San José State University
Charles W. Davidson College of Engineering
Department of Mechanical Engineering
ME 285, Mechatronic Systems Engineering, Spring 2022

Instructor:	Saeid Bashash
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Office Hours:	Wed. 17:00-18:30 Or by appointment
Class Days/Time:	Lecture: Tu-Th 5:00 PM-5:50 PM Lab: Fri 5:30 PM-8:15 PM (ENG 135)
Classroom:	ENG 135 (A Zoom link will be provided for the online sessions)
Prerequisites:	Basic knowledge in computer programming and control systems

Course Description

Introduction to mechatronic systems: Combine hardware, software and system integration. Subjects include basic circuits, logic gates, OpAmps, encoder/decoder, DC and stepper motor, A/D and D/A, C-language, interfacing and control. Hands-on lab practices.

Course Learning Outcomes

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

1. *Develop mathematical models for electrical, mechanical, and electro-mechanical systems*
2. *Simulate the models of dynamic systems in computer environment*
3. *Explain the basic structure of a microcontroller, the nature of IO ports, and the common peripheral subsystems found in most microcontrollers*
4. *Interface a microcontroller to sensors, actuators, and user I/O devices*
5. *Extract useful data from a noisy signal*
6. *Identify system characteristics by inspection of a data plot*
7. *Design and implement a hardware controller*
8. *Write and optimize code for embedded programming*

Required Texts/Readings/Materials

There are no required textbooks for this course. The main reference will be the lecture notes, which will be uploaded onto Canvas on a regular basis. Three textbooks are recommended for further reading.

Recommended Texts/ Readings/Materials

- J. Carryer, R. Ohline, and T. Kenny (2010). Introduction to Mechatronic Design. Pearson.
- K. Åström and R. Murray. (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
- William Palm III (2013). System Dynamics. McGraw-Hill Education, 3rd edition.

Required Hardware

- Arduino Uno microcontroller
- A standard portable digital multimeter for voltage, current, and resistance measurements

Additional materials will be provided.

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 a SJSU email address is necessary to access the license.
- Students without a strong background in MATLAB or Simulink are highly encouraged to complete the "MATLAB Onramp" and "Simulink Onramp" courses from https://matlabacademy.mathworks.com/. These courses are free, and come with a certificate upon successful completion.
- Python (Online via Google's Colab or with an IDE like Jupiter Notebook or PyCharm)
- Arduino IDE
- Tinkercad (Online account)

Grading Information

The weighting of course assignments for determining the course grade are as follows:

- Homework: 10%
- Lab Assignments: 25%
- Midterm Exam: 20%
- Term Project: 15%
- Final Exam: 30%
- Lecture Questions: 2% (Bonus)

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

- Completion of the pre-lab exercises: 30%
- Involvement in the lab activities: 30%
- Completion check at the end of the lab: 40%

The scores on your assignments and exams will be combined and totaled using the weighting scheme described above. The grade will be rounded up to the nearest integer, and a final letter grade will be issued 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 Assignments

Homework is generally due one week after it is assigned. All submissions will be online via Canvas. There will be **only one allowance** for late homework submission and that will include a **20% grade penalty**. The late submission will be due 3-5 days after the original due date. All submissions will be carried out via Canvas. The late submission will be due shortly before the assignment link will expire.

Lecture Questions

To make sure you are engaged in the class, I will frequently call your names and ask spontaneous questions related to the lecture. The questions will be simple enough to answer within a few seconds. A tool will be used to randomly draw the names and track the responses. If you are attending online, you will need to be ready to turn on your microphone, answer the question, and then turn it off. You'll receive up to 2% bonus credit for answering the lecture questions.

Labs

There will be weekly lab sessions focusing on the practical aspects of the topics discussed in the course. The first two labs will be on enhancement of software skills for Python, MATLAB, Simulink, and Simscape. The

remaining labs will include hands-on experiments with various sensors, actuators, and microcontrollers. You will receive a lab kit at the beginning of the semester, and return it after the final project is over toward the end of the semester. A Lab TA will check your progress and help you to complete the lab exercises.

You are expected to study the lab instructions and complete the pre-lab assignments before attending the labs. Completion of the pre-lab exercises will be checked at the beginning of each lab session. Moreover, there will be an assignment completion check at the end of each lab session. You must notify the instructor in advance if you will be late to the lab.

Midterm and Final Exams

Both the midterms and the final exam will be based on the topics covered in the lectures and lab sessions. The exams will be closed book and closed notes, but you may receive a formula sheet. Reviewing the lecture notes, labs, and homework problems will help prepare for the exams.

Project

There will be a project assigned toward the end of the semester. The project will focus on the design and implementation of a PID controller for controlling the position and velocity of a DC motor. The project will include both analytical and experimental components and will require a technical report.

Class Protocols

I expect everyone to make their best effort to attend *all* class sessions. Please arrive to the classroom *before* the session begins, and put your cell phone on the 'silent' or 'vibrate' mode. You are encouraged to ask questions and participate in the classroom discussions, however, disrupting the class by engaging in conversation with your classmates must be avoided.

* We will follow strict masking and social distancing rules enforced by the university.

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/

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Tentative Course Schedule

Week	Date	Topics
1	1/27	Course overview
2	2/1, 2/3	Modeling and simulation of dynamic systems using MATLAB and Python
3	2/8, 2/10	Introduction to Simulink and Simscape
4	2/15, 2/17	Introduction to C programming language
5	2/22, 2/24	Microcontroller architectures and arithmetic operations
6	3/1, 3/3	Microcontroller peripherals (Parallel I/O system, PWM, timers, and interrupts)
7	3/8, 3/10	Modeling electrical systems (resistor-capacitor-inductor and op-amps circuits)
8	3/15, 3/17	Inter-processor communications (Bit parallel, bit serial: SPI, UART, and I2C)
9	3/22, 3/24	Midterm review - **Midterm Exam (3/24)**
11	4/5, 4/7	Modeling electromechanical systems
11	4/12, 4/14	DC motor types and rotary encoders
12	4/19, 4/21	Fundamentals of feedback control systems
13	4/26, 4/28	State space modeling
14	5/3, 5/5	State space control and Kalman filtering
15	5/10, 5/12	Project and Final Exam review
Final Exam	**5/24**	**Tuesday (5/24/2022), 2:45 – 5:00 pm, ENG 135**