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10EE55

Fifth Semester B.E. Degree Examination, June/July 2015
Modern Control Theory

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Explain the following terms :
   i) State variables
   ii) State space. **(04 Marks)**

b. Obtain the state model in physical variable form for the circuit shown in Fig. Q1(b). **(08 Marks)**

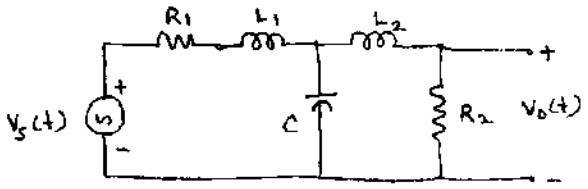

Fig. Q1(b)

c. The transfer function of a linear time invariant system is given by $\frac{Y(b)}{R(b)} = \frac{3s^2 + 2s + 6}{s^3 + 7s^2 + 14s + 8}$.
Obtain the state space representation in diagonal form. **(08 Marks)**

2 a. Represent the following systems in state space :
   i) Phase variable form : $\frac{Y(s)}{u(s)} = \frac{4s^3 + 3s^2 + 2s + 5}{6s^4 + 11s^3 + 5s^2 + 6x + 5}$
   ii) Jordan canonical form : $G(s) = \frac{(s+2)}{(s+5)^2(s+7)^2}$ and obtain their state diagram for both forms. **(14 Marks)**

b. List out least one advantages and one disadvantages of selecting :
   i) Physical variable
   ii) Phase variable
   iii) Canonical variables for state – space formulation of control systems. **(06 Marks)**

3 a. Determine the eigen values and eigen vectors of the matrix A given :
$A = \begin{bmatrix} 3 & 4 \\ 2 & 1 \end{bmatrix}$. **(08 Marks)**

b. Determine the transfer function for the system given below :
$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & -2 \\ 4 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 2 \\ 1 \end{bmatrix} u \quad y = [1,1] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$. **(08 Marks)**

c. What are the advantages of diagonalisation of a matrix? **(04 Marks)**

4 a. A system is represented by a state model :

$$\dot{x} = \begin{bmatrix} -2 & -1 & -3 \\ 0 & -2 & 1 \\ -7 & -8 & -9 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 2 \\ 1 \\ 2 \end{bmatrix} \qquad y = [4,6,8] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

i) Check whether the system is
ii) Completely controllable
Complexly observable use Kalman's test. **(08 Marks)**

b. A system is described by the following differential equation. Represent the system in state space : $\frac{d^3x}{dt^3} + 3\frac{d^2x}{dt^2} + 4\frac{dx}{dt} + 4x = u_1(t) + 3u_2(t) + 4u_3(t)$ the outputs are :

$y_1 = 4\frac{dx}{dt} + 3u_1$; $y_2 = \frac{d^2x}{dt^2} + 4u_2 + u_3$. **(06 Marks)**

c. What is state transition matrix? List the properties of state transition matrix. **(06 Marks)**

PART – B

5 a. A single input system is given by the following state equation :

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -1 & 0 & 0 \\ 1 & -2 & 0 \\ 2 & 1 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 10 \\ 1 \\ 0 \end{bmatrix} u$$

Design a state feedback controller which will give closed-loop poles at $-1 \pm j2$, -6. Determine the state feedback gain matrix by any one method. **(12 Marks)**

b. What is a state observer? With a block diagram, explain a linear system with full-over state observer. **(08 Marks)**

6 a. What are the characteristics of non –linear systems? **(05 Marks)**

b. Explain the following types of non –linearities :
i) Back lash ii) dead zone iii) saturation. **(09 Marks)**

c. What is a controller? What are the various types of controllers? Explain briefly. **(06 Marks)**

7 a. What is a singular point? Explain the classification of singular points depending on the location of Eigen values. **(08 Marks)**

b. Explain briefly any one method of constructing a phase trajectory. **(08 Marks)**

c. Explain the limit cycle behaviour of non – linear systems. **(04 Marks)**

8 a. Check for sign definiteness of the following quadratic forms :

i) $v(x) = -2x_1^2 - 2x_2^2 - 4x_3^2 - 2x_1x_2 + 4x_2x_3 + 4x_1x_3$

ii) $v(x) = -2x_1^2 - x_2^2 - 4x_3^2 - 2x_1x_2 + 2x_2x_3 + 4x_3x_1$. **(06 Marks)**

b. Explain Krasovskii's method of construction of Liapunov function for non-linear systems. **(06 Marks)**

c. Explain Liapunov's theorems on :
i) Stability
ii) Asymptotic stability
iii) Instability. **(08 Marks)**

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