SAN JOSÉ STATE UNIVERSITY
Department of Mechanical and Aerospace Engineering

ME/EE 106 - Fundamentals of Mechatronics — Spring 2008

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Office hrs: M 1:30 - 3 pm, Tu-Th 2:30 – 3:30 pm, W 1:30 – 2:30 pm, or by appointment only

Class rooms: E-341 (Lecture), E-125 (Lab.)

Class time/code:

ME 106 Lecture s07 (31414) – TuTh	1330 – 1420	
Lab, section s08 (31415) – Tu	1430 – 1715	First lab meeting on 1-29-08
Lab, section s09 (31416) – Th	1430 – 1715	First lab meeting on 1-31-08
Lab, section s10 (31417) – F	1430 – 1715	First lab meeting on 2-01-08
Lab, section s11 (31418) – Tu	1800 – 2045	First lab meeting on 1-29-08
Lab, section s12 (31419) – Th	1800 – 2045	First lab meeting on 1-31-08
EE 106 Lecture s07 (31933) – TuTh	1330 – 1420	
Lab, section s08 (31934) – Tu	1430 – 1715	First lab meeting on 1-29-08
Lab, section s09 (31935) – Th	1430 – 1715	First lab meeting on 1-31-08
Lab, section s10 (31936) – F	1430 – 1715	First lab meeting on 2-01-08
Lab, section s11 (31937) – Tu	1800 – 2045	First lab meeting on 1-29-08
Lab, section s12 (31938) – Th	1800 – 2045	First lab meeting on 1-31-08

Final Exam: **Thursday, May 15, 2008 1215 – 1430**

COURSE DESCRIPTION:

Introduction to mechatronics with emphasis on analog electronics, digital electronics, sensors and transducers, actuators, and microprocessors. Lectures are intended to provide the student with foundational concepts in mechatronics and practical familiarity with common elements making up mechatronic systems. Laboratory experiments are designed to give the student hands-on experience with components and measurement equipment used in the design of mechatronic products.

Prerequisites: ME 30, EE 98.

Recommended (not required) Texts: *Applied Mechatronics*, Smaili, A. and Mrad, F., Oxford University Press, New York, 2007, ISBN: 978-0-19-530702-3 or *Introduction to Mechatronics and Measurement Systems 3rd ed.*, Histand, M. B., Alciatore, D. G., WCB/McGraw-Hill, Boston, 2007, ISBN: 9780072963052.

Grading (weighting): HW 15%, Lab Reports 20%, Term Project 25%, Quizzes 20%, Final Exam 20%

Grading (overall):

Overall percentage	Grade
100 – 93%	A
92 – 90%	A-
89 – 87%	B+
86 – 83%	B
82 – 80%	B-
79 – 77%	C+
76 – 72%	C
71 – 69%	C-
68 – 66%	D+
65 – 62%	D
61 – 59%	D-
<58%	F

Homework: Homework and lab reports will be due at the start of the respective session on the assigned date, generally one week after assigned. Late homework or lab reports will not be accepted unless ***prior*** arrangements have been made due to extraordinary circumstances.

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 (S04-12) and will not be tolerated in the class. Students are expected to have read the Policy, which is available at:

http://www.sjsu.edu/senate/S04-12.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, 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://www.stanford.edu/dept/vpsa/judicialaffairs/students/plagiarism.sources.htm

I encourage students to collaborate on assignments, such as homework and lab reports, however what this means is that you can work together to 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, and you must write your own lab reports.

