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06EE55

Fifth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Modern Control Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer 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. Define: i) State; ii) State variable; iii) State vector; iv) State space. **(08 Marks)**

c. Obtain the state model of the electric network shown in Fig.Q.1(c) selecting v_1 and v_2 as state variables and current through e_2 as the output. **(07 Marks)**

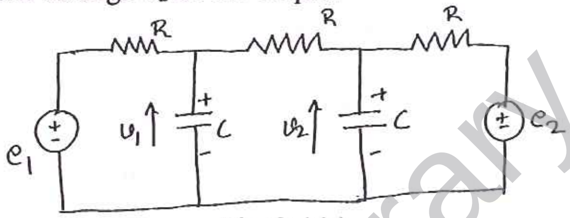

Fig.Q.1(c)

2 a. What are the advantages and limitations of phase variables? **(06 Marks)**

b. A feedback system is represented by closed loop transfer function $T(s) = \dfrac{y(s)}{u(s)} = \dfrac{10}{s^3 + 4s^2 + 2s + 1}$.

i) Draw a suitable signal flow graph and obtain the state model.

ii) Obtain the state model by direct decomposition of transfer function. **(14 Marks)**

3 a. Obtain a transfer function for a system represented by

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -2 & -3 \\ 4 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 3 \\ 5 \end{bmatrix} [u] \quad \text{and} \quad y = [1 \quad 1] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}.$$ **(06 Marks)**

b. Find the modul matrix given.

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}; \quad B = \begin{bmatrix} 0 \\ 0 \\ 2 \end{bmatrix}; \quad C = [1 \quad 0 \quad 0]; \quad D = 0$$ and hence obtain state model in canonical form. **(10 Marks)**

c. What are generalized eigen vectors? Explain. **(04 Marks)**

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

b. Obtain the state transition matrix (STM) for $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$.

Using:

i) Laplace Transformation method.

ii) Cayley Hamilton method. **(10 Marks)**

c. Define controllability and observability. **(04 Marks)**

PART – B

5 For the system defined by $\dot{X} = Ax + Bu$, where $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix}$ $B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$. By using state feed back control u = -kx it is desired to have the closed loop poles at S = -1 ± J2, s = -10.
Determine the state feed back gain matrix K by.
i) Using transformation matrix T.
ii) Using direct substitution method.
iii) Using Ackermann's formula. **(20 Marks)**

6 a. Define a controller. Explain the effects of PI and PD controller on the performance of typical 2nd order system. **(08 Marks)**
b. Explain the following non linearity's: i) Saturation; ii) ON-OFF relay; iii) Dead zone; iv) Backlash. **(12 Marks)**

7 a. What are singular points? Explain the different types of singular points in non linear control system based on the location of the eigen values of the system. **(10 Marks)**
b. Determine the singular point of the following differential equation $\ddot{y} + 3\dot{y} + 2y = 0$. **(04 Marks)**
c. Write a note on "limit cycles". **(06 Marks)**

8 a. Define: i) Stability; ii) Asymptotic stability; iii) Asymptotic stability in the large. **(06 Marks)**
b. Determine whether the following quadratic form is positive definite $Q(x_1, x_2, x_3) = 10x_1^2 + 4x_2^2 + x_3^2 + 2x_1x_2 - 2x_2x_3 - 4x_1x_3$. **(06 Marks)**
c. Define the following:
i) Positive definiteness of scalar functions.
ii) Negative definiteness of scalar functions.
iii) Positive semi definiteness of scalar functions.
iv) Indefiniteness of scalar functions. **(08 Marks)**

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