

ECE 491: Mechatronic Systems Design Laboratory

Credit Hours	Undergraduate: 4
Course Goal	The goal of this course is to become familiar with the design, fabrication, and testing of the complete mechatronic system in the form of an autonomous driving car.
Description	Mechatronic systems encompass the integration of electrical and mechanical components, sensors, actuators, microcontrollers and control. The course will provide a hands-on introduction to the design of a complete mechatronic system. The students will build and perfect autonomously driving model cars, and compete on a closed circuit track as well as potential external autonomous car competitions.
Prerequisite	CS107 or CS 109, ideally ECE310, ECE 225, and some C programming experience
Reference Texts	J.E. Carryer, R.M. Ohline, T.W. Kenny, "Introduction to Mechatronic Design," Prentice Hall <i>Mechatronics: mechanical systems interfacing</i> by D.M. Auslander
Major Topics	<ol style="list-style-type: none"> 1. Introduction to mechatronics 2. Embedded systems design <ol style="list-style-type: none"> a. Microcontroller architecture b. Programming review 3. Mechatronic Hardware <ol style="list-style-type: none"> a. Motors and controllers b. Servos c. Power systems d. Sensors & Encoders 4. Hardware/Software Integration <ol style="list-style-type: none"> a. IO Integration/PWM Control b. PID review and theory c. Filtering and integration.
Grading	Class Participation ----- 5% In class quizzes (4 total, each 2.5%) ----- 10% Lab Checkoffs (10 total, each 1%) ----- 10% Project (Proposal 5%, Progress report 2.5%, Final Presentation 5%, Final Report 7.5%) ----- 20% Contests (first round 10%, second round 15%) ----- 25% Exams: (Midterm Exam: 10% and Final Exam: 20%) ----- 30%
Instructor	Igor Paprotny Email: paprotny@uic.edu URL: www1.ece.uic.edu/~paprotny Tel: 312-996-6016 Office Hours: Thursday 3:00 pm to 5:00 pm, Office Location: SEO 1115
TAs	John Sabino (jsabin3@uic.edu) TA Hours: Friday 1:00 – 3:00 pm 4251 SELE
Course Access	Through Course Website on UIC Blackboard: http://blackboard.uic.edu
Class and Lab Time	Lecture Class (Room # 101 LH): Tuesday 5:00 pm – 6:50 pm (6:30 pm) Lab Class (Room #4251 SELE): Thursday 11:00 – 12:50 pm + Friday TBD (open hours)

Expected Lab Participation – min 8h/student/week

Professional
and Ethics
Policy

Read announcements on Blackboard (BB) regularly.
Promptly review any notes posted on BB.

Take exams on scheduled dates. No make-up exams or alternate arrangements will be allowed unless for reasons beyond a student's control (supporting documents required) or allowed by university policy (below).

Submit homework, lab and project reports on time. Laboratory assignments and project reports submitted late will receive no (zero) credit.

Policy on
Academic
Dishonesty

Dishonest actions by students will result in appropriate disciplinary action. Intentional use or attempt to use unauthorized assistance, materials, or information, in any quiz, examination, or assignment, may lead to penalties such as a failing grade. College of Engineering and University guidelines will be followed.

Policy on
Observance of
Religious
Holidays

Students who wish to observe their religious holidays must notify the faculty member by the tenth day of the term that they will be absent unless their religious holiday is observed on or before the tenth day. In such cases, the student shall notify the faculty member at least five days in advance of the date when he or she will be absent. The faculty member shall honor the request and not penalize the student for missing class. If an examination or project is due during the absence, the student shall be given an assignment equivalent to the one completed by those students in attendance.

UIC Disability
Accommoda-
tion.

http://www.uic.edu/depts/oaa/disability_resources/faq/accommodations.html

Grievance
Procedure

http://www.uic.edu/depts/oaa/faculty/FINAL_VERSION_STUDENT_PROCEDURES.pdf

Exam Notes
Policy

Midterm and final exams are open book. However, I recommend you consolidate your notes.

Lab Safety
Policy

During your lab you will be fabricating actual microdevices. This requires that you will be working with potentially harmful chemicals, materials and equipment. You will receive training to operate and conduct the lab safely. Reckless or dangerous behavior will not be tolerated, and may result in expulsion from the laboratory sessions.

Class Schedule (Tentative)

Lecture Week		Lecture and Demo Topic	Project Checkpoint
1.	1/10	Introduction to Mechatronics Design: <ul style="list-style-type: none"> Definitions Mechatronic system, review of preliminaries Introduction to autonomous car Demo: Lab prep	None
2.	1/17	FRDM-KL25Z overview: <ul style="list-style-type: none"> Interfacing with the real world IO/GPIO/ADC electronics construction practices Demo: Soldering, FRDM-KL25Z, Kinetis Studio	Team formation, Soldering circuit
3.	1/24	Hardware Design: Actuation <ul style="list-style-type: none"> DC Motors MOSFET review Motor controllers Demo: Altium PCB Design	Hello World, Blink LED
4.	1/30 (Q1)	Hardware Design: Actuation <ul style="list-style-type: none"> PWM for motor control Steering, PWM for steering 	Written project proposal due Fri. 2/3, car chassis clean and checked
5.	2/7	Hardware Design: Power Delivery <ul style="list-style-type: none"> Power conditioning DC-DC converter 	Drive motor from battery PCB #1 due Friday 2/13 (noon)
6.	2/14 (Q2)	Hardware Design: Sensing <ul style="list-style-type: none"> Overview, velocity sensing Encoders, Velocity sensing 	CPU board driving stalled motor and RC servo from battery
7.	2/21	Hardware Design: Sensing <ul style="list-style-type: none"> OP-Amp review Line camera 	Open loop Figure 8 (PCB on car) Lab Clean
8.	2/28	Software Design: Control <ul style="list-style-type: none"> Modeling of the car Friction Velocity control 	Bench top line following, drop and run
9.	3/7 (Q3)	Software Design: Control <ul style="list-style-type: none"> Steering control Non-holonomic control PID velocity/steering control 	Closed loop track following PCB #2 due Fri. 3/10 (noon) Progress report due Fri. 3/10
10.	3/14	Midterm Exam	Velocity control, Figure 8 ($> m/sec$).sensor mech. Response: Lab Clean
	3/21	SPRING BREAK	
11.	3/28	Software Design: Control <ul style="list-style-type: none"> PID Revisited filtering 	Practice course and step response
12.	4/4	HW and SW robustness	Round 1 contest – Friday 4/7
13.	4/11	Mechatronic systems – Examples I	
14.	4/18	Exam Review	
15.	4/25	Student oral presentations	Round 2 contest – Friday 4/28 Final report due Friday 4/28 at 5 pm
16.	TBD	Final Exam	