Additional Notes:

- We will make extensive use of email, WebCT, and the ME 106 web site for the class (http://www.engr.sjsu.edu/bjfurman/courses/ME106/ME106courseinfo.htm). The very first thing you must do on the first day of class is to subscribe to the class email list: (http://lists.sjsu.edu/mailman/listinfo/me106s08)! Do not delay in joining this list. Check your email at least once a day for class communiqués.
- If you are going to be absent from class, please give me a call, or send me an email prior to the class meeting to let me know that you will not be coming. Don't just not show up!
- Please make it a point to ask questions in class or in office hours whenever you don't understand something! If you don't, then you are essentially paying tuition for nothing! The pace of this class is relatively fast, especially if you have little prior experience with electronics, so don't slack off.
- Campus policy in compliance with the Americans with Disabilities Act: If you need course adaptations or accommodations because of a disability, or if you need special arrangements in case the building must be evacuated, please communicate this to the instructor as soon as possible. Presidential Directive 97-03 requires that students with disabilities register with the Disability Resource Center (DRC) to establish a record of their disability."
- Start working on the term project as soon as possible. The most common lament heard from students who fare poorly in the class is, "We should have started earlier on the project."
- Lab experiments are intended to be performed in a group of two students. The laboratory report is to be written *individually*. It is acceptable to work *collaboratively* with your lab partner or other students in the class on the lab report, but it is **NOT** acceptable to copy someone else's report, in whole or in part. Examples of collaboration are: reviewing the data you gathered with your lab partner for consistency, jointly developing an outline of the key points to be included in the report, deciding together on the format and content of figures, etc. Examples of plagiarism are: copying and inserting sentences, paragraphs, or other text into your report that your lab partner or someone else wrote; copying figures or tables that your lab partner or someone else put together, etc.

[1] Definition adapted from "Defining and Avoiding Plagiarism: The WPA Statement on Best Practices," http://www.ilstu.edu/~ddhesse/wpa/positions/WPAplagiarism.pdf; and "What is Plagiarism?," http://www.stanford.edu/dept/vpsa/judicialaffairs/students/plagiarism.sources.htm.

[2] Adapted from, "Avoiding Plagiarism," http://owl.english.purdue.edu/handouts/research/r_plagiar.html.

- Last day to drop courses: **Monday, February 4th, 2008**
- Last day to add courses: **Monday, February 11th, 2008**

Course Goals

1. To develop an understanding of the basic elements underlying mechatronic systems: analog electronics, digital electronics, sensors, actuators, and microcontrollers.
2. To understand how to interface electromechanical systems to microcontrollers.
3. To gain hands-on experience with commonly used electronic test and measurement instrumentation.
4. To improve written communication skills through laboratory and project reports.
5. To gain practical experience in applying knowledge gained in the course through a hands-on project.

Learning Objectives for ME 106

By the end of the course the student will be able to do the following:

1. Explain the concept and characteristics of a signal source.
2. Select and configure operational amplifier circuits to achieve desired interfacing requirements between a signal source and a downstream device such as a microcontroller or data acquisition system.
3. Explain the practical limitations of operational amplifiers and can quantitatively estimate the effects of these limitations on output voltage and current of the op-amp.
4. Design and analyze the performance of RC low-pass and high-pass filter circuits.
5. Explain the basic operation of bipolar and MOS field-effect transistors and can design with them to activate solenoids, relays, motors, etc. from signal sources.
6. Explain the input/output characteristics of digital logic devices and can design a logic circuit to accomplish a given task.
7. Explain the underlying operational principles and construction of electromagnetic actuators such as DC, AC, and stepping motors.
8. Determine the torque and speed requirements for a given motion control application considering system inertia, external forces or torques, and motion profiles and select an appropriate motor.
9. Explain the basic structure of a microcontroller.
10. Write a program to successfully perform digital input and output from a microcontroller port.
11. Explain the common analog-to-digital-conversion (A/D) methods.
12. Write a program to successfully do A/D conversion using a microcontroller.
13. Explain the digital-to-analog (DAC) conversion process.
14. Write a program to successfully interface analog and digital devices, such as sensors and actuators, with a microcontroller.
15. Function effectively as part of a team in carrying out laboratory experiments and an open-ended project.
16. Document a laboratory experiment and an open-ended project clearly and completely in written form.

