ME 106 - Term Project Information

The term project is a chance for you to apply the skills you are learning in Mechatronics to design and build a device that incorporates sensors, actuators, and a microcontroller to solve a particular problem. Students in previous semesters have consistently rated the term project as one of the best aspects of the course. I hope that you will find this to be true as well.

This semester you will define, design, build, and demonstrate a mechatronic system that fulfills the requirements described below. Your system must:

- Use a microcontroller as the primary means for controlling the operation of the system
- Use at least one sensor AND at least one actuator in the control of the device

(An actuator is a device that applies a force or torque to move something. Typically, an actuator will require more power than can be supplied directly by the microcontroller, and so will require an interface between it and the microcontroller. Your system must include some kind of power interface between the microcontroller and a device in your system that requires more power than the microcontroller can supply. You are not limited to using sensors that you encounter in the lab; in fact, you are encouraged to go beyond the sensors that you will learn about in the lab as the need arises.)

Special emphasis and extra-credit will be given to groups who,

1. Refine a proof-of-concept for an oxygen hose ‘minding’ apparatus for an elderly person who is tethered to an oxygen generator in her house (see Prof. Furman if you are interested in this project).
2. Do something original using the TI LaunchPad Development System (see: http://www.ti.com/ww/en/launchpad/launchpad.html?DCMP=mcu-launchpad&HQS=launchpad) See Prof. Furman for a loaner kit if you would like to pursue this option.

Thus, you have wide latitude in selection of an appropriate project (see your instructor if you have trouble coming up with ideas for your project). Please note that you must obtain approval from your instructor for your proposed project prior to embarking on its realization. See the key dates and deliverables below for more details.

The project is intended to be a team effort of two to three people at most; however individual projects may be approved if and only if there are compelling reasons to do so. Again, you must get approval for the makeup of your proposed group before diving into the project. Students who are also in ME 154 are encouraged to choose a project that could count for both courses and build a team with teammates who are in both courses. Joint ME 106/ME 154 projects may have a team of more than four members, but no more than two of these may be from ME 106.

Grading of the project will be carried out using the following criteria:

- **Concept (20%)** Your device will be judged on its technical merits, including, innovation, appropriate use of hardware and software to produce a mechatronic system, and application of physical and engineering principles in the design. Projects that are oriented toward improving safety, the environment, or the quality of life especially for the disabled, elderly or disadvantaged are likely to be favored highly. Drink mixers, pet feeders, jar openers, can crushers, secret knock doors, automatic window blinds, etc. are likely to NOT be favored very highly and are discouraged, unless they show real innovation.
- **Implementation (20%)** Your device will be judged on how well the concept was implemented in hardware. The focus here will be on the quality of workmanship and finished appearance.
- **Performance (20%)** Your device will be judged on how well it performed during the project evaluation session.
- **Final Report and Project Videos (20%)** This aspect focuses on the completeness and quality of your written documentation of the design of the system. A key feature will be, “How easy would it be for someone acquainted with Mechatronics to understand, reproduce, and/or modify this design as documented?” Part of your documentation will be two short videos posted to YouTube, one that describes the design and demonstrates its operation, and a second in which each member of the team describes his or her contribution to the project and what was learned in the process.
- **Phase 1 and 2 Project Reviews (20%)** Your progress and accomplishments will be evaluated part way through the semester.

[Individual contribution to the project will be assessed by each team member and will form a separate part of the overall course grade (see the section describing the Grading Policy in the syllabus). Your instructor will give you a form for this assessment]

Laboratory sessions toward the end of the semester will be devoted to project work (priority will be given to teams who are regularly scheduled to be in the lab on any particular day, but other teams can use the lab if space is available). You will need to make use of these lab sessions and time outside of class to complete your project, so I suggest that you start NOW. The most common lament by former students who fare poorly on the term project is
always; “I should have started working on the project sooner.” Please don’t let this happen to you!

We will have an informal project exhibition on Tuesday, May 10, 2016, beginning at 10:30 am, and extending to approximately 1 pm, so plan accordingly. The exhibition will take place in E125 and the hallways surrounding it.

A hard copy and softcopy of your report will be due on or before Tuesday, May 17, 2016 at 5 pm. Turn in one hardcopy per team, and submit the softcopy to Canvas. Use the naming convention: 

ProjectReport_lastname1_lastname2.filetype, where lastnameN is the last name of the Nth team member. The hardcopy of your report must have the individual performance evaluations as the last pages or be attached to the report. This can be done in separate envelopes if desired, but all must be included or ATTACHED to the report. The References section must list the URL for your YouTube videos. Submit softcopy of the individual performance evaluations separately in Canvas.

Process for Completing the Term Project

1. Form a team of two (preferred) to three classmates, and figure out when you can meet on a regular basis to work on the project. Larger teams are discouraged. I will consider proposals for larger teams, but only if there are compelling reasons or for joint ME 106/ME 154 projects. Be warned: a larger team does not necessarily result in a better project or better grade. In fact, the opposite often occurs.

