APJ ABDULKALAM TECHNOLOGICAL UNIVERSITY
08 PALAKKAD CLUSTER

6221-17Dec-2 **(Pages:3)** **Name :** .....

Reg. No: .....

FIRST SEMESTER M.TECH. DEGREE EXAMINATION DECEMBER 2017

Branch: Electrical Engineering **Specialization: Power Electronics**

08EE6221 System Dynamics

Time:3 hours **Max. marks: 60**

Answer all six questions.

Modules 1 to 6: Part 'a' of each question is compulsory and answer either part 'b' or part 'c' of each question.

Q.no.	Module 1	Marks
1.a	What are the important features of the system state matrix, A in phase variable form. Explain with a suitable example.	3
	Answer b or c	
b	A system described by the equation $\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -8 & -6 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$ The system is initially at $x(0) = [1\ 0]^T$. Find the states for any time, t with (a) no input and with (b) with unit step input	6
c	Obtain the state model of the system with following transfer function by direct decomposition method $G(s) = \frac{5s^2+6s+8}{s^3+3s^2+7s+9}$	6

Q.no.	Module 2	Marks
2.a	List out the necessity and advantages of Discrete time control systems?	3
	Answer b or c	
b	Solve the following difference equation by using z-transform. Also draw the state diagram for the system $x(k+2) + 3.x(k+1) + 2.x(k) = u(k) + 2u(k+1)$	6

c Obtain the state and output equations in discrete time domain for the system represented by the following transfer function with the help of state transition matrix 6

$$G(s) = \frac{1}{(s+1)(s+2)}$$

Q.no.	Module 3	Marks
3.a	Differentiate stable and asymptotically stable systems with the help of Lyapunov theory	3

Answer b or c

b Check the sign definiteness of the following equation 6

$$V(x) = 8x_1^2 + x_2^2 + 4x_3^2 + 2x_1x_2 - 4x_1x_3 - 2x_2x_3$$

Figure 1

c Use Variable gradient method for constructing the Lyapunov function for the nonlinear system described by the following equations 6

$$\dot{x}_1 = x_2$$
$$\dot{x}_2 = -x_1^3 - x_2$$

Q.no.	Module 4	Marks
4.a	Determine the input matrix B such that the system given below is controllable	3

$$\dot{\mathbf{x}} = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix} \mathbf{x} + \mathbf{B}u$$

Answer b or c

b Test the controllability and observabilty of a DC motor having transfer function $\frac{10}{s^2(s+1)(s^2+2s+2)}$ 6

c Consider the system with state equation 6

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(t)$$

Check the controllability using (a) Gilbert's Test and (b) Kalman's Test

Q.no.	Module 5	Marks
5.a	Discuss the effect of state feedback on controllability	4
	Answer b or c	
b	For the system given below design a state feedback controller such that the maximum percentage overshoot is 25% and settling time (2%) is 3 seconds $$G(s)=\frac{(S+1)}{(S+4)(S+3)(S+2)}$$	8
c	Consider a system described by the transfer function $$G(s)=\frac{1}{(S+4)(S+3)(S+2)}$$ Design a. A full order observer for the system with poles s = -10,-10,-10 b. A reduced order observer with poles -10 and -10	8

Q.no.	Module 6	Marks
6.a	Give the different performance measures commonly used in classical control system design. Mention significance of each in control system design along with their expression in continuous domain.	4
	Answer b or c	
b	A continuous system is described by $\dot{\mathbf{x}}(t)=\begin{bmatrix}0 & 1\\ -8 & -6\end{bmatrix}\mathbf{x}(t)+\begin{bmatrix}0\\ 1\end{bmatrix}u(t)$ and $\mathbf{y}(t)=c\mathbf{x}(t)$. Solve matrix Riccatti equation that results in the control signal that minimises the performance index, $J=\int_0^5[\mathbf{y}^T(t)\mathbf{y}(t)+\mathbf{u}^T(t)\mathbf{u}(t)]dt$. Solve this for c=[0 1] and [1 0]	8
c	Explain typical performance measures used in optimal control system design. Also, propose a performance measure for controlling the system with an objective of minimizing time and fuel consumption.	8