San José State University
Charles W. Davidson College of Engineering
Department of Mechanical Engineering

KT-ME 285 Mechatronic Systems Engineering
(Draft 09/23/2016)

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Office Hours:	After seminar on Monday and Wednesday, or by appointment
Class Meeting Information	Seminar: M & W 7:30 – 8:20 PM Lab: TBD (Both sessions in KT Confucius Classroom) First Session: 8/24/2016; Last Session: 12/12/2016 Plan to bring a computer with you (or share with a colleague) that can access the internet AND that has at least one USB port that can access a flash memory device, such as a USB drive.
Prerequisites:	BSME and at least an undergraduate course in Circuit Analysis and Computer Programming (Python, C, or C^{++})
Required Hardware:	Laptop or notebook computer that you can bring to class BeagleBone Black microcomputer, 5V/1A DC power supply, and Digilent Analog Discovery USB Oscilloscope (okay to share one with a colleague)

Web Pages and Messaging

Copies of the course materials such as the syllabus, informational handouts, etc., may be found on the Canvas course management site. You are responsible for regularly checking this website and the messaging system through MySJSU (or other communication system as indicated by the instructor) to stay on top of deadlines and announcements for the course. When you first log into Canvas, navigate to 'Settings' (from upper horizontal, dark blue menu bar), and the 'Ways to Contact', and make sure that the email account is set to one that you will check regularly.

Course Description

Concepts, elements, and practice for integrating hardware and software to create intelligent mechatronic systems.

Course Goals and Learning Objectives

The goals of this course are to help you:

- Understand the major conceptual pieces comprising a mechatronic system
- Get hands on experience with the common elements of mechatronic systems, such as sensors, actuators, interface hardware and methods, and microcontrollers.
- Get hands on experience integrating the elements into a mechatronic system.
- See how mechatronic systems can lead to more capable, robust, and adaptable electromechanical systems
- Become more comfortable with the terminology, components, opportunities, and challenges faced by colleagues in disciplines that contribute to the development of mechatronic systems other than your own discipline.
- Apply what you learn to design and build a mechatronic system

Learning Objectives

The student who successfully completes the course will be able to:

1. List and explain the major conceptual pieces comprising a mechatronic system and provide examples of mechatronic systems
2. Explain the basic structure of a microcontroller, the nature of IO ports, and the common peripheral subsystems found in most microcontrollers
3. Interface a microcontroller to sensors, actuators, and user I/O devices
4. Explain the need for and design signal conditioning strategies for signal sources
5. Explain the underlying operational principles and construction of electromagnetic actuators, in particular permanent magnet DC (PMDC) and stepping motors
6. Control the speed of PMDC motors by pulse width modulation (PWM)
7. Select and size an actuator for a particular application
8. Explain the essential features and applications of common communication protocols
9. Implement common communication protocols between a microcontroller and peripheral devices
10. Write embedded software to successfully interact with sensors, power interfaces, analog and digital IO ports, and other peripheral elements in the control of a mechatronic system
11. Conceive, design, and implement a mechatronic system that satisfies a particular need

Text

Molloy, Derek (2014). Exploring BeagleBone: Tools and Techniques for Building with Embedded Linux. ISBN: 978-111893512. (referred to below as, ExpBB)

The text is available at: (http://www.amazon.com/Exploring-BeagleBone-Techniques-Building-Embedded/dp/1118935128/ref=sr_1_1?s=books&ie=UTF8&qid=1416264201&sr=1-1&keywords=Exploring+BeagleBone%3A+Tools+and+Techniques+for+Building+with+Embedded+Linux&pebp=1416264168489) or http://www.wiley.com/WileyCDA/WileyTitle/productCd-1118935128.html.

Required Hardware

BeagleBone Black. There are many sources from which to obtain this board. See the list of distributors at: http://beagleboard.org/

5V DC regulated power supply with at least 1A continous output current. For example, http://www.adafruit.com/products/276

Digilent Analog Discovery USB Oscilloscope. (Note: you will use the 'scope in the lab sessions, which will be done in groups of two to three. If you know a colleague who will be in the class, you may share one of these between the two of you.) The Analog Discovery can be purchased from Digilent at: http://www.digilentinc.com/Products/Detail.cfm?NavPath=2,1040,1043&Prod=ANALOG-DISCOVERY

Library Liaison

Our liaison to the University Library is Yiping Wang <yiping.wang@sjsu.edu>, 408-808-2633. Yiping can help you make optimum use of information resources available to you through the University Library.