2. Submit your team structure and vital information for your team to your instructor by the date listed in the Syllabus and the section on Deliverables below. There is a template available for this at: 

http://www.engr.sjsu.edu/bjfurman/courses/ME106/ME106vital_info.doc

3. Identify the general problem that your team will solve, and develop a set of specifications for how your solution should perform. Design specifications provide “precise and explicit information about the requirements for a product design” (Design Specification, 2010). These are the performance targets that you will use as a guide in your design process and the criteria that you will use to assess how successful your design is. For example, if your device needs to move an object a certain distance within a period of time, list this as one of your design requirements: “Must move a widget weighing no more than X grams from pick up to drop off location in less than 5 seconds.” When you eventually get the solution together, you need to evaluate its performance with respect to your design specifications. Your report will document how well your solution met or did not meet the design specifications.

4. Develop at least 10 fundamentally different ways to solve the problem. [Note: “develop” means make a few simple hand sketches of each concept, and write a brief description about each one, so that someone with an engineering background, but not necessarily with a background in Mechatronics could understand the concept. To see how the ‘pros’ brainstorm, check out: http://www.youtube.com/watch?v=2Dtrkrz0yoU] Rank the concepts in order of preference. I recommend that each individual on the team first generate his or her own ideas alone. Then with the team together, share the ideas and generate a whole bunch more ideas together as a group. Try to withhold criticism of any idea until you’ve generated an extensive list from both individual and group sessions. This process is called ‘brainstorming’ (It is not unreasonable to expect each person to be able to generate at least 10 individual concepts and for the whole team to come up with at least 10 more. Don’t be afraid to think ‘out of the box’ in coming up with ways to solve the problem! Sometimes outlandish ideas will lead to novel solutions.)

5. After all the brainstorming from step 4, choose the top 10 ideas using some criteria developed by your team. (I recommend that your criteria include some of the elements in the grading criteria above.) Use the Pugh Selection Method to help in your selection process.

6. Submit your top 10 concepts and descriptions to Prof. Furman for approval per the assignment schedule below.

7. Break the overall system into subsystems (that is, smaller self-contained units that can function without dependence on other subsystems), and assign team members as ‘owners’ to develop that particular subsystem. Try to make the subsystems modular, so that they can be built and tested independently of the complete system. This will speed your development time and improve the reliability of the overall system.

8. Procure materials and components. See the ME 106 website (http://www.engr.sjsu.edu/bjfurman/courses/ME106/componentinfo.htm) for lists of suppliers. There are several local suppliers of surplus and used equipment that will give students discounts.

9. Fabricate, assemble, and test the subsystems.

10. Combine the functional and fully tested subsystems into the complete device, and test it to verify that it meets the performance specification.

11. Fix any problems that arise from full system testing.

12. Prepare your video documentation and final report. Make sure that the privacy setting on your videos is set
to either unlisted or public, but NOT private (else I will not be able to view it and your grade for the project will suffer!) Submit hardcopy to your instructor by the due deadline AND softcopy via Canvas.

**Notes on the assignment:**

1. Assign a team manager for your group, and set up regular meeting times outside of class time to work on the project. Divide up the development effort, and keep in frequent communication with the team members through regular meetings, email, etc. Try to divide the work, so that each member gets to work on some tasks that are out of their area of strength. [Keep in mind, the point of all this is to learn about mechatronics, so use it as chance to gain new knowledge and practice new skills.] If problems with communication or participation arise in your group, try to work them out quickly. If they persist, let Prof. Furman know ASAP.

2. The Department can provide limited materials for this project. Consequently, you may have to come up with the bulk of what you need to manufacture your project. Visit [http://www.engr.sjsu.edu/bjfurman/courses/ME106/componentinfo.htm](http://www.engr.sjsu.edu/bjfurman/courses/ME106/componentinfo.htm) for links to suppliers.

3. Shop facilities are available in E123 at regular hours during the week for those who have successfully passed the ME/Tech 41 Shop Safety course and have received their access privilege from the MAE office. The shop manager will be happy to help you fabricate parts, but only if you have a sketch or engineering drawing (with dimensions) of your parts.

