International Islamic University Chittagong
Department of Electrical and Electronic Engineering

Final Examination Spring-2020	Program: B.Sc. Engg. (EEE)
Course Code: **EEE-4701**	Course Title: Control System I
Time: **5 hours** (Writing - **4 hours 30 minutes** + **30 minutes** submission time)	Full Marks: **50** [**Written**-30 + **Viva**-10 +**Quiz**-10]

[Answer **each of the** questions from the followings; Figures in the right margin indicate full marks. **Answer script must be submitted through online method within 5 hours from starting time. Also, write down the Q. Set on the front page of your answer script]**

Course Outcomes:

S/N	**Course Outcomes (COs):** Upon the successful completion of the course, students will be able to	Corres-ponding Pos	Bloom's taxonomy domain/level
CO-1	Learn about basic control system engineering to model, analysis, and design a system	PO-1	Cognitive/ Understanding.
CO-2	Demonstrate basic proficiency in solving basic electrical and mechanical control system modeling	PO-2	Cognitive/ Evaluating
CO-3	Design basic controllers for application-specific troubleshooting, identify problems and provide solutions for society's sustainable development.	PO-3	Cognitive/ Creating

R=Remember, U=Understand, Ap=Apply, An=Analyze, E=Evaluate, C=Create

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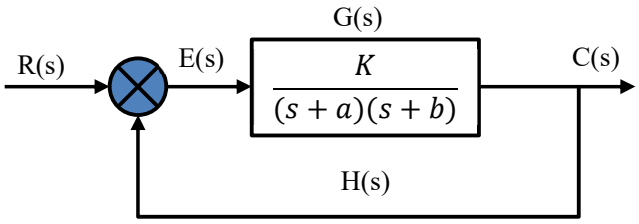
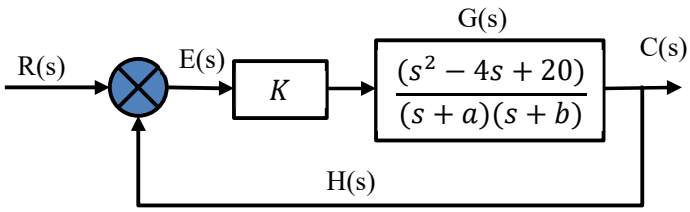
Q. Set-F

	As a control system analysis and design engineer, your first task is to measure the system performance such as transient response and steady state error of a system response. If the system performance does not meet the requirement, then your second task is to choose the appropriate compensators and do the necessary design for achieving the desired response. A typical closed loop system is given below.  Figure 1: A position control system. [*Consider (a = Last digit of ID + 1), (b = a + 1) and K = 100*]			
1(a).	**Define** Natural frequency and Damping Ratio?	**CO1**	**R,U**	**01**
1(b).	**Determine** the transient performance of the system given in **Figure 1.**	**CO2**	**E**	**02**
1(c).	The transfer function of a rotational mechanical system is given below. $$G(s) = \frac{\frac{1}{J}}{s^2 + \frac{D}{J}s + \frac{K}{J}}$$ As a control system design engineer, you have to design the parameter values (J and D) of the mechanical system as per customer requirements of (last digit of ID + 10)% overshoot and a settling time of 6 seconds for a step input of Torque T(s).	**CO3**	**C**	**03**

2(a).	**Define** steady state error. **What** are the sources of steady state error?	**CO1**	**R**	**01**
2(b).	For the system in **Figure 1**, **identify** the system types and **evaluate** the static error constants and steady state error.	**CO2**	**An, E**	**02**
2(c).	**Determine** the value of K so that there is 5% error in the steady state.	**CO3**	**C**	**03**
	An uncompensated system is given below for which root locus will be drawn and compensators will be **designed**.  Figure 2: An uncompensated system.			
3(a).	**Define** root locus. **What** is the control system problem addressed by root locus?	**CO1**	**R,U**	**01**
3(b).	**Sketch** the root locus of the system in **Figure 2** and find the following i) The breakaway point on the real axis. ii) The exact point and gain where the locus crosses the jw-axis. iii) The range of K within which the system is stable. iv) The exact point and gain where the locus crosses the 0.45 damping ratio line.	**CO3**	**Ap, An**	**05**
4(a).	**Write** down the characteristics of PD and Lead compensators. **Explain** one principle difference between them.	**CO1**	**R, E**	**02**
4(b).	**Which** compensator do you select to improve the transient response and steady state error of the system in **Figure 2** and **why**?	**CO3**	**An**	**02**
4(c).	**Write** down the design steps of this compensator that you have chosen in Question 4(b).	**CO3**	**C**	**02**
5(a).	**Produce** the analytical expression for the magnitude and phase response of a unity feedback system having forward transfer function $G(s) = \frac{K}{s+ab}$ [*Consider (a = last digit of ID + 1), (b = a + 1) and* ***K = 8*** *for this question forward*]	**CO2**	**Ap**	**02**
5(b).	**Sketch** the polar plot of the system in Question 5(a).	**CO3**	**An**	**02**
5(c).	**Draw** the bode log-magnitude plot and bode phase plot for the system having open loop transfer function of $G(s) = \frac{1}{s+a}$	**CO2**	**Ap**	**02**
6.	Viva/Viva-Quiz: The time of viva/viva-quiz will be declared in google classroom.	**CO3**	**R**	**20**