Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
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A Constituent Institution of Manipal University

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

END SEMESTER EXAMINATIONS, NOV - 2017

SUBJECT: MODERN CONTROL THEORY [ICE 3101]

Duration: 3 Hour Max. Marks:50

Instructions to Candidates:
- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A State any two properties of state transition matrix. **2**

1B For the electrical system shown in Fig (Q1B) select minimal state variables and find the state model in physical variable form. Take $V_O(t)$ as the output. **3**

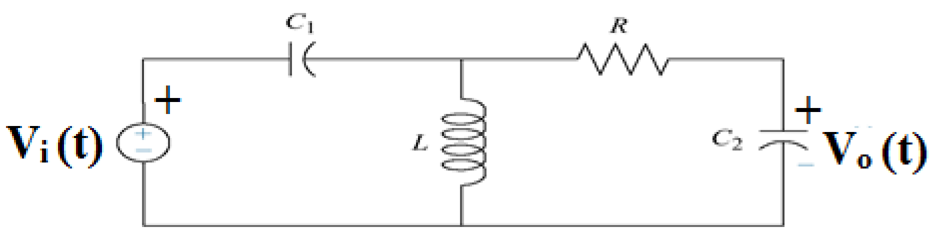

Fig (Q1B)

1C Diagonalize the system matrix A given by, **5**

$$A = \begin{bmatrix} 2 & 0 & 2 \\ 1 & 3 & 1 \\ 1 & 0 & 2 \end{bmatrix}$$

2A Derive an expression for transfer function from state models **2**

2B Derive the state models for the differential equation $\dddot{y} + 6\ddot{y} + 3\dot{y} + 5y = \ddot{u} + 2\dot{u} + 7u$ in observable canonical form. **3**

2C Without interchanging the blocks, using cascade realization, obtain the state models from the block diagram shown in Figure (Q2C). **5**

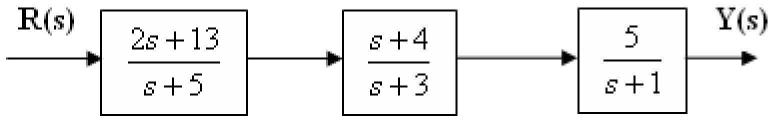

Fig (Q2C)

3A Find the Z transform of sin ωt **2**

3B Find the inverse Z transform of G(s) = $\dfrac{s}{(s+1)^2(s+2)}$ **3**

3C Solve the state equation **5**

$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}u;\quad y=x_1$ Also obtain the step response of the system.

4A Check the sign definiteness of the following scalar functions **2**

i) $V(x) = 2x_1^2+2x_2^2+2x_3^2+6x_1x_2+4x_2x_3-2x_3x_1$ ii) $V(x) = x_1^2+2x_2^2+2x_3^2+4x_2-2x_2x_3+4x_3x_1$

4B Consider the discrete time state equation described as **3**

$x(k+1)=\begin{bmatrix}0 & 1\\ -1 & -2\end{bmatrix}x(k)+\begin{bmatrix}0\\ 1\end{bmatrix}(-1)^k,\ y(k)=\begin{bmatrix}-1 & 1\end{bmatrix}x(k)$ where $x(0)=\begin{bmatrix}1\\ 1\end{bmatrix}$. Find the closed form of solution for y(k) where $k \geq 1$.

4C Discretize the continuous time system **5**

$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}u;$ Take sampling time, T= 1sec.

5A State stability and instability in the sense of Lyapunov. **2**

5B A linear autonomous system is described by the discrete state model **3**
$x(k+1)=\begin{bmatrix}0.5 & 1\\ -1 & -1\end{bmatrix}x(k)$ Using Lyapunov direct method, determine the stability of the equilibrium state.

5C A discrete regulator system has the plant **5**
$x(k+1)=\begin{bmatrix}1 & 0.1\\ 0 & 1\end{bmatrix}x(k)+\begin{bmatrix}0.005\\ 0.1\end{bmatrix}u(k),\ y(k)=\begin{bmatrix}1 & 0\end{bmatrix}x(k)$ Design a state feedback control law such that the response of the closed loop system has the damping ratio= 0.6 and undamped natural frequency, ω_n = 8 rad/sec. Take T = 1sec.