

FCH
Basics of Modern Control Systems (EE650)

Instructor:

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Course webpage: https://home.iitk.ac.in/~apatel/EE650_2627.html

Lectures Time: Wed, Fri 18:15-19:30

Lectures Venue: L10

Office Hour: on email request

Mode of announcements: Email and webpage (please check both the platforms)

Prerequisites: Knowledge of Classical Control (~EE250)

Objective of the course: The objective of this course is to provide a rigorous introduction to modern control theory using state-space methods for system modeling, analysis, estimation, and controller design. It bridges the gap between classical control techniques and contemporary control methodologies used in research and advanced engineering applications.

Outcomes of the course: At the end of the course, students will be able to model and analyze linear and nonlinear dynamical systems using state-space methods, and evaluate system properties such as controllability, observability, and stability. They will be able to design modern controllers and state estimators, implement them using computational tools, and apply appropriate control techniques to solve practical engineering problems.

Tentative Contents:

- Introduction and a revisit to linear algebra
- Modeling in state space, Equilibrium, Linear (Linearized) systems
- Nonlinear systems, phase-plane analysis
- Data-driven model
- Input-Output Maps from State space and vice-versa.
- Canonical forms and similarity transformation
- Solutions to state equations
- Controllability, Reachability, and Stabilizability
- Observability, Constructability, and Detectability
- Lyapunov stability
- Lyapunov-based controller design
- State-feedback pole-placement controller design
- Optimality, Linear Quadratic Regulator
- Full-order and reduced order observer design
- Kalman Filter
- Linear Quadratic Gaussian controller design
- Feedback linearization*
- Brief overview on different directions of control theory

Grading Policy:

Mid Sem Exam- 25%

End Sem Exam- 25%

Quizzes- 20%

(There will be 4 quizzes, each carrying 5%, **NO MAKE-UP QUIZ UNDER ANY CIRCUMSTANCES. No advance notice for these quizzes – surprise in nature**)

Project – 20%

Assignment-10%

Attendance Policy: Attendance will not be used for evaluations, but it is recommended to attend the lectures. We will entertain visiting hours only if your attendance is above 80%.

Recommended Books:

1. K Ogata, Modern Control Engineering, 4th Edition, Prentice Hall, 2010
2. M Gopal, *Modern Control System Theory*, New Age International Publishers, 1993
3. H K Khalil, *Nonlinear Systems*, 3rd Edition, Pearson, 2001.

Relevant research articles and supplementary reading materials will be shared during the course to complement the recommended textbooks and cover recent developments in the field.

Academic Integrity Policy:

- i. Students are expected to maintain the highest standards of academic integrity. Any form of plagiarism, cheating, unauthorized collaboration, fabrication of results, or use of unfair means is strictly prohibited.
- ii. Discussion of course concepts is encouraged; however, all submitted assignments, quizzes, projects, and examinations must represent the student's own work unless explicitly stated otherwise.
- iii. Any external source, including books, research articles, software libraries, online resources, or AI-assisted tools, must be appropriately acknowledged. Failure to provide proper attribution will be treated as plagiarism.
- iv. Violations of academic integrity will be dealt with in accordance with the Institute's policies and may result in penalties ranging from loss of marks to disciplinary action, including reporting to the Students' Standing Committee (SSAC).
- v. If widespread academic misconduct is observed, the instructor reserves the right to revise the evaluation policy or introduce additional assessment measures to preserve fairness.

Makeup and Late Submission Policy:

- i. Make-up examinations for the mid-semester and end-semester examinations will be conducted strictly in accordance with the Institute's regulations.
- ii. No make-up quizzes will be conducted.
- iii. Late submission of assignments or project components may incur penalties unless prior approval is obtained or the delay is due to circumstances recognized under medical grounds.
- iii. Any exceptions not covered above will be considered solely at the discretion of the instructor, whose decision shall be final.