

# **MAE 188**

## **Engineering Design in Industry (EDI)**

### **Course Syllabus**

**Fall 2020**

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<http://sites.uci.edu/maeedi/>



# General Course Resources/Guidelines

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- Course description
- Detailed typical course schedule
- General policies
- Class meetings
- Midterm Presentation
- Final Presentation
- Project Binder



# EDI Course Description

**Course Objectives and Outcomes:** In this course you will learn a formal design process through its implementation on a "real" engineering project. The course will involve the application of engineering principles to design, the use of modern engineering tools, working in teams, and developing communication skills.

- A project of interest is selected by the sponsor company
- A team of ~5 students is selected from the enrolled students to work with the sponsor company. Students are senior level, graduating mechanical and aerospace engineers.
- A kickoff meeting (typically a breakfast) is conducted to introduce the team and company, formulate/clarify the goal statement, and get things started.
- Students visit the company on a weekly basis
- Students meet weekly with the faculty advisers in a classroom format for project guidance and recommendations.
- At week 6 a midterm (design review) is conducted at the company with the entire team
  - Several proposed solutions will be presented and recommendations made (justified)
  - The customer (company) selects preferred approach
- Remainder of the quarter is spent refining the selected design solution which is presented finals week at UCI.
- The team provides documentation of the project to the company at the end with final drawings, solid models, data sets, etc. to support the effort.
- Some projects result in a physical prototype or can occur over 2 quarters



# Typical Course Schedule

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## **Week 1: Identify Customer Needs**

- Prepare goal statement
- Collect desires and ideas from company representatives
- Solicit and record the project requirements

## **Week 2: Generate Solution Ideas and Establish Target Specifications**

- Translate customer needs into technical terms
- Develop metrics
- Determine marginal and ideal values for each metric
- Collect company data, vendor information, sales literature

## **Week 3: Information Gathering and Design Concept Generation**

- Collect recommended solutions from company representatives
- Develop solutions from existing products and concepts
- Generate new concepts
- Pare solution space using handbooks, textbooks, model analysis

## **Week 4: Analyze Design Concepts**

- Prepare a drawing of the concept
- Specify component parts, with vendor and cost
- Pursue proof of concept tests.
- Identify advantages and disadvantages

## **Week 5: Concept Selection**

- Compare solution concepts relative to requirements
- Identify recommended solution concept
- Identify proof of concept, design and manufacturing issues
- Prepare recommended new goal statement and project schedule

## **Week 6: Preliminary Design Review (at company)**

- Technical presentation focusing on engineering details
- Revise goal statement and requirements

## **Week 7-10: Accelerated Execution of the EDI Process**

- Define specifications
- Assemble solution concepts and information
- Prepare multiple solutions and downselect
- If appropriate develop a prototype and test it

## **Week 11: FINAL PRESENTATION**



# Course Requirements

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## Time Commitment

- At least 12 hours per week earning the 4 units awarded by this course.
- Typically ~4 hours spent at the company site or interacting with company representatives
- 1 hour per week classroom meeting
- Typically ~4 hours are generally spent during the working hours of 8-5, M-F in order to ensure adequate contact with vendors and other working professionals.
- The final 3-4 hours are flexible to accomplish tasks.
- These times are approximate and should be considered guidelines. Flexibility is allowed.

## Class Meetings

The class meeting time will consist primarily of progress reports from the project groups.

## Attendance is mandatory at all meetings

Consider class load and OTHER projects carefully

## Core Lab Safety Course:

You must take the UCI online core lab safety course. See instructions on the course website



# Class Policies

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## Requirements:

*Team Leader* - each group will select a team leader at the beginning of the project. The team leader is responsible for assigning team members to take minutes, posting action items for the team, and serves as a main point of contact for communications between faculty advisers, the team, and the company.

*Binder* - each group is to maintain a project binder that contains all of the project information. It is divided into sections to assist the inclusion of all appropriate material. The binder is a running record of the project and must be kept up-to-date.

*Action Items* - each group member will be given an action item agreed upon by the team during weekly scheduled meetings with the faculty advisors. The completion of these action items represents the member's contribution to the project and are critical to the teams' overall performance. Action items are to be collected and posted by the team leader in the drop box at least one hour prior to class time for review by the faculty advisors.

*Presentations* - each group will make two presentations, one at the **midterm design review** and one at the **final design review** (during finals week). Every group member must participate in these presentations, and each member should present their contribution to the project.

*Attendance* - attendance at the weekly project review class meetings is required of all group members and interaction with company representatives is required of all group members.

