![USC Logo]

Department of Aerospace and Mechanical Engineering

AME 504: Mechatronics Systems Engineering
Units 4
Fall 2023

Course Syllabus

Course General:
The course meets on Wednesday 6:30 ~ 9:10 pm.
Location: SGM-601

Course Instructor: Dr. Yong Chen,
Office: OHE-430E
Office Hours: Wednesday 10:00-12:00pm and 1:30-3:30pm, or by appointment.
Contact Info: Tel: 213-740-7829; Email: yongchen@usc.edu

Teaching Assistant: TBA.
Office:
Office Hours:
Contact Info:

Course Description

Mechatronic systems engineers use precision mechanical, electrical, computer engineering, as well as math and physics, to design high performance and sophisticated products and equipment demanded by competitive marketplace. Modern products (such as automobiles, dishwashers, cameras, ATMs, medical equipment, space craft, communication satellites, etc.) and manufacturing equipment (such as 3D printers, CNC machines, industrial robotics, and autonomous systems, etc.) contain numerous computers and mechatronics modules. Their creations require engineers to be able to combine mechanical, electric, electronic and software subsystems using advanced scientific and engineering knowledge.

This course introduces to graduate students the basic mechatronics system components, and the design principles of using mechatronics to meet functionality requirements of products, processes and systems. Several lab-oriented assignments and team-based course projects are presented with innovative case studies in diverse application domains. The course will also prepare the students to read literature, understand real-world problems, and identify possible innovations to the field.

The course is a combined lecture and laboratory teaching. The Labs will require students to use a provided micro-controller kit to finish hardware development assignments. The course is intended for students who plan to have a career in the areas of product design and development, manufacturing process development, robotics, automation, technology management, innovation and entrepreneurship, etc.

Learning Objectives

After completing this course, students will be able to:
- analyze modern mechatronics components;
- explain the underlying principles and alternatives for mechatronics systems design;
- select mechatronics components and appropriate technologies for diverse domains of applications;
- create and devise realistic industrial systems;
- work as part of a team on practical mechatronics systems.

Prerequisites: none

Recommended Preparation: Undergraduate engineering or physical sciences degree; computer programming (C particularly recommended) on the level of ITP 165 or CSCI 102. The material and assignments will assume students have *hand-on skills* and are comfortable with *computer programming*.

Required Textbook

- "Mechatronics," Sabri Cetinkunt, Wiley, 2015 (ISBN-13: 978-1118802465).

Supplemental References

- "Mechatronics," Williams Bolton, Pearson, 2018 (ISBN-13: 978-1292250977).
- "Fundamentals of Mechatronics," Musa Jouaneh, Cengage Learning, 2011 (ISBN-13: 978-1111569013).
- "Mechatronics: a Foundation Course", Clarence de Silva, CRC Press, 2010 (ISBN-13: 978-1420082111).
- "Mechatronics Systems Fundamentals", Rolf Isermann, Springer, 2005 (ISBN-13: 978-3540497677).
- "Automation, Production Systems, and Computer-Integrated Manufacturing," Mikell P. Groover, Prentice Hall, 2008 (ISBN-13: 978-0132393218).

Grading Policy

The first part of the course will include problem assignments and will be capped into a midterm exam. A product dissection project will be assigned. In the second part of the course, students will be required to do an application development project. The grading for the class will be determined using the following weights:
- Problem assignments…………………… 35%

- Midterm……………………………………… 20%
- Product dissection project…………….. 15%
- Application development project … 25%
- Participation………………………………… 5%

Total Score……………………………………… 100%

Problem Assignments: Students will be given a week for each assignment. An assignment will consist of solving problems that correspond to the materials covered in the previous week. There will be 7 problem assignments. Most assignments are hands-on and required to use the microcontroller board that will be provided to the students in the beginning of the class. Assignments are due at the start of the next class. Submission will be accepted for credit up to one class period after the due date for 50% credit. There will be no acceptance after one week.

Midterm Exam: One examination will be given in the middle of the semester.

Product dissection project: The objective of the product dissection project is to help the students to learn the design of an existing mechatronics system product in depth. A project team will have 3 students. Each team is expected to select a product, read related materials, and dissect the product to understand and modify the product. The students are required to write a dissection study report and present their findings in the class. The study report requirements will be discussed in the class with sample reports given in Blackboard. Some example products dissected before include toy robot, laser printer, Roomba, e-scooter, inkjet printer, hand-held sewing machine, microwave heater, extruder-based 3D printer, etc. Each project team will propose products to study and discuss them with the instructor to finalize it in the beginning of the project.

Application Development project: The objective of the application development projects is to help the students to gain hands-on experience by using learned materials in solving real world problems. Each project team will have 3 students. They are expected to work together to accomplish the assigned tasks. In the application development project, each team is expected to develop a mechatronics system application to solve a non-trivia problem. Formal project proposals should be submitted and approved by the instructor. The final project should include a presentation with a working system demonstration and a technical report. The technical report requirements will be discussed in the class with sample reports given in Blackboard. Some example project topics include auto-bead machine, automated 3D printing system, salad machine, wearable gimbal for camera, robotic arm, automated cooktop, etc. Each project team will propose project ideas and discuss them with the instructor to finalize the project topic in the beginning of the project.

