University of Sargodha
College of Engineering and Technology
Department of Electrical Engineering

Course Syllabus
EE-321: Linear Control Systems

Semester / Session: 6th/Spring-2020

Instructor: Dr. Imran Khan
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Office Hours: 0800hrs to 1600hrs

Course TA: N.A.

Course Description: This course presents an introduction to feedback control systems. Control systems have importance in all fields of engineering. The objective is to provide the student with the basic concepts of control theory as developed over the years in both frequency and time domain.

Catalog Data:

Course Code:	EE-321
Course Title:	Linear Control Systems
Credit Hours:	3
Course Designation:	Core
No of Sessions per week:	2 (Total 32 sessions)
Session Duration:	90 min

Catalog Description: **EE - 321 Linear Control Systems, Credits (3)**

Modeling of electrical, mechanical and electro-mechanical systems, Open loop vs closed loop control, Block diagrams and signal flow graphs, Second Order Systems (Step and Impulse response, Performance criteria, steady state error, sensitivity and stability), PID Control, Analysis and design with root locus method, Bode plots and Nyquist criterion (gain margins and phase margins), The state space method (state equations, flow graphs, stability, compensation techniques), Simulation and Controller design using MATLAB/Simulink.

Prerequisite: Signals and Systems

Prerequisites by Topics: Differential equations with constant co-efficient

Co-requisite: NIL

Textbook: Gene F. Franklin, J. D. Powell and A. Emami-Naeini, "Feedback Control of Dynamic Systems", 5th Edition.

References:

1. Dorf and Bishop, "Modern Control Systems", 8th Edition.

Prepared by: Dr. Imran Khan **Date: Jan. 14, 2020**
Signature: _____

2. K. Ogata, "Modern Control Engineering".

Program Learning Outcome:

This course is designed in conjunction with the following PLOs.

PLO 1. Engineering Knowledge: An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PLO 2. Problem Analysis: An ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences

PLO 3. Design/Development of Solutions: An ability to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PLO 5: Modern Tool Usage: An ability to create, select and apply appropriate techniques, resources and modern engineering and IT tolls, including prediction and modeling to complex engineering activities with an understanding of the limitations.

Course Learning Outcome (CLO):

Upon successful completion of this course, the student will be able to:

CLO 1. Describe and identify basic concept of feedback and control system. [Congnitive-2 & 3]

CLO 2. Use the control systems concepts to investigate the dynamic properties of physical Systems. [Congnitive-4]

CLO 3. Employ the acquired knowledge to conceive and design Control Systems to small-to-moderate scale problems. [Congnitive-5]

CLO 4. To visualize the effects of various parameters of systems and control using MATLAB and Simulink. [Congnitive-3]

Mapping of CLOs to PLOs and Learning Domains:

Course Learning Outcome	Program Learning Outcome	Learning Domain
CLO-1	PLO-1	Cognitive 2 & 3
CLO-2	PLO-2	Cognitive 4
CLO-3	PLO-3	Cognitive 5
CLO-4	PLO-5	Cognitive 3

Course Professional Outcome/ Industrial Usage:

This course is an introductory course on Control Systems. It is designed for students in engineering and other related fields. It introduces students to the concepts of dynamic analysis and control.

Course Outline and Sessions Breakdown:

I. Introduction to the course and motivation
(2 Sessions)
Introduction to the course contents, a broad perspective, utilization, pre-requisite concepts required, Open-loop vs Closed loop control.

II. Mathematical Modeling of Systems (CLO-1, 4)
(4 Sessions)
Modeling of Electrical Systems
Modeling of Mechanical Systems
Modeling of Electro-Mechanical Systems
Transfer Function representation of systems
The notion of open loop and closed loop control systems

III. Block Diagrams and Signal Flow Graphs (CLO-1)
(4 Sessions)
Block diagram: Generation and simplification
Signals Flow graphs: Notion and Simplification

IV. Second Order Systems (CLO-2, 3)
(6 Sessions)
Impulse response
Effect of poles and zeros and BIBO stability
Step response: Transient and steady state
Performance criterion
Final value theorem and steady state errors
Pole placement

V. PID Control (CLO-3)
(2 Sessions)
Proportional control vs speed of response
Derivative control vs system damping
Integral control vs steady state error

VI. Root Locus (CLO-2, 3, 4)
(5 Sessions)
The notion of locus
Plotting Root Locus (180 degree locus, jw-crossing, stability)
Routh Hurwitz Criterion
s-plane region for given performance characteristics
Lead and Lag compensator design via Root Locus

VII. Frequency Response (CLO-2, 3, 4)
(5 Sessions)
Frequency response
Bode Plots: Gain and phase plots
Nyquist stability criterion: Gain margin and phase margin

VII. State Space (CLO-2, 3, 4)
(4 Sessions)
The notion of state space
Differential equation to state space
Transfer function to state space
Eigen values and stability
Compensation using state space

Computer Usage: MATLAB/Simulink.

Projects / Design Activities: Students will be asked to simulate and/or prototype control system for a real time phenomenon.

Evaluation Criteria:		
	1. Assignments	10%
	2. Quizzes	15%
	3. Project	05%
	4. Mid-Term Exam	20%
	5. Final Exam	50%

Policies

(a) No make up tests or quizzes, except in case of emergency, e.g. illness and accident. For make up tests, medical certificate is required and the instructor must be notified in advance of the test.
(b) No late assignment will be accepted.