USN

10EE55

Fifth Semester B.E. Degree Examination, Dec.2017/Jan.2018
Modern Control Theory

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***
2. ***Assume suitable missing data.***

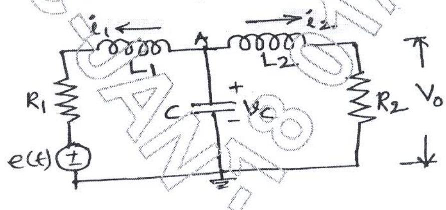
PART – A

1 a. Compare Modern control theory with Conventional control theory. **(04 Marks)**

b. Define the concept of i) State ii) State variables iii) State space iv) State model. **(06 Marks)**

c. Obtain the state model for the circuit shown in fig. Q1(c), by choosing i_1, i_2 and V_c as state variables. The voltage across R_2 is the output (V_0). **(10 Marks)**

Fig.Q1(c)



2 a. Obtain the State model using phase variables if a system is described by differential equation as : **(06 Marks)**

$$5\frac{d^3y}{dt^3}+6\frac{d^2y}{dt^2}+11\frac{dy}{dt}+10y=3\,u(t).$$

b. Develop the state model in Jordon's canonical form for a system having transfer function as

$$T(s)=\frac{2s^2+6s+7}{(s+1)^2(s+2)}.$$ **(06 Marks)**

c. A feedback system is represented by closed loop transfer function, Draw a signal flow graph (SFG) and obtain the state model. **(08 Marks)**

$$T(s)=\frac{8}{s^3+7s^2+14s+8}.$$

3 a. Obtain the state model of the linear system by Direct decomposition method, whose transfer function is **(06 Marks)**

$$\frac{Y(s)}{U(s)}=\frac{5s^2+6s+8}{(s^3+3s^2+7s+9)}.$$

b. Find the transfer function of the system having state model as below : **(06 Marks)**

$$X=\begin{bmatrix}1 & -2\\ 4 & -5\end{bmatrix}x+\begin{bmatrix}2\\ 1\end{bmatrix}u\ ;\quad Y=[\,1\ \ 1\,]x.$$

c. For the system matrix given by $A=\begin{bmatrix}-4 & 1 & 0\\ 0 & -3 & 1\\ 0 & 0 & -2\end{bmatrix}$.

Determine i) Characteristic equation ii) Eigen value iii) Eigen vector iv) Modal matrix. **(08 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

4 a. What is State transition matrix $\phi(t)$. List out the properties of STM. (06 Marks)

b. Given that

$$A_1 = \begin{bmatrix} \sigma & 0 \\ 0 & \sigma \end{bmatrix} ; \quad A_2 = \begin{bmatrix} 0 & w \\ -w & 0 \end{bmatrix} ; \quad A = \begin{bmatrix} \sigma & w \\ -w & \sigma \end{bmatrix}. \text{ Compute } e^{At}.$$ (06 Marks)

c. Determine the State transition matrix by Caley – Hamilton method for the system described by $\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -2 & 0 \end{bmatrix} x(t)$. (08 Marks)

PART – B

5 a. Define Controllability and Observability. A system is describe by (10 Marks)

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ 9 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 9 \end{bmatrix} u.$$

Determine the state feedback gain matrix (k), so that control law u = -kx will place the closed loop poles at $-3 \pm j3$ by using Ackerman's formula.

b. Design a full order state observer for the system with

$$\dot{x}(t) = \begin{bmatrix} -1 & 1 \\ 1 & 2 \end{bmatrix} x \quad ; \quad y(t) = [1 \;\; 0\,]x.$$

The desired eigen values for the observer matrix are $\mu_1 = -5$ and $\mu_2 = -5$. (10 Marks)

6 a. What are P, PI and PID controllers? What are their effects on system performance? (06 Marks)

b. Explain the following non – linearities as : i) Saturation ii) Dead zone iii) Friction and iv) Backlash. (08 Marks)

c. Explain the properties of the non linear system. (06 Marks)

7 a. What are Singular Points? Explain the types of a singular points. (06 Marks)

b. Explain the construction of the phase trajectory by delta method. (08 Marks)

c. Identify and classify the singular points of the system with differential equation as $\ddot{y} + \dot{y} + y^3$. (06 Marks)

8 a. Define the following : i) Stability ii) Asymptotic stability iii) Asymptotic stability in the large. (06 Marks)

b. Determine whether the following quadratic form is positive definite :
$Q(x_1\, x_2\, x_3) = 10x_1^2 + 4x_2^2 + x_3^2 + 2x_1x_2 - x_2x_3 - 4x_1x_2$. (06 Marks)

c. Examine the stability of the system described by the differential equation using Krasovskii's method.

$$\dot{x}_1 = x_1$$
$$\dot{x}_2 = x_1 - x_2 - x_2^3$$ (08 Marks)

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