MEC 411 Control System Analysis and Design
Online Lecture, In-Person Lab, subject to change
(4 Credits) FALL 2021

Instructor: Noah D. Machtay, Ph.D., P.E.
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Virtual Office Hours: Th, 12:00PM-3:00PM, meet.google.com/zoj-rdib-swx
Virtual Lecture: MWF 2:40-4:00PM, Zoom Through Blackboard
Monday Lab: 10:30AM-1:20PM, HE139
Wednesday Lab: 10:30AM-1:20PM, HE139
Thursday Lab: 8:00AM-10:50AM, HE139

Attendance policy: Lectures will be conducted live using Zoom, through Blackboard, and may or may not be recorded for use in the class, or in future classes. In some cases, lectures may be pre-recorded with Echo recordings posted in advance of discussion lectures. In those cases, students are expected to watch each video in advance of the respective discussion lecture scheduled for the date listed for each video, and attend the discussion lecture prepared with questions and comments related to that video. Students must stay current with the echo video schedule to properly participate in discussion lectures. Live online lectures and pre-recorded lectures may be substituted at any time at the instructor's discretion; students must stay aware of course announcements.

Recommended Text: Franklin, "Feedback Control of Dynamic Systems," 6th Edition, Pearson Prentice Hall 2010. ISBN: 0-13-601969-2.

Assignments: Homework problems have been assigned for the duration of the semester, and have been posted along with their solutions. Homework is not graded, due to the prevalence of website selling solutions to homework sets. Homework is assigned solely for the benefit of the student, so that they may practice the principles discussed during lecture, evaluate their understanding, and, in part, prepare for examinations. There will also be a number of laboratory reports that must be completed and submitted. Assignments are due and must be submitted as specified on Blackboard, through the Blackboard system; it is each group member's responsibility to ensure that their reports are properly submitted through Blackboard before the deadline; late submissions will result in a grade of zero for the assignment.

Lab work: Students will form into lab groups. Lab groups are responsible for completing reports and design projects as instructed, and preparing and submitting reports as a group. It is each student's responsibility to ensure that the group functions well and achieves the assigned goals. Students found to be making insufficient contributions to their group's work will be removed from the group, and will receive a grade of zero for all lab and/or design work, at the sole discretion of the instructor.

Exams/Term Projects: *Two midterm exams and a final exam.* Midterm 1 will be held on 10/20/2021, and Midterm 2 will be held on 11/17/2021. Final exam as scheduled by the registrar. Exams will be closed book and open notes; students may have notes they have prepared in their own handwriting; no printed materials. Exams will be administered using the Respondus system, and students are responsible for preparing this system on their computers, and ensuring that they have a proper testing environment available, with suitable hardware, internet, privacy, etc. and so on. In place of any or all exams, instructor, at their discretion, may substitute term projects to be worth an equivalent percentage of the semester grade.

Grading: *1st midterm: 15%, 2nd midterm: 15%, Lab and Design reports: 30%, Final: 30%, Participation: 10%.*

Cell phone and electronic device policy: Cellular phones or other communication devices are not permitted in lectures or labs, and are especially prohibited from exams. If you are found to be in possession of such a device during an exam, you will be ejected from the exam and will receive a grade of zero. Audio or video recording or photography during lectures is strictly prohibited, and anyone found in violation will be ejected from the course with a failing grade.

Course Objectives: This course will cover the 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 and lead-lag compensator

design, time permitting. A preexisting understanding of calculus up to and including differential equations and Laplace transforms is ***essential*** (see prerequisites) as these tools are intrinsic to the study of control system analysis and design.
Prerequisites: AMS 361 or MAT 303, MEC 262, MEC316.

Excused absences: From the university policy statement regarding religious holidays, students will be expected to notify their professor in advance, but definitely before the final date of the 'add/drop' period of their intention to be out for religious observance. Notification of intention to be out for a religious holiday MUST be made through the CEAS Undergraduate office, who will verify and evaluate the notification, and provide the instructor with appropriate instructions; you must include your name, SBID#, and the course number when contacting CEAS in regards to your absence.

For hopefully obvious reasons, students may not come to the laboratory when ill. Students are excused from laboratory attendance due to illness, and are just required to arrange with their groupmates to take on additional report preparation tasks to compensate accordingly. Prolonged illness that prevents significant participation in a lab project in its entirety will be resolved on an individual basis, and may include make-up lab sessions or other mechanisms; this should be discussed with the instructor as early as is practicable given the circumstances, and we'll figure it out.

Making a false request for an excused absence is an act of academic dishonesty and will be prosecuted accordingly.

Statement on Academic Dishonesty
Academic dishonesty is an extremely serious offense and will not be tolerated in any form. Academic dishonesty in general is the presentation of intellectual work that is not originally yours. Examples include, *but are not limited to*, copying or plagiarizing class assignments including homework, reports, designs, and other submitted materials; copying or otherwise communicating answers on exams with other students; bringing unapproved aids, either in physical (written) or electronic form to an exam; obtaining copies of an exam prior to its administration, etc. Academic dishonesty violates both the ethical and moral standards of the Engineering profession and all infractions related to academic dishonesty will be prosecuted to the fullest via the CEAS CASA committee. For you, the honest student, academic dishonesty results in lower class curves, hence a depression in your GPA and class standing, while cheapening the degree you earn. Please note that failing to provide proper citations in a paper or report constitutes plagiarism and will be prosecuted accordingly. [1]

Allowed Calculators
Only the following calculators will be allowed for the midterm and final exams. There will be no exceptions.

