San José State University
Department of Mechanical Engineering
ME/EE 106 – Fundamentals of Mechatronics Engineering
Spring 2015

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Office Hours: M 7:00 – 7:30 PM at Eng 348

Lecture 06 ME (29877):
Lab 07 (29989):
Lab 08 (29990):
Lecture 06 EE (29878):
Lab 07 (29989):
Lab 08 (29990):

Prerequisite: EE 098 and ME 030 (or CS 49C OR CMPE 30 OR CMPE 46) or their Equivalents (with a grade of ‘C-’ or better in each). For IT majors: TECH 060, MATH 071, CMPE 046 (with a grade of ‘C-’ or better in each).

Accessing Course Materials and Messaging
Copies of course materials such as syllabus, major assignment handouts, etc., may be found on the SJSU Canvas course management system: https://sjsu.instructure.com/courses/1143137 (See https://sjsu.instructure.com/ for more information). We will also use the website: http://www.engr.sjsu.edu/bjfurman/courses/ME106/ME106courseinfoS15.htm You are responsible for regularly checking for updates and reading messages through MySJSU or Canvas.

Course Description
Introduction to mechatronics with emphasis on analog electronics, digital electronics, sensors, 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. (3 units; lecture/lab)

Course Goals
1. Develop an understanding of the basic elements underlying mechatronic systems: analog electronics, digital electronics, sensors, actuators, microcontrollers, and embedded software.
2. Understand how to interface electromechanical systems to microcontrollers.
3. Gain hands-on experience with commonly used electronic test and measurement instrumentation.

4. Improve written communication skills through laboratory and project reports.

5. Gain practical experience in applying knowledge gained in the course through a hands-on project.

**Learning Objectives**

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

1. Articulate what the essence of mechatronics is and provide examples of mechatronic systems.

2. Explain the concepts of input and output impedance, voltage division, and circuit loading.

3. Explain the concept and characteristics of a signal source.

4. Design and analyze the performance of RC low-pass and high-pass filter circuits.

5. Explain the basic structure of a microcontroller, the nature of IO ports, and the common peripheral subsystems found in most microcontrollers.

6. 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.

7. Explain what analog-to-digital-conversion (A/D) is and how to implement it using a microcontroller.

8. 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.

9. Explain practical limitations of operational amplifiers and quantitatively estimate the effects of these limitations on output voltage and current of the op-amp.

10. Explain the basic operation of bipolar and MOS field-effect transistors and design with them to activate solenoids, relays, motors, etc. from signal sources.

11. Explain the input/output characteristics of digital logic devices and design a logic circuit to accomplish a given task.

12. Explain the underlying operational principles and construction of electromagnetic actuators such as DC, AC, and stepping motors.

13. 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.

14. Function effectively as part of a team in carrying out laboratory experiments and open-ended projects.

15. Document a laboratory experiment and open-ended projects clearly and completely in written form.
**Required Textbook**

**Recommended Textbooks**

**Required Hardware**
Arduino microcontroller (Duemilanove or UNO R3). Sources for these boards include: NKC Electronics, Adafruit Industries, Sparkfun Electronics, Modern Device, sainsmart (local sources: Jameco, Radio Shack, Fry’s Electronics), and many others.

**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.

**Classroom Protocol**
Students should make their best effort to attend *all* class sessions and laboratory periods. Please arrive to the classroom or laboratory *before* the session begins, so that others are not disturbed by your entry after instruction has begun. If you normally keep a cell phone with you, turn-off or put your cell phone on ‘vibrate’ before you enter the classroom. Having your cell phone ring during class is disruptive, and will not be tolerated.

**Dropping and Adding**
Students are responsible for understanding the policies and procedures about add/drop, grade forgiveness, etc. Refer to the current semester’s Catalog Policies section at http://info.sjsu.edu/static/catalog/policies.html. Add/drop deadlines can be found on the current academic calendar web page located at http://www.sjsu.edu/academic_programs/calendars/academic_calendar/
The Late Drop Policy is available at http://www.sjsu.edu/aars/policies/latedrops/policy/
Students should be aware of the current deadlines and penalties for dropping classes. Information about the latest changes and news is available at the Advising Hub at http://www.sjsu.edu/advising/.
Assessments and Grading Policy
Assessment for the purposes of determining your course grade will consist of evaluating your performance on homework assignments, laboratory reports, mid-term examination, projects, and the final examination.

