Code No: G5614/R13

M. Tech. I Semester Supplementary Examinations, January-2017

MODERN CONTROL THEORY

(Common to PSC&A, EPE, 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

1. a Explain the concept of state? [2]
   b A system is described by the state equation [10]
   $\dot{x}(t) = Ax(t) + Bu(t); x(0) = x^0; y(t) = cx(t)$
   where $A = \begin{bmatrix} -5 & -4 & 2 \\ 3 & 3 & -2 \\ 0 & 2 & -2 \end{bmatrix}, B = \begin{bmatrix} -1 & 0 \\ 1 & 1 \\ 0 & 2 \end{bmatrix}, c = [1 \quad 1 \quad 0]$. Draw state diagram?

2. a Explain the physical significance of the concept of controllability and observability? [6]
   b Discuss observability canonical forms of state model? [6]

3. a Describe the controllability tests for continuous time invariant systems. [6]
   b Consider a system satisfying the differential equations [6]
   $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 2 & 0 \\ -1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ -1 \end{bmatrix} u.$
   Is this system controllable?

4. a Explain the popular nonlinearities. [6]
   b List out the properties of nonlinear systems. [6]

5. a Derive the describe function of relay with dead zone. [5]
   b Describe the stability analysis of Non-Linear systems through describing functions. [7]

6. a Explain the concept of singular point. [4]
   b Consider the system described by the following equation: $\ddot{x} + \dot{x} + x^3 = 0$. Given the initial conditions $x(0) = 1, \dot{x}(0) = 0$, construct the trajectory starting at the initial point. [8]

7. a What are the different types of stability? Define and explain each of them with examples. [6]
   b Suppose you are given a linear continuous time autonomous system, how do you decide whether a system is globally asymptotically stable? [6]

8. For the system $\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x$ find a suitable Lyapunov function V(x). Find an upper bound on time that it takes the system to get from the initial condition $x(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ to within the area defined by $x_1^2 + x_2^2 = 0.1$. [12]

*****