MEC 560, Spring 2024

Advanced Control Systems

Instructor: Prof. Seung-Bok Choi, Email seungbok.choi@sunykorea.ac.kr

Lecture Course: MEC560

Lecture Time: Monday 3:00-5:50 pm

Lecture Place:

Office No. and Hours: B621 and TBA

Course Description:

Analytical methods applied to the design of multivariable linear control systems. Introduction to linear system theory: linearization, solution of linear matrix differential equations, stability, controllability, observability, transformations to canonical forms. Formulation of control objectives. Deterministic state observer. Full-state feedback control based on pole assignment and linear quadratic optimization theory. The response of linear systems to random input; stochastic state estimator (Kalman filter).

Textbook:

1) **Linear System Theory and Design by C. T. Chen**
2) **Optimal Control Theory: An Introduction by D. E. Kirk**

Lecture Notebook: Will be provided by Professor S. B. Choi

Grading Distribution:

Homework and Attendance: 15%
Midterm Examination: 30%
Kalman Filter Self-study Presentation: 15%
Final Examination: 40%

Grading Scale:

The grading distribution will be converted to the point with the given weight percentage, and the total point (sum of each point) is to be normalized to 100. Then, the final grade will be given based the following point range.

A: 95-100, A-: 90-95

B+: 85-90, B: 80-85, B-: 75-80

C+: 70-75, C: 65-70, C-: 60-65

D+: 55-60, D: 50-55

F: below 50

Major Topics:

1) Mathematical Description of Control System
2) Linear Algebra for Control System
3) State Space Solution
4) Controllability and Observability
5) State Feedback controller Design
6) State Estimator (Observer) Design

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7) Fundamentals of Optimal Control
8) Dynamic Programming
9) Calculus of Variations
10) Optimal Control via Variational Approach
11) Linear Quadratic Regulator (LQR) Design
12) Kalman Filter Design

Course Learning Objectives:

1) Students review the linear control system represented by Transfer Function.
2) Students can learn how to express various control systems.
3) Students can learn the linear algebra to understand matrix manipulation.
4) Students learn how to solve the linear control system using the state transition matrix.
5) Both controllability and observability: State feedback control and observer design
6) Students can formulate various performance measures to be minimized.
7) Dynamic programming and Calculus of Variations are treated.

8) Riccati Equations for linear time varying and invariant are formulated.

9) Linear Regulator Problems integrated with State Space Model are designed.

10) Design of Kalman Filter

Week Schedule: 16:00- 19:00 (Monday)

Week No.	Lecture Day	Lecture Method	Lecture Subject
1	2/26		Review of LTI System
2	3/4		Mathematical Expression of Control Systems
3	3/11		Linear Algebra I
4	3/18		Linear Algebra II
5	3/25		State transition matrix
6	4/1		Solution of linear control systems
7	4/8		Controllability and observability
8	4/15		State feedback and Obser Design
9	4/22		**Midterm Examination**
10	4/29		Basic of Optimal Control System
11	5/6		Formulation of Various Performance Measures
12	5/13		Dynamic Programming
13	5/20		Calculus of Variations
14	5/27		Formulation of Riccati Equation
15	6/3		Linear Regulator and Kalman Filter
16	6/10		**Final Examination**

Academic Integrity Statement:

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website: http://www.stonybrook.edu/commcms/academic integrity/index.html

Critical Incident Management Statement:

The State University of New York, Korea expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn.

Attendance Policy of SUNY Korea:

1. All students of SUNY Korea are required to attend every class.
2. Unexcused absences will affect seriously the student's final grade in the course.
3. If a student has over 20% unexcused absence, the student's final course grade will be an 'F'.

Example)

- If the class is a 150-minute class, and is held once a week, the 4th unexcused absence of a student will lead to an F grade of the course.
- If the class is a 75-minute class, and is held twice a week, the 7th unexcused absence of a student will lead to an F grade of the course.
- If the class is a 50-minute class, and is held three times a week, the 10th unexcused absence of a student will lead to an F grade of the course.
- In Intensive English Course (IEC), if a student misses the class more than 40 hours in a semester, the student will receive an F grade on the course.

4. Students should report the reason of absence to the instructor in advance, or immediately after the absence.
5. When a student excuses his/her absence, the student must provide documentation of the reason for the absence to the instructor.
6. The instructor of the course reserves the right to excuse absences.
7. The course instructor may excuse the absence if the submitted documentation fulfills the conditions below.
   - Extreme emergencies (e.g. death in the family)
   - Severe medical reasons with doctor's note (Not a slight illness)
   - Very important events (e.g. national conference, official school event)
8. At the end of semester, the course instructor should submit a copy of the attendance sheet to the Academic Affairs Office.