Subject Code: G5614/R13

M. Tech – I Semester Regular/Supplementary Examinations, April, 2015

MODERN CONTROL THEORY

(Common to PS, PSC&A, EPE, PSE, PS&C, APS, PE&ES,EPS, PE, P&ID, PE&ED, PE&D, EM&D,PE&PS and APS)

Time: 3 Hours **Max Marks: 60**

Answer any FIVE questions

All questions carry EQUAL marks

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1. a) Differentiate between eigen values and eigen vectors?
   b) Write a canonical form representation of linear operator?
   c) Define the concept of state? Write the state equations for dynamic systems?

2. a) What is the significance of the state transition matrix? State and prove the state transition matrix properties?
   b) Obtain the state transition matrix for the state model whose A matrix is given by

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

3. a) Explain the concept of controllability and observability?
   b) Consider the system described by

$$\begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \end{pmatrix} = \begin{pmatrix} 1 & 1 \\ -2 & -1 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + \begin{pmatrix} 0 \\ 1 \end{pmatrix} u$$

$$Y = (1 \quad 0) \begin{pmatrix} x_1 \\ x_2 \end{pmatrix}$$

Is this system is controllable and observable?

4. a) Explain the popular intentional nonlinear elements and their functionalities.
   b) Derive the describe function of saturation nonlinearity?

5. a) Explain the graphical method for constructing trajectories by using Isocline method?
   b) Obtain a phase plane portrait of the system given by

$$\ddot{x} + \dot{x} + |x| = 0$$

6. a) Define Lyapunovs stability and Instability Theorem.
   b) Illustrate the generation of Lyapunov function by variable gradient method?

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7. a) Define the state observer? Deduce the expression for full order observer?

   b) Consider the system defined by:

$$\dot{X} = \begin{pmatrix} -1 & 1 \\ 0 & 2 \end{pmatrix} X + \begin{pmatrix} 1 \\ 0 \end{pmatrix} u$$

   Show that this system cannot be stabilized by the state feedback control $\mu = -kx$ whatever matrix k is chosen.

8. Write a short note on the following

   a) Formulation using Hamiltonian method

   b) Linear quadratic regulator

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