COURSE SCHEDULE (approximate)

Wk.	Date	Subject
1	1/24/08	Enrollment, course organization, intro to mechatronics, review of basic electronics
Reading		http://www.memagazine.org/backissues/may97/features/mechtron/mechtron.html http://www.allaboutcircuits.com/vol_1/chpt_6/index.html http://www.allaboutcircuits.com/vol_1/chpt_10/8.html
Lab		No lab! Labs begin the week of 1/29/08
2	1/29-31	Signal sources and their limitations; RC filters
Reading		http://www.allaboutcircuits.com/vol_2/chpt_8/index.html
Lab		Introduction to the Mechatronics Laboratory (note: Take the pre-lab quiz in WebCT prior to your session)
Due		1/29/08: Questionnaire; Deadline for joining class email list; Deadline for verifying WebCT access 1/31/08: HW #1 (at the start of the class period)
3	2/5-7	Microprocessor fundamentals, I/O ports, ATmega128 intro, Digital I/O
Reading		http://www.freescale.com/files/microcontrollers/doc/ref_manual/M68HC05TB.pdf, ('What's a Micro?'), AVR Architecture at: http://www.avrbeginners.net/ (especially 'I/O Ports, General Description') ATmega128 summary or full manual (http://www.atmel.com/dyn/resources/prod_documents/doc2467.pdf) See especially the sections on, Features, Overview, I/O Ports, and Electrical Characteristics.
Lab		Introduction to the ATmega128 (note: Take the pre-lab quiz in WebCT prior to your session)
Due		2/7/08: HW #2 (at the start of the class period)
4	2/12-14	Programming the ATmega128
Reading		See the C tutorial in ME 106 WebCT site http://www.users.on.net/~symes/CwithAVR/IntrotoCwithAVR.htm Introduction to the ATmega128
Lab		RC Filters (note: Take the pre-lab quiz in WebCT prior to your session)
Due		2/14/08: HW #3 (at the start of the class period)
5	2/19-21	Diodes, transistors, using transistors to switch power to loads
Reading		http://www.allaboutcircuits.com/vol_3/chpt_3/index.html http://www.allaboutcircuits.com/vol_3/chpt_4/index.html
Lab		LED's and Transistors (note: Take the pre-lab quiz in WebCT prior to your session)
Due		2/19/08: Term Project Vital Information sheet. (use template from: http://www.engr.sjsu.edu/bjfurman/courses/ME106/ME106vital_info.zip) 2/21/08: HW #4 (at the start of the class period)
6	2/26-28	MOSFET's and power interfacing applications
Reading		http://www.allaboutcircuits.com/vol_3/chpt_2/10.html http://www.fairchildsemi.com/an/AN/AN-7500.pdf
Lab		Digital I/O (note: Take the pre-lab quiz in WebCT prior to your session)
Due		2/28/08: HW #5 (at the start of the class period)
7	3/4-6	Motor action, DC motors, drive system inertia calculation
Reading		http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/elemot.html#c1 http://www.faulhaber-group.com/n390270/n.html
Lab		Interfacing RC Servos (note: Take the pre-lab quiz in WebCT prior to your session)
Due		3/4/08: Term Project concept sketches (check Term Project guideline) 3/6/08: HW #6 (at the start of the class period)