Dropping and Adding

Students are responsible for understanding the policies and procedures about add/drops, academic renewal, etc. Information on add/drops are available at http://info.sjsu.edu/home/schedules.html. Information about late drop is available at http://www.sjsu.edu/aars/policies/latedrops/policy/. Students should be aware of the current deadlines and penalties for adding and dropping classes.

Assignments and Grading Policy

Assessment for the purposes of determining your course grade will consist of evaluating your performance on homework assignments, laboratory projects, quizzes and/or examinations, and a final examination. Quizzes may take place in lecture and/or lab and *may* be unannounced (so keep up on your reading and studying for this class).

Weighting of Course Components

HW 10%, Laboratory Projects 20%, Term Project 20%, Individual Performance 10%, Quizzes and Exams 20%, Final Exam 20%.

Criteria for Assigning Letter Grades

The scores on you homework, laboratory projects, quizzes and exams, and final examination will be combined and totaled using the weighting scheme described above. A final letter grade will be determined from your overall performance (percentage) using the following criteria:
A 100 – 93%; A- 92 – 90%; B+ 89 – 87%; B 86 – 83%; B- 82 – 80%; C+ 79 – 77%; C 76 – 72%;
C- 71 – 69%; D+ 68 – 66%; D 65 – 62%; D- 61 – 59%; F <58%. Note: MAE must earn at least a grade of C- to pass the course.

The final examination for the course will be on 12/19/2016.

University Policies

Academic Integrity

Students in this course are expected to maintain high ethical standards in ***all*** matters pertaining to the course, including, but not limited to, examinations, homework, course assignments, presentations, writing, laboratory work, team work, treatment of class members, and behavior in class. Cheating and plagiarism are violations of the SJSU Policy on Academic Integrity S07-2 and will not be tolerated in the class. Students are expected to have read the Policy, which is available at:

http://www.sjsu.edu/studentconduct/docs/S07-2.pdf

Plagiarism is defined as, *the use of another person's original (not common-knowledge) work without acknowledging its source*.[1] Thus plagiarism includes, but is not limited to[2]:

- copying in whole or in part, a picture, diagram, graph, figure, program code, algorithm, etc. and using it in your work without citing its source
- using exact words or unique phrases from somewhere without acknowledgement
- putting your name on a report, homework, or other assignment that was done by someone else

Students are expected to familiarize themselves with how to avoid plagiarism. Several helpful resources can be found at:

http://studentaffairs.stanford.edu/communitystandards/integrity/plagiarism

I encourage students to collaborate on assignments, such as homework and lab reports, however what this means is that you can work together, decide on solution *strategies*, discuss what should be included in reports and how they should be organized, etc., but you ***may not*** copy answers in whole or in part (this includes program code), and you must put together your own lab reports. So for this class, all assignments are to be completed by the individual student unless otherwise specified. If you would like to include in your assignment any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Policy F06-1 requires approval of instructors.

Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The website for Student Conduct and Ethical Development is available at http://www.sjsu.edu/studentconduct/.

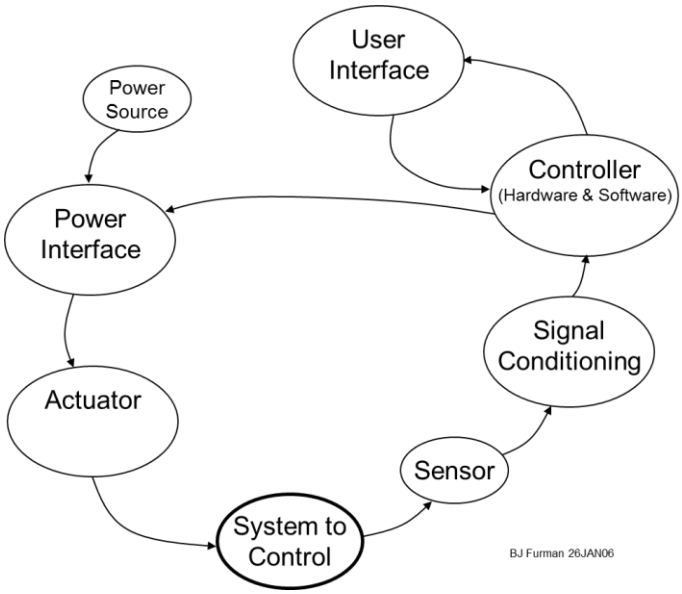
Campus Policy in Compliance with the American Disabilities Act

