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.

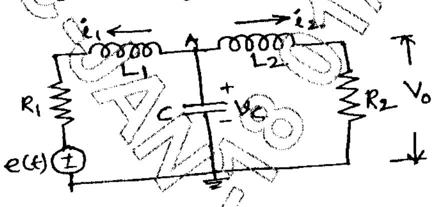
PART – A

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)**

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

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)**

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

b. Given that

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