8	3/11-13	Motor sizing, stepper motors
Reading		http://www.compumotor.com/literature/pdf/pg223_engrg_mtrsz.pdf http://www.faulhaber-group.com/n128948/n.html (see the Motion Control Handbook, p. 16-23) http://www.cs.uiowa.edu/~jones/step/ http://www.eio.com/jasstep.htm
Lab		Interfacing a DC Motor and Encoder (note: Take the pre-lab quiz in WebCT prior to your session)
Due		3/13/08: HW #7 (at the start of the class period)
9	3/18-20	Operational amplifiers, limitations of op-amps
Reading		http://www.allaboutcircuits.com/vol_3/chpt_8/index.html http://hyperphysics.phy-astr.gsu.edu/hbase/electronic/opampcon.html#c1
Lab		Printer Carriage Motion Control (note: Take the pre-lab quiz in WebCT prior to your session)
Due		3/18/08: System block diagram, calculations, preliminary test results 3/20/08: HW #8 (at the start of the class period)
10	3/25-27	**S P R I N G B R E A K !**
Reading		http://sunnyday.mit.edu/papers/therac.pdf - a fascinating case study on a mechatronic system gone awry!
Lab		
11	4/1-3	Comparators, signal conditioning; A/D and D/A conversion
Reading		http://www.allaboutcircuits.com/vol_3/chpt_8/12.html http://home.cogeco.ca/~rpaisley4/Comparators.html http://www.elecdesign.com/Files/29/6987/6987_01.pdf http://www.embedded.com/columns/technicalinsights/60403334?printable=true
Lab		Electronic Scale (note: Take the pre-lab quiz in WebCT prior to your session)
Due		4/1-4/4: Evidence of first working prototype (show lab instructor during your lab period) 4/3/08: HW #9 (at the start of the class period)
12	4/8-10	Digital electronics, basic logic functions
Reading		http://www.allaboutcircuits.com/vol_4/index.html http://www.eelab.usyd.edu.au/digital_tutorial/
Lab		Open Lab for term project
Due		4/10/08: HW #10 (at the start of the class period)
13	4/15-17	Logic gates, logic ICs
Reading		http://www.allaboutcircuits.com/vol_4/index.html
Lab		Open Lab for term project
Due		4/17/08: HW #11 (at the start of the class period)
14	4/22-24	Sensors for mechatronic devices
Reading		http://newton.ex.ac.uk/teaching/CDHW/Sensors/
Lab		Open Lab for term project
Due		4/24/08: HW #12 (at the start of the class period)
15	4/29-5/1	Special topics in mechatronics
Reading		TBD
Lab		Open Lab for term project
Due		TBD

16	5/6-8	Special topics in mechatronics
Reading		TBD
Lab		Open Lab for term project
Due		5/8/08: Term Project Fair. Time: 1:30 – 4:00 pm. Location: in and around E125. Bring project and poster.
17	5/13-15	Course review, final exam
Reading		
Lab		
Due		5/13: Term Project Report (hardcopy (in class) and softcopy via WebCT). One report per team. Return any hardware that you borrowed. **5/15: Final Exam: Thursday, May 15, 2008 1215 – 1430**

References

(In addition to these hardcopy references, check out the ME106 tutorial web pages)

Ball, S. (2003). *Analog Interfacing to Embedded Microprocessor Systems*, 2nd ed., Newnes, ISBN: 0750677236

Barnett, R., O'Cull, L., Cox, S. (2003). *Embedded C Programming and the Atmel AVR*, Delmar Learning, Clifton Park, NY.

Catsoulis, J. (2002). *Designing Embedded Hardware*, O'Reilly, ISBN: 0596003625

Jones, J. L., Flynn, A. M. (1998). *Mobile Robots: Inspiration to Implementation*, 2nd ed., A. K. Peters, Wellesley, Mass.

Ganssle, J. (1999). *The Art of Designing Embedded Systems*, Newnes, ISBN: 0750698691

Horowitz, P., Hill, W. (1989). *The Art of Electronics*, 2nd ed., Cambridge University Press, New York.

Labrosse, J. J. (1999). *Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C*, 2nd ed., CMP Books, ISBN: 0879306041

McComb, G. (1987). *The Robot Builder's Bonanza: 99 Inexpensive Robotics Projects*, Tab Books, Blue Ridge Summit, PA.

Mims, Forrest M. III. (1983). *Getting Started in Electronics* (Radio Shack cat. no. 62-5004), and his *Engineer's Mini-Notebook* series (particularly: Schematic Symbols, Device Packages, Design and Testing; Sensor Projects; 555 Timer Circuits; Optoelectronic Circuits), Radio Shack, Tandy Corp., Fort Worth, TX.

Pardue, J. (2005). *C Programming for Microcontrollers*, Smiley Micros, Knoxville, TN, www.SmileyMicros.com, ISBN: 0976682206.

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.

Scherz, P. (2006). *Practical Electronics for Inventors*, 2nd ed., McGraw-Hill/TAB Electronics, ISBN: 0071452818

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

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.

(Please check the Course Reserve in the MLK Library for several of the references listed above.)