the nature of Eigen values of system matrix for any five types of singular points.	(5)
8		Explain Liapunov second method of stability for nonlinear systems.	(5)

PART B

Answer any two full questions, each carries 10 marks.

9		A unity feedback system has an open loop transfer function G(S) = K/[S(1+2S)]. Design a suitable lag compensator so that phase margin is 40^o and the velocity error constant is 5.	(10)
10		Design a lead compensator for a unity feedback system with open loop transfer function G(S) = K/[S(S+8)] to satisfy the following specifications. (1) Percentage overshoot = 9.5% (2) Natural frequency of oscillation=12 rad/sec (3) Velocity error constant ≥ 10.	(10)
11	a)	Explain the Ziegler-Nichols method of tuning a PID controller.	(6)
	b)	What is meant by series compensation and feedback compensation in control systems?	(4)

PART C

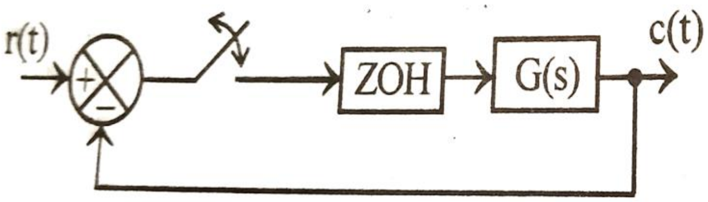
Answer any two full questions, each carries 10 marks.

12 a) Define controllability and observability of a system and check whether the system $\frac{Y(s)}{U(s)} = \frac{1}{(s+1)(s+2)}$ is controllable or not. (6)

b) Check the stability of the sampled data control system shown below (4)

z^3-0.2z^2-0.25z+0.05=0

13 Determine the pulse transfer function of the discrete time control system shown in figure for a sampling time of T=1 sec. Also find the response to unit step input. The transfer function of the system is G(s) = 1/(s+1). (10)



14 a) Derive the state model of an R-L-C series circuit (3)

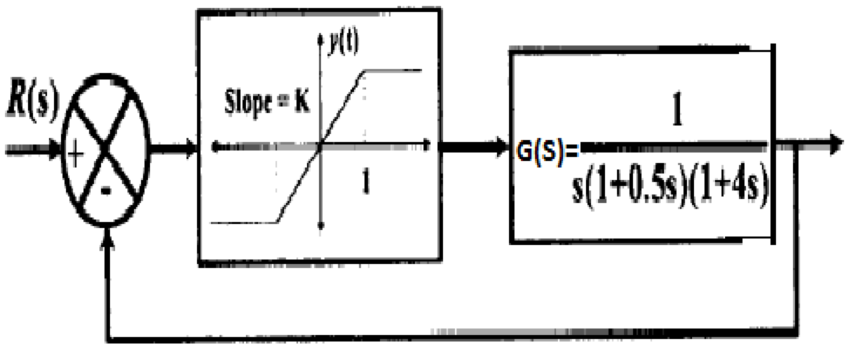
b) Consider a linear system described by the transfer function Y(s)/U(s) =10/[S(S+1)(S+2)]. Design a feedback controller with a state feedback so that the closed loop poles are placed at -2, -1±j1. (7)

PART D

Answer any two full questions, each carries 10 marks.

15 Derive the Describing function of saturation with Dead-zone nonlinearity. (10)

16 Consider a unity feedback system shown in figure having a saturating amplifier with a gain K. Determine the maximum value of K for the system to be stable. What would be the frequency and nature of limit cycle for a gain of K=2.5? (10)



17 A linear second order system is described by the equation (10)

$\ddot{e} + 2\delta\omega_n\dot{e} + \omega_n^2 e=0$

Where $\delta = 0.15$, $\omega_n = 1$rad/sec, e(0)=1.5, and $\dot{e}(0) = 0$

Determine the singular point and state the stability by constructing the phase trajectory using the method of isoclines.

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION(S), DECEMBER 2019

Course Code: EE304

Course Name: ADVANCED CONTROL THEORY

Max. Marks: 100 Duration: 3 Hours

PART A

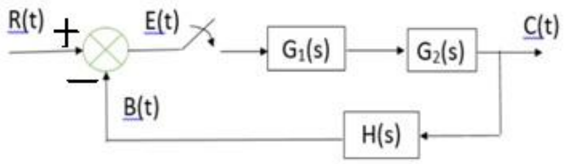
Answer all questions, each carries 5 marks. Marks

1 Obtain the transfer function of a lead compensator with the help of an electrical network. (5)

2 Derive the transfer function of a PID Controller (5)

3 Derive a relation between state equation and transfer function for LTI system. (5)

4 Obtain the pulse transfer function for the system shown below. (5)



5 With a neat diagram explain how the describing function analysis is used to determine the stability of a system? (5)

6 What are jump response and limit cycles in connection with nonlinear systems? (5)

7 Explain with neat diagram, what is phase trajectory and phase portrait? (5)

8 Define positive definite and positive semi definite functions according to Liapunov stability criteria, with suitable examples. (5)

PART B

Answer any two full questions, each carries 10 marks.

