APJ ABDULKALAM TECHNOLOGICAL UNIVERSITY

08 PALAKKAD CLUSTER

Name: ....

Q. P. Code : PE0820121-I (Pages: 3)

Reg. No: ....

FIRST SEMESTER M.TECH. DEGREE EXAMINATION MARCH 2021

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

08EE6221 System Dynamics

(Common to PE)

Time: 2 hour 15 minutes **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.

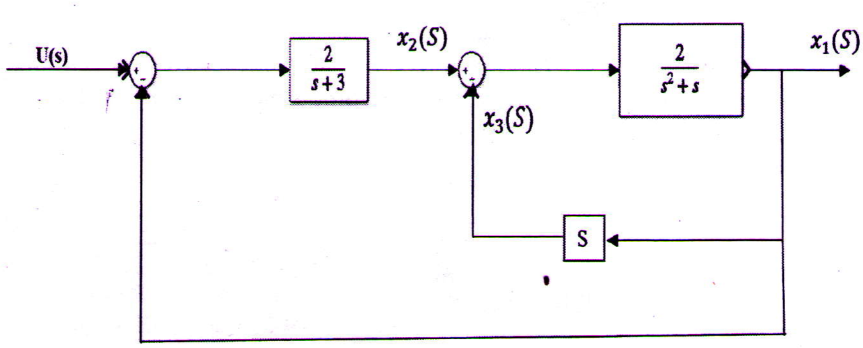
Q. No.	Module 1	Marks
1. a	Obtain the expression for the sensitivity of eigen values with respect to parameter of the system matrix.	3
	Answer b or c	
b	For a system represented by state equation $\dot{x} = Ax(t)$. The response is, $x(t) = \begin{bmatrix} e^{-2t} \\ -2e^{-2t} \end{bmatrix}$, when $x(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$ and $x(t) = \begin{bmatrix} e^{-t} \\ -e^{-t} \end{bmatrix}$ when $x(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$. Determine state transition matrix and system matrix A.	6
c	Consider the system defined by $\dot{x} = \begin{bmatrix} a & b \\ 0 & d \end{bmatrix} x$. Obtain state model in the decoupled form. Find the participation of modes in states and states in modes	6

Q. No.	Module 2	Marks
2. a	Obtain the solution of linear time varying discrete time state equation and list any two properties of State Transition Matrix	3
	Answer b or c	
b	A Discrete time system has the transfer function $\frac{Y(Z)}{U(Z)} = \frac{4Z^3-12Z^2+13Z-7}{(Z-1)^2(Z-2)}$. Determine the state model of the system in Phase variable form and Jordan canonical form	6

c	A Discrete time system is described by differential equation, $$y(k+2) + 5y(k+1) + 6y(k) = u(k)$$ Determine the state model in canonical form hence find the output y(k) when input is u(k) = 1. Assume x(0) = 0		6

Q. No.	Module 3	Marks
3. a	Explain Lyapunov's general stability definitions as applied to a system.	3
	Answer b or c	
b	A linear system is described by $\dot{x} = Ax$, where $A = \begin{bmatrix} -2 & 1 \\ -5 & 0 \end{bmatrix}$. Check stability by Lyapunov method.	6
c	Construct Lyapunov function using variable gradient method for the following system. $$\dot{x}_1 = x_2$$ $$\dot{x}_2 = -x_1{}^3 - x_2$$	6

Q. No.	Module 4	Marks
4. a	Write the state space representation of a linear continuous time system. Discuss the state controllability of the system. Applying duality principle.	3
	Answer b or c	
b	Form the state model for the given system in which $x_1(s)$, $x_2(s)$, $x_3(s)$ represents the state vector. Determine the controllability and observability of the given system.	6



c Check the controllability of the given system. **6**

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \\ x_3(k+1) \end{bmatrix} = \begin{bmatrix} \lambda_1 & 0 & 0 \\ 0 & \lambda_1 & 1 \\ 0 & 0 & \lambda_1 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \\ x_3(k) \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} u(k)$$

And also mention the conditions for which discrete system completely state controllable.

Q. No.	Module 5	Marks
5. a	With the help of a block diagram, explain the effect of state feedback control system.	**4**

Answer b or c

b Consider a linear system described by the transfer function, **8**

$$\frac{Y(S)}{U(S)} = \frac{10}{S(S+2)(S+1)}$$

Design a feedback controller with a state feedback so that the closed loop poles are placed at -2, -1 ± j

c Design a minimum order observer for the system: **8**

$$A = \begin{bmatrix} 0 & 20.6 \\ 1 & 0 \end{bmatrix};B = \begin{bmatrix} 0 \\ 1 \end{bmatrix};C = \begin{bmatrix} 0 & 1 \end{bmatrix}$$

Assume the desired eigen values of the observer,

$$\mu_1 = -1.8 + 2.4j\,, \mu_2 = -1.8 - 2.4j$$

Q. No.	Module 6	Marks
6. a	Explain optimal control of (i) state regulator problem (ii) minimum fuel problem	**4**

Answer b or c

b Determine the optimal control signal for the system described by $\dot{x} = Ax + Bu$. **8**

Where $X = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}, A = \begin{bmatrix} 0 & 1 \\ 0 & -1 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$. So that the performance index,

$J = \int_0^\infty (x^T x + u^t u)dt$ is minimised.

c A continuous system is described by $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}\begin{bmatrix} x_1 \\ x_1 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix}u$. Assume the linear control law u = -Kx. Determine K so that the following performance index $J = \int_0^\infty x^T x\, dt$ is minimised. Assume $x(0) = \begin{bmatrix} C \\ 0 \end{bmatrix}$. Choose undamped natural frequency $w_m = 2$ rad/sec. **8**