**BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI**

**FIRST SEMESTER 2021-2022**

**Course Handout (Part II)**

Date: 20/08/2021

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

### Course No. : EEE F422

### Course Title : Modern Control Systems

**Instructor-in-charge : Pratyush Chakraborty**

**1. Scope & Objective of the Course:**

Control theory is an indispensable subject used for improving performances of various systems present around us. Most of these systems are complex in nature. This course mainly focuses on modern control techniques that were developed historically after classical control theory. The topics are state variable methods, digital control, nonlinear dynamical systems and control, and optimal control.

**2.** **Textbook**: (**T**) I.J. Nagrath and M. Gopal, Control Systems Engineering, New Age International (P) Ltd, 5th ed, 2007.

**3. Reference Book:**

(**R1**) M. Gopal, Modern Control System Theory, New Age International (P) Ltd, 3rd ed.

(**R2**) Linear Systems, Thomas Kailath, Prentice Hall

**4. Course Plan:**

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| --- | --- | --- | --- |
| **Lect. No.** | Topics to be covered | **Learning objectives** | **Chapter in the Textbook** |
| 1-2 | Introduction | General overview of the course, History of Control Theory, Review of Classical Control | 1.1,1.3 |
| 3-6 | State Variable Method for linear time-varying systems | Understanding the concept of state, converting an ordinary differential equation into different state realizations | 12.1-12.3 |
| 7-8 | Similarity Transform | Understanding the connection across different state realizations, diagonalization, Jordan form | 12.5 |
| 9-11 | Time Response | Understanding state transition matrix, solving state equation in various methods | 12.6 |
| 12-14 | Observability and Controllability | Understanding the concept of controllable and observable system | 12.7 |
| 15-17 | Pole Placement Design and State Observers | Understanding state feedback, pole placement method and development of state observers | 12.8-12.9 |
| 18-19 | Introduction to Digital Control System | Understanding basics of digital control system, spectrum analysis of sampling process, signal reconstruction | 11.1-11.3 |
| 20-21 | Difference equations | Understanding Z and inverse Z transform | 11.4-11.7 |
| 22-23 | Z transform analysis of sampled data control system | Analysis of sample and hold circuits | 11.8 |
| 24-25 | The z and s domain relationship, stability analysis | Investigation of stability using various methods | 11.9 |
| 26-27 | State Variable Analysis of Digital Control System | Understanding state variable methods in digital control | Class notes, 12.4 |
| 28-34 | Optimal Control | Understanding Optimal Control, Dynamic Programming, Pontryagin’s Maximum Principle | 14 |
| 35-36 | Nonlinear systems | Understanding behavior of nonlinear systems and common physical nonlinearities | 15.1, 15.2 |
| 37-40 | Phase Plane Method, Limit Cycles, Describing functions, Lyapunov’s criterion | Investigation of stability of nonlinear systems by various methods | 15.3-15.9, 13.1-13.4 |
| 41-42 | Introduction to Intelligent Control | Understanding the concept of Stochastic Optimal Control, Markov Decision Process, Introduction to Reinforcement Learning | Class notes |

**5. Evaluation Scheme:**

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| --- | --- | --- | --- | --- | --- |
| **Component** | **Duration** | **Weightage** | **Marks** | **Date & Time** | **Nature of Component** |
| Midsem | 90 min | 30% | 60 | 19/10/2021 1.30 - 3.00PM | Open Book |
| Comprehensive exam | 120 hours | 35% | 70 | 15/12 AN | Open Book |
| Quizzes (Best 1 out of 2) | 40 min | 15% | 30 | To be decided | Open Book |
| Seminar | 20 min | 10% | 20 | To be decided | Open Book |
| Assignments | - | 10% | 20 | To be decided | Open Book |

**6. Chamber Consultation Hours:** To be announced in the class.

**7. Notices:** All notices will be displayed on CMS only.

8. **Make-up Policy:** Make-up shall be given only to genuine cases. No make-up for quizzes and

assignments.

**9. Academic Honesty and Integrity Policy:**

Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

**Dr. Pratyush Chakraborty**

**(Instructor In-Charge, EEE F422)**