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: MODERN 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 ii) state variable iii) state trajectory iv) state space. **02**

1B. List the advantage of State space analysis and limitations of transfer function model. **03**

1C. Write the following equation in state variable form $(5s^4+4s^3+3s^2+6s+8)x(s)=u(s)$ **05**

2A. Obtain the expression for transfer function derived from state model. **02**

2B. Develop the following system in controllable canonical form **03**

$$G(s)=\frac{s+1}{s^2+3s+8}$$

2C. A system is described by the following transfer function **05**

$G(s)=\dfrac{s^2+4s+4}{s^3+5s^2+4s}$. Develop a state model in (a) Phase variable form (b) Diagonal form.

3A. Find the rank and Eigen values of the following matrices **02**

$$A=\begin{bmatrix}1 & 2 & 3\\ 1 & 4 & 2\\ 2 & 6 & 5\end{bmatrix}$$

3B. A linear time-invariant system is described by **05**

$\dot{x}(t)=\begin{bmatrix}0 & 1\\ -8 & -6\end{bmatrix}x(t)+\begin{bmatrix}0\\ 1\end{bmatrix}u(t)$. The system is initially at x(0)=[1 0]^t. Determine x(t) with unit step input, using Laplace transform method.

3C. Determine whether the following system is completely controllable and completely observable or not. **03**

$$\dot{x}=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 0 & -2 & -3\end{bmatrix}x+\begin{bmatrix}0\\0\\1\end{bmatrix}u.$$ y=[3 4 1]x

4A. Define singular points. How are they classified ? **02**

4B. Brief the concept of state observer with a sketch. **03**

4C. A system is described by $\dot{x}=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -1 & -5 & -6\end{bmatrix}x+\begin{bmatrix}0\\0\\1\end{bmatrix}u.$ Design a state feedback controller such that the poles are placed at -10, (-2 $\pm$ j). **05**

5A. Define Jump phenomena with a sketch. **02**

5B. Explain isocline method of drawing phase-plane trajectory. **03**

5C. Consider the forward path of a negative unity feedback system having **05**

$G(s)=\dfrac{1}{(s+1)(s+5)(s+2)}$ with saturation nonlinearity.

Check whether the limit cycle exists or not. If exists determine the amplitude and frequency of oscillation.

6A. Find the sign definiteness of the following scalar functions **02**

$$(i)\, f(x)=x_1^2+3x_2^2+5x_3^2+2x_1x_2+8x_2x_3+4x_3x_1$$

$$(ii)\, f(x)=2x_1^2+6x_2^2+8x_3^2+4x_1x_2+x_2x_3+2x_3x_1$$

6B. Determine the stability of the non-linear system governed by the equations **03**

$\dot{x}_1=-x_1+2x_1^2x_2;\ \dot{x}_2=-x_2$.

6C. A system is described by the following equation $\dot{x}=Ax.$ Where $A=\begin{bmatrix}-1 & -2\\ 1 & -4\end{bmatrix}.$ **05**

Assuming Q to be identity matrix, solve for matrix P and comment on the stability of the system.

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