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NEW SCHEME

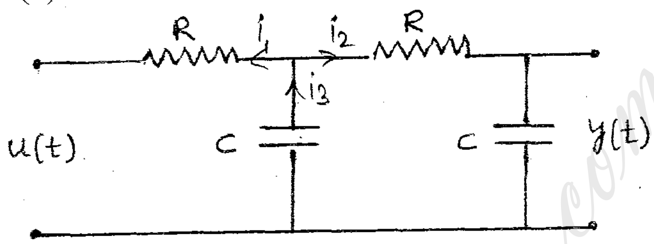
Fifth Semester B.E. Degree Examination, Dec. 06 / Jan. 07
Electrical and Electronics Engineering
Modern Control Theory

Time: 3 hrs.] [Max. Marks:100

Note: ***1. Answer any FIVE full questions.***
2. Assume any missing data.

1 a. What is a controller? Explain P, I, PI and PID controllers. **(10 Marks)**

b. Obtain the state space representation model for the following electrical circuit in fig.1(b). Given R = 1 Ohm and C = 1 Farad. **(10 Marks)**



$V_{C1} = x_1$
$V_{C2} = x_2$
$u + \dot{i}_1 R_1 = V_{C1}$
$\dot{i}_2 R_2 + V_{C_1} = V_{C2}$
$u + \dot{i}_1 R_1 = x_1$

Fig.1(b)

2 a. Explain the terms: i) State ii) State variable iii) State vector iv) State space – with an example. **(10 Marks)**

b. Obtain the state space representation of the following system and draw its phase variable diagram:

$$\dddot{Y} + 6\ddot{Y} + 11\dot{Y} + 6Y = 6u\,.$$ **(10 Marks)**

3 a. What is state transition matrix? List out the properties and advantages of state transition matrix. **(10 Marks)**

b. Obtain the state transition matrix using:
i) Laplace Transformation method and
ii) Cayley – Hamilton method.
for the system describe by,

$$X(t) = \begin{bmatrix} 0 & 1 \\ -4 & -4 \end{bmatrix} X(0)$$ **(10 Marks)**

4 a. State the conditions for completely controllability and complete observability. Determine the state controllability and observability of the system described by,

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} [u]$$

$$Y = \begin{bmatrix} 4 & 5 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$ **(10 Marks)**

b. Explain common physical non-linearities in control systems. **(10 Marks)**

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5 a. What are singular points? Explain different singular points adopted in non-linear control systems. **(08 Marks)**

b. Find out singular points for the following systems:

i) $\ddot{x} + 0.5\dot{x} + 2x = 0$

ii) $\ddot{y} + 3\dot{y} + 2y = 0$

iii) $\ddot{y} + 3\dot{y} - 10 = 0$. **(12 Marks)**

6 a. Obtain the necessary and sufficiency condition for arbitrary pole placement. **(10 Marks)**

b. Obtain the gain matrix for the system:

$$\dot{X} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} [u]$$

Given: $\xi\omega_n = 4$. **(10 Marks)**

7 a. Determine whether or not following quadratic form is positive definite:

$Q(x_1, x_2) = 10x_1^2 + 4x_2^2 + x_3^2 + 2x_1x_2 - 2x_2x_3 - 4x_1x_3$ **(10 Marks)**

b. Explain with an example – i) Liapunov Main Stability theorem ii) Liapunov Second method and iii) Krasovskii's theorem. **(10 Marks)**

8 a. Find the Liapunov function for the system:

$$X(t) = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix} X.$$ **(08 Marks)**

b. Draw the phase-plane trajectory for the following equation using Isocline method:

$\ddot{x} + 2\xi\omega\dot{x} + \omega^2 x = 0$

Given, $\xi = 0.5$, $\omega = 1$, Initial point (0, 6). **(12 Marks)**

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