International Islamic University Chittagong

Department of Electrical and Electronic Engineering

B. Sc. Engineering in EEE

Midterm Examination, Autumn 2022

Course Code: **EEE 4701** Course Title: **Control System I**

Time: 1 hour 30 minutes Full Marks: 30

(i) Answer all the questions. The figures in the right-hand margin indicate full marks.

(ii) Course Outcomes (COs) and Bloom's Levels are mentioned in additional Columns.

Course Outcomes (COs) of the Questions Upon the successful completion of the course, students will be able to	
CO1	Learn about basic control system engineering to model, analysis, and design a system.
CO2	Demonstrate basic proficiency in solving basic electrical and mechanical control system modeling.
CO3	Design basic controllers for application-specific troubleshooting, identify problems and provide solutions for society's sustainable development.

Bloom's Levels of the Questions						
Letter Symbols	**R**	**U**	**Ap**	**An**	**E**	**C**
Meaning	Remember	Understand	Apply	Analyze	Evaluate	Create

Modelling a system in time domain or in frequency domain is the first step of the control system analysis and design process. A schematic diagram of an electrical system is shown in Fig. 1. Do the following analysis of the system.

$x_1(t)$: capacitor voltage
$x_2(t)$: inductor current
$u(t)$: input

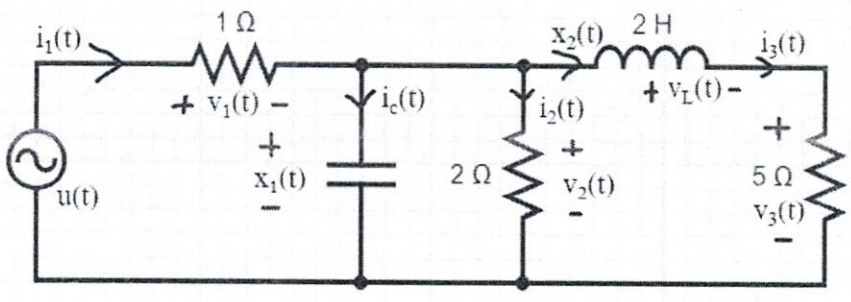

Fig.1: An electrical system.

1)	a)	**Formulate** the state space model of the system taking capacitor voltage and inductor currents as state variables. Consider a suitable output and 1F of capacitance for the capacitor in the system.	**CO2**	**C**	**5**
1)	b)	Identify the differences between transfer function model and state space model of a system.	**CO1**	**U**	**5**

Or,

1)	a)	**Formulate** a state space model using phase variable method from general mathematical model of a system.	**CO2**	**C**	**5**
1)	b)	**Discuss** a control system. **Write** down the analysis and design objectives and **illustrate** the control system design steps.	**CO1**	**U**	**5**

2) a) **A state space model of a system is given below:** **CO2** **E** **5**

$$\dot{x} = \begin{bmatrix} 2 & -5 \\ 0 & -2 \end{bmatrix} x + \begin{bmatrix} 0 \\ 7 \end{bmatrix} u$$
$$y = [1 \quad 0]x + [0]u$$

Develop the signal flow graph for the state space model above. Also, prepare the block diagram from the signal flow graph of the state space model.

2) b) **Find** the equivalent transfer function, Ts=Cs/Rs, for the system shown in **Fig. 2**. **CO2** **E** **5**

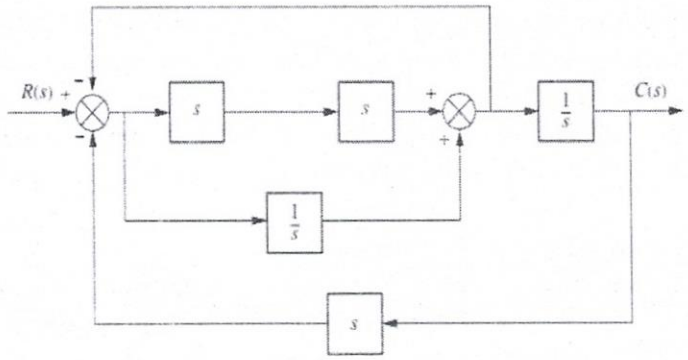

Fig. 2

3) a) **Determine** the range of gain, K, for the system of **Fig. 3** that will cause the system to be stable, unstable, and marginally stable. Assume, K > 0. **CO1** **E** **5**

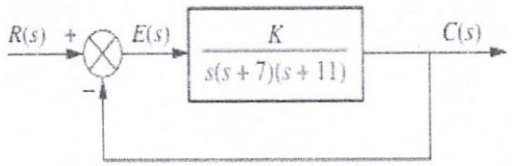

Fig. 3

3) b) Determine the stability of the closed-loop transfer function **CO1** **E** **5**

$$T(S) = \frac{10}{S^5 + 2S^4 + 3S^3 + 6S^2 + 5S + 3}$$