Casio:	All FX-115 and FX-991 models. Any Casio calculator must contain fx-115 or fx-991 in its model name.
Hewlett Packard:	The HP 33s and HP 35s models, but no others.
Texas Instruments:	All TI-30X and TI-36X models. Any Texas Instruments calculator must contain either TI-30X or TI-36X in its model name.

Approximate Course Schedule, subject to revision:

Topic 1	Introduction, Course Objectives, Open vs. Close-Loop Systems
Topic 2	Review of Mathematical Models, Linear vs Non-linear Systems
Topic 3	Laplace Transforms, Laplace Domain vs Time Domain, Overdamped vs Underdamped Systems
Topic 4	Transfer Functions, Block Diagram, Signal Flow Graph, Three Term PID Controller
Topic 5	Transient vs Steady State Response, Control of Transient Response
Topic 6	System Performance, Rise Time, Settling Time, Percent Overshoot, Peak Time, Parameter Selection
Topic 7	Stability, Routh-Hurwitz Stability Criterion
Topic 8	Control System Characteristics, Sensitivity, Noise Attenuation, Disturbance Rejection
Topic 9	Stead State Error, Test Inputs, Simplification of Linear Systems
Topic 10	Root Locus Analysis, Root Locus Analysis for Multi-Parameter Systems
Topic 11	Frequency Response, Fourier Transforms, Frequency vs Time vs Laplace Domain
Topic 12	Bode Diagrams, Combined Log-Magnitude Phase Plot
Topic 13	Stability in the Frequency Domain, The Nyquist Stability Criterion, Gain and Phase Margin
Topic 14	Compensator Design (Cascade, Feedback, Load, and Input Compensators), Phase Lead and Phase Lag Compensators

[1] Dr. Jon Longtin, Department of Mechanical Engineering, Stony Brook University

Approximate Lab Schedule, subject to revision:

9/13-9/17	Start Lab 1
9/20-9/24	Complete Lab 1
9/27-10/1	Start Lab 2
10/4-10/8	Continue Lab 2
10/8	Lab 1 Report Due
10/11-10/15	No Lab – Fall Break
10/18-10/22	Complete Lab 2
10/25-10/29	Start Lab 3
11/1-11/5	Continue Lab 3
11/5	Lab 2 Report Due
11/8-11/12	Continue Lab 3
11/15-11/19	Complete Lab 3 and Demonstrate
12/3	Lab 3 Report Due

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.

Grading Policy:

Undergraduate:	
100-95 = A	
94-90 = A-	
89-87 = B+	
86-84 = B	
83-80 = B-	
79-77 = C+	
76-74 = C	
73-70 = C-	
69-65 = D+	
64-60 = D	
<60 = F	

Note: All grades are TRUNCATED, not rounded.

University required statements:
"STUDENT ACCESSIBILITY SUPPORT CENTER (SACS) STATEMENT (must be the following language)
If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, 128 ECC Building, (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. For procedures and information go to the following website: https://ehs.stonybrook.edu/programs/fire-safety/emergency-evacuation/evacuation-guide-people-physical-disabilities and search Fire Safety and Evacuation and Disabilities.
ACADEMIC INTEGRITY STATEMENT (must be the following language as approved by the undergrad council):
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 aca-

demic 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/uaa/academicjudiciary/

CRITICAL INCIDENT MANAGEMENT (must be the following language as approved by the undergrad council):

Stony Brook University 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. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures."

"**Mode of Conduct for Exams and Summative Quizzes:** using LockDown Browser and a Webcam for Online Exams

This course requires the use of LockDown Browser and a webcam for online exams. The webcam can be built into your computer or can be the type that plugs in with a USB cable. Watch this short video (http://www.respondus.com/products/lockdown-browser/student-movie.shtml) to get a basic understanding of LockDown Browser and the webcam feature. A student Quick Start Guide (PDF) (http://www.respondus.com/products/monitor/guides.shtml) is also available.

Then, download and install LockDown Browser from this link:
http://www.respondus.com/lockdown/download.php?id=772113517

Don't Google for a download link — it may be for the wrong school! Our version of the LockDown Browser is tied to Stony Brook University.

If you get a warning message from your anti-virus software, please white-list this download.

To ensure LockDown Browser and the webcam are set up properly, do the following:

- Start LockDown Browser, log into Bb, and select this course.
- Locate and select the **Help Center** button on the LockDown Browser toolbar.
- Run the **Webcam Check** and, if necessary, resolve any issues.
- Run the **System & Network Check**. If a problem is indicated, see if a solution is provided in the Knowledge Base. Troubleshooting information can also be emailed to our institution's help desk.
- Exit the Help Center and locate the Respondus Test named RespondusTest, which is part of the *Getting Started* menu.
- Upon completing and submitting the Respondus Test, exit LockDown Browser.

