ENGR 4020: Mechatronics System Design

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Office Hours: By Appointment and
M-T-W 12PM-2PM
R 1PM-3PM

Course Caption

Mechatronics is the multidisciplinary union of mechanical, electrical, and computer engineering. This course employs knowledge from these disciplines to explore mechanics, electrical sensing, control, and actuation, and computer programming of mechatronic devices. Students will design, build and program electromechanical devices to autonomously perform specific tasks.

Required Resources

- MATLAB and Simulink Student Suite: $99
  Required Add On: Robotics System Toolbox
  Optional Add on: Computer Vision Toolbox, useful for self study and extension
- AutoCAD Student Edition: Free
- kiCAD: Free

Course Learning Outcomes

By the conclusion of this course, students will:

1. Design mechatronic systems to complete a specific task
2. Implement real-time control to mechatronics systems
3. Program a microcontroller to control a mechatronic system
4. Communicate their work effectively in written lab documentation and project reports
5. Work effectively as a team to design and implement a mechatronic system
6. Complete and document laboratory experiments with mechatronic systems
7. Be able to learn new software tools through self study
8. Be able to read and interpret a datasheet

Prerequisites

ENGR 2110, 3220, 3280

Credit

4 Credit Lecture + Lab

Time and Room

M-W-F, 2:00-3:00 PM, *Lecture* Hartung 314
TH, 3:00-4:50 PM, *Lab* Hartung 314

Attendance

Attendance will be taken by a sign in sheet. If you are going to miss class, please inform the instructor BEFORE class by email or phone. You are responsible for all materials presented in the class, whether or not you are present in lecture. A maximum of three (3) unexcused absences are allowed for any and all reasons. No explanation is necessary for this absence. Unexcused absences above this number will affect the final course grade according to the following schedule.

First two absences: No effect on final grade
1 more absence: Final grade lowered 1/2 letter grade
2 more absences: Final grade lowered 1 letter grade
3 more absences: Final grade of F assigned

Assignment Policy

If an assignment is given, it will be due by 4 PM on its due date. Late assignments will be penalized 20% for each business day it is late. Students will always complete assignments as a team, but the responsibility for editing and turning in will alternate between group members. All grades will be shared by team members unless there are extenuating circumstances.

Academic Integrity

As an institution of higher education committed to academic and Christian discovery, Anderson University expects faculty and students alike to maintain the highest standards of academic and personal integrity. "Anderson University seeks to support and promote qualities of academic honesty and personal integrity and regards cheating, plagiarism, and all other forms of academic dishonesty as serious offenses against the University community" (Faculty Handbook 4.23 Policy on Academic Integrity). See the student handbook for examples of plagiarism. Any detected Academic Integrity issues will result in a personal meeting with the instructor to determine if further corrective action is necessary, which may include failure of the assignment, failure of the course, and/or written notice of the infringement to the Provost which will be added to the student's permanent academic record.

Graded Requirements

Requirement	Point Value
Homework and Quizzes	100
Lab Assignments	200
Project Milestones and Reports	400
Final Project Competition and Report	300
Total	1000

Grading Scale

Average (%)	Letter Grade
93.0	A
90.0	A-
87.0	B+
83.0	B
80.0	B-
77.0	C+
73.0	C
68.0	C-
65.0	D
< 65.0	F

Academic Support Statements

Accessibility and Accommodations

Important: If you have any special accessibility needs (i.e. use of screen reading software, captioning, etc.), please notify your professor and the Director of Disability Services for Students (Kissinger Academic Center for Excellence, Nicholson Library; 765-641-4223) as soon as possible.

If you anticipate or experience physical or academic barriers based on disability, you are encouraged to contact the Director of Disability Services for Students (Kissinger Academic Center for Excellence, Nicholson Library; 765-641-4223). To receive reasonable accommodations, you must contact Disability Services for Students, provide documentation, and request accommodations. You should also notify your course instructor during the first week of classes.

Kissinger Academic Center for Excellence

The Kissinger Academic Center for Excellence (KACE), located on the ground floor of the Nicholson Library, provides excellent resources in all areas of study regardless of academic ability. Many students can benefit from academic support and/or sharpen their skills through studying with others. In addition, excellent students often maintain their skills by working as

peer tutors. The services are available for all enrolled students at no charge. For information, call 765-641-4225.

Course Schedule

MT-1	1/15/20	Intro to Mechatronics
MT-2	1/17/20	Programming Basics and Pushbuttons
MT-3	1/22/20	Work Day For Milestone 1
MT-4	1/24/20	One Directional Motor Control
MT-5	1/27/20	H-Bridges
MT-6	1/29/20	PWM
MT-7	1/31/20	Servomotor Control
MT-8	2/3/20	Analog Input
MT-9	2/5/20	Work Day for Milestone 2
MT-10	2/7/20	Analog Input with Optosensors and AutoCAD Intro
MT-11	2/10/20	AutoCAD Self Study [no class meeting]
MT-12	2/12/20	AutoCAD Self Study [no class meeting]
MT-13	2/14/20	Encoders
MT-14	2/17/20	Functions and Mechanical Design 1
MT-15	2/19/20	Mechanical Design 2
MT-16	2/21/20	Proximity Sensing
MT-17	2/24/20	Motors
MT-18	2/26/20	Interrupts and Timers
MT-19	2/28/20	Control Systems Review
MT-20	3/2/20	Intro to MATLAB for Controls
MT-21	3/4/20	Work Day for Milestone 3
MT-22	3/6/20	PID Control
MT-23	3/9/20	State Space Control Basics
MT-24	3/11/20	Full State Feedback
MT-25	3/13/20	Full State Control Design with MATLAB [no class meeting]
MT-26	3/23/20	Observer Design
MT-27	3/25/20	Combined Control
MT-28	3/27/20	State Space Control in Mechatronic Systems
MT-29	3/30/20	Printed Circuit Board Layout 1
MT-30	4/1/20	PCB Layout 2
MT-31	4/3/20	Gears
MT-32	4/6/20	IMU and GPS
MT-33	4/8/20	Work Day for Milestone 4
MT-34	4/15/20	Kalman Filter
MT-35	4/17/20	Computer Vision Fundamentals and Edge Detection
MT-36	4/20/20	Edge Detection
MT-37	4/22/20	Line Detection
MT-38	4/24/20	Work Day for Final Competition
MT-39	4/27/20	Final Competition Day 1
MT-40	4/29/20	Work Day for Final Competition
MT-41	5/1/20	Assessment and Documentation [no class meeting]

Lab Schedule

Lab 1	1/16/20	Intro to mbed, Digital and Analog Outputs
Milestone 1	1/23/20	Programming the mbed
Lab 2	1/30/20	Motor Control
Milestone 2	2/6/20	Open Loop Navigation
Lab 3	2/13/20	Laser Cutter
Lab 4	2/20/20	Optical Encoder
Lab 5	2/27/20	Hall Effect Encoder
Milestone 3	3/5/20	Return and Object to Base
Lab 6	3/12/20	Interrupt Task Execution
Lab 7	3/26/20	Control Implementation
Lab 8	4/2/20	PCB Fabrication
Milestone 4	4/9/20	Sort Objects and Deliver
Lab 9	4/16/20	Kalman Filtering
Lab 10	4/23/20	Computer Vision
Final Competition Day 2	4/30/20	Final