NEW SCHEME

EE52

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Fifth Semester B.E. Degree Examination, January/February 2005

Electrical & Electronics Engineering

Modern Control Theory

Time: 3 hrs.] [Max.Marks : 100

Note: ***Answer any FIVE full questions.***

1. (a) Mention the disadvantages of conventional control theory and explain how these are overcome in modern control theory with particular reference to (i) nonlinear systems (ii) time varying system (iii) Analysis (iv) design and (v) computer applications. **(10 Marks)**

(b) Obtain the state space representation in phase variable canonical form for the system represented by

$D^4y+20D^3y+45D^2y+18Dy+100y=10D^2u+5Du+100u$ with y as output and u as input. **(10 Marks)**

2. (a) Determine the transfer matrix for the system **(10 Marks)**

$$\begin{bmatrix} \mathring{x}_1 \\ \mathring{x}_2 \end{bmatrix} = \begin{bmatrix} -3 & 1 \\ -2 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 4 & 6 \\ -5 & 0 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} : \begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} 1 & -1 \\ 8 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

(b) For a system represented by $\mathring{x} = Ax$ the response to one set of initial conditions is $x(t) = \begin{bmatrix} 2e^{-4t} \\ e^{-4t} \end{bmatrix}$ and another set of initial condition is $x(t) = \begin{bmatrix} 4e^{-2t} \\ e^{-2t} \end{bmatrix}$ Determine the matrix A and the state transition matrix $\phi(t)$ **(10 Marks)**

3. (a) Mention the conditions for complete controllability and complete observability of continuous time systems. Using these, explain the principle of duality between controllability and observability. **(10 Marks)**

(b) Use controllability and observability matrices to determine whether the system represented by the flow graph shown in Fig 1. is completely controllable and completely observable **(10 Marks)**

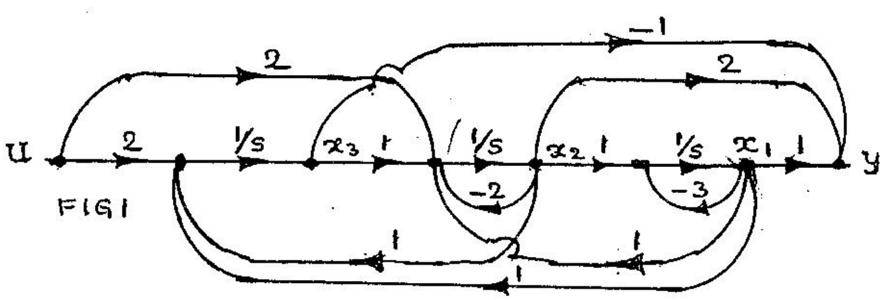

FIG 1

4. (a) Given the time invariant system

$$\begin{bmatrix} \mathring{x}_1 \\ \mathring{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & \alpha \\ 0 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u : y = [1\ 0] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

and that $u(t) = e^{-1}$ and $y(t) = 2 - \alpha te^{-1}$, find $x_1(t)$ and $x_2(t)$. Find also $x_1(0)$ and $x_2(0)$. What happens if $\alpha = 0$? **(10 Marks)**

(b) Find the transformation matrix P that transforms the matrix A into diagonal or Jordon form, where

$$A = \begin{bmatrix} 4 & 1 & -2 \\ 1 & 0 & 2 \\ 1 & -1 & 3 \end{bmatrix}$$ **(10 Marks)**

5. (a) Explain the following behaviour of nonlinear systems

i) Frequency amplitude dependence

ii) Multivalued responses and jump resonances. **(10 Marks)**

(b) Determine the kind of singularity for each of the following differential equations.

i) $\ddot{y} + 3\dot{y} + 2y = 0$

ii) $\ddot{y} - 8\dot{y} + 17y = 34.$ **(10 Marks)**

6. (a) What is a phase plane plot? Describe delta method or any other method of drawing phase plane trajectories. **(10 Marks)**

(b) Draw the phase plane trajectory for the system described by the differential equation.

$D^2x + x = 0$ with initial conditions $x(o) = 1$ and $Dx(o) = 0$. **(10 Marks)**

7. (a) Prove that the necessary and sufficient condition for arbitrary pole placement in that system be completely state controllable. **(10 Marks)**

(b) An observable system is described by

$$\mathring{x} = \begin{bmatrix} 1 & 2 & 0 \\ 3 & -1 & 1 \\ 0 & 2 & 0 \end{bmatrix} x + \begin{bmatrix} 2 \\ 1 \\ 1 \end{bmatrix} u \ ; \ y = [0\ 0\ 1]x$$

Design a state observer so that the eigen values are at -4 ; $-3 \pm J1$. **(10 Marks)**

8. (a) State and explain Liapunov's theorems on

i) asymptotic stability

ii) global aeymplotic stability and

iii) instability. **(10 Marks)**

(b) Use Krasovskil's theorem to show that the equilibrium state $x = 0$ of the system described by

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

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

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

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