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with the DRC (Disability Resource Center) to establish a record of their disability.

[1] Definition adapted from "Defining and Avoiding Plagiarism: The WPA Statement on Best Practices," http://wpacouncil.org/positions/WPAplagiarism.pdf; and "What is Plagiarism?," http://studentaffairs.stanford.edu/communitystandards/integrity/plagiarism.

[2] Adapted from, "Avoiding Plagiarism," https://owl.english.purdue.edu/owl/resource/589/01/.

Mechatronics Concept Map



References

(In addition to these references, check out the tutorial web pages for the undergraduate ME106 course)

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Pont, M. J. (2001). *Patterns for Time-Triggered Embedded Systems: Building Reliable Applications with the 8051 Family of Microcontrollers*, Addison-Wesley, Harlow, England, ISBN: 0201331381.

Simon, D. E. (1999). *An Embedded Software Primer*, Addison-Wesley Professional, ISBN: 020161569X

Smaili, A. & Mrad, F. (2008). *Applied Mechatronics*, Oxford University Press, New York. ISBN: 978-0195307023

Stiffler, A. K. (1992). *Design with Microprocessors for Mechanical Engineers*, McGraw-Hill, New York.

Valvano, J. W. (2000). *Embedded Microcomputer Systems: Real Time Interfacing*, Thomson-Engineering, ISBN: 0534366422.

K-T ME 285 Course Schedule (tentative)

Wk.	Week	Subjects
1	8/24/2016	Enrollment, course organization and overview, overview of mechatronics, embedded systems Reading: beagleboard.org website; ExpBB - Chapter 4; Analog Discovery Quick Start videos (https://www.youtube.com/watch?list=PLSTiCUiN_BoJ0ZwU5wj73OO_7BI2NcihM&v=aYgFKIsrOYQ); and other resources (TBA) Lab 1: Basic Electronics Review and Test and Measurement Equipment
2	8/29/2016 9/7/2016	Basic circuit analysis and components, microcontroller hardware and peripheral systems, digital and analog IO with the BBB Reading: ExpBB - Chapter 4; BBB website http://beagleboard.org/; http://exploringbeaglebone.com/ Lab 2: Hello BeagleBone Black! Digital and analog IO with the BBB
3	9/7/2016	Power electronics for interfacing actuators, PMDC motors and RC servos Reading: ExpBB - Chapter 4, 6, 9 Lab 3: Interfacing to control power: DC motors and actuators
4	9/12/2016	Stepper motors, other actuators Reading: ExpBB - Chapter 9 Lab 4: Stepper motor control
5	9/19/2016	Signal sources, signal conditioning, op-amps and amplifiers Reading: ExpBB - Chapter 4, 6, 9, 10 Lab 5: Sensors and signal conditioning
6	9/26/2016	Midterm exam
7	10/3/2016	Control systems and vision Reading: ExpBB - Chapter 12 Lab 6: Vision
8	10/10/2016	Project proposal presentations
9	10/17/2016	Communication protocols: RS232/485, I^2C, SPI, CAN, and Ethernet Reading: ExpBB - Chapter 8 Lab 7: I^2C and shift registers
10	10/24/2016	User interface and sensors Reading: ExpBB - Chapter 4, 6, 9, 10, 11 Lab 8: System integration and testing (bring as much of your project as you can to debug)
11	10/31/2016	Project progress report presentations
12	11/7/2016	Advanced topics
13	11/14/2016	Invited speaker
14	11/21/2016	Course wrap-up
15	11/28/2016	Final project presentations
16	12/5/2016	Final project presentation
17	12/12/2016	Course review