SE 423 – INTRODUCTION TO MECHATRONICS
http://coesls.ece.uiuc.edu/ge423

SPRING 2020

Lecture M W 11:00AM to 11:50AM, Room 305 Materials Science & Engineering Building
Lab AB1 Wednesday 3:00PM to 6:00PM Room 302 Transportation Building
Lab AB3 Thursday 9:00AM to 12:00PM Room 302 Transportation Building
Lab AB2 Thursday 3:00PM to 6:00PM Room 302 Transportation Building

Instructor:  Dan Block Email:  d-block@illinois.edu
Office:  3005 ECE Building Phone: 217-244-8573
Office hours:  Monday and Wednesday 12-1PM, Tuesday 3-5PM and by appointment.

TA:  Xiao, Chenzhang Email:  cxiao3@illinois.edu
Office hours:  TBD

Prerequisite:  SE 320 or equivalent Control Systems course, C programming experience is highly recommended.

References:

Due Dates:  Homework assignment due dates are listed below in the time schedule. No late submissions accepted for homework.
The Lab “check off” procedure will be explained thoroughly in your lab section.

Quizzes:  I do not intend to have lecture quizzes/tests but that could change depending on class attendance in lecture.

Semester Project:  This is where you put it all together. I still have not made up my mind on the exact final project for this semester but more than likely each group will be able to choose from a number of different project ideas. You will work in groups of 4 to complete the project. There will be specified “checkpoint” due dates to make sure you keep on the right track and do not wait until the last week to finish all the work.

Grading of this project is heavily focused on the amount of work you put into it throughout the semester and not necessarily on the success of the project. So even though this is a group project you will be graded individually on the amount of work you put into the project. Groups will have at least one weekly meeting with me (or one of the TAs) to demonstrate progress but I expect we will be meeting even more often as you have questions, etc. with your project.
Grading: All students are encouraged to attend every class period. The lecture content will follow the laboratory assignments in an obvious manner, so failure to attend a lecture will be a severe handicap in the lab. The semester project should represent the entire content of the class and is representative of a final exam grade.

Check-off on all labs 25%
Homework 30%
LABVIEW Assignments 5%
Semester Project 40%

Policy on cheating
Students are encouraged to work together on homework assignments; however, original solutions are required. For homework, the threshold of cheating is defined as follows: If the person grading the assignments is able to identify students who have worked together by their solutions or specific aspects of their solution approach, then the solutions are not original! A homework or other assignment where cheating is found will automatically be given a zero grade.

Copying of information from websites without proper citation is considered cheating. Any copying of information without proper citation will result in a zero grade for the assignment.

