Name: **C**

Reg No:

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

07 THRISSUR CLUSTER

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2017

Chemical Engineering

(Process Control)

07CH6105 Modern Control Theory

Time: 3 hours Max. Marks: 60

Answer all six questions. Part 'a' of each question is compulsory.

Answer either part 'b' or part 'c' of each question

Q.no.	**Module** 1	**Marks**
1a	Obtain the state model of the system whose transfer function is given as $\frac{Y(s)}{U(s)} = \frac{10}{s^3 + 4s^2 + 2s + 1}$	**4**
	Answer b or c	
b	Explain the basic elements of a state diagram? Draw the block diagram of the system described by state model, $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} a_1 & a_2 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} u; y = x_3$	**5**
c	Explain state vector, input vector, output vector. Write the state model of a system containing m input variables and p output variables.	**5**

Q.no.	**Module 2**	**Marks**
2a	State and prove Cayley Hamilton theorem.	**4**
	Answer b or c	
b	Explain Quadratic forms and sign definiteness of Quadratic forms.	**5**

c Find the state transition matrix of A, $A=\begin{bmatrix}4 & 1 & -2\\ 1 & 0 & 2\\ 1 & -1 & 3\end{bmatrix}$ **5**

Q.no.	Module 3	Marks
3a	Given A=$\begin{bmatrix}2 & -2 & 3\\ 1 & 1 & 1\\ 1 & 3 & -1\end{bmatrix}$. Find the state transition matrix.	**4**

Answer b or c

b Derive any one method of solution of non homogeneous state equations? **5**

c Obtain the time response of the following system **5**

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}2\\ 0\end{bmatrix}u$$

$$\begin{bmatrix}x_{1(0)}\\ x_{2(0)}\end{bmatrix}=\begin{bmatrix}0\\ 1\end{bmatrix}$$

$$u(t)=e^{-t}, t\geq 0$$

Q.no.	Module 4	Marks
4a	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 Jordan Canonical form.	**4**

Answer b or c

b Explain stability, asymptotic stability and instability using suitable physical models. **5**

c State and explain the Lyapunov stability theorems **5**

Q.no.	Module 5	Marks
5a	Choose a quadratic scalar form and determine the stability of the system described by $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$	**5**
	Answer b or c	
b	Given a linear time independent system $\dot{x} = Ax$, where $A = \begin{bmatrix} 0 & 4 \\ -8 & -12 \end{bmatrix}$. Determine its stability by the Lyapunov direct method.	**7**
c	Test the stability of the system described by $\dot{x}_1 = -x_1 + 2x_1^{\,2}x_2$, $\dot{x}_2 = -x_2$ by use of the variable gradient method	**7**

Q.no.	Module 6	Marks
6a	Test the observability of the following system $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ -2 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$	**5**
	Answer b or c	
b	Test the observability and controllability of the following system $\dot{X} = AX + BU$, $Y = CX$ $X = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$, $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$, $C = \begin{bmatrix} 4 & 5 & 1 \end{bmatrix}$	**7**
c	Describe the features of an optimal control problem.	**7**