Title: Mechatronic Systems Design 1

Credits: 4 Design/Lab

WSU Catalog Description: Students work in small groups to design and build "smart" devices or systems. These products will integrate sensors, digital logic and/or microprocessors, and user interfacing. The products will be requested by "clients" and the student will work as part of a cross-disciplinary team.

Coordinator: Robert Erlandson, Professor of Electrical and Computer Engineering

Instructor: Robert F. Erlandson, Professor of Electrical and Computer Engineering

Office Hours: Mondays 1-3pm, Thursdays 3-4pm

Office Location: 3115 Engineering

Phone: (313) 577-3900 Email: ac5957@wayne.edu

Course Meeting Time: Arranged on a team basis

Course Meeting Location: 3342 Engineering Building

Goals: To provide students a comprehensive design experience which will require them to integrate knowledge and skills from across their undergraduate academic experiences. The design projects derive from community needs.

Learning Objectives: At the end of this course, students will be able to:

1. Apply their prior knowledge to a comprehensive design problem.
2. Use a variety of design tools, testing and debugging tools.
3. Utilize existing resources for legally mandated accessible design requirements.
4. Apply both universal and accessible design principles.

Textbook: None

Reference Materials: Technical specifications, application notes, current technical journals, etc. Much of the technical material comes from industry web sites.

Prerequisites: ECE 4600 or equivalent. Permission of the instructor. At least a senior standing.

Projects:
1. Therapeutic Exercise End-Effector for ARM Clinic
   a. Biometric Inc. Conversion to end-effector
      Hardware and software elements
   b. Knob Exercise Module
      Hardware and software elements
2. Cross-Modality Vision/Vestibular Interaction Model

Course Structure: The students break into small group design teams. Each team has a specific project. Teams select a project from a list provided by the instructor. These projects
originate from community clients and a liaison from the community works with the students on the design effort. After selecting a project the student teams visit the client’s facilities and work with the client to develop functional requirements. The students translate these functional requirements into technical requirements and develop several alternative designs. The client reviews the design alternatives and together with the student team decides on a specific implementation. The student teams develop timelines, milestones, and deliverables. The instructor, laboratory engineer, and class GTA meet with each student team once a week and the teams provide weekly status reports. Upon project completion the student team presents the finished project to the client along with any necessary documentation, e.g., user or service manual, schematics, source code. The majority of the student project’s are funded by an NSF Bioengineering/Rehabilitation Engineering Student Design grant. As such the projects must be usable by or serve individuals with disabilities. The students must also write a final report that is edited for NSF reporting, printed in Student Design Series publication, and posted on the Enabling Technologies Laboratory web site.

**Computer Resources:** The Enabling Technologies Laboratory has a number of workstations, each workstation has its own computer. In addition students have access to all College and University computer facilities.

**Laboratory Resources:** The class meets in and uses the resources of the Enabling Technologies Laboratory (ETL). The lab has system development, testing, and debugging tools and equipment for hardware and programming projects. The College of Engineering Machine Shop provides fabrication support. A commercial PC Board company is used to fabricate required PC boards.

**Laboratory Policy:** Students must be respectful of the laboratory facilities and equipment. Students will be checked out before being allowed to operate any of the laboratory’s equipment. The laboratory door must be locked at all times. The laboratory is monitored by a security camera which transmits images to a remote server. Laboratory phones, equipment, printers and associated consumables must be used only for class related activities.

**Grading Procedure:** See attached rubric.

The weighted score from the rubric determines the grade.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Score</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>3.4-3.9</td>
</tr>
<tr>
<td>A-</td>
<td>3 - 3.3</td>
</tr>
<tr>
<td>B+</td>
<td>2.7 - 2.9</td>
</tr>
<tr>
<td>B</td>
<td>2.3-2.6</td>
</tr>
<tr>
<td>B-</td>
<td>2 - 2.2</td>
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<tr>
<td>C+</td>
<td>1.7 - 1.9</td>
</tr>
<tr>
<td>C</td>
<td>1.3 - 1.6</td>
</tr>
<tr>
<td>C-</td>
<td>1 - 1.2</td>
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<tr>
<td>D+</td>
<td>0.9</td>
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<tr>
<td>D</td>
<td>0.8</td>
</tr>
<tr>
<td>D-</td>
<td>0.7</td>
</tr>
<tr>
<td>E</td>
<td>below 0.7</td>
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</tbody>
</table>
**Attendance and Participation:** Each student is expected to contribute to the overall execution of the design project in a manner agreed upon by the student design team and instructor. This includes, but is not limited to, attending and participating in team meetings, meeting deliverable and schedule deadlines, performing all duties and responsibilities agreed upon by the team.

**Makeup Exam and Makeup Assignment Policy:** Not Applicable

**Outcome Coverage:**
(a) **An ability to apply math, science and engineering knowledge.** Each design project provides a unique opportunity for students to exercise and apply the mathematical, science, and engineering knowledge gained in prior classes.

(b) **An ability to design and conduct experiments, as well as to analyze and interpret data.** The design process requires the testing and evaluation of the processes being designed. The students must design test cases, gather data, analyze the data, and evaluate the data with respect to design requirements.

