



BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani

Pilani Campus

Course Handout (Part II)

Date: 17/08/2020

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No.	: EEE F422
Course Title	: Modern Control Systems
Instructor-in charge	: Bijoy Krishna Mukherjee
Team of Instructors	: NA

1. **Course Description:** Feedback control is a central aiding tool in a wide range of engineering and even some non-engineering applications. This is a second UG level course on the subject, which takes the so-called Modern approach as opposed to the Classical approach taken in the previous compulsory course on the subject. This course discusses the basic analytical and design techniques using the concept of state variables; the techniques of optimal control and estimation theory and an introductory level treatment of nonlinear systems. The underlying mathematical concepts of these techniques will be emphasized and also some flavor of applications will be given through examples, exercises and take home assignments drawn from various engineering domains.

2. Scopes and Objectives

After completing this course the students will be able to

- 1) Analyze various properties of linear and nonlinear dynamic systems
- 2) Analyze discrete time dynamic systems
- 3) Design state and output feedback controllers in time domain
- 4) Design optimal controllers in deterministic/stochastic domains
- 5) Design Kalman Filter and Extended Kalman Filter (very popular signal processing techniques)
- 6) Design simple nonlinear controllers
- 7) Simplify higher order LTI models to lower order ones

3. Prescribed Text/ Reference Books

1. Control Systems by I.K. Nagrath and M. Gopal, New Age
2. Control Systems Engineering by Norman Nise, John Wiley
3. Modern Control Theory by M. Gopal, New Age
4. Control Systems Design by Friedland, Dover Publications
5. Systems and Control by S.H. Zak, OUP
6. Modern Control Design with Matlab and Simulink by Ashish Tewari, John Wiley



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4. Course Plan

Module	Lecture Sessions	References	Learning Outcomes
1. State Space Analysis & Design (40%)	L1-2: Review of classical control; Overview of the course; Review of state space modelling	Class notes, R1, R2, R3, R4, R5, R6	Understanding the modern control approach vis-à-vis the classical control approach; Analysis and controller design for LTI systems using the modern control approach
	L3-5: Similarity transformations		
	L6-7: Solution of state equation		
	L8: Controllability, observability and stability		
	L9: Discrete-time systems		
	L10-12: Linear state feedback controller and its properties		
	L13-14: State observer and observer based state feedback controller		
	L15-16: Model order reduction techniques		
2. Nonlinear Systems (30%)	L17-20: Introduction to nonlinear systems- representation, peculiarities and examples; Linearization of nonlinear systems	Class notes, R1, R5	Understanding the peculiarities of nonlinear systems vis-à-vis linear systems; Stability and performance analysis of nonlinear systems
	L21-24: Describing function and phase plane analysis techniques		
	L25-27: Lyapunov stability; Some applications of Lyapunov stability method		



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3. Optimal Estimation & Control (30%)	L28-29: Mathematical background for optimal control - Calculus of variations	Class notes, R3, R4, R5, R6	Understanding optimal control techniques in deterministic domain; Understanding optimal state estimation and control techniques in stochastic domain
	L30-32: LQR control and its properties		
	L33-35: Stochastic processes		
	L36-38: Stochastic state estimation - Kalman filter and extended Kalman filter		
	L39-40: LQG control; Concluding comments on the course		

5. Evaluation Scheme:

Evaluation Component	Weightage (Marks)	Date & Time	Remarks
Test-1	15 M	Sept. 10 to 20	
Test-2	15 M	Oct. 09 to 20	
Test-3	10 M	Nov. 10 to 20	
Compre	30	Dec. 04	
Take home assignments	30 M		

Closed Book Test: No reference material of any kind will be permitted inside the exam hall.

Open Book Exam: Use of any printed/written reference material (books and notebooks) will be permitted inside the exam hall. Loose sheets of paper will not be permitted. No exchange of any material will be allowed.

6. Chamber Consultation Hour: Saturday 5 p.m. to 6 p.m.

7. Notices: All notices regarding the course will be posted on NALANDA

8. Make-up Policy: Make-up will be granted only to exceptional cases with strong reasons.

(Bijoy Krishna Mukherjee)
Instructor In charge
EEE F422



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