Homework is due one week after it is assigned. You must turn in the homework at the beginning of the lecture. You will not get credit for the late assignments.

Laboratory reports will be handled similarly: The report must be submitted one week after the laboratory experiment was performed. Turn in the report to your lab instructor at the beginning of the lab period.

Weighting of Course Components for Determining the Course Grade
HW 20%, Lab Reports 20%, Term Project 20%, Midterm 20%, and Final Exam 20%

Criteria for Assigning Letter Grades
The scores on your homework, laboratory reports, exams, term project, 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:

Note: ME students must earn at least a grade of C- to pass the course.

University Policies
Academic integrity
Your commitment as a student to learning is evidenced by your enrollment at San Jose State University. The University’s Academic Integrity policy, located at http://www.sjsu.edu/senate/S07-2.htm, requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The Student Conduct and Ethical Development website is available at http://www.sa.sjsu.edu/judicial_affairs/index.html.

Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person’s ideas without giving proper credit) will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified. If you would like to include your assignment or any material you have submitted, or plan to submit for another class, please note that SJSU’s Academic Policy S07-2 requires approval of instructors.

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

Students are encouraged 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.

**SJSU Senate Policy S12-3 - Federal Regulation of the definition of the credit hour:**
Success in this course is based on the expectation that a student will spend, for each unit of credit, a *minimum* of 45 hours over the length of the course (normally three hours per unit per week with one of the hours used for lecture) for instruction or preparation/studying or course related activities including but not limited to internships, labs, clinical practica, etc. Other course structures will have equivalent workload expectations as described in the syllabus. [Thus, for this class, it is expected that you will spend *at least* seven hours outside of class working on homework, lab work, project work, test preparation, and etc.]

**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.

**Student Technology Resources**
Computer labs for student use are available in the Academic Success Center located on the 1st floor of Clark Hall and on the 2nd floor of the Student Union. Additional computer labs are available for MAE students in E213 and E215. Computers are also available in the Martin Luther King Library (see: [http://www.sjlibrary.org/services/computers/index.htm](http://www.sjlibrary.org/services/computers/index.htm)).

A wide variety of audio-visual equipment is available for student checkout from Media Services located in IRC 112. These items include digital and VHS camcorders, VHS and Beta video players, 16 mm, slide, overhead, DVD, CD, and audiotape players, sound systems, wireless microphones, projection screens and monitors.

**SJSU Writing Center**
The SJSU Writing Center is located in Room 126 in Clark Hall. It is staffed by professional instructors and upper-division or graduate-level writing specialists from each of the seven SJSU colleges. Our writing specialists have met a rigorous GPA requirement, and they are well trained to assist all students at all levels within all disciplines to become better writers. The Writing Center website is located at [http://www.sjsu.edu/writingcenter/](http://www.sjsu.edu/writingcenter/).
Additional Notes:

- We will make extensive use of the Canvas course management system, the ME 106 web site: [http://www.engr.sjsu.edu/bjfurman/courses/ME106/ME106courseinfoS15.htm](http://www.engr.sjsu.edu/bjfurman/courses/ME106/ME106courseinfoS15.htm)
  Make sure that you adjust your settings in Canvas, so you will get notifications in a way that you check frequently.

- You will need to have access to an Arduino controller board for homework assignments. See the list of sources for where to buy a microcontroller on Page-2.

- If you are going to be absent from class or lab, please send me an email as soon as you know that you will not be able to attend. Don’t just not show up!

- Each reading assignment shown in the Course Schedule below should be completed prior to the lecture for the week in which the assignment is listed. In other words, read the assigned chapters before the next lecture! Doing so will help prepare you for lecture and will help you maximize your learning efficiency. It will also help you score well on any in-class quizzes on the readings. When you read, summarize the important points and jot down any questions that you have. Bring your questions with you to the lecture.

