Course Syllabus

MEC 560: Advanced Control Systems

Spring 2026

Instructor	Amin Fakhari, Ph.D., Department of Mechanical Engineering
Office	165 Light Engineering, Stony Brook University
Office Hours	TuTh 11:00 AM – 12:00 PM (or by appointment)
Phone	(631) 632-8329
Email*	amin.fakhari@stonybrook.edu

* All course-related questions should be asked during lectures and office hours. Email should be used only for personal issues. I will respond to your emails as soon as possible, however, please allow up to 2 business days for a response. Your SBU email must be used for all your communications. Please include the course number in the subject line of your email.

Course Detail

Title	MEC 560: Advanced Control Systems
Credit	3
Lecture	Tue. 3:30 – 6:20 PM, Fray Hall 317
Prerequisites	Undergraduate level control, a foundation in linear algebra and calculus, and programming in MATLAB or Python.

Recommended References

- João P. Hespanha, *Linear Systems Theory*, 2nd Edition, Princeton Uni. Press, 2018 [Publisher].

- Robert L. Williams II, Douglas Lawrence, *Linear State-Space Control Systems*, Wiley, 2007 [Publisher].

- Chi-Tsong Chen, *Linear System Theory and Design*, 4th Edition, Oxford Uni. Press, 2013 [Publisher].

- William L. Brogan, *Modern Control Theory*, 3rd Edition, Pearson, 1991 [Publisher].

- Christopher M. Kellett and Philipp Braun, *Introduction to Nonlinear Control: Stability, Control Design, and Estimation*, Princeton University Press, 2023 [Publisher].

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. Linear systems with stochastic inputs and measurement noise. The response of linear systems to random input; stochastic state estimator (Kalman filter); separation principle of stochastic control and estimation; system robustness.

Course Learning Objectives

Upon completion of this course, students will be able to
- Understand causality, time variance/invariance, and linearity.
- Derive the state-space representation of dynamic systems.
- Derive solutions to LTI and LTV systems.
- Understand internal/Lyapunov stability and input-output stability of linear systems.
- Understand the concepts of controllability and observability.
- Understand and implement state feedback and output feedback control design techniques.
- Understand and implement state estimation techniques using observers and Kalman filters.
- Understand LQR optimal control.

Tools

Brightspace: It is required that you use the Brightspace for this course. Brightspace is used for facilitation of communications between faculty and students, posting of the course materials, important announcements, and grades, and submission of assignments. You need to check your SBU email or Brightspace announcements regularly [Android App, iOS App].

MATLAB: It is a programming and numeric/symbolic computing environment developed by MathWorks. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamical systems and embedded systems. You can Download and Install MATLAB Software using your SBU email address.

Python: It is an interpreted, object-oriented, high-level programming language. Python is open-source and free to use, has a large and active community, and offers a wealth of libraries.

Homework Assignments and Final Project

- Homework assignments will be posted on Brightspace.
- If students use AI tools to assist with homework or projects, they must clearly cite and acknowledge the use of such tools in the acknowledgment section, specifying the type and extent of assistance received.
- Students are permitted up to 15 late days for use on homework assignments throughout the semester; however, no assignment may be submitted more than 5 days late. Once the 15-day allowance is used, **no late submissions will be allowed**.
- No late submission is allowed for the final project report.
- Students' code will not be debugged during office hours or over email; they are responsible for troubleshooting their own code.

Examinations

Midterm Exam   Tuesday, March 10, 2026
Final Exam   Tuesday, May 12, 2026, 5:30 − 8:00 PM
Final Project   Tuesday, May 12, 2026, 5:30 PM (due date)

(a) Make-up exams are considered only for students who provide official documentation of a compelling reason (e.g., medical emergency) before, or within two days following the missing exam. There will be no make-up exams for reasons that can be within your control (e.g., pre-arranged travel or other engagements).
(b) The exam dates are subject to change. Students will be notified in a timely manner of any changes.

Grading Policy

Homework	15%
Midterm Exam	35%
Final Exam	35%
Final Project	15%

(a) Above distributions are subject to minor adjustments.

Grading Scale

A	[100, 90]%	**A**$^-$	(90, 85]%		
B$^+$	(85, 80]%	**B**	(80, 75]%	**B**$^-$	(75, 70]%
C$^+$	(70, 65]%	**C**	(65, 60]%	**C**$^-$	(60, 55]%
F	(55, 0]%				

Tentative Course Schedule

Week 1: Modeling of Dynamic Systems
Week 2: State-Space Fundamentals
Week 3: Solutions to Linear Systems
Week 4: Solutions to Linear Systems (contd.)
Week 5: Stability
Week 6: Stability (contd.)
Week 7: Midterm Exam
Week 8: Controllability and State Feedback
Week 9: Controllability and State Feedback (contd.)
Week 10: Observability and Output Feedback
Week 11: Observability and Output Feedback (contd.)
Week 12: Optimal Control
Week 13: Optimal Control (contd.)
Week 14: Feedback Linearization

Syllabus Disclaimer

The instructor views the course syllabus as an educational understanding between the instructor and students. Every effort will be made to avoid changing the course schedule, materials, assignments, and deadlines, but the possibility exists that unforeseen events will make syllabus changes necessary. The instructor reserves the right to make changes to the syllabus as deemed necessary. Students will be notified in a timely manner of any syllabus changes via email or in the Blackboard Announcements. Please remember to check your SBU email or Blackboard Announcements regularly.

University Policies and Statements

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 is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at http://www.stonybrook.edu/commcms/academic_integrity/index.html.

Student Accessibility Support Center (SASC) Statement

If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact

the Student Accessibility Support Center, Stony Brook Union Suite 107, (631) 632-6748, or at sasc@stonybrook.edu. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential. Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and the Student Accessibility Support Center (SASC). For procedures and information go to Evacuation Guide for People with Physical Disabilities and search Fire Safety and Evacuation and Disabilities.

Critical Incident Management Statement

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Student Conduct and Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.

Copyright Statement

Course material accessed from Blackboard or the Stony Brook website is for the exclusive use of students who are currently enrolled in the course. Content from these systems cannot be reused or distributed without written permission of the instructor and/or the copyright holder. Duplication of materials protected by copyright, without permission of the copyright holder, is a violation of the Federal copyright law, as well as a violation of SUNY copyright policy.