SE 423 – Introduction to Mechatronics, Spring 2020

<table>
<thead>
<tr>
<th>Lecture Dates</th>
<th>Topics</th>
<th>Current Lab</th>
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<tbody>
<tr>
<td>Wednesday January 22, 2020</td>
<td>Introduction, Walk through Syllabus, What is Mechatronics? What parts are we focusing on? Introduction to TI DSP and ARM processors and TI MSP430 microcontrollers. What are System and Peripheral Registers? Hex numbers and Bitwise operators.</td>
<td>Lab #1</td>
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<td>Wednesday, January 29, 2020</td>
<td>- Time Loading Diagrams - SYS/BIOS: 1) Clock and SWIs 2) HWI and Timer 3) TSK, SEM and QUE - Priority Structure of SYS/BIOS - SYS/BIOS Examples</td>
<td>Lab #1/Finish Soldering Microcontroller</td>
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<td>Monday, February 3, 2020</td>
<td>- Pullup/Pulldown resistor for Digital inputs - printf, sprintf, null terminated strings - RS 232 Serial Port, The ASCII character set - SYS/BIOS Example for I2C communication</td>
<td>Lab #2</td>
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<td>Wednesday, February 5, 2020</td>
<td>HW #1 Due - Microcontroller Default Starter Project Review - Go over LabView TCP/IP send and receive code - SYS/BIOS Examples Continued</td>
<td>Lab #2</td>
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<td>Monday, February 10, 2020</td>
<td>- Functions in C, Passing parameters by value or reference - What is an Optical Encoder? A DAC? - What is a Digital I/O port? Driving LEDs - What is a PWM signal? How to generate a PWM signal on the microcontroller. - The TMS320F28335 processor, SYS/BIOS Examples Continued</td>
<td>Lab #3</td>
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<tr>
<td>Wednesday, February 12, 2020</td>
<td>- H-bridge, Example circuit - Friction Compensation - SYS/BIOS Examples Continued</td>
<td>Lab #3</td>
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| **Monday, February 17, 2020** | - SPI and I2C serial protocols  
- SPI interfacing example: The LS7366R-S Chip  
- I2C interfacing example: The MAX7321 Chip  
- What is an ADC? Talk about sampling, hardware interrupts  
- TMS320F28335’s ADC peripheral.  
- Filter design and implementation, Filter Examples in Matlab. | Lab #4 |
| **Wednesday, February 19, 2020** | - Serial interfacing  
- Glue logic examples for serial interfacing | Lab #4 |
| **Monday, February 24, 2020** | - Review Lab #4 Take Home Exercise  
- SPI peripheral on the TMS320F28335 and AM5729 | Lab #4 |
| **Wednesday, February 26, 2020** | - Demo Circuit Board layout software EagleCAD | Lab #4 |
| **Monday, March 2, 2020** | - Developing Linux applications for Embedded Linux devices.  
- The RC Servo Motor. How to setup a PWM signal for the RC Servo Motor  
- PID controller. Ziegler-Nicholas Tuning Method  
- Integral Windup. Rollover issues.  
- Robot’s speed control algorithm with steering. | Lab #5 |
| **Wednesday, March 4, 2020** | - Linux Boot procedure. Modify the Linux Kernel. Creating the Linux file system.  
- Using Shared Memory to communicate between a Linux application and a DSP application running simultaneously.  
- Cache memory. Why is it needed, and what issues does it cause when working with Dual Processor or Direct Memory Access (DMA). | Lab #5 |
| **Monday, March 9, 2020** | - Review Tasks  
- The IR Sensor  
- The MaxSonar Ultrasonic Sensor  
- The Digital Compass  
- The Rate Gyro  
- The LADAR (Laser Range Finder)  
- Wall-following, Inner-loop and Outer-loop controllers  
- Review what is expected with your LabView application. | Lab #6 |
| **Wednesday, March 11, 2020** | - Coordinate Transformations  
- Dead-Reckoning  
- Dealing with the Drift of the integral of the rate gyro  
- Finding Landmarks with the different distance sensors. | Lab #6 |
| **Monday, March 16, 2020** | Spring Break | Spring Break |
| **Wednesday, March 18, 2020** | Spring Break | Spring Break |
| **Monday, March 23, 2020** | - Review Structures and Unions and Bit Fields, pointers and function parameters  
- Talk about the LADAR. How it works and How we interface with it.  
- Go through example LADAR interface code. | Lab #7 |
| **Wednesday, March 25, 2020** | - CMOS Cameras and the BAYER format.  
- Start introduction to vision processing. | Lab #7 |
| **Monday, March 30, 2020** | - Color Camera DSP VPIF peripheral and source code.  
- Introduce Vision Processing  
- The CMOS Camera  
- The BAYER format  
- Centroid calculation | Lab #7 |
| **Wednesday, April 1, 2020** | - RGB color space  
- HSV color space  
- Vision Segmentation algorithm finding multiple blobs. | Lab #7 |
| **Monday, April 6, 2020** | - Vision Segmentation algorithms.  
- Robot following Flash light / Bright Color | Lab #8 |
<p>| <strong>Wednesday, April 8, 2020</strong> | - Vision Segmentation algorithms. | Lab #8 |</p>
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<tr>
<th>Date</th>
<th>Activities</th>
<th>Status</th>
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| Monday, April 13, 2020| - Using camera to calculate distance to an object.  
                        - Using Landmarks to update robot’s position                                                        | Lab #8        |
| Wednesday, April 15, 2020| - Finish up Vision Segmentation algorithms.  
                          - Path Planning.  
                          - Bug Algorithms for avoiding obstacles in robot’s path.  
                          - A* (A star) path planning algorithm                                                              |               |
| Monday, April 20, 2020| - A* (A star) path planning algorithm                                                                | Semester Project|
| Wednesday, April 22, 2020| - A* (A star) path planning algorithm                                                                | Semester Project|
| **Wednesday, April 22, 2020** | **HW #5 Due**                                                                                    |               |
| Monday, April 27, 2020| - Dead-Reckoning  
                          - Using Landmarks to update robot’s position  
                          - Using Kalman filtering to help mix OptiTrack motion capture data with Dead-Reckoned robot position. | Semester Project|
| Wednesday, April 29, 2020| - More on Kalman Filtering.  
                          - Go through Kalman filtering code.                                                                | Semester Project|
| Monday, May 4, 2020| - Go through Kalman filtering code.  
                          - Go through move to XY point code.                                                                 | Semester Project|
| Wednesday, May 6, 2020| - Go through move to XY point code.                                                                  | Semester Project|
| **Wednesday, May 6, 2020** | **HW #6 Due**                                                                                    |               |
| **Monday, May 11, 2020** | **8AM-11AM**                                                                                      | Project Presentations|

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