San José State University
Charles W. Davidson College of Engineering
Department of Mechanical Engineering
ME 190, Mechatronic Systems Design, Fall 2022

Instructor:	Prof. Winncy Du
Office Location:	E310-F
Telephone:	408-924-3866
Email:	winncy.du@sjsu.edu
Office Hours:	Tu & Th 17:00-18:00 (or by appointment) via Zoom or in E310-F
Lecture Time & Location:	Lecture, Sec. 1 (40292): TuTh 1:30 PM-2:20 PM **E329** (Prof. Winncy Du)
Lab Time & Location, and TA Information	Lab, Sec. 2 (40680): Tu 2:30 PM-5:15 PM **E135** (TA: Salman Saeed, salman.saeed@sjsu.edu) Lab, Sec. 3 (41827): Th 10:30 AM-1:15 PM **E135** (TA: Salman Saeed, salman.saeed@sjsu.edu) Lab, Sec. 4 (42108): Th 2:30 PM-5:15 PM **E135** (TA: Vincent Tran, vincent.v.tran01@sjsu.edu)
Prerequisites:	ME 106; co-req. ME147. With C- or better

Reference Textbooks

There are no required textbooks for this course. Lecture notes will be uploaded onto Canvas on a regular basis. The following references are highly recommended:

- William Palm III (2021). *System Dynamics*. McGraw-Hill Education, 4th edition. ISBN-10. 0078140056 · ISBN-13. 978-0078140051.
- Åström, K. and Murray, R. (2012). *Feedback Systems*: An Introduction for Scientists and Engineers. Princeton University Press, Princeton, NJ. The complete text is available for free online at: http://www.cds.caltech.edu/~murray/books/AM08/pdf/am08-complete_28Sep12.pdf

Course Description

Process modeling from test data. Computer-aided dynamic system control analysis and design. Application and integration of microcontroller for digital process and servo control. Development of smart and intelligent products with microcontroller.

Course Learning Outcomes

Upon successful completion of this course, students will be able to:

1. *Develop models for electrical, mechanical, and electro-mechanical systems*
2. *Simulate the models of dynamic systems in the computer environment*
3. *Extract useful data from a noisy signal*

4. *Identify system characteristics by inspection of experimental data*
5. *Design and implement hardware controllers*
6. *Write and optimize code for embedded programming*

Required Hardware

- MinSeg Mega robotic kits will be used for most of the labs and the final project. The kits will be provided to students via an equipment loan program. Students can also purchase their own kits.
- Please install MATLAB and Simulink on your computer, as well as the Arduino Support Package for Simulink via MATLAB's add-on explorer, and the Rensselaer Arduino Support Package library (RASPlib). You will also need a multimeter for the labs.

Required Software

- MATLAB and Simulink (Free for SJSU students via the campus-wide license: https://www.mathworks.com/academia/tah-portal/san-jose-state-university-31511582.html; A Mathworks account with SJSU email address is necessary to access the license). When installing MATLAB, install the following Toolboxes:
    - Simulink
    - Simscape
    - Control System Toolbox
    - Signal Processing Toolbox
    - Optimization Toolbox
    - Symbolic Math Toolbox
- Students without a strong background in MATLAB and/or Simulink are highly encouraged to complete "MATLAB Onramp" and "Simulink Onramp" courses from https://matlabacademy.mathworks.com/. These courses are free, and come with a certificate upon successful completion.

Grading Scheme

- Homework: 15%
- Lab Activities and Reports: 25%
- Midterm Exam: 20%
- Term Project: 10%
- Final Exam: 30%
- Class engagement or other educational activities (Extra credit): 2%

The grade for each lab is the aggregation of three sub-grades:

- Preparation before the lab: 30%
- Completion check at the end of the lab: 30%
- Report: 40%

The grade will be rounded up to the nearest integer, and a final letter grade will be determined using the following criteria:

Grade	*Points*	*Percentage*
A plus	*95 to 100*	*95 to 100%*
A	*91 to 94.9*	*91 to 94.9%*
A minus	*88 to 90.9*	*88 to 90.9%*
B plus	*85 to 87.9*	*85 to 87.9%*
B	*81 to 84.9*	*81 to 84.9%*
B minus	*78 to 80.9*	*78 to 80.9%*
C plus	*75 to 77.9*	*75 to 77.9%*
C	*71 to 74.9*	*71 to 74.9%*
C minus	*68 to 70.9*	*68 to 70.9%*
D plus	*65 to 67.9*	*65 to 67.9%*
D	*61 to 64.9*	*61 to 64.9%*
D minus	*58 to 60.9*	*58 to 60.9%*
F	*0 to 57.9*	*0 to 57.9%*

Homework

Homework, to be submitted via Canvas, is generally due one week after its assignment. There will be **only one allowance** for late homework submission and that will include a **20% grade penalty**.

Lab Assignments

Lab instruction and materials will be posted on Canvas. All the MinSeg labs will be carried out via Simulink. More information will be provided on the details of the libraries required for the labs.

Make sure that you read the lab manual/materials prior to the lab starts. During the lab hours, the TAs will help you with any questions or issues you have not been able to resolve on your own. Both the preparation before the lab and the completion at the end of the lab will be a part of your lab grade. The lab report submission policy is similar to that of homework: Only one late submission is allowed, which will come with 20% grade deduction.

Midterm and Final Exams

Both the midterm and the final exam will be based on the topics covered in the lectures. The exams will be closed book and closed notes, but you will be given the necessary formula. Reviewing the lecture notes, homework problems, and the labs will help you prepare for the exams.

Project

There will be a project assigned toward the end of the semester on developing a control system for the MinSeg robot to stabilize it in the upright position. The project will include analytical, computational, and experimental components.

Class Protocol

Students are expected to attend all class sessions and be responsive to the questions and quizzes.

University Policies

Per University Policy S16-9, university-wide policy information relevant to all courses, such as academic integrity, accommodations, etc. will be available on Office of Graduate and Undergraduate Programs' Syllabus Information web page at http://www.sjsu.edu/gup/syllabusinfo/

Tentative Course Schedule

Week	Date	Lecture Topics	Lab
1	8/23, 8/25	Course overview; Introduction to MATLAB	
2	8/30, 9/1	Introduction to Simulink	Lab 1
3	9/6, 9/8	Modeling electrical systems	Lab 2
4	9/13, 9/15	Discretization of differential equations	Lab 3
5	9/20, 9/22	Analog and digital filtering	Lab 4
6	9/27, 9/29	Signal sampling and Fast Fourier Transform (FFT)	Lab 5
7	10/4, 10/6	Laplace Transform and transfer function	Lab 6
8	10/11, 10/13	Midterm Review - **Midterm Exam (10/13)**	
9	10/18, 10/20	Modeling and analysis of DC motors	Lab 7
10	10/25, 10/27	Fundamentals of feedback systems	Lab 8
11	11/1, 11/3	Control design using classical methods	Lab 9
12	11/8, 11/10	Review of rigid body dynamics (Deriving MinSeg dynamics)	Lab 10
13	11/15, 11/17	State space representation	Project
14	11/22	Control design using modern methods (State space control)	Project
15	11/29, 12/1	Linear Quadratic Regulator (LQR)	Project
16	12/6	Final Review	
Final Exam	**12/14/2022**	**Wednesday (Dec 14), 12:15 – 2:30 PM E329**	