Mechatronics Systems Design

Semester: Spring 2024
Number of Credits: 3
Course: MENG 2400

Instructor Info

Dr. Madi Babaiasl

Office Hrs: Tue. & Thu. 2pm - 3pm or by appointment

Office Location: MDD 2051

Website: https://github.com/madibabaiasl/mechatronics-course

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Course Info

Prerequisites: ECE 1100, ECE 1200

Class days: Tue. & Thu.

Class hours: 11am-12:15pm

Class Location: McDonnell Douglas Hall | Room 1032

Course Description

Welcome to the crossroads of innovation where mechanical systems shake hands with the digital world - Mechatronics Systems Design! Imagine a world where your creations can sense, act, and think. In this course, you will breathe life into metal and wires, transforming static pieces of technology into dynamic systems that respond to the environment with precision and intelligence. From the rumbling engines of industry to the silent precision of digital devices, mechatronics is the invisible thread that weaves through the fabric of modern technology. You will start by building a solid foundation, understanding the interplay between resistors, capacitors, and inductors. Then, like an architect of the algorithmic age, you will harness the power of the Arduino to bridge the gap between binary and mechanical. Through hands-on experiments and collaborative projects, you will design, prototype, and test systems that could change the way we live. This is not just learning; it's a transformation into the innovators and problem solvers that the future demands. Buckle up for an adventure in Mechatronics Systems Design.

Tentative topics include:

- Introduction to Systems Design
- Introduction to Arduino and Arduino electronic devices
- Basic electronics - Breadboard, resistors, transistors, capacitors, inductors
- Analog and digital I/O sensor, digital logic, LED's, Op-amps
- Actuators – DC and AC motor control
- Arduino Programming (structured programming techniques, developing sketches and functions)
- Interfacing sensors and actuators with Arduino
- Serial communication
- Some advanced topics like AI and IOT (if time permits)

Course Objectives

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

- Master systems design methodologies to conceptualize and fabricate intelligent systems that respond adaptively to environmental stimuli.
- Analyze and synthesize electronic circuits by selectively integrating essential components such as resistors, capacitors, and inductors, to construct complex smart system architectures.
- Interface a diverse array of digital and analog input/output devices with Arduino platforms
- Employ advanced structured programming techniques to architect, develop, and refine efficient software sketches and functions, underpinning the functionality of mechatronic systems.
- Implement and perfect debugging strategies for Arduino programming, utilizing tools like the serial monitor to diagnose and troubleshoot software anomalies and hardware interferences, ensuring system reliability and performance.

Resources

Recommended Textbooks:

- Bolton, William. Mechatronics: electronic control systems in mechanical and electrical engineering. Pearson Education, 2015.
- Bishop, Robert H., ed. Mechatronics: an introduction. CRC Press, 2017.
- David, G. Alciatore. Introduction to mechatronics and measurement systems. MCGRAW-HILL EDUCATION, 2018.

Note that the material that I will teach is a combination of many sources (some are not listed above and some are developed by myself) and I will give the required text to you on the GitHub page of the course. The books above can be used as a reference but our main text is the GitHub Wiki.

Software Packages and programming languages:
Arduino IDE, LabVIEW, SolidWorks, MATLAB & Simulink, Python, C

Hardware:
Arduino Uno microcontroller boards, Sensor kits for various applications (including temperature, proximity, and motion sensors), Actuators including servos, stepper motors, and DC motors, Breadboards and prototyping wires, Electronic components (resistors, capacitors, inductors, transistors, integrated circuits), Motor drivers and controllers, Multimeters, Power supplies, and computers with suitable configurations.

Teaching method & Assessment

The pedagogical approach for Mechatronics Systems Design is a blend of theoretical instruction, practical application, and collaborative learning. Our aim is to not only impart knowledge but also to cultivate the skills and mindset required for innovation in mechatronics.

Teaching Method:

- Interactive Lectures and labs: Fundamental concepts will be introduced through lectures that encourage active participation (my aim is to help you "feel" all the concepts through hands-on experiments). Real-world examples will be employed when suitable to demonstrate how mechatronics principles are applied in industry. Lectures and labs are interwoven most of the time.
- Project-Based Learning: Students will participate in team and individual projects that require them to design, prototype, and test mechatronic systems.
- Peer Collaboration: Emphasis will be placed on collaborative learning through group discussions, peer assessments, and team projects.

Assessment:

- Quizzes and Tests: Regular quizzes will assess comprehension of core concepts, cumulative knowledge, and problem-solving abilities.
- Laboratory Reports: Written reports will document laboratory exercises, reinforcing the learning outcomes and assessing the ability to accurately conduct and communicate experimental work.
- Project Deliverables: Assessment of group and individual projects will be based on design documentation, prototype functionality, and the final product, reflecting the practical application of course content.
- Participation: Active participation in class discussions and group work will be monitored and contribute to the final grade.
- Peer Review: Students will provide feedback on their peers' contributions to team projects.

Grading Criteria:

The grading criteria for the Mechatronics Systems Design course are designed to reflect a balanced evaluation of both individual effort and collaborative proficiency. The following components will constitute the final grade:

- Labs and Projects (70%): Practical application of mechatronics principles is at the core of this course. Labs and project work, including design, prototyping, and testing, will account for most of the final grade. This also includes peer evaluations within group projects.
- Class Participation and Attendance (20%): Active participation in class discussions and consistent attendance are essential for collaborative learning and will be reflected in the grade.
- Quizzes (10%): Short quizzes will periodically assess understanding of recent topics, encouraging ongoing review and retention of course content.