9 a) Draw the bode-plot of lag compensator and obtain an expression for maximum phase lag and corresponding frequency. (6)

b) Explain turning of PID controller using Ziegler-Nichols tuning method. (4)

10 Explain the procedure for design of a lag Compensator using Bode Plot with suitable example (10)

11 Consider a unity feedback system with open loop transfer function (10)

$$G(s) = \frac{k}{s(s+8)}$$

Design a lead compensator to meet the following specification:

1. Percentage peak overshoot is 9.5%
2. Natural frequency of oscillations 12 rad/sec
3. Velocity error constant ≥ 10

PART C

Answer any two full questions, each carries 10 marks.

12 a) A system is described by $\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -4 & -4 \end{bmatrix} x(t)$ (5)

Determine state transition matrix for the system.

b) Define controllability. Explain with a suitable example, how can we check the controllability of a system? (5)

13 Derive the state model of the following transfer function in, (10)

(i) Controllable canonical form

(ii) Diagonal canonical form

$$\frac{y(s)}{u(s)} = \frac{5(s+2)}{s(s+1)(s+3)}$$

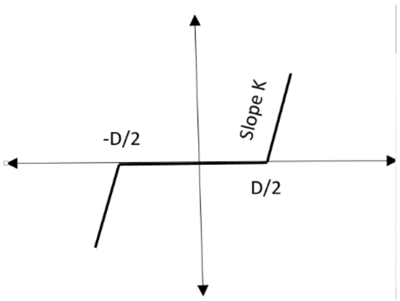
14 Examine the stability of the system with the following characteristic equation using Jury's stability test. (10)

$$z^4 - 1.2z^3 + 0.07z^2 + 0.3z - 0.08 = 0$$

PART D

Answer any two full questions, each carries 10 marks.

15 Identify the following non linearity and derive a describing function for the same (10)



16 Consider the following non linear differential equation. (10)

$$\ddot{y} - \left(0.1 - \frac{10}{3}\dot{y}^2\right)\dot{y} + y + y^2 = 0$$

Find all singular points of the system, classify them and sketch the phase portrait in the neighbourhood of singular points.

17 a) Discuss any three non linearities present in nature. (6)

b) Investigate the stability of the following non-linear system using Liapunov direct method (4)

$\dot{x}_1 = x_2$

$\dot{x}_2 = -x_1 - x_1^2 x_2$.

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Sixth semester B.Tech examinations (S), September 2020

Course Code: EE304

Course Name: ADVANCED CONTROL THEORY

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries5 marks. Marks

1	What is a PI controller? What are its effects on the system performance?	(5)
2	What is a lead compensator? Obtain its frequency response characteristics	(5)
3	What is state space? What are the advantages of state space analysis?	(5)
4	What is pulse transfer function? What is the stability criterion of a sampled data control system?	(5)
5	Mention any two characteristics of Nonlinear systems. What are limit cycles?	(5)
6	Define Describing function. What is the difference between stability analysis of linear and nonlinear systems?	(5)
7	What is the difference between describing function and phase plane method of stability analysis?	(5)
8	Explain Liapunov direct method of stability for nonlinear systems.	(5)

PART B

Answer any two full questions, each carries10 marks.

9	The open loop transfer function of a unity feedback control system is given by G(S) = K/[S(1+0.5S)(1+0.2S)]. It is desired that (i) the steady state error to unit ramp input is less than 0.125 (ii) Phase margin≥300 (iii) Gain margin≥10 db. Design a suitable compensator.	(10)
10	Design a suitable compensator for a unity feedback system with open loop transfer function G(S)=K/[S(S+4)(S+7)] to satisfy the following specifications. (1)Percentage overshoot=12.63% (2)Natural frequency of oscillation=8 rad/sec(3)Velocity error constant≥2.5.	(10)
11	Explain the Ziegler-Nichols method of tuning a PID controller when (a) dynamic model is known (b) dynamic model is not known.	(10)

PART C

Answer any two full questions, each carries10 marks.

12 a) Obtain the state model of the system whose transfer function is given by (5)

$Y(s)/U(s)= 10/[s^3+4s^2+2s+1]$

b) Obtain the state model of a field controlled DC motor. (5)

13 A discrete time system is described by the difference equation (10)

$y(k+2)+5y(k+1)+6y(k)=u(k)$

$y(0)=y(1)=0$; $T=1$ sec.

(a) Determine state model in a canonical form (b) Find the state transition matrix

14 Check the stability of the sampled data control system with the following characteristic equation using Jury's stability test $z^4-1.7z^3+1.04z^2-0.268z+0.024=0$ (10)

PART D

Answer any two full questions, each carries 10 marks.

15 Derive the Describing function of saturation with deadzone. (10)

16 Construct the phase trajectory for the system (10)

$\dot{x_1} = x_2, \dot{x_2} = -sign(x_1) where sign(x_1) = \begin{cases} 1 for x_1 > 0 \\ -1 for x_1 \leq 0 \end{cases}$ starting from (2,0)

17 Test the stability of the system using Lyapunov stability theorem (10)

(a) $\dot{x_1} = -x_1 + 2x_1^2 x_2$, $\dot{x_2} = -x_2$

(b) $\dot{x_1} = x_2, \dot{x_2} = -sin(x_1) - x_2$

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