USN

10EE55

Fifth Semester B.E. Degree Examination, Dec.2015/Jan.2016

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. Write any four advantages of state variable approach over classical control theory. **(04 Marks)**

b. For the electrical network shown in Fig Q1 (b), consider voltage across capacitor 'C' and current flowing through inductor L as state variables and current flowing through resistor is taken as output variable, obtain the state model. **(10 Marks)**

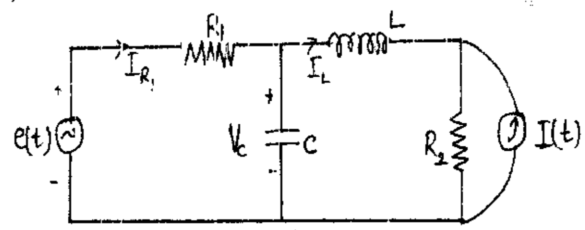

Fig. Q1(b)

c. Explain the term 'state'. For the following differential equations, which represents a multi variable system, obtain state equation and output equation.-

$$\frac{d^2 y_1(t)}{dt^2} + 4\frac{dy_1(t)}{dt} - 3y_2(t) = U_1(t) \quad \rightarrow ①$$

$$\frac{dy_1(t)}{dt} + \frac{dy_2(t)}{dt} + y_1(t) + 2y_2(t) = U_2(t) \quad \rightarrow ②$$ **(06 Marks)**

2 a. Represent the following systems in state space

i) Phase variable form $\frac{y(s)}{u(s)} = \frac{4s^3 + 3s^2 + 2s + 5}{6s^4 + 11s^3 + 5s^2 + 6s + 5}$

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 atleast one advantage and one disadvantage of selecting i) Physical variable ii) Phase variable and iii) Canonical variable for state space formulation of control systems. **(06 Marks)**

3 a. For the given state model obtain the transfer function.

$$\begin{bmatrix} x_1^1 \\ x_2^1 \\ x_3^1 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & -1 & 1 \\ 0 & -1 & -10 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 10 \end{bmatrix} [u]$$

$$Y = [1\ 0\ 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$ **(06 Marks)**

7 a. Determine the kind of singularity for each of the following differential equations.
i) $y'' + 3y' + 2y = 0$ ii) $y'' - 8y' + 17y = 34$ **(08 Marks)**

b. Explain the phenomenon of jump resonance. **(06 Marks)**

c. Discuss the basic concept of phase – plane method. **(06 Marks)**

8 a. A system is described by the following equation $x' = Ax$, where $A = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix}$

Assuming matrix Q to be indentity matrix, Solve for matrix P in the equation $A^T P + PA = -Q$. Use Liapunov theorem and determine the stability of the origin of the system. Write the Liapunov function V(x). **(10 Marks)**

b. Define : i) Stability ii) Asymptotic stability iii) Asymptotic Stability in the large in the sense of Liapunov. **(06 Marks)**

c. Show that the following quadrate form is positive definite.
$V(x) = 8x_1^2 + x_2^2 + 4x_3^2 + 2x_1x_2 - 4x_1x_3 - 2x_2x_3$ **(04 Marks)**

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