(c) **An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.** This is the primary focus of the class.

(d) **An ability to function on multi-disciplinary teams.** Many of the student design teams are multi-disciplinary and every effort is made to organize the teams along multi-disciplinary lines. In every case the students must work with a client and the client is regarded as a member of the design team.

(e) **Identify, formulate and solve engineering problems.** This is central to the design process. Students must determine the functional requirements of the client and then translate these into technical specifications and ultimately design requirements. The students must then build, fabricate, or otherwise implement the designed entity.

(f) **An understanding of professional and ethical responsibility.** The ethical and professional responsibilities of an engineer are explicitly discussed with respect to accurately representing the features and functionality of their designs, the cost of their designs, their conduct as a team member and as a representative of the College and University.

(g) **An ability to communicate effectively.** The students must communicate effectively to accurately understand a client’s functional requirements. The students must communicate amongst themselves and with the liaison and instructors. The students must communicate the alternative designs and then clearly present the final product to the client. The students prepare a variety of documentation; functional and technical requirements, weekly status reports, schematics, well documented source code, PC board layouts, timelines, and a final report.

(h) **The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.** The Enabling Technologies Laboratory emphasizes a universal design approach and where necessary an accessible design approach (as mandated by a variety of U.S. laws). The U.S. and a host of countries have laws requiring the accessibility of products by individuals with disabilities. Universal design is a design philosophy and approach well suited for addressing the diverse market requirements of a global economy. Students spend time looking at existing solutions, functionality and costs. Our
student population is diverse coming from the U.S., Canada, Asian countries, Mid-Eastern and European countries. It is natural to discuss the client’s needs and design alternatives with respect to similar applications and alternatives in the countries represented by the students.

(j) a knowledge of contemporary issues. Addressing the needs of individuals with disabilities, gaining knowledge and practical applications of the legally mandated accessibility requirements, using the design guidelines prepared by the Access Board, and the World Wide Web Consortiums, Web Accessibility Initiative (W3C-WAI) are examples of dealing with contemporary issues. Listening to the clients and understanding their needs broadens the student's awareness of contemporary issues. Applying and gaining an understanding of universal design principles forces the students to think of diverse consumer groups and global marketing issues.

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. Students will use computer simulation and modeling software as well as computational and analysis software, i.e., Workbench, Mathcad and/or Matlab. Students will be required to use web based resources for component selection and additional reference materials. Students will use modern development and test equipment.

Cheating Policy and Penalty for Cheating:
Cheating will not be tolerated. If students are caught cheating they will receive an E for the class.

Plagiarism is a form of cheating. According to WSU rules and regulations it is grounds for dismissal from school. Anyone caught cheating on assignments, quizzes or engaging in plagiarism will receive an E for this class and could be subject to further disciplinary action. It is assumed you understand what plagiarism means. If you do not then see the following definition and resources.

>“Plagiarism is using others’ ideas and words without clearly acknowledging the source of that information.” From What is Plagiarism and how to recognize and avoid it.

http://www.Indiana.edu/~wts/plagiarism.html

Prepared By: Robert F. Erlandson, Professor of Electrical and Computer Engineering

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<table>
<thead>
<tr>
<th>Quality of the finished product</th>
<th>Schedules and costs meet</th>
<th>Documentation</th>
<th>Quality of team client interactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>40%</td>
<td>20%</td>
<td>30%</td>
<td>10%</td>
</tr>
<tr>
<td>Exceptional</td>
<td>The finished product meets or exceeds all specifications, is fully operational with no errors or defects.</td>
<td>All milestones were met or surpassed. The project came in at or under budget.</td>
<td>All documentation was prepared on time, neat, spelling correct, grammar correct, and well organized. The final report possessed a depth and breadth that was appropriate to the quality of their product. The final presentation was creative and very well received by the client.</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>The finished product meets all the specified requirements, but still exhibits a few none serious errors or malfunctions.</td>
<td>All milestones were meet and the project came in at or marginally above the budget.</td>
<td>Documentation was prepared on time, neat, spelling correct, grammar correct, and well organized. There is nothing exceptional, but contains everything required.</td>
</tr>
<tr>
<td>Marginally acceptable</td>
<td>The product does not meet all specifications, but performs most of the required functions with few if any errors or malfunctions. The client agrees to accept the product even though it does not meet the agreed upon functional requirements.</td>
<td>Milestones were slipped or missed. The project did not finish on time and required extra time to complete – where there were no external circumstances for the cause of the delays. The budget ran significantly over.</td>
<td>Most documentation was prepared on time, it was neat, but not well organized. It was confusing and not clearly written. There were spelling and grammatical errors. The final presentation was not well organized, the team was not prepared.</td>
</tr>
<tr>
<td>Unacceptable</td>
<td>The product does not work or it does not meet the core agreed upon functional specifications either because they were not implemented or the system is too error prone.</td>
<td>The project missed most or all milestones and the finished product was unacceptable.</td>
<td>The documentation was not prepared on time, or was so poorly written as to be not understandable. There was no final presentation because the product itself was unacceptable.</td>
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