Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

FIFTH SEMESTER B.TECH. (INSTRUMENTATION AND CONTROL ENGG.)

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: MODERN CONTROL THEORY [ICE 3101]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. Derive transfer function from continuous time state models **2**

1B. Diagonalize **3**

$$A=\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}$$

1C. Obtain the state transition matrix of the system shown below and also find its zero input response $\dot{x}=\begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix}x+\begin{bmatrix} 0 \\ 1 \end{bmatrix}u\ ;\ y=\begin{bmatrix} 1 & 0 \end{bmatrix}x;\ x(0)=\begin{bmatrix} 1 & 0 \end{bmatrix}^T$ **5**

2A. Explain the concept of controllability **2**

2B. List and prove any three properties of state transition matrix **3**

2C. A system is described by **5**

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

Design a full order observer that has a undamped natural frequency of 10 rad/s and damping ratio of 0.5, using Ackerman's formula.

3A. Find the Z transform of the function **2**

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

3B. A system is described by the difference equation y(k+2)+3y(k+1)+2y(k) = u(k) Obtain the step response of the system. Assume zero initial condition. **3**

3C. A system is described by **5**

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

Design a state feedback controller that places the poles at -1, -2.

4A. Find the z inverse of the function **2**

F(z) = $\dfrac{z^2+z+1}{(z+2)^2(z+1)}$

4B. Derive an expression for discretization of continuous time systems **3**

4C. Pulse transfer function of the discrete time system is given by **5**

$G(z)=\dfrac{z+2}{z(z+1)^2}$. Obtain the state models (i) Cascade form (ii) Jordan form

5A. Check the sign definiteness of the following Quadratic form **2**

(i) $V(x)=6x_1^2+4x_2^2+x_3^2+2x_1x_2-2x_2x_3-4x_1x_3$

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

5B. Define Stability, Asymptotic stability and Instability in the sense of Lyapunov **3**

5C. Determine the stability of the system by Lyapunov method $x(k+1)=Fx(k)$, where **5**

$F=\begin{bmatrix}-1 & -2\\ 1 & -4\end{bmatrix}$.

********** END **********