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Name of Examination : **Summer 2021** - (Preview)

Course Code & Course Name : **IN353U - Control System Design**

Generated At : **19-04-2022 13:00:44**

Maximum Marks : **60**

Duration : **3 Hrs**

[Edit](#) [Print](#) [View Answer Key](#) [Close](#) **Answer Key Submission Type:** Marking scheme with model answers and solutions of numerical

Instructions:

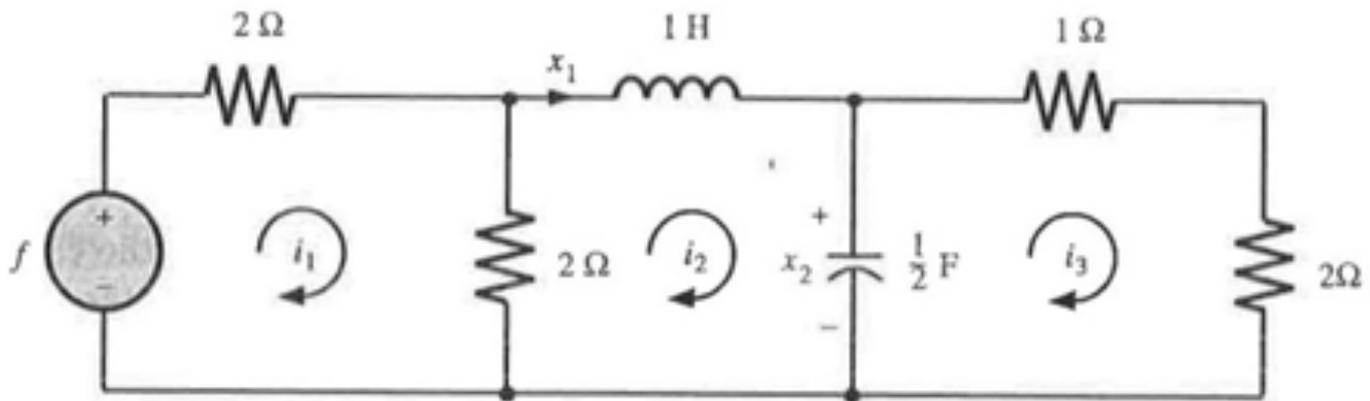
1. All questions are compulsory.
2. Illustrate your answer with suitable figures/sketches wherever necessary.
3. Assume suitable additional data; if required.
4. Use of logarithmic table, drawing instruments and non programmable calculators is allowed.
5. Figures to the right indicate full marks.

1) Solve any two subquestions.

a) Explain the following terms with suitable mathematical representation [6]

i) State equations ii) State vector iii) State variables.

b) Determine the state space representation for following electrical circuit [6]



c) Determine the matrix exponential, and hence the state transition matrix and the homogeneous response to the initial conditions $x_1(0) = 2$, $x_2(0) = 3$ of the system with state equations. [6]

$$\dot{x}_1 = -2x_1 + u \quad \dot{x}_2 = x_1 - x_2.$$

2) Solve any two subquestions.

a) Determine the transfer function from given state space. [6]

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -8 & -14 & -7 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}, \quad C = [15 \ 5 \ 0], \quad D = 0.$$

b) Write any three properties of the state transition matrix and prove anyone with a suitable example. [6]

c) Write a short note on modelling of mechanical system in state-space. [6]

3) Solve any two subquestions.

a) Find the state space representation of the given transfer function system in the diagonal canonical form. [6]

$$G(s) = \frac{2s+3}{s^2+5s+6}$$

b) Write a short note on the comparison of lead, lag, and lag-lead compensation. [6]

c) Explain the control system design via pole placement. [6]

4) Solve all subquestions.

a) Diagonalize A if possible. [6]

$$A = \begin{bmatrix} 5 & 0 & 0 & 0 \\ 0 & 5 & 0 & 0 \\ 1 & 4 & -3 & 0 \\ -1 & -2 & 0 & -3 \end{bmatrix}$$

b) Write a short note on the state observer. [6]

5) Solve all subquestions.

a) Explain the concept of controllability and observability. [6]

b) Explain the concept of modelling pressure systems in state space. [6]

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