ME 72: Engineering Design Laboratory

Instructors:

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Course Web Site: *http://robotics.caltech.edu/∼jwb/courses/ME72/ME72.html*

Goals of ME 72:

The goal of ME 72 is to give students a reasonably complete experience with the design process from initial concept, through analysis, to prototyping, testing, and refining. This process is organized around a contest, whose description and rules can be found in a separate handout (entitled "Fire and Fly"). More concretely, this course also aims to:

- Give student teams the experience of solving an open ended electro-mechanical design problem.
- Review and extend basic design methodologies that were introduced in ME 71.
- Introduce students to basic motor control technology.
- Give students the experience of building an electromechanical system.
- Introduce a limited subset of the basic mechanical elements which are typically used in machine design.

Class Format of ME 72:

ME 72 is a project class, and most of the learning in this class will take place during the process of building and fielding your contest design solution. Class time will be devoted to: (1) reviews of appropriate design issues and design methodologies, (2) reviews of relevant

technical issues (electric motor modeling, motor control, fluid dynamics of flight, and the basics of flight control); (3) student project reviews (a poster session, a preliminary design review, and a critical design review). Also, class time will be used for M.E. shop demonstrations on subjects that are relevant to the contest. During the last few weeks of each quarter, when students are intensively working on their projects, class lecture time will be limited.

Homework, Finals, and Grading:

The course work will consist almost entirely of a final project. There is no midterm or final exam in the traditional sense. However, the work of the final project will broken down into a series of tasks that involve milestones and intermediate deliverables, mock-ups, system analyses, simulations, drawings, and documentation, in addition to the actual physical construction of the project. The various activities and their timing are aimed to keep everyone on track to effectively compete in March, 2008. Additionally, each student must keep a "design notebook" throughout the two quarters. These notebooks will be check at regular intervals, and a final grade will be assigned to the notebook at the end of each quarter.

The final grade for the first quarter will be computed as:

- 85% for the deliverables related to the final project. This final project deliverables, and their weighting in the overall grading, are as follows:
  - 5%: Shop exercise to build a container for the receiver and battery pack
  - 10%: Poster Session (initial concepts and their justification for the contest design, preliminary analysis, skeches of design candidates).
  - 20%: Preliminary Design Review (PDR), including device mock-up, and development of critical objectives, functions, and design constraints.
  - 20%: Critical Design Review (CDR), including calculations, simulations, and mock-ups as necessry.
  - 30%: Fabrication of a launching OR flying/projectile device prototype.
- 15% for the quality of the design notebook.

Note that all of the projects are done in teams. The grade assigned to the team on each team-based deliverable is the grade received by all team members. However, the course notebook and some of the intermediate deliverables will come from individual efforts. Thus, there is room for individual effort to affect the final grade. The grading scheme during the second quarter will be similar, though there will be a component of the grade that relates directly to your performance in the final contest. However, only 20% of the final grade in the second quarter will be related to your contest entry's actual performance. The rest of the grade will be based on the quality and creativity of your design process (as evidence by the various design artifacts that you create), and the quality of your final project's fabrication.

Grading of design projects is often subjective. We will attempt to be as fair as possible and lay out the grading procedure for each deliverable in a handout that describes the details that make up each deliverable. Students are encouraged to aggressively ask questions when the grading procedure is not clear.

Course collaboration policy. We encourage students to discuss the competition and the intermediate milestones with other students and with the class instructors and T.A.s. Group projects by their nature involve collaboration. On individual homeworks or deliverables, while discussions with other class participants is encouraged, the‘ work that is ultimately turned in should reflect entirely the effort of the individual.

Shop Materials and Tools

We will provide a ready supply of the basic contest materials that you need for most of the class activities. As described in the contest rules document, students may wish to buy additional battery packs, decoration supplies, bonding material, etc. that may be needed to efficiently design, build, and test their contest entries.

Basic hand tools are available for each student to use in the M.E. shop. We encourage those students who have not already done so to purchase their own basic set of measurement tools.

References

There is no text for this course. We will photocopy and distribute course material as necessary. We will try to keep copies of handouts on the course web site.

Tentative Course Syllabus

In addition to the subjects described below, we also hope to have a few guest lectures, whose schedule will be determined by the availability of the lecturers. Additionally, some class meetings will be devoted to shop demonstrations of relevant mechanical fabrication methods and common mechanical components. It is our intention to have a lighter lecturing schedule during the last 2-3 weeks of the course, when students are expected to fabricate a major component prototype.

- Review of structured design methods (2 lectures)
- Simple modeling of motors and transmissions (2 lectures)
- Review of aerodynamics of flight (4 lectures)
- Basic flight control (2 lectures)
- Description of servomotor mechanisms and operation (1 lecture).
- Basic mechanism design and analysis (2 lectures)