Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

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

END SEMESTER EXAMINATIONS, DEC 2016/JAN 2017

SUBJECT: MODERNN CONTROL THEORY [ICE 301]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** the questions.
- Missing data may be suitably assumed.

1A. Derive an expression for transfer function from state models. **02**

1B. Obtain the any one state model for the system with transfer function $G(s) = \dfrac{s+3}{s(s+1)(s+2)}$. **03**

1C. Diagonalize the system matrix **05**

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -8 & -14 & -7 \end{bmatrix}$$

2A. Write down any two formula's for finding state transition matrix **02**

2B. Obtain the step response of the system **03**

$\dot{x} = \begin{bmatrix} -1 & 1 \\ -1 & -1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \ ; x(0) = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$, and output $y = [1 \quad 0]x$

2C. A Continuous time system is described by the state model **05**

$\dot{x} = \begin{bmatrix} 0 & 1 & 1 \\ 0 & 0 & 1 \\ -4 & -2 & -1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u \ ; \ y = [1 \quad 0 \quad 0]x;$ Is the system is controllable?

Also design a state feedback controller which will place the closed loop controller poles at s= -1, s= -3 and s=-2 verify the result by applying Ackermann's formula.

3A. Explain the characteristics of nonlinear systems **02**

3B. Derive describing function of dead zone nonlinearity **03**

3C. In the forward path of a unity feedback system, a saturating amplifier shown in figure Q3C is cascaded with a linear plant having $G(s) = \dfrac{8}{s(s+2)^2}$. Determine the largest value of K for the system to remain stable.

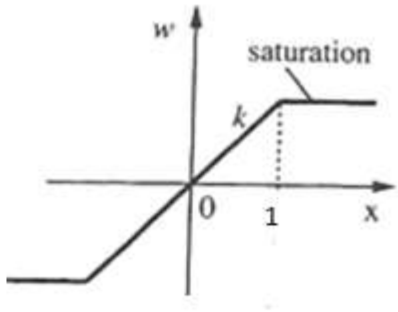

Fig. Q3C

4A. Define (i) Instability (ii) Stability in the sense of Lyapunov. **02**

4B. Determine the stability of the origin of the following system. **03**

$\dot{x}_1 = x_2 - x_1(x_1^2 + x_2^2)$

$\dot{x}_2 = -x_1 - x_2(x_1^2 + x_2^2)$

4C. Check the sign definiteness of the following quadratic functions **05**

i) $F(x) = 2x_1^2 + 4x_2^2 + 2x_3^2 + 6x_1x_2 + 8x_1x_3 - 8x_2x_3$

ii) $F(x) = 4x_2^2 + 2x_3^2 + 4x_1x_2 - 8x_2x_3 - 2x_1x_3$

iii) $F(x) = 2x_1^2 - x_2^2 + 2x_3^2 + 6x_1x_2 + 8x_1x_3 - 8x_2x_3$

iv) $F(x) = 2x_1^2 + 4x_2^2 + x_3^2 - 2x_1x_2 + 8x_1x_3 - 8x_2x_3$

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

5A. Define (i) Phase plane (ii) Describing function **02**

5B. Explain Pells method for drawing phase trajectories **03**

5C. Draw the various singular points of a second order system in phase plane or $(x, \dot{x})$ *plane* **05**

6A. List the properties of Lyapunov function **02**

6B. Generate a Lyapunov function and determine the stability of the following system **03**

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix} x$$

6C. Consider a nonlinear system described by the equation $\ddot{x} + \dot{x}(x^2 + \dot{x}^2) + x = 0$. Investigate the stability of the system. **05**