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Name:..

Reg. No....

SIXTH SEMESTER B.TECH. DEGREE EXAMINATION, MAY 2012

EE.09.603 – Modern Control Theory

Time: Three hours **Maximum : 70 marks**

PART A

Short answer questions (one/two sentences) **(5 x 2 marks = 10 marks)**

1. Write the state equation for the discrete time system and also draw the state model diagram.
2. State the types of non-linearity in practical use.
3. When a system is considered as asymptotically stable in-the-large?
4. What do you understand by performance index in optimal control problem?
5. Define controllability.

PART B

Analytical/Problem solving questions **Answer any four** **(4 x 5 marks = 20 marks)**

The plant model of a system is given below

$$A = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix} \qquad B = \begin{bmatrix} 0 \\ 2 \end{bmatrix} \qquad C = \begin{bmatrix} 1 & 2 \end{bmatrix}$$

Obtain the Transfer function.

6. Derive the describing function of Dead - zone nonlinearity.
7. Discuss the principle of Second method of Lyapunov's stability theorem.
8. Check the observability of given system

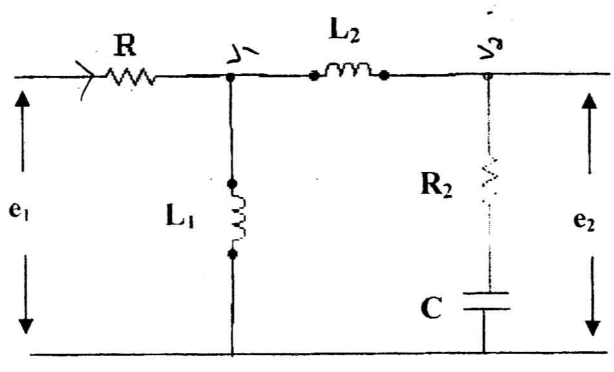
$$\dot{X} = \begin{bmatrix} -2 & 1 \\ 1 & -2 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} U; \qquad y = \begin{bmatrix} 1 & -1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

9. Write a brief note on state regulator problem.

10. Derive the state transition matrix.

PART –C Answer all the questions **4 x 10 = 40**

11. A. (i) Obtain the state model for the network shown in Fig. below.



(ii) Obtain the canonical form of state space representation for the given transfer function,

$$\frac{Y(s)}{U(s)} = \frac{3}{(s+1)(s+3)(s+5)}$$

(OR)

B. i) Obtain the Transformation matrix to convert the given system into canonical form.

$$\overset{*}{X} = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \end{bmatrix} U$$

ii) How will you assess the controllability, when the system is in Jordan canonical form? Explain with an example.

12. A. A linear second order servo is described by the equation, $\ddot{y} + 2\zeta\omega_n\dot{y} + \omega_n^2 y = \omega_n^2$. where $\zeta = 0.15$, $\omega_n = 1$ rad/sec, $y(0) = 1.5$, $\dot{y}(0) = 0$ Determine singular points. Construct phase trajectory using the method of isoclines.

(OR)

B. Obtain the phase plane portrait of the non-linear system given as:

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

13. A. The system is described by the following state equation, check stability at equilibrium point using quadratic function.

$$\dot{X} = \begin{bmatrix} -1 & -2 \\ 1 & -4 \end{bmatrix} X$$

(OR)

B. Investigate the stability of the origin of the following system, using Lyapunov's second method.

$$\dot{x}_1 = x_2$$
$$\dot{x}_2 = -x_1 - x_2$$

14. A. Given $\dot{x}_1 = -x + U$; $x(0) = 0$, $x(3) = 1$, Find U^* that minimizes $J = \int_0^3 (x^2 + U^2)dt$.

(OR)

B. Design a state feedback controller to place the poles at -10 and -10 for the system represented as

$$\dot{X} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \qquad y = \begin{bmatrix} 2 & 0 \end{bmatrix} X.$$