Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S5 (S,FE) Examination May 2025 (2019 Scheme)

Course Code: RAT307

Course Name: CONTROL SYSTEMS

(Provide normal graph sheets and semi-log graph sheets)

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer all questions; each question carries 3 marks) Marks

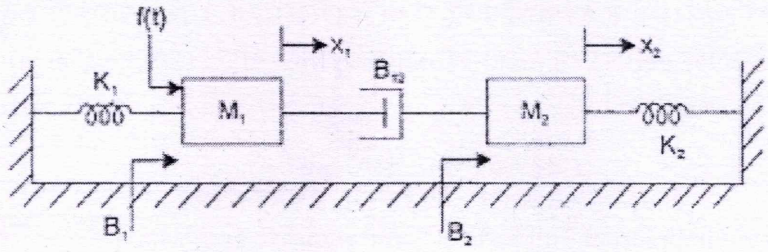
1	Differentiate between Force voltage and Force current analogy.	3
2	What are the different types of actuators?	3
3	What does the arrangement of the Routh array indicate about system stability?	3
4	The transfer function of a system is given as $\frac{5}{S^2 + 3.2S + 64}$ Find the damping ratio and natural frequency of oscillation.	3
5	Define stability of a system based on Root locus.	3
6	Differentiate PI and PD controller.	3
7	List the properties of State Transition Matrix.	3
8	When is a system said to be controllable?	3
9	Differentiate linear and non-linear systems.	3
10	Explain the describing function analysis of non-linear systems.	3

PART B

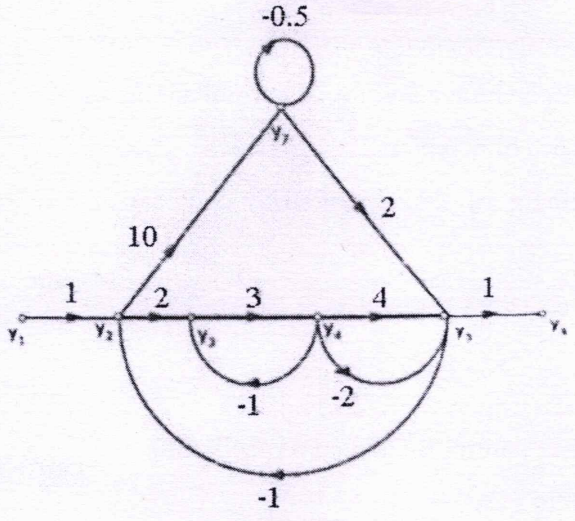
(Answer one full question from each module, each question carries 14 marks)

Module -1

11	Determine the given transfer functions $\frac{X_1(S)}{F(S)}$ *and* $\frac{X_2(S)}{F(S)}$ for the system shown below	14



12 Find the transfer function corresponding to the given signal flow graph using Mason's gain formula. 14



Module -2

13 For a unity feedback control system, the open loop transfer function 14

$G(S) = \frac{10(S+2)}{S^2(S+1)}$

Find (a) the position, velocity, and acceleration error constants. (b) the steady error when the input is R(s), where R(s) = $\frac{3}{s} - \frac{2}{s^2} + \frac{1}{3s^3}$

14 a) Use Routh's stability criterion to check for the stability of the given systems. 8

i) $S^3 + 6S^2 + 4S + 100 = 0$

ii) $S^5 + S^4 + 2S^3 + 2S^2 + 15 = 0$

b) Find the time response a first order system, when it is fed with 6

i) unit step input

Module -3

15 A unity feedback system has an open loop transfer function 14

$$\frac{K}{S(S^2 + 4S + 13)}$$

Sketch the root locus.

16 Construct the bode plot for the given transfer function 14

$$200\frac{(S+10)}{S(S+5)\,(S+20)}$$

Also determine the stability.

Module -4

17 a) Obtain the state space representation of 8

$$\frac{d^3y}{dt^3} + 6\frac{d^2y}{dt^2} + 11\frac{dy}{dt} + 10y = 8u(t)$$

b) Which are the canonical forms for parallel decomposition? Using any one canonical form method, generate the state model for 6

$$\frac{Y(S)}{U(S)} = \frac{S+3}{S^2+3S+2}$$

18 a) A linear time-invariant system is characterized by state equation 6

$$\begin{bmatrix}\dot{X}1\\ \dot{X}2\end{bmatrix} = \begin{bmatrix}1 & 0\\ 1 & 1\end{bmatrix}\begin{bmatrix}X_1\\ X_2\end{bmatrix}$$

Compute the solution of the state equation, assuming the initial vector

$$X_0 = \begin{bmatrix}1\\ 0\end{bmatrix}$$

b) Consider the state model below, check whether the system is controllable and observable using Kalman's test. 8

$$\begin{bmatrix}\dot{X}1\\ \dot{X}2\end{bmatrix} = \begin{bmatrix}1 & 1\\ -2 & -1\end{bmatrix}\begin{bmatrix}X_1\\ X_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix} \mathrm{U}$$

$$\mathrm{Y} = [\,1\ 0\,]\begin{bmatrix}X_1\\ X_2\end{bmatrix}$$

Module -5

19 Describe the Lyapunov stability theorems. 14

20 Derive the describing function of dead zone non-linearity. 14

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