

**International Islamic University Chittagong**  
**Department of Electrical and Electronic Engineering**

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

--

**Q. Set-O**

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.

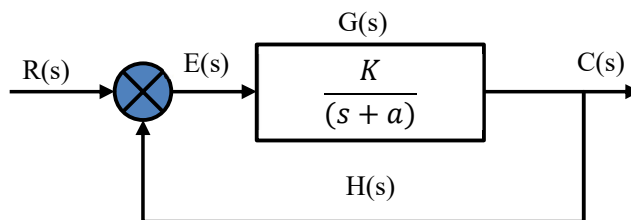
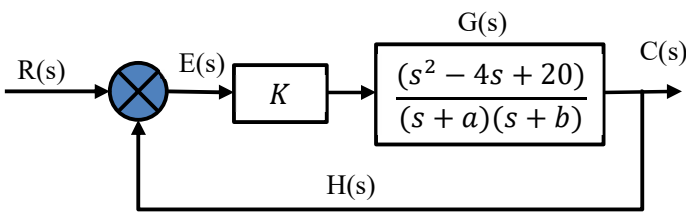


Figure 1: A position control system.

[Consider ( $a = \text{Last digit of ID} + 1$ ), ( $b = a + 1$ ) and  $K = 100$ ]

<b>1(a).</b>	<b>Define</b> Natural frequency and Damping Ratio?	<b>CO1</b>	<b>R,U</b>	<b>01</b>
<b>1(b).</b>	<b>Determine</b> the transient performance of the system given in <b>Figure 1</b> .	<b>CO2</b>	<b>E</b>	<b>02</b>
<b>1(c).</b>	The transfer function of a rotational mechanical system is given below. $G(s) = \frac{1}{s^2 + \frac{D}{J}s + \frac{K}{J}}$ 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 <b>ID + 10</b> )% overshoot and a settling time of 1 seconds for a step input of Torque T(s). [Consider $K=6 \text{ Nm/rad}$ ]	<b>CO3</b>	<b>C</b>	<b>03</b>

2(a).	What is the purpose adding integrator at forward path?	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 9% error in the steady state.	CO3	C	03
	<p>An uncompensated system is given below for which root locus will be drawn and compensators will be designed.</p>  <p style="text-align: center;">Figure 2: An uncompensated system. [Consider (a = Last digit of ID + 1), (b = a + 1)]</p>			
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 $G(s) = \frac{K}{s + a + b}$ [Consider (a = last digit of ID + 1), (b = a + 1) and K = 9 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 $G(s) = \frac{s}{s+a}$	CO2	Ap	02
6.	Viva/Viva-Quiz: The time of viva/viva-quiz will be declared in google classroom.	CO3	R	20