

DRAFT SYLLABUS
ME EN 5230/6230, CS 6330

INTRODUCTION TO ROBOT CONTROL- SPRING 2021

- Instructor:** Stephen Mascaro, MEK 2020, smascaro@mech.utah.edu, 581-7228.
- IVC Format:** Lectures will be recorded and posted on Canvas as outlined on the schedule. Scheduled IVC times (M/W 11:50am-1:10 pm) will be used as optional help sessions for assignments, and for the midterm exam. Students will need Zoom and a reliable internet connection.
- Labs:** MEK 0111. Lab Fee: \$40. Use card access to enter and complete labs at your convenience.
- Web Page:** A course webpage has been set up on Canvas at <https://utah.instructure.com/>
The web page will be updated regularly with assignments and solutions. Gradescope <https://www.gradescope.com/> will be used for electronic submissions and grading.
- Objectives:** Control of serial manipulators is examined. Topics include control system fundamentals, sensors and actuators, joint level control, centralized control, operational space control, and force control. Projects provide hands on experience controlling a serial link manipulator.
- Prerequisites:** ME EN 5220/6220 or CS 5310/6310 (Intro to Robotics) or equivalent is absolutely required. ME EN 5200/6200 (Classical Control Systems) is strongly recommended.
- Text:** Robotics: Modeling, Planning and Control, by Siciliano, Sciavicco, Villani and Oriolo, Springer, 2009. Marriott Library has link to E-book (Mostly just need chapters 8&9).
- References:** 1. *Intro to Robotics Course Notes* by Hollerbach (available online)
2. *Control System Engineering*, 7th Ed. by Norman S. Nise, 2015.
- Software:** MATLAB will be required. It is freely available to all students at osl.utah.edu
- Teaching Assistant:** Ali Filsoofi <ali.samarefilsoofi@utah.edu>

Problem Set and Lab Assignment Policies:

1. It is the students' responsibility to regularly check **Canvas** for assignments and solutions.
2. Students may choose to do either traditional in-person lab assignments or alternative virtual lab assignments.
3. Assignments must be submitted electronically on **Gradescope** by midnight on the date due. Unless prior arrangements exist, late assignments will be marked down 10% per business day up to 2 days. Thereafter, no credit will be given. Solutions will generally be posted 2 days after due date.
4. Students may collaborate, but each student must complete each Problem Set individually (MATLAB files and figures CANNOT be shared). In the case of Lab Assignments, students are encouraged to work in teams to program controllers and collect data, but each student must turn in their own write-up (in this case MATLAB files and data may be shared, but plots may not). Use of old material from previous years is forbidden. Violation of these policies will result in a failing grade on the assignment.
5. For clarification on assignments and solutions, please contact the instructor. For grading issues, first contact the course TA.

Exam Policies:

1. Exams must be taken at the scheduled time (proctored on Zoom) unless prior arrangements are made at least two weeks before.
2. Accommodations will be arranged if a student has a special requirement due to a disability. It is the responsibility of the student to request these accommodations at least two weeks prior to the exam and provide documentation specifying the arrangements from the University of Utah Center for Disability Services (see College Guidelines below).
3. Any students cheating on an exam will receive a failing grade for the class.

Grade Weightings:	Problem Sets: 30%	Midterm Exam: 20%
	Labs: 20%	Final Exam: 30%

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Academic Integrity:

Academic Integrity: Engineering is a profession demanding a high level of personal honesty, integrity and responsibility. Therefore, it is essential that engineering students, in fulfillment of their academic requirements and in preparation to enter the engineering profession, adhere to the Department of Mechanical Engineering Policy for Academic Misconduct. This policy is based upon the University of Utah's Policy 6-400: Code of Student Rights and Responsibilities¹ (student code) where academic misconduct "...includes, but is not limited to, cheating, misrepresenting one's work, inappropriately collaborating, plagiarism, and fabrication or falsification of information. It also includes facilitating academic misconduct by intentionally helping or attempting to help another to commit an act of academic misconduct."

