Fifth Semester B.E. Degree Examination, Dec.08/Jan.09
Modern Control Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Compare modern control theory with conventional control theory. **(05 Marks)**

b. Differential equation of dynamic system is $\ddot{c}_1 + \dot{c}_1 + 3c_1 - 5c_2 = r_1$

$\ddot{c}_2 + 2c_1 + \dot{c}_2 = r_2$

Write state equation & output equation. **(07 Marks)**

c. A feed back system is characterized by the closed loop transfer function

$$T(s) = \frac{s^2 - 3s + 3}{s^3 - 2s^2 + 3s + 1}$$

Draw a suitable signal flow graph & obtain the state model. **(08 Marks)**

2 a. Obtain the state model in canonical form for the system described by the differential equation & write the block diagram. $\dddot{y} + 6\ddot{y} + 11\dot{y} + 6y = \dddot{u} + 8\ddot{u} + 17\dot{u} + 8u$ **(08 Marks)**

b. A system is described by the following set of equations. Develop a block diagram for he system showing the transfer functions between different inputs & outputs.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}\begin{bmatrix} u_1 \\ u_2 \end{bmatrix} \text{ and } \begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} 1 & 2 \\ 1 & 0 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$ **(08 Marks)**

c. What is Eigen value? Prove that the eigen values of a 'A' are invariant under a linear transformation. **(04 Marks)**

3 a. Find the transformation matrix 'p' that transforms the matrix 'A' into diagonal or Jordan form where $A = \begin{bmatrix} 4 & 1 & -2 \\ 1 & 0 & 2 \\ 1 & -1 & 3 \end{bmatrix}$ **(10 Marks)**

b. What is a state transition matrix? For $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$ compute the state transform matrix e^{At} using Cayley Hamilton theorem. **(10 Marks)**

4 a. Determine the complete time response of the system given by

$$\dot{X}(t) = \begin{bmatrix} 0 & 1 \\ -2 & 0 \end{bmatrix} X(t) \text{ where } X(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \text{ and } Y(t) = \begin{bmatrix} 1 & -1 \end{bmatrix} X(t)$$ **(10 Marks)**

b. Define controllability & observability and write the state & output equations for the system shown in Fig.4(b). Determine whether the system is completely controllable and observable. **(10 Marks)**

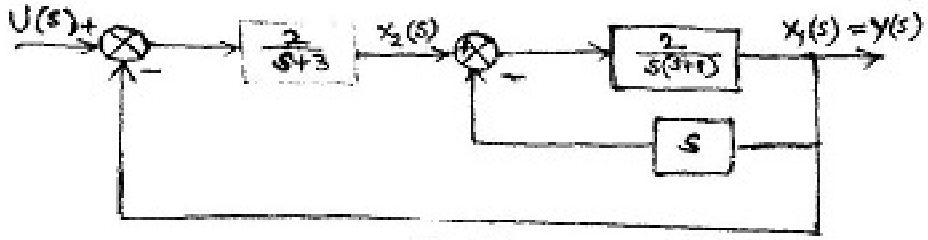

Fig.4(b)

PART – B

5 a. Describe the different methods for evaluation of state feed back gain matrix 'K'. **(10 Marks)**

b. It is desired to place the closed loop poles of the following system at S = – 3 and S = – 4 by a state feedback controller with the control u = – Kx. Determine the state feedback gain matrix K and the control signal. **(10 Marks)**

6 a. Consider the system described by the state model $\dot{x} = Ax$, $y = Cx$ where $A=\begin{bmatrix}-1 & 1\\ 1 & 2\end{bmatrix}$, $C=\begin{bmatrix}1 & 0\end{bmatrix}$. Design a full order state observer. The desired eigen values for the observer matrix are $u_1 = -5$, $u_2 = -5$. **(12 Marks)**

b. Mention the different types of inherent nonlinearities & explain deadzone with suitable example. **(08 Marks)**

7 a. What is a singular point? Explain the different types of singular points in a non-linear control system based on the location of eigen values of the system. **(10 Marks)**

b. What is a phase plane plot? Describe delta method of drawing phase plane trajectories. **(10 Marks)**

8 a. Use Krasovskii's theorem to show that the equilibrium state x=0 of the system described by

$$\dot{x}_1 = -3x_1 + x_2$$

$$\dot{x}_2 = x_1 - x_2 - x_2^3$$

is asymptotically stable in the large. **(10 Marks)**

b. Explain with an example:

(i) Liapunov main stability theorem.

(ii) Liapunov second method.

(iii) Krasovskii's theorem.