Grades will follow the standard scale: $A \geq 93\%, 93\% > A- \geq 90\%, 90\% > B+ \geq 87\%, 87\% > B \geq 83\%, 83\% > B- \geq 80\%, 80\% > C+ \geq 77\%, 77\% > C \geq 73\%, 73\% > C- \geq 70\%, 70\% > D+ \geq 65\%, 65\% > D \geq 60\%, 60\% > F$.

Please note that these components may be adjusted slightly to accommodate specific class needs and to reflect the emphasis on hands-on learning experiences.

Important Information:

- Attendance and Participation: Regular attendance is crucial for success in this course. Each student can only have a maximum of three excused absences (please email and explain your emergency). More than three absences will result in an "F" for this course. Active participation in lectures and labs is expected and will be factored into your final grade. Doing anything other than class activities during class time is not acceptable and will affect your participation score at the end.
- Assignment Deadlines: Assignments must be submitted by the specified deadlines. Late submissions up to one week will be considered for half credit.

- Completion Requirement: Failure to complete any of the labs, projects, and exams will result in a grade of "F" for the course. It is imperative to fulfill all course components to achieve a complete evaluation.
- Use of Electronic Devices: The use of laptops and tablets is permitted for note-taking and course-related activities. However, the use of mobile phones for non-academic purposes during class is discouraged.
- Use of Artificial Intelligence: Students are allowed to use AI tools for enhancing their learning experience, provided they adhere to academic integrity guidelines and clearly cite any AI assistance in their submissions.
- Safety in Labs: Adherence to safety protocols in the laboratory is mandatory. Failure to comply with safety instructions may result in removal from the lab and potential course penalties.
- Office Hours: Students are encouraged to take advantage of office hours for additional support, clarification on course material, or discussion of academic concerns. Office hours outside the suggested ones are by appointment only.
- Feedback and Communication: Constructive feedback is welcome to continually improve the learning experience. Students are encouraged to communicate any concerns or suggestions.

Academic Integrity

Academic integrity is honest, truthful and responsible conduct in all academic endeavors. The mission of Saint Louis University is "the pursuit of truth for the greater glory of God and for the service of humanity." Accordingly, all acts of falsehood demean and compromise the corporate endeavors of teaching, research, health care, and community service through which SLU fulfills its mission. The University strives to prepare students for lives of personal and professional integrity, and therefore regards all breaches of academic integrity as matters of serious concern. The full University-level Academic Integrity Policy can be found on the Provost's Office website at: https://www.slu.edu/provost/policies/academic-and-course/academic-integrity-policy.pdf.

Additionally, each SLU College, School, and Center has its own academic integrity policies, available on their respective websites.

Disability Accommodations

Students with a documented disability who wish to request academic accommodations must formally register their disability with the University. Once successfully registered, students also must notify their course instructor that they wish to use their approved accommodations in the course.

Please contact the Center for Accessibility and Disability Resources (CADR) to schedule an appointment to discuss accommodation requests and eligibility requirements. Most students on the St. Louis campus will contact CADR, located in the Student Success Center and available by email at accessibility_disability@slu.edu or by phone at 3149773484. Once approved, information about a student's eligibility for academic accommodations will be shared with course instructors by email from CADR and within the instructor's s official course roster. Students who do not have a documented disability but who think they may have one also are encouraged to contact to CADR. Confidentiality will be observed in all inquiries.

Title IX

Saint Louis University and its faculty are committed to supporting our students and seeking an environment that is free of bias, discrimination, and harassment. If you have encountered any form of sexual misconduct (e.g. sexual assault, sexual harassment, stalking, domestic or dating violence), we encourage you to report this to the University. If you speak with a faculty member about an incident of misconduct, that faculty member must notify SLU's Title IX coordinator, Anna R. Kratky (DuBourg Hall, room 36;akratky@slu.edu; 314-977-3886) and share the basic facts of your experience with her. The Title IX coordinator will then be available to assist you in understanding all of your options and in connecting you with all possible resources on and off campus. If you wish to speak with a confidential source, you may contact the counselors at the University Counseling Center at 314-977-TALK. To view SLU's sexual misconduct policy and for resources, please visit the following web addresses: www.slu.edu/here4you and https://www.slu.edu/general-counsel.

Wellness

All students experience stressors and challenges at some point, and seeking support is beneficial. Such challenges may be the result of academic concerns (such as those related to particular assignments or content in a course), or they may be more personal in nature (such as concerns related to relationships, mental health, loss, identities, alcohol or drugs, housing or food security, or finances, among other things). If you experience these or other difficulties, please consider seeking support from the resources available to you.

- For concerns related to this course, please contact me. I am invested in your success and will support your success in the ways I can.

- Additionally, you have access to the many resources SLU provides in support of your personal wellness. You will find a list of available resources on the Well-being page of the SLU website.

If you or someone you know is experiencing a crisis: please consult the Crisis Support and Warning Signs on the University Counseling Center website.

In the spirit of cura personalis, the University sees your academic success as connected to your health and well-being and provides resources to support your holistic wellness.