Course Syllabus

MEC 411: Control System Design & Analysis

Fall 2023

Instructor	Amin Fakhari, Ph.D., Department of Mechanical Engineering
Office	165 Light Engineering, Stony Brook University
Office Hours	MoWe 4:15 – 5:45 PM (and, any other time by appointment)
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* All non-personal course-related questions should be posted on the Brightspace Discussions Forum (see section Tools below). Email should be used only for strictly personal issues. I will respond to your emails as soon as possible, however, please allow up to 48 hours for a response. Please use your SBU email for all your communications.

Teaching Assistant #1	Zihan Yu (Zihan.Yu@stonybrook.edu)
Office Hours & Office	Tuesday 9:30 – 11:30 AM, 131 Heavy Engineering
Teaching Assistant #2	Abdullah Al Muti Sharfuddin (AbdullahAlMut.Sharfuddin@stonybrook.edu)
Office Hours & Office	–

Course Details

Title	MEC 411: Control System Design & Analysis
Credit	4
Lecture	MoWe 2:30 – 3:50 PM, Melville Library W4550
Monday Lab	Mo 10:00 AM – 12:50 PM, Heavy Engineering 139
Wednesday Lab	We 10:00 AM – 12:50 PM, Heavy Engineering 139
Thursday Lab	Th 8:30 – 11:20 AM, Heavy Engineering 139
Prerequisites	MEC 220; MEC 262; AMS 361 or MAT 303

Course Description

Analysis and design of feedback control systems. Topics include system modeling; transfer function; block diagram and signal-flow graph; sensors, actuators, and control circuit design; control system characteristics and performance; stability analysis; root locus method; Bode diagram; PID & lead-lag compensator design.

Course Learning Objectives

1. Ability to analyze differential equations using Laplace transforms and model the behavior of physical systems using differential equations.
2. Ability to represent a control system using block diagrams, signal flow graphs, and transfer functions.
3. Ability to identify system performance characteristics used for parameter selection.
4. Ability to analyze system behavior using the Root Locus method.
5. Understanding of the functionality of PID controllers.
6. Familiarity with frequency response, the construction, and analysis of Bode diagrams, stability in the frequency domain, and compensator design.
7. Understanding of the use and application of technology including oscilloscopes, waveform generators, multimeters, power supplies, and MATLAB software.

Recommended Textbooks

- Norman S. Nise, *Control Systems Engineering*, 8th Edition, Wiley, 2019 (ISBN: 9781119474227) [Publisher, Amazon].
- Katsuhiko Ogata, *Modern Control Engineering*, 5th Edition, Pearson, 2010 (ISBN: 9780136156734) [Publisher, Amazon].
- Gene F. Franklin, David Powell, Abbas F. Emami-Naeini, *Feedback Control of Dynamic Systems*, 8th Edition, Pearson, 2021 (ISBN: 9780137516834) [Publisher, Amazon].

Tools

Brightspace: It is required that you use the Brightspace for this course. Brightspace is used for the facilitation of communications between faculty and students, posting of 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].

Brightspace Discussions Forum: By using the Discussions tool/forum in Brightspace, you can get help fast and efficiently from your classmates, the TA(s), and the instructor. All non-personal course-related questions that might be of interest to other students should be posted (either anonymously or identified) on the Brightspace Discussions forum and not emailed to the TA(s) or the instructor. Email should be used only for strictly personal problems or issues.
Note that this discussion forum is for additional learning and assistance. It is not the place for cyberbullying, memes, grade complaints, concerns/comments/criticisms about the course, or in general, anything unrelated to the course material and student learning. Improper behavior will result in reporting the individual's behavior to the Office of Student Conduct and Community Standards.

Calculator: Only NCEES Allowed Calculators will be permitted to be used on all quizzes, midterm, and final exams. Please see the Calculator Policy and Allowed Calculators on ME website.

