R09

Code No: C0708

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech I Semester Examinations, April 2011

ADVANCED CONTROL SYSTEMS

(ELECTRICAL POWER SYSTEMS)

Time: 3hours **Max. Marks: 60**

Answer any five questions

All questions carry equal marks

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1. An open loop transfer function of unity feed back system is $G(s) = \frac{4K}{s(s+2)}$.

   Design a compensator for the system so that the static velocity error coefficient K_v is 20 sec^{-1}, the phase margin is at least 50^0, and the gain margin is at least 10 db. [12]

2. (a) Explain the procedure to formulate a Liapunov function and to investigate the stability of a linear system.

   (b) Check the stability of the system described by

   $$\dot{x}_1 = x_2$$
   $$\dot{x}_2 = -x_1 - x_1^2 x_2$$ [12]

3. (a) Consider the second-order system

   $$\dot{X} = AX, \text{ where } X = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}, \quad A = \begin{bmatrix} -1 & -2 \\ 1 & -4 \end{bmatrix},$$

   Find the real symmetric matrix P, which satisfies stability condition of Liapunov's method.

   (b) A linear autonomous system is described by the state equation

   $$\dot{X} = AX, \text{ where } X = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}, \quad A = \begin{bmatrix} -4K & 4K \\ 2K & -6K \end{bmatrix},$$

   Find restrictions on the parameter K to guarantee stability of the system. [12]

4. a) Explain the Isocline method for construction of trajectories.
   b) Obtain a phase-plane portrait of the following system [12]

   $$\ddot{x} + 0.5\dot{x} + 2x + x^2 = 0$$

5. (a) Explain how to study the stability of the system through describing function analysis.
   (b) Determine the describing function for the nonlinear element described by, $y=x^3$, where x= input to the nonlinear element and y=output of the nonlinear element.

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6. (a) Derive the necessary conditions for the systems to be controllable.

(b) Determine controllability and observability of the following systems

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

$$y(t) = [1 \quad 0]\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$ [12]

7. (a) Explain the concept of first order eigen vector sensitivities for continuous time systems.

(b) Explain the mode observability structure of multi variable linear system. [12]

8. (a) Explain the concept of second – order eigen value sensitivities for continuous time systems.

(b) Explain the confluent eigen values.

(c) Explain design procedure of PID controller. [12]

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