When taking an online exam that requires LockDown Browser and a webcam, remember the following guidelines:

- Ensure you're in a location where you won't be interrupted
- Turn off all other devices (e.g. tablets, phones, second computers)
- Clear your desk of all external materials not permitted — books, notes, other devices
- Remain at your computer for the duration of the test
- If the computer or networking environment is different than what was tested above, repeat the Webcam and System checks prior to starting the test
- To produce a good webcam video, do the following:
    - Avoid wearing baseball caps or hats with brims
    - Ensure your computer or tablet is on a firm surface (a desk or table) — not on your lap, a bed, or other surface that might move
    - If using a built-in webcam, avoid tilting the screen after the webcam setup is complete
    - Take the exam in a well-lit room and avoid backlighting, such as sitting with your back to a window
- Remember that LockDown Browser will prevent you from accessing other websites or applications; you will be unable to exit the test until all questions are completed and submitted."[2]

[2] Dr. Anurag Purwar, Department of Mechanical Engineering, Stony Brook University

Course Delivery Mode and Structure:

This is an online course, delivered in the Blackboard learning management system (LMS). Students must be mindful of all course expectations, deliverables and due dates. All assignments and course interactions will utilize internet technologies. See "Technical Requirements" section for more information. In Blackboard, you will access online lessons, course materials, and resources.

How We Will Communicate:

Course-related questions should be asked during online Discussion Sessions. If you use Blackboard's Email Tool, it will automatically include your full name, course name and section when you send me an email. I strive to respond to your emails as soon as possible, but I generally get to replies in approximately 48 hours. Your Stony Brook University email must be used for all University related communications. You must have an active Stony Brook University e-mail account and access to the Internet. *All instructor correspondence will be sent to your SBU e-mail account.* Please plan on checking your SBU email account daily for course related messages.

Technical Requirements:

This course uses Blackboard for the facilitation of communications between faculty and students, submission of assignments, and posting of grades. The Blackboard course site can be accessed at https://blackboard.stonybrook.edu If you are unsure of your NetID, visit https://it.stonybrook.edu/help/kb/finding-your-netid-and-password for more information. You are responsible for having a reliable computer and Internet connection throughout the term. ***Caution! You will be at a disadvantage if you attempt to complete all coursework on a smart phone or tablet.*** *It may not be possible to submit the files required for your assignments.*

The following list details a minimum recommended computer set-up and the software packages you will need to have access to, and be able to use:

- PC with Windows 10
- Latest version of Chrome, Firefox or Explorer; (A complete list of supported browsers and operating systems can be found on the My Institution tab of the Blackboard website.)
- Sufficient RAM, CPU, GPU, and storage to properly run all required software
- High speed internet connection
- Printer
- Word processing software (Microsoft Word, Pages, etc.)
- Headphones
- Microphone
- Webcam
- Ability to download and install software applications and plug-ins (note: you must have administrator access to install applications and plug-ins).
- National Instruments Labview
- Arduino IDE
- Matlab
- Microsoft Office

Technical Assistance:

If you need technical assistance at any time during the course or to report a problem with Blackboard you can:

- submit a help ticket on the web at http://it.stonybrook.edu/services/itsm)
- call (631) 632-9800 (technical support, log-in issues, computer support, wifi, software & hardware)
- call (631) 2-CELT [631-632-2358]
- Note that the course instructor cannot provide technical assistance

Attendance and Late Work Policy:

Late Work Policy: Late work will not be accepted. Late work will receive a grade of zero.

Course and University Policies

Disability Support Services (DSS) Statement:

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, Room 128, (631)632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential.

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. 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 **Important Note:** Any form of academic dishonesty, including cheating and plagiarism, will be reported to the Academic Judiciary.

Critical Incident Management:

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of University 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.

UNDERSTAND WHEN YOU MAY DROP THIS COURSE:

It is the student's responsibility to understand when they need to consider disenrolling from a course. Refer to the Stony Brook Academic Schedule for dates and deadlines for registration: http://www.stonybrook.edu/commcms/registrar/calendars/academic_calendars

Incomplete Policy:

Under emergency/special circumstances, students may petition for an incomplete grade. Circumstances must be documented and significant enough to merit an Incomplete. If you need to request an incomplete for this course, contact the CEAS undergraduate office for approval as far in advance as possible.

Course Materials and Copyright Statement:

Course material accessed from Blackboard, SB Connect, SB Capture, Echo, Zoom, Google, or a Stony Brook Course 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 who retains ownership of all materials.

Students are bound by the following statement, to which they must agree:
"Academic integrity is expected of all students at all times, whether in the presence or absence of members of the faculty. Understanding this, I declare that I shall not give, use, or receive unauthorized aid in this examination. I have been warned that any suspected instance of academic dishonesty will be reported to the appropriate office and that I will be subjected to the maximum possible penalty permitted under University guidelines."