Roll No .....

MEIC - 205

M.E./M.Tech., II Semester

Examination, December 2015

Advance Controlled Systems

Time : Three Hours

Maximum Marks : 70

Note : i) Attempt any five questions.

ii) All questions carry equal marks.

1. Consider a continuous-time system

$\dot{X} = Bx + By$ and $Y = Cx + Dy$ where

$$A = \begin{bmatrix} -2 & 2 \\ 1 & -3 \end{bmatrix},\ B = \begin{bmatrix} -1 \\ 5 \end{bmatrix},\ C = \begin{bmatrix} 2 & -4 \end{bmatrix} \text{ and } D = [6].$$

Discretizing time axis into intervals of T = 0.2 sec. obtain state transition and output equations that yield discrete-time solutions for x and y.

2. A unity feedback system has $G(s) = \dfrac{K}{s(s+2)(s+5)}$. Sketch the root locus and show on it breakaway point and line and determine the value of K for $\xi = 0.5$.

3. Explain variable structure control and its applications.

4. Consider the non-linear system described by $\dot{x}_1 = x_2 - x_1\left(x_1^2 + x_2^2\right)$ and $\dot{x}_2 = -x_1 - x_2\left(x_1^2 + x_2^2\right)$ clearly, the origin ($x_1 = 0$, $x_2 = 0$) is the only equilibrium state. Determine its stability.

5. Consider a non-linear system described by the equations $\dot{x}_1 = x_2$ and $\dot{x}_2 = -(1 - |x_1|)x_2 - x_1$. Analyse the stability using Lyapunov function $V = x_1^2 + x_2^2$.

6. A function $f(x_1, x_2, x_3) = x_1^2 + x_2^2 + x_3^2$ has to be extremized when it lies on the intersection of the surfaces $x_3 = x_1x_2 + 4$ and $x_1 + x_2 + x_3 = 1$. Formulate a suitable Lagrangian to find optimal value of the states.

7. Find the extremals of the functional

$$V(x) = \int_0^{\pi/2} \left(\dot{x}_1^2 + \dot{x}_2^2 + 2x_1x_2\right) dt$$

Subject to the boundary conditions $x_1(0) = 0$, $x_1(\pi/2) = 1$, $x_2(0) = 0$ and $x_2(\pi/2) = -1$.

8. Write short notes on any two of the following :

a) Basic features of non-linear control system.

b) Pole placement problem.

c) General optimal-control problem.

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