Assignments & Lab Responsibilities

- Homework problems for each topic, along with their solutions, will be posted on Brightspace. Homework will not be graded because of the accessibility of solutions on the Internet. They will be mainly assigned to provide students with an opportunity to practice the principles discussed during lectures and effectively prepare for examinations.
- Students should form groups of 3 individuals at the beginning of the semester to perform all experiments. Be careful to select people that you will trust to do work reliably and on time; do not necessarily pick your "friends".
- There will be three laboratory reports that must be completed and submitted on Brightspace as a group. Each student must write one report as the first author. However, all students should contribute equally in performing all the experiments and writing the reports. It is each group member's responsibility to ensure that their reports are properly submitted before the deadline. For each day your lab report is late, its grade will be reduced by 30%, regardless of who was the first author of the report.
- Attendance in the lab sessions is mandatory; however, students will be excused in the event of illness. In such cases, they are expected to coordinate with their groupmates to take on additional report preparation tasks to compensate for their absence. Prolonged illness that prevents participation in more than one lab session must be discussed with the instructor.

Lab Reports Format

All Lab Reports should be typed with a 12pt font. The required sections of the Lab Reports are listed in order of appearance as follows:

A. Title Page
B. Table of Contents
C. Abstract
D. Introduction and Experimental Theory
E. Experimental Procedure
F. Results
G. Discussion
H. Conclusions
I. References
J. Appendices (if you have any)

Notes:

- Refer to the lab manual for more details on each section.
- Do not simply copy the sentences from the Lab Manual. Express the concepts in your own words.
- Handmade drawings of the experimental setup are permitted.
- Number all the pages and justify the text between the page's right and left margins.
- All equations must be numbered.
- All figures and tables must be labeled with a number and a caption.
- All the numerical quantities (in figures, tables, calculations, etc.) must have proper units.
- Use MATLAB to create graphs of your experimental data.
- Refer to figures and tables in the text as Fig. # and Table #.

Examinations

Midterm Exam #1	Wednesday, Oct. 4, 2023 (in class)
Midterm Exam #2	Wednesday, Nov. 8, 2023 (in class)
Final Exam	Tuesday, Dec. 12, 2023, 5:30 – 8:00 PM (in class)

(a) All the exams are closed books/notes.
(b) Make-up exams are considered only for students who provide documentation of a compelling reason (e.g., medical emergency) before, or within three 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). An unexcused exam absence will be scored as a zero.
(c) The exam dates are subject to change. Students will be notified in a timely manner of any changes.

Grading Policy

Midterm Exam #1	20%
Midterm Exam #2	20%
Final Exam	30%
Lab and Design Reports (Weighted Equally)	30%

(a) Any disagreement with exam grading must be settled within one week after posting the grades.
(b) No individual extra credit work or extra points will be offered to improve grades.

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]%
D$^+$	(55, 50]%	**D**	(50, 45]%	**F**	(45, 0]%

- Grading probably will not be on a curve.

Tentative Course & Lab Schedule

	Monday		Wednesday		Weekly Lab Schedule
Aug	08/28	Syllabus, Introduction	08/30	Laplace Transform	–
Sep	09/04	Labor Day	09/06	Laplace Transform	(Group Formation Due on 09/08)
	09/11	Modeling of Dynamic Syst.	09/13	Modeling of Dynamic Syst.	–
	09/18	Modeling of Dynamic Syst.	09/20	Modeling of Dynamic Syst.	Start Lab 1
	09/25	System Modeling Diagrams	09/27	System Modeling Diagrams	Complete Lab 1
Oct	10/02	(Review)	10/04	**Exam #1**	Start Lab 2
	10/09	Fall Break	10/11	Time Response	–
	10/16	Time Response	10/18	Time Response	Continue Lab 2 (Lab 1 Report Due on 10/20)
	10/23	Stability	10/25	Stability	Complete Lab 2
	10/30	Steady-State Errors	11/01	Steady-State Errors	Start Lab 3
Nov	11/6	Root Locus Techniques	11/08	**Exam #2**	Continue Lab 3 (Lab 2 Report Due on 11/10)
	11/13	Root Locus Techniques	11/15	Root Locus Techniques	Continue Lab 3
	11/20	Design via Root Locus	11/22	Thanksgiving Break	–
	11/27	Design via Root Locus	11/29	Frequency Response	Complete Lab 3 & Demonstrate
Dec	12/04	Frequency Response	12/06	Frequency Response	(Lab 3 Report Due on 12/08)
	12/11	Review	(**Final Exam** on Tuesday 12/12)		

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 Brightspace announcements.

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.

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