Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

FIFTH SEMESTER B.TECH (INSTRUMENTATION AND CONTROL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

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. Define (i) State vector (ii) State space **02**

1B. Consider the system with transfer function **03**

$G(s)=\dfrac{s+2}{s^2+3s+2}$. Obtain the observable and controllable canonical realization of the system.

1C. Obtain the diagonal canonical realization of the system **05**

$$G(s)=\frac{6}{s^3+6s^2+11s+6}$$

2A. Write down the properties of state transition matrix **02**

2B. The state space representation of a separately excited DC servomotor with dynamics is given **03**

$\begin{bmatrix}\dot{\omega}\\ \dot{i}_a\end{bmatrix}=\begin{bmatrix}-1 & 1\\ -1 & -10\end{bmatrix}\begin{bmatrix}\omega\\ i_a\end{bmatrix}+\begin{bmatrix}0\\ 10\end{bmatrix}u$, where ω is the angular displacement and i_a is the armature current and u is the armature voltage. What is the transfer function $\dfrac{\omega(s)}{u(s)}$ of the motor. Take angular displacement of the motor as output.

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

$\dot{x}(t)=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}x(t)+\begin{bmatrix}0\\ 2\end{bmatrix}u(t)$; $y(t)=[1 \quad 0]\,\underline{x}(t)$ Is the system controllable, observable? Also design a state feedback controller which will place the closed loop poles at s = 0.3 and s= 0 .5 .Verify the result by applying Ackermann's formula.

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

3B. Derive the describing function of viscous and coulomb friction **03**

3C. An autonomous system is described by $\dot{x}=Ax$. The response of the system to two sets **05**

of initial conditions are $x = \begin{bmatrix} 2e^{-4t} \\ e^{-4t} \end{bmatrix}$ for $x(0) = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$; and $x = \begin{bmatrix} 4e^{-2t} \\ e^{-2t} \end{bmatrix}$ for $x(0) = \begin{bmatrix} 4 \\ 1 \end{bmatrix}$. Find the state transition matrix.

4A. Define (i) Singular point (ii) boundedness **02**

4B. Check the sign definiteness of the following quadratic functions **02**

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

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

4C. Consider a third order linear system with dead zone nonlinearity given by **06**

$G(s) = \dfrac{1}{s(s+3)(s+5)}$. Check whether the limit cycle exits or not. If exists determine the amplitude and frequency of oscillation. Also comment on the limit cycle. Let slope K=3. Total length of the dead zone is 4.

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

5B. Explain the procedure of Isocline method for drawing phase trajectories **03**

5C. Find the equilibrium points for the system described by $\ddot{y} + (1 - y)\dot{y} + 3\mathrm{y} + 0.5\mathrm{y}^3$ **05**

6A. State Lyapunov (i) Stability theorem (ii) Instability theorem **02**

6B. Generate a Lyapunov function and describe the stability of the following system $A = \begin{bmatrix} -1 & -2 \\ 1 & -4 \end{bmatrix}$ **03**

6C. Use direct method of Lyapunov to show that the following linear autonomous system is stable for K > 0, also find the range for K. **05**

$$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & -1 & 1 \\ -2K & -1+K & -K \end{bmatrix} x$$

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