GE 423 – INTRODUCTION TO MECHATRONICS

http://coecsl.ece.uiuc.edu/ge423

SPRING 2014

Lecture M W 11:00AM to 11:50AM, Room 106B3 Transportation Building
Lab AB1 Tuesday 3:00PM to 6:00PM 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: 237A Everitt Lab — Phone: 244-8573
Office hours: Monday 12-1PM, Tuesday 12-1PM, and by appointment.

Textbook: NOT REQUIRED but recommended. Herbert Schildt, *Teach Yourself C, Third Edition*, Osborne McGraw-Hill. 1997.

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

References:

- J. Edward Carryer, R. Matthew Ohline and Thomas W. Kenny. *Introduction to Mechatronic Design.* Prentice Hall, 2011.
- David G. Alciatore and Michael Histand. *Introduction to Mechatronics and Measurement Systems, 2nd Edition*. McGraw-Hill, Boston, 2003. http://www.engr.colostate.edu/~dga/mechatronics/
- Greg Perry with Sanjaya Hettihewa. *SAMS Teach Yourself Visual Basic 6 in 24 Hours, Second Edition*, Sams Publishing. 1998.
- John Billingsley. *Essentials of Mechatronics*, Wiley-interscience. 2006.
- Roland Siegwart and Illah R. Nourbakhsh. *Introduction to Autonomous Mobile Robots*, MIT Press. 2004.
- Gene F. Franklin, J. David Powell and Abbas Emami-Naeini. *Feedback Control of Dynamic Systems Third Edition*, Addison-Wesley Publishing Company. 1994.

Due Dates: **Homework** assignment due dates are listed below in the time schedule. No late submissions will be accepted for homework.
The **Lab** "check off" procedure will be explained thoroughly in your lab section. The due dates are posted at http://coecsl.ece.uiuc.edu/ge423/Lab Due Dates.htm

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 it will entail an obstacle course that will require your group to build "pickup" mechanisms for the robot car and program the robot to navigate the course. 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 will be 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	30%
Homework	30%
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.

GE 423 – Introduction to Mechatronics, Spring 2014

Lecture Dates	Topics	Current Lab
Wednesday January 22, 2014	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.	Lab #1
Monday, January 27, 2014	- Microcontroller Default Starter Project - The CCSv5.4 Development Environment - Timer and Digital I/O Registers - Scheduling: 1) Single Process Application 2) Hardware Interrupt Scheduler 3) Real-Time OS, DSP/BIOS Scheduler	Lab #1
Wednesday, January 29, 2014	- Time Loading Diagrams - DSP/BIOS: 1) PRD and SWIs 2) HWI and CLK 3) TSK, SEM and QUE - Priority Structure of DSP/BIOS - DSP/BIOS Examples	Lab #1/Finish Soldering Microcontroller
Monday, February 3, 2014	- Pullup/Pulldown resistor for Digital inputs - printf, sprintf, null terminated strings - RS 232 Serial Port, The ASCII character set - DSP/BIOS Example for I2C communication	Lab #2
Wednesday, February 5, 2014 **HW #1 Due**	- Microcontroller Default Starter Project Review - Go over VB TCPIP send and receive code - DSP/BIOS Examples Continued	Lab #2
Monday, February 10, 2014	- 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, DSP/BIOS Examples Continued	Lab #3
Wednesday, February 12, 2014	- H-bridge, Example circuit - Friction Compensation - DSP/BIOS Examples Continued	Lab #3
Monday, February 17, 2014	- SPI and I2C serial protocols	Lab #4

	- 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.	
Wednesday, February 19, 2014	- Parallel interfacing vs. serial interfacing - Glue logic, Read Cycle and Write Cycle - Glue logic examples for parallel and serial interfacing	Lab #4
Monday, February 24, 2014	- Review Lab #4 Take Home Exercise - SPI peripheral on the TMS320F28335 and the OMAPL138. - Glue logic interfacing examples continued.	Lab #4
Wednesday, February 26, 2014 **HW #2 Due**	- Demo Circuit Board layout software EagleCAD	Lab #4
Monday, March 3, 2014	- Developing Linux applications for Embedded Linux devices. - Continue EagleCAD software demonstration. - 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 5, 2014	- Linux Boot procedure. Modify the Linux Kernel. Creating the Linux file system.	Lab #5
Monday, March 10, 2014	- 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 VB application.	Lab #6
Wednesday, March 12, 2014 **HW # 3 Due**	- 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 17, 2014	- Review Structures and Unions and Bit Fields, pointers and function parameters - Talk about how the DSP communicates to the ATMEL microcontroller through I2C - Talk about the LADAR. How it works and How we interface with it. - Go through example LADAR interface code.	Lab #7
Wednesday, March 19, 2014	- CMOS Cameras and the BAYER format. - Start introduction to vision processing.	Lab #7
Monday, March 24, 2014	Spring Break	Spring Break
Wednesday, March 26, 2014	Spring Break	Spring Break
Monday, March 31, 2014	- Color Camera DSP VPIF peripheral and source code. - Introduce Vision Processing - The CMOS Camera - The BAYER format - Centroid calculation	Lab 7
Wednesday, April 2, 2014 **HW #4 Due**	- RGB color space - HSV color space - Vision Segmentation algorithm finding multiple blobs.	Lab 7
Monday, April 7, 2014	- Vision Segmentation algorithms. - Robot following Flash light / Bright Color	Lab #8
Wednesday, April 9, 2014	- Vision Segmentation algorithms.	Lab #8

Monday, April 14, 2014	- Vision Segmentation algorithms. - Using camera to calculate distance to an object. - Using Landmarks to update robot's position	Lab #8
Wednesday, April 16, 2014	- Vision Segmentation algorithms.	Lab #8
Monday, April 21, 2014	- 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).	Semester Project
Wednesday, April 23, 2014 **HW #5 Due**	Demonstration of NS Basic application development for the Apple Iphone/Ipod Touch.	Semester Project
Monday, April 28, 2014	- 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 30, 2014	- More on Kalman Filtering. - Go through Kalman filtering code.	Semester Project
Monday, May 5, 2014	- Go through Kalman filtering code. - Go through move to XY point code.	Semester Project
Wednesday, May 7, 2014 **HW #6 Due**	- Path Planning. - Bug Algorithms for avoiding obstacles in robot's path. - Using two Landmarks to Triangulate the Robot's Position	Semester Project
Friday, May 16, 2014 **8:00AM-11:00AM**		**Project Presentations**