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Reg No.:_____ Name:_____

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

B.Tech Degree S6 (S,FE) / S6 (PT) (S,FE) Examination May 2023 (2015 Scheme)

**Course Code: EE304**

**Course Name: ADVANCED CONTROL THEORY**

Max. Marks: 100 Duration: 3 Hours

**PART A**

***Answer all questions, each carries5 marks.*** Marks

1 The transfer function of a compensator is $\frac{1+0.1s}{1+0.01s}$. Identify the corner frequencies. Is it a lag compensator or lead compensator? Give reason. (5)

2 What are the advantages of PID controller compared to P controller? (5)

3 Consider a system with a transfer function (5)

$$\frac{Y(s)}{U(s)} = \frac{10}{(s+1)(s+5)}$$

Obtain the state space model of the system in a canonical form. Find the Eigenvalues of the system matrix

4 Consider the system given below (5)

$$\dot{X} = \begin{bmatrix} -1 & 0 \\ 0 & -3 \end{bmatrix} X + \begin{bmatrix} 1 & a \\ 0 & b \end{bmatrix} U$$

Find the range of values of "a" and "b" for the system to be controllable

5 With the help of a suitable example and figures explain jump resonance (5)

6 Sketch and write the expression for the output of dead zone non-linearity if the input is $X\sin(wt)$, gain of amplification can be assumed as $k$. (5)

7 What are singular points? Draw the nature of trajectories of any three types of singularity (5)

8 Check the definiteness of the following function (5)

$V(x) = 10x_1^2 + 20x_1x_2 + 10x_2^2$

**PART B**

***Answer any two full questions, each carries10 marks.***

9 A unity feedback system has an open loop transfer function G(S) = K/[s(s+1)]. Design a suitable compensator for the system to satisfy the following specifications. (i) Phase margin $\geq 45^o$. (ii) Steady state error for a unit ramp input $\leq 1/15$. (ii) The gain crossover frequency of the system must be less than 7.5 rad/sec. (10)

10 Design a suitable compensator for a unity feedback system with open loop transfer function G(S) = K/[s(s+2)(s+8)] to satisfy the following specifications. (10)

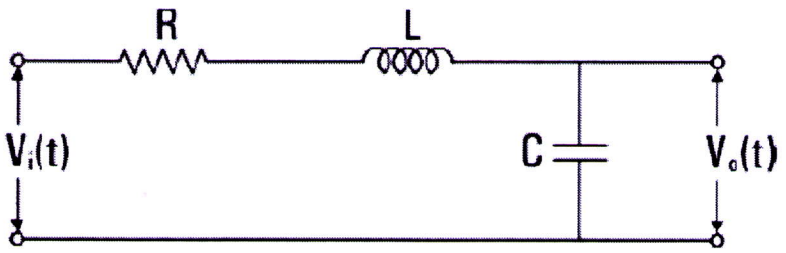
(i) Percentage overshoot $\leq$ 16% for unit step input (ii) setling time for unit stepinput to be less than 6.1s (iii) Steady state error $\leq$ 0.125 for unit ramp input.

11 The open loop transfer function of a unity feedback system is $\frac{1}{s^2}$. Design an appropriate compensator using root locus method so that settling time is less than 4 s and damping ratio is 0.45 (10)

## PART C

***Answer any two full questions, each carries10 marks.***

12 a) (5)




Consider the system given above, with R=10 ohm, L=1mH and C=1μF.

Obtain a state space model by choosing physical variables as state variables

b) Transform the system model derived in 12 a) into phase variable form (5)

13 a) (10)

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

$$y(t) = \begin{bmatrix} 0 \\ 1 \end{bmatrix} x(t)$$

Consider the system given above if initial conditions are zero

Find the output Y(t) if the input is

$$u(t) = \begin{bmatrix} r(t) \\ e^{3t} r(t) \end{bmatrix}$$

Given $r(t)$ is unit step function

14 a) A sample data system is described by the following equation (5)

$y(k)+3y(k-1)+2y(k-2)=u(k)+5u(k-1)$

Obtain pulse transfer function

b) Consider the system with characteristic polynomial (5)

$F(z)=2z^4 + 7z^3 + 10z^2+4z+1$

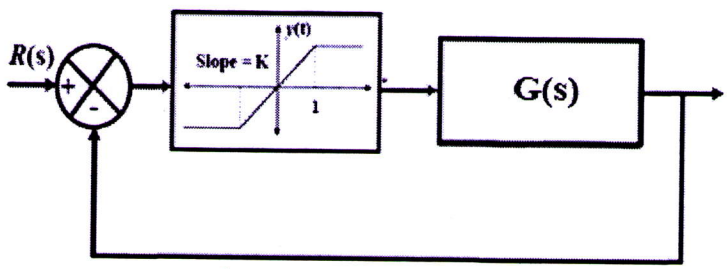
Investigate the stability of the system using Jury's Test

## PART D

***Answer any two full questions, each carries 10 marks.***

15 Construct the phase trajectory for the system $\dot{x_1} = x_2, \dot{x_2} = sin(x_1) - x_2$ starting from (4,0) and identify the nature of equilibrium point at (π,0). (10)

16 Consider a third order system with transfer function $G(s) = \frac{2}{s(1+2s)(1+s)}$ with a saturation amplifier given in figure below. The amplifier is having gain K in linear region. Determine largest value of gain K for the system to stay stable. What would be the frequency and nature of limit cycle for a gain of K=10? (10)




17 Consider a non linear system described by the following equations (10)

$$\dot{x_1} = x_2$$

$$\dot{x_2} = -x_1^3 - x_2$$

Investigate the stability using Liapunov's method

Hint: V(x)= $x_1^4 + x_1^2 + 2x_1x_2 + 2x_2^2$

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