As part of the ME policy, students must review and acknowledge the "ME Academic Misconduct Policy" and the "ME EN 5230/6230 Definition of Academic Misconduct" provided on the course Canvas page. Students must provide acknowledgment of these policies via the Canvas Academic Integrity Module for this course before the end of the second week of class or they will be asked to drop the class and will otherwise receive an EU grade.

University Policies:

1. ***The Americans with Disabilities Act.*** The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, (801) 581-5020. CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in an alternative format with prior notification to the Center for Disability Services.
2. ***University Safety Statement.*** The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit safeu.utah.edu.
3. ***Addressing Sexual Misconduct.*** Title IX makes it clear that violence and harassment based on sex and gender (which includes sexual orientation and gender identity/expression) is a civil rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran's status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to the police, contact the Department of Public Safety, 801-585-2677(COPS).

College Guidelines:

Policies regarding appeals procedures, disability accommodations, and adding/withdrawing/repeating courses can be found on the COE website:
<https://www.coe.utah.edu/students/current/semester-guidelines/>

¹ Student Code: <http://regulations.utah.edu/academics/6-400.php>.

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TENTATIVE SCHEDULE

No	Date	RECORDED LECTURE TOPIC	READING	INTERACTIVE VIDEO CONFERENCE	ASSIGNMENT DUE
	1/18	Martin Luther Day Holiday			
1	1/20	Introduction		Introduction	
2	1/25	Manipulator Kinematics/Statics	Hollerbach Ch. 4,5,7,8,9		
3	1/27	Manipulator Dynamics	Hollerbach Ch. 10	PS#1 Help	
4	2/01	Drive Train Dynamics	Siciliano 5.1-5.2	PS#1 Help	
5	2/03	Motor and Amplifier Dynamics		PS#1 Help	PS#1: Kinematics & Statics
6	2/08	Sensors and Control Hardware	Siciliano 5.3-5.4	PS#2 Help	
7	2/10	Real-Time Control Demo		PS#2 Help	PS#2: Manipulator Dynamics
	2/15	President's Day Holiday			
8	2/17	Feedback Control		PS#3 Help	PS#3: Drivetrain/Motor Dynamics
9	2/22	Root Locus Control Design		PS#4 Help	
10	2/24	Lyapunov Stability	Arimoto 1983	PS#4 Help	PS#4: Open Loop Control
11	3/01	Decentralized Control	Siciliano 8.1-8.4	PS#5 Help	
12	3/03	Inverse Dynamics Control	Siciliano 8.5.1-2	PS#5 Help	PS#5: 1 DOF Linear Control
13	3/08	Robust Control	Siciliano 8.5.3	PS#6 Help	Lab 1: 1 DOF Linear Control
14	3/10	Adaptive Control	Siciliano 8.5.4	PS#6 Help	PS#6: 2 DOF Control
15	3/15	Learning Control	Arimoto 1991	Review for Midterm	Lab #2: DOF Control
16	3/17	Midterm Exam			
17	3/22	Operational Space Control	Siciliano 8.6	PS#7 Help	
18	3/24	Stiffness Control	Siciliano 9.1-9.2	PS#7 Help	PS#7: Robust/Adaptive Control
19	3/29	Impedance Control	Siciliano 9.3	PS#8 Help	Lab #3: Robust/Adaptive Control
20	3/31	Admittance Control		PS#8 Help	PS#8: Op Space Control
	4/05	Non-Instructional Day			
21	4/07	Direct Force Control	Siciliano 9.4-9.5	PS#9 Help	Lab #4: Op Space Control
22	4/12	Hybrid Position/Force Control	Siciliano 9.6-9.7	PS#10 Help	PS#9: Indirect Force Control
23	4/14	Multi-Arm Coordination	Uchiyama 1988	PS#10 Help	PS#10: Hybrid Control
24	4/19	Teleoperation	Niemeyer 1991	PS#11 Help	Lab #6: Hybrid Control
25	4/21	Teleoperation		PS#11 Help	PS#11: Multi-Arm Coordination
26	4/26	Visual Servoing	Siciliano 10	Review for Final	Lab #7: Teleoperation
	4/28	Reading Day			
	5/04	Final Exam: 10:30-12:30pm			

Note: All dates and assignments are subject to change. Additional problems may be assigned for 6000 level students. Students should monitor Canvas for updates.