Subject Code: G5614/R13

M. Tech –I Semester Regular/ Supply Examinations, February, 2016

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

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1. a) Prove that similar matrices have the same characteristics polynomial and therefore the same eigen values?

   b) Find the eigen values and Jordan form representation for the following matrices?

$$\begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -2 & -4 & -3 \end{pmatrix}$$

2. a) Show that the solution to the homogenous state equation $\dot{X}(t) = AX(t)$ is unique

   b) The following facts are known about the linear system

$$\dot{X}(t) = AX(t)$$

If $x(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$, $then\ x(t) = \begin{bmatrix} e^{-2t} \\ -2e^{-2t} \end{bmatrix}$

f $x(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$, $then\ x(t) = \begin{bmatrix} e^{-t} \\ -e^{-t} \end{bmatrix}$ Find e^{At} and hence A.

3. a) Explain the general concept of observability? Explain the observability tests for continuous time invariant systems?

   b) Consider the system described by

$$\begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \end{pmatrix} = \begin{pmatrix} 0 & 1 \\ -4 & -1 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + \begin{pmatrix} 1 \\ 1 \end{pmatrix} u$$

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

   Is this system is controllable and observable?

4. The block diagram of a system with hysteresis is shown in Figure.1 Using describing function method, determine whether limit cycle exists in the system. If limit cycles exists, determine their amplitude and frequency.

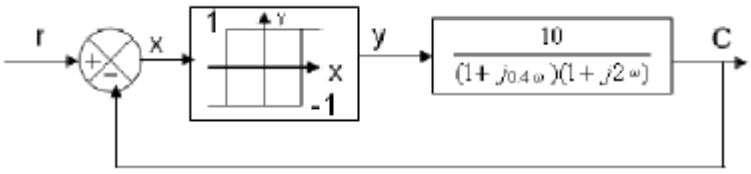

Figure.1

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5. Linear second order servo is described by the equation $\ddot{e} + 2r\omega_n\dot{e} + \omega_n^2 e = 0$ where τ=0.15, ω_n= 1 rad/sec e(0)=1.5 and $\dot{e}(0)$ = 0. Determine the singular point. Construct the phase trajectory, using the method of isoclines.

6. a) Explain the stability analysis of the linear continuous time invariant systems by Lyapunov second method.
   b) Illustrate the generation of Lyapunov function by Krasooviski's method?

7. a) Define the state observer? Deduce the expression for reduced order observer?
   b) Consider the system defined by:

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

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

8. Suppose that the system

$$\dot{x}_1(t) = x_2(t)$$
$$\dot{x}_2(t) = u(t)$$

   is to be controlled to minimize the performance measure

$$J(x,u) = \frac{1}{2}\int_0^2 u^2 dt$$

   Find a set of necessary conditions for solving optimal control using Hamiltonian formula of variational calculus.

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