- The Course Schedule below also lists handouts, which are materials that we will use in lecture and that you would do well to bring with you to the lecture session. You can access the handouts along with the lecture slides in the Content area of the course shell in Canvas.

- Following each lecture, I highly recommend that you review any notes you took in lecture along with the notes that you took from reading. Read back through your notes, and fill in any gaps that you may have missed or that became clearer from the lecture. Write down any questions you have in the margins of your notes. Be sure to come to office hours or ask about your questions in class.

- 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.

- Start working on the projects 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 term 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.
References

(ME 106 Course Reserves. In addition to these hardcopy references, check out the ME106 tutorial web pages)

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.
<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topics, Readings, Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jan 26, 2015</td>
<td>Intro to mechatronics, review of basic electronics -  <strong>Lab:</strong> Intro to Mech. Lab Learning Objectives: 1, 2 - Text Chapter: 9: 9.1 – 9.7.1; 9.11 – 9.14</td>
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<td>2</td>
<td>Feb 2, 2015</td>
<td>Signal sources and their limitations; RC filters –  <strong>Lab:</strong> Intro to Arduino Learning Objectives: 3, 4 - Text Chapters: 9.8 – 9.9</td>
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<tr>
<td>3</td>
<td>Feb 9, 2015</td>
<td>Microcontroller fundamentals, I/O ports, Digital I/O -  <strong>Lab:</strong> RC Filters Learning Objectives: 5, 6 - Text Chapters: 2 - 3</td>
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<tr>
<td>4</td>
<td>Feb 16, 2015</td>
<td>Introduction &amp; Programming the Arduino -  <strong>Lab:</strong> Digital I/O Learning Objectives: 5, 6 - Text Chapters: 5 - 6</td>
</tr>
<tr>
<td>5</td>
<td>Feb 23, 2015</td>
<td>Diodes, transistors, using trans. to switch power to loads -  <strong>Lab:</strong> LED &amp; Transistors , Learning Objectives: 10 - Text Chapters: 10; 23.2</td>
</tr>
<tr>
<td>6</td>
<td>Mar 2, 2015</td>
<td>MOSFET’s and power interfacing applications -  <strong>Lab:</strong> Motion Control Learning Objectives: 6, 10 - Text Chapters: 10</td>
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<tr>
<td>7</td>
<td>Mar 9, 2015</td>
<td>Motor action, DC motors, drive system inertia –  <strong>Lab:</strong> Servo System Design Learning Objectives: 12, 13 - Text Chapters: 22</td>
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<tr>
<td>8</td>
<td>Mar 16, 2015</td>
<td>Motor sizing, Stepper Motors -  <strong>Lab:</strong> Stepping Motors Learning Objectives: 12, 13 - Text Chapters: 22</td>
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| 9    | Mar 23, 2015   | Spring Break: No Classes – No Lab  
**Reading:** Therac 25 Case Study  http://sunnyday.mit.edu/papers/therac.pdf   |
| 10   | Mar 30, 2015   | Midterm Exam  
**Lab:** Electronic Scale  |
| 11   | Apr 6, 2015    | Op Amps, Comparators, A/D & D/A convertors -  **Lab:** Term Project Learning Objectives: 3, 6, 7, 8, 9 - Text Chapters: 11; 11.5 - 12 - 19                                           |
| 12   | Apr 13, 2015   | Digital Electronics, Basic Logic Functions -  **Lab:** Term Project Learning Objectives: 11 - Text Chapters: 18                                                                                           |
| 13   | Apr 20, 2015   | Logic Gates, Logic ICs -  **Lab:** Term Project Learning Objectives: 11 - Text Chapters: 18                                                                 |
| 14   | Apr 27, 2015   | Sensors for Mechatronics Devices -  **Lab:** Term Project Learning Objectives: 6 - Text Chapters: 13                                                                 |
| 15   | May 4, 2015    | Special Topics in Mechatronics -  **Term Project Presentation**  |
| 16   | May 11, 2015   | Course Review  |
| Final Exam | May 18, 2015 | 7:45 PM – 10:00 PM  E339 |