M-Tech S1

APJ ABDULKALAM TECHNOLOGICAL UNIVERSITY
08 PALAKKAD CLUSTER

08PE22118 **(Pages: 3)** Name: .... Reg. No: ....

FIRST SEMESTER M.TECH. DEGREE EXAMINATION DECEMBER 2018

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

08EE 6221 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	Derive an expression for the sensitivity of eigen values with respect to parameters of the system matrix.	3
	Answer b or c	
b	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 sates in modes.	6
c	Obtain the solution of the state equation, $\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x$, to the initial condition x(0) = [2 3]^T	6

Q.no.	Module 2	Marks
2.a	Explain a procedure to obtain a discrete time state equation of a continuous system at sampling instants.	3
	Answer b or c	
b	Consider the system defined as $\frac{Y(z)}{U(z)} = \frac{z+1}{z^2+1.3z+0.4}$. Obtain state space representations in (i) controllable and (ii) observable canonical forms.	6

c Obtain the state transition matrix x[k], and y[k] of the discrete system with $x[k+1] = G\,x[k] + H\,u[k]$; $y[k] = C\,x[k]$ where $G = \begin{bmatrix} 0 & 1 \\ -.16 & -1 \end{bmatrix}$, $H=\begin{bmatrix} 1 \\ 1 \end{bmatrix}$, $C = [1 \quad 0]$. u[k] is the unit step input and $x[0] = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$. 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	Discuss the stability of the system, $x[k+1] = \begin{bmatrix} 0 & 1 \\ -0.5 & -1 \end{bmatrix} x[k]$. Use Liapunov's method.	6
c	Explain the application of Krasovski's theorem for stability analysis. Analyse the stability of the system using the same. $\dot{x}_1 = -x_1$, $\dot{x}_2 = x_1 - x_2 - x_2^3$	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. Then obtain an observable state model, applying duality principle.	3
	Answer b or c	
b	Discuss the state controllability of the following system $\dot{x} = \begin{bmatrix} -3 & 1 \\ -2 & 1.5 \end{bmatrix} x + \begin{bmatrix} 1 \\ 4 \end{bmatrix} u$. Justify your result.	6
c	Explain an observable state model. State and prove the condition for observability of a continuous time linear time invariant system.	6

Q.no.	Module 5	Marks
5.a	Discuss the effect of state feedback on controllability.	4

Answer b or c

b	Explain the process of observer design. Consider the system defined by $\ddot{y} = u$. Design a state observer such that the eigen values of observer gain matrix are at -2 $\pm$ j2$\sqrt{3}$.	8
c	Consider a system defined by x[k+1] = $\begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix}$x[k] + $\begin{bmatrix} 0 \\ 1 \end{bmatrix}$u(k). Determine a suitable state feedback gain matrix K such that the system will have the closed loop poles at 0.5 $\pm$ j0.5. Verify by Ackerman's method also.	8

Q.no.	Module 6	Marks
6.a	Explain optimal control of (i) state regulator problem and (ii) tracking problem.	4
	Answer b or c	
b	A continuous system is described by $\dot{x} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}$x + $\begin{bmatrix} 0 \\ 1 \end{bmatrix}$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.	8
c	(i)Explain the use of Liapunov's second method for the solution of parameter optimization problem. (ii) Consider the system $\dot{x} = \begin{bmatrix} 0 & 1 \\ -1 & -2\xi \end{bmatrix}$x, x[0] = $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$. Determine the value of $\xi > 0$, so that when the system is subjected to a unit step input r(t), the following performance index is minimised J = $\int_0^\infty x^T Q \, x dt$, Q = $\begin{bmatrix} 1 & 0 \\ 0 & \mu \end{bmatrix}$, $\mu > 0$.	8