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: MODERNN CONTROL THEORY [ICE 301]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. What are the advantages of state space analysis **2**

1B. Consider the system with transfer function **3**

$G(s) = \dfrac{s+2}{s(s+4)(s+5)}$. Obtain the state model in cascade form.

1C. A state model is given below. Using linear transformation obtain another state model **5**

$$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -30 & -31 & -10 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u \;;\; y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} x$$

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

2B. The state space representation of a system is given by **3**

$\dot{x} = \begin{bmatrix} -1 & 1 \\ -1 & -1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u,\; y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$ Obtain the transfer function.

2C. A Continuous time system is described by the state model **5**

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

Also design a state feedback observer which will place the closed loop observer poles at s = - 0.5, s = 0 and s = 1 verify the result by applying Ackermann's formula.

3A. Explain Jump phenomena in nonlinear systems **2**

3B. Derive describing function of Saturation nonlinearity **3**

3C. In the forward path of a unity feedback system, a saturating amplifier shown in figure Q3C is cascaded with a linear plant having $G(s) = \dfrac{1}{s(s+2)(s+4)}$. Determine the largest value of K for the system to remain stable.

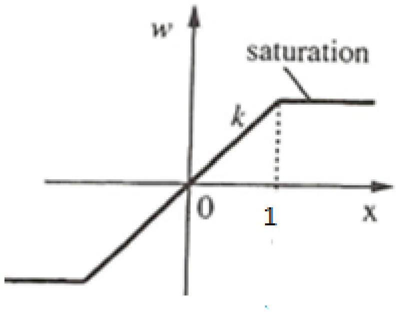

Fig. Q3C

4A. Define (i) Sylvesters criteria (ii) Stability in the sense of Lyapunov. **2**

4B. Determine the stability of the origin of the following system. **3**

$\dot{x}_1 = -x_2 - x_1^3$

$\dot{x}_2 = x_1 - x_2$

4C. Check the sign definiteness of the following quadratic functions **5**

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

ii) $F(x) = 4x_2^2 + 2x_3^2 + 3x_1x_2 - 8x_2x_3 - 2x_1x_3$

iii) $F(x) = 2x_1^2 - x_2^2 + 2x_3^2 + 3x_1x_2 + 8x_1x_3 - 8x_2x_3$

iv) $F(x) = 2x_1^2 + 4x_2^2 + 5x_3^2 - 2x_1x_2 + 8x_1x_3 - 8x_2x_3$

v) $F(x) = x_1^2 + x_2^2 + 5x_3^2 + 2x_1x_2 + 2x_1x_3 - 6x_2x_3$

5A. Define (i) Phase plane (ii) Describing function **2**

5B. Explain Isicline method for drawing phase trajectories **3**

5C. Find the equilibrium points for the system described by $\ddot{y} + (1-y)\,\dot{y} + 3y + 0.5y^3 = 0$ **5**

6A. State Lyapunov (i) Stability theorem (ii) Instability theorem **2**

6B. Generate a Lyapunov function and determine the stability of the following system **3**

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

6C. Determine the type of singular point and draw phase plane portrait for the given Vander pol equation $\ddot{x} - (0.2 - \frac{10}{3}x^2)\dot{x} + x + x^2 = 150$. Define all singularities sketch the phase plane trajectories near each singularity. **5**

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