Participation: Participation in the class is required. Random roster calls will be made over the semester to determine the participation. Bonus points are available for enthusiastic participation in class. If you miss a class, please work with your fellow students to catch up on what you missed. Please turn cell phones off or put them in vibrate mode before coming to class.

Tentative Course Schedule

There is a lecture session each week with lab-related assignments.

Week #	Lecture - Wednesday (6:30~9:50 pm)	Lab / Assignment	Reading / Project
1	**Lecture 1** Aug. 23 - Course introduction and mechatronics systems	Self-study on related prerequisites.	Help to form project team (3 students/team)
2	**Lecture 2** Aug. 30 - Case study of a mechatronics system; product dissection and smart product development	Assignment 1 assigned	Product dissection assigned.
3	**Lecture 3** Sept. 6 - Introduction of micro-controllers and programmable logic controllers for automation	Assignment 2 assigned	
4	**Lecture 4** Sept. 13 -Electrical components; digital and analog I/O; and A/D and D/A converters	Assignment 3 assigned	Dissection product selection due.
5	**Lecture 5** Sept. 20 - Actuators and motor control; discussion of actuator selection	Assignment 4 assigned	
6	**Lecture 6** Sept. 27 -Mechanical components & mechanisms, including fastening components and 3D-printed novel mechanisms	Assignment 5 assigned	
7	**Lecture 7** Oct. 4 -Sensors, including vision sensors and a discussion of sensor selection		Application development project assigned.
8	**Lecture 8** Oct. 11 -*Product Dissection Presentation*		- Product dissection report due
9	**Lecture 9** Oct. 18 -**Midterm Exam** & Application development project discussion	Assignment 6 assigned	
10	**Lecture 10** Oct. 25 -Programmable motion control and applications, including Laplace transforms and PID control		- Application development topic due.

11	**Lecture 11** Nov. 1 - Numerical control manufacturing (machining and accumulation); introduction of Digital Twins and Industrial 4.0, and a motion testbed	Assignment 7 assigned	
12	**Lecture 12** Nov. 8 -Application: Digital design and 3D printing systems; and recent 3D printing developments		Visit **WESTEC 2023** (Nov. 7-9, Long Beach, CA)
13	**Lecture 13** Nov. 15 -Application: Robotics, 3D scanning and user interaction systems; Introduction of flexible electronics and wearable products; and project discussion		
14	**Lecture 14** Nov. 22 -**Thanksgiving recess** (no class)		
15	**Lecture 15** Nov. 29 -*Application development project presentation* of methods and implementations		
Final	Dec. 6 (7-9 pm) - ***Application development project demonstration*** of functional devices (Final Exam Date - Refer to the final exam schedule in the USC Schedule of Classes at www.usc.edu/soc)		Application development project report due -Final Summative Experience required by the university.

Academic integrity:

The University of Southern California is foremost a learning community committed to fostering successful scholars and researchers dedicated to the pursuit of knowledge and the transmission of ideas. Academic misconduct is in contrast to the university's mission to educate students through a broad array of first-rank academic, professional, and extracurricular programs and includes any act of dishonesty in the submission of academic work (either in draft or final form). This course will follow the expectations for academic integrity as stated in the USC Student Handbook. All students are expected to submit assignments that are original work and prepared specifically for the course/section in this academic term. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from

the instructor(s). Students suspected of engaging in academic misconduct will be reported to the Office of Academic Integrity.

Other violations of academic misconduct include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the [student handbook](#) or the [Office of Academic Integrity's website](#), and university policies on [Research and Scholarship Misconduct](#).

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Course Content Distribution and Synchronous Session Recordings Policies

USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relationship to the class, whether obtained in class, via email, on the internet, or via any other media. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Statement on Academic Conduct and Support Systems

Academic Integrity:
The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, comprises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It

stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the student handbook or the Office of Academic Integrity's website, and university policies on Research and Scholarship Misconduct.

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

Counseling and Mental Health - *(213) 740-9355 – 24/7 on call*
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide and Crisis Lifeline - *988 for both calls and text messages – 24/7 on call*

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

[Relationship and Sexual Violence Prevention Services (RSVP)](#) - *(213) 740-9355(WELL) – 24/7 on call*
Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

[Office for Equity, Equal Opportunity, and Title IX (EEO-TIX)](#) - *(213) 740-5086*
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

[Reporting Incidents of Bias or Harassment](#) - *(213) 740-5086 or (213) 821-8298*
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

[The Office of Student Accessibility Services (OSAS)](#) - *(213) 740-0776*
OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

[USC Campus Support and Intervention](#) - *(213) 740-0411*
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

[Diversity, Equity and Inclusion](#) - *(213) 740-2101*
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

[USC Emergency](#) - *UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call*
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

[USC Department of Public Safety](#) - *UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call*
Non-emergency assistance or information.

Office of the Ombuds - *(213) 821-9556 (UPC) / (323-442-0382 (HSC)*
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - *(323) 442-2850 or* otfp@med.usc.edu
Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.