International Islamic University Chittagong

Department of Electrical and Electronic Engineering

B. Sc. Engineering in EEE

Midterm Examination, Spring 2023

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), Program Outcomes (POs) and Bloom's Levels (BL) of the Questions		
CO	**CO Statements**	**PO**
CO1	Learn about basic control system engineering to model, analysis, and design a system	**PO1**
CO2	Demonstrate basic proficiency in solving basic electrical and mechanical control system modeling	**PO2**
CO3	Design basic controllers for application-specific troubleshooting, identify problems and provide solutions for society's sustainable development.	**PO3**

Bloom's Levels of the Questions						
Letter Symbols	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**
Meaning	Remember	Understand	Apply	Analyze	Evaluate	Create

1) The first step of a controller design is to model the system either in the frequency domain or in the time domain. Fig. 1 shows an electrical network of simplified transmission line supplying a resistive load where R=10Ω, L=1mH and C=1μF.

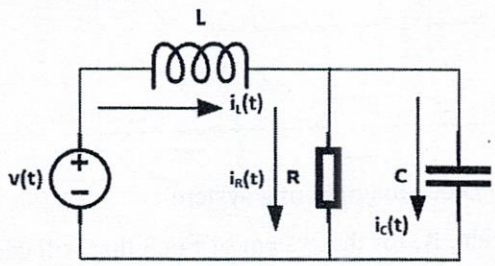

Fig. 1: Electrical network

1) a) Write down the name of two major control system performance measurement parameters. Briefly explain the analysis and design objectives of a control system. Also, show the steps of the control system design process. CO1 C2 5

1) b) Model the system, shown in Fig. 1, in frequency domain and find the transfer function, G(s) of the system if the output is the current through the resistor. CO2 C5 5

Block reduction technique and Mason's rule are used to find single transfer function of a system having multiple subsystems for design and analysis. Fig. 2 shows the block diagram of a system.

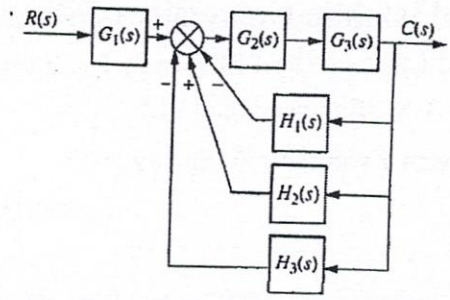

Fig. 2: Block diagram of a system

2) a) Reduce the block diagram of Fig. 2 to a single transfer function. And, convert the block diagram of Fig. 2 to a signal flow graph. CO2 C4 5

2) b) Determine the transfer function for the signal flow graph found in question 2(a). Make your comments on the result. CO2 C5 5

Or,

2) a) Draw a signal-flow graph for the following state and output equations: CO2 C4 5

$$\dot{x}_1 = 2x_1 - 5x_2 + 3x_3 + 2r$$
$$\dot{x}_{12} = -6x_1 - 2x_2 + 2x_3 + 5r$$
$$\dot{x}_3 = x_1 - 3x_2 - 4x_3 + 7r$$
$$y = -4x_1 + 6x_2 + 9x_3$$

2) b) Find the equivalent transfer function, Ts=Cs/Rs, for the system shown in Fig.3. Make your comments on the result. CO2 C5 5

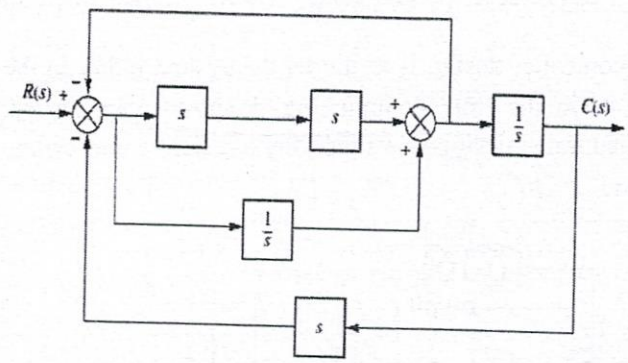

Fig.3. Block diagram of a system

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, CO1 C5 5

$K > 0$

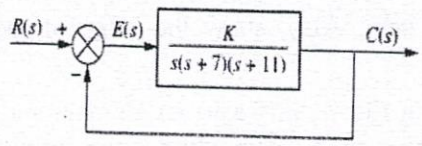

Fig.3

3) b) Find the number of right half plane poles in the closed loop transfer function. CO1 C2 5

$$T(S) = \frac{10}{S^5 + 7S^4 + 6S^3 + 42S^2 + 8S + 56}$$