4. Don’t procrastinate!

5. Information on how to make a video for your project can be found at: [coming soon]

### Key Dates

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<th>Wk</th>
<th>Deliverables</th>
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<tr>
<td>3: 02/11</td>
<td>Submit in hard and softcopy the contact information for your team using the sheet available at: <a href="http://www.engr.sjsu.edu/bjfurman/courses/ME106/ME106vital_info.zip">http://www.engr.sjsu.edu/bjfurman/courses/ME106/ME106vital_info.zip</a></td>
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<td>4: 02/18</td>
<td>Concepts with sketches (at least 10, where applicable) and background description</td>
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<td>6: 03/3</td>
<td>System block diagram, design specifications, calculations, preliminary test results, individual commitment form</td>
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<td>7: 03/8-10</td>
<td>Phase 1 Project Review (show lab instructor during your lab period). At a minimum, you must show a sketch or drawing of your device, your block diagram, AND some evidence in both hardware and software that you are progressing toward a working prototype; a Gantt chart showing tasks and their owners; and an assessment by the team manager of the team members’ performance to date</td>
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<td>12+: 04/12+</td>
<td>Open laboratory sessions for project work</td>
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<td>13: 04/19-21</td>
<td>Phase 2 Project Review (show lab instructor during your lab period). At a minimum, you must show evidence beyond what you showed in the Phase 1 review, in both hardware and software, that you are progressing toward a working prototype; a updated Gantt chart showing tasks and their owners; and an assessment by the team manager of the team members’ performance to date</td>
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**Wk 16: 05/10**  Presentation of term projects in E125 beginning at 10:30 am (Project Exhibition)

**Wk 17: by 05/17** Term project report due by 5 pm to the ME office and videos posted to YouTube (See below for how to write the report)

### Guidelines for Term Project Report

- One report for your group

- A title page, at a minimum listing: the title of the project (descriptive and specific), the entity for which the report was written, i.e., San José State University, Department of Mechanical Engineering, ME 106 Fundamentals of Mechatronics, the names of the team members, the date of submission. The title page should be attractive and complete. The best reports typically have a nice, clear photograph or drawing of their solution as part of the title page.

- A Summary section that succinctly and specifically states: what you did, how you did it, what happened, and what was learned. This section should consist of approximately four paragraphs, and be about one or two pages long. Make sure that you include in this section at least one photograph or sketch of your device that provides a good visual summary of your project.
An Introduction section that describes what the project was all about, first in general (by referring to this guideline to describe the general goal and design requirements of the project), but then specifically, giving background on the need and specific objectives that your design addresses. This section should be at least one page long. Make sure that you include sufficient sketches, drawings, and/or photographs AND verbiage to clearly explain to someone unfamiliar with your project what it is all about and what your device is supposed to accomplish.

A section that clearly states the specifications for your design. Design specifications are the performance and attribute targets that you strive to meet in your final design and that guide you in the design process.

A section that describes your design in DETAIL. This section must have figures (i.e., drawings, photos, sketches all with annotation, see below) that document your design. In this section, you must have at LEAST an overall photograph, sketch, or drawing and a detailed schematic diagram of the circuits used in your design in this section. You might find it helpful to use Electronics Workbench software in the Mechatronics laboratory to draw the schematic. There is a freeware version of a program called CircuitMaker that you can get at: http://babbage.cs.qc.edu/courses/cs343/Circuit_Maker/ that you can use at home. There are also programs for designing printed circuit boards (PCB) that can facilitate drawing a schematic (DipTrace, http://www.diptrace.com/ and Eagle, http://www.cadsoftusa.com/ are two relatively popular PCB design programs). Follow the guidelines in http://www.engr.sjsu.edu/bjfurman/courses/ME120/me120pdf/ME120labreportguide.pdf for how to annotate your figures. This section must also have a system block diagram to clearly communicate what the major subsystems are and how they are integrated into the whole design. This section must also have analysis and description of how you verified that your design met the specifications. Also include a flowchart that outlines how the design and software operate. You will have achieved success in writing this section if a peer in the class could take what you have written, and referring to it alone, reproduce your device. Detailed drawings for any parts that you fabricated should be included in an Appendix and referred to in the body of the report.

A section that addresses the outcome of the project: how well it worked or didn't work, what you would do if you had more time to improve the design, and what you learned. Please be specific about the performance of your device with respect to the design specifications, and give specific recommendations for improvements or further work. General blathering will not earn a good score on this section. Include reflections on your team’s process of problem solving, how effective it was, and what you would do differently if you had to do the project over again.

A list of references used following the guidelines given in: http://www.engr.sjsu.edu/bjfurman/courses/ME120/me120pdf/ME120labreportguide.pdf. Include a link to your YouTube video(s) at the bottom of your list of references.

An Appendix that documents aspects of your project that are important, but that may be unwieldy or might otherwise disrupt the flow of the main body of the report. Examples include:

- The source code of the program that operated your device. (Well commented!)
- Detail drawings of any parts that you fabricated
- Data sheets (or key excerpts if the full data sheet is too long to include in its entirety) of devices or sensors that you used
- Bill of materials (BOM) for all the parts that comprise your design. If possible, also list in the BOM sources and costs for the parts.
- Concepts for alternative designs and documentation of your selection process (such as a Pugh Chart)
- Other items that might be helpful to someone who was attempting a similar project, but that don’t warrant inclusion in the main body of the report.

Attach your individual performance evaluation forms (each team member must fill out a form) to your report. You may put your evaluation in a sealed envelope if you wish, but make sure that it is attached to your report.

*** IMPORTANT NOTE ***

Upload a softcopy version of your report to Canvas. See the Term Project Assignment there.
References