**Academic Honesty Policy:** Refer to the standard language in the appropriate section of the Schedule of Classes

**Add/Drop Policy:** Refer to the standard language in the appropriate section of the Schedule of Classes



# Class Meetings

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## **Attendance is mandatory at all meetings.**

- Meetings are scheduled for 50 minutes each week.
- The major portion of each class meeting is spent on the progress made by *each student* on the project.
- The *agenda* and the *minutes* are the responsibility of the project group.
- A typical agenda will include: (i) Announcements, (ii) Progress on action items from previous week, (iii) Further needs and next steps, (iv) Updated timeline, (v) Assignments for coming week
- The meeting should always include a clear indication of who is signed up to do what for the upcoming week
- Please upload all items to the EEE Dropbox associated with your project to serve as an archive and working location for everything



# Grading

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Grades are assigned individually based on:

- (a) attendance and participation at the weekly project reviews [10%]
  - (b) performance on weekly tasks assigned [30%]
  - (c) midterm review performance [20%]
  - (d) final presentation [20%]
  - (e) company interaction [10%]
  - (f) group interaction [10%]
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- Grading is done for each individual based on:
    - Weekly oral summary reports (evidence of effort/time)
    - Written summary reports (evidence of effort/time)
    - Performance on midterm/final/poster presentation
    - Attendance
    - Evaluation by liaison(s)
  - A successful project does not mean everyone gets an A
  - A project that falls short of the goal does not mean no one gets an A





# Example Requirements Document

**Title:** Stabilized Camera Mount

**Company:** 2D3

**Project Goal:** To design a 2-axis, motor controlled, stabilized camera mount that will point nadir. This gimbal will be attached to an airplane and be able to accommodate a DSLR

Criteria	Nominal	Optimal	Importance	Notes
Supportable Camera Weight	>1kg + lens	>2kg + lens	5	
Maximum Air Speed	150 knots	160 knots	1	
External Forces	+4/-1 G's		4	
Temperature Range	-5 to 60 DEG C	-10 to 80 DEG C	4	
Quick Release	no	Yes	2	"indexed quick-release mounting scheme "
Accessible Camera	no	Yes	2	Cable wires
Maximum Slew rate	250 deg/s		2	
Camera movement	1 sec total; 50ms pause		3	Stop-to-stop (90°) and back again (180° total)
Pointing Precision	3 milli rad	1 milli rad	4	
Pointing Accuracy	5 milli rad	3 milli rad	4	
Angular Excursions				Refer to next 2 items
Maximum Pitch	30 Deg	45 Deg	3	from nadir
Maximum Roll	30 Deg		3	from nadir (Modified Cessna Cam Box, 45° for fully custom enclosure
Size	Sphere, r=.25 meter		3	of the entire gimbal/camera set up
Weight	<30 lbs	<10 lbs	2	of the entire gimbal/camera set up
Power	<1000W w/Battery	<200W	5	to power the sensor, camera, gimbal
Flight Duration	5 hrs		1	
Airframe	Cessna 172/182	Universal	1	
Camera Platform	DSLR			
Costs	<\$8,000.00	<\$6,000.00	5	BOM cost w/ \$1K camera

Relative Importance



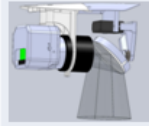




1 – least important

5 – most important



# Downselect Design Concepts

An alternative format for downselecting concepts using a different scoring format is show below:

	Free hanging Ball Joint	Std. pan & tilt	Mirror on gimbal	Stewart platform	Inertial gimbal	3 axis platform	2 axis platform
							
DOF	2	2	2	6	3	3	2
Method of motion	gravity	two servos	two servos	6 linear actuators	gravity	3 servos with linkage arm	2 servos with linkage arm
Relative complexity	●	●	●	●	●	●	●
Pros	no power or electronics req.	proven	reduced mass and moment on system	large DOF	no power or electronics req.	proven	proven
Cons	no control method, could sway	may not be fast or accurate enough	requires 2X precision from servos	complex, expensive	no control method, could sway	limited range of motion	limited range of motion
Cost	●	●	●	●	●	●	●
Speed	○	●	●	●	○	●	●
Resolution	●	●	●	●	●	●	●
Range of Motion	●	●	●	●	●	●	●
Fatal Flaw	cannot control	none	requires a mirror larger than 10" x 10"	too expensive, limited range of motion, too slow	cannot control	limited range of motion	limited range of motion

● Optimal    ● Nominal    ○ Unknown    ● Unacceptable



# Midterm Design Review

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The midterm design review will ideally take place at the industry site. You must schedule the review for the 6th week at a time that works for all parties. Don't delay setting this date—sometimes advanced paperwork is needed to gain access to the site.

The presentation is to provide an opportunity for attendance by others interested both in the activities of the UCI team and the results of the design effort. The presentation should convey your understanding of the goal, the issues, the alternatives and the possible outcomes. After the presentation the students and EDI advisors.

This is a suggested content:

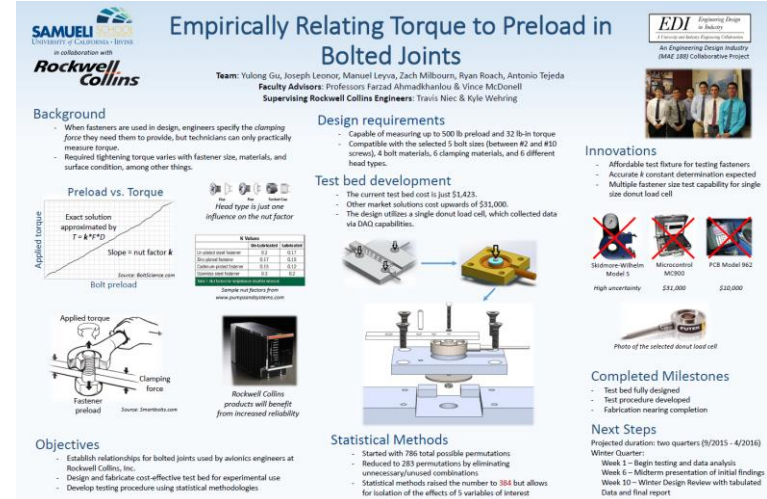
- Slide 1: This should contain the title of the project. Your names and the names of the faculty advisors and industry sponsors.
- Slide 2: The project goal. Discuss briefly the needs of your sponsor, your understanding of your contribution, and present a one sentence statement of your goal.
- Slide 3: The project requirements. Organize the characteristics of a successful design.
- Slides 4-10: Survey your research. Identify the basic issues. Present existing solutions, test plans, calculations
- Slides 11-15: Survey possible designs. Identify features that appear common to all the designs. Identify the specific benefits or drawbacks of special features.
- Slide 16: Present your proposed solution.
- Slide 17: Present the issues that remain to be resolved to achieve this solution.
- Slide 18: Present a proposed time table and budget.
- Slides 19-20: Conclusion. Revisit the goal of the project and how the proposed design addresses this goal



# Poster Presentation

The following information should be included in the poster:

- Title of the project
- Quarter and year
- Names of team members and faculty advisors
- Logos for EDI and Samueli School of Engineering
- Company name, company liaisons, and company logo
- A picture of the team
- Background
- Goal
- Timeline
- Budget
- Current status and future work
- Charts, CAD models, pictures of the prototype, and test results



# Final Presentation

The final presentation is generally given in a conference room at UCI. Members from all project teams should attend to see what the other teams have been doing

The final presentation should (1) summarize the project goal and your activities toward achieving the goal for those in the audience who are not familiar with the problem and (2) present a clear outcome/design to the company sponsor. As with the midterm presentation, all group members should participate in the final presentation of the project.

Each presentation will be allotted 30 minutes and 15 minutes for questions from the audience. There will be plenty of time after all of the presentations to follow up on questions that are not addressed in the formal presentation time.

For the final presentation, be sure to provide enough background so that a general audience will understand why the project is important/needed. Don't assume everyone in the audience already understands this

With only 30 minutes, clear and concise presentation of the critical features is necessary. Your slides should include the following:

- Title slide
- Photograph of the team in front of company, or with critical element of the project.
- Summary of design issue (sufficient so general audience members understand the need)
- Status at 6th week
- Summary of final steps (i.e., last 4 weeks)
- Update Section (2-3 viewgraphs)
- Downselection matrices
- Recommendations

**~75% of the presentation**

Dress formally

Remember to leave 15 minutes for questions.



# General Presentation Style

1. Plan the presentation for 30 minutes. A slow start, questions, and general discussion will expand this rapidly to an hour. Plan 1.5 minutes per slide, which means approximately 20 slides should form the main talk
2. Number each slide. Use the formal #/total so the audience can direct question to specific slides and also so they have a sense of how far along you are
3. Focus on visuals and rely on your verbal presentation to convey your message. Don't just read text on the slide. Avoid "death by PowerPoint"\*
4. Use a pointer to draw the audiences attention to specific points or features of a figure
5. Specific test data or calculations should be prepared and held aside (for example in an Appendix). Be prepared to refer to these slides in addressing questions. You can refer to these details in the main presentation but don't dwell on them as time is limited
6. The presentation must be concise and complete, focusing on the highlights, but containing sufficient details to demonstrate your understanding and analysis of the problem
7. Make hardcopies of the presentation to pass out. The listeners will use the hardcopy to take notes
8. Plan on having someone take notes regarding comments and questions made during the presentation. These should be incorporated into future classroom presentations as well as updated design requirements

**\*This slide is a good example of "death by PowerPoint"**

**But the points here are for reference and standalone so are more verbose than would be desired for an actual presentation to be given**





# Project Binder

## EDI: PROJECT BINDER

The project binder will contain all of the important documentation for your project. You are responsible for keeping the binder current and in readable condition.

All of the material in the binder can be revised as the project progresses, but **DO NOT REPLACE ANYTHING**. If a revision occurs, simply document the revision with the new date and explanation, and add it to the binder.

The binder is a living and evolving document describing the life of the project. If you need special pockets or pages to properly document your project in the binder, let one of the faculty supervisors know. For example, an appropriate disc can be included with any special program written for the project. All elements of the binder should be dated and an author identified (when appropriate).

The binder can be reviewed at anytime; it must be up-to-date. The binder should contain the following sections listed here.

**1. MANAGEMENT** - A snapshot of the project and its participants.

- \* Project Goal
- \* Company Contacts
- \* Group Members
- \* Other Industrial Contacts
- \* Project Timeline

**2. PROJECT DEFINITION** - The elements that define the project.

- \* Principal Goal
- \* Constraints
- \* Requirements

**3. ANALYSIS** - Supporting engineering analytical efforts (each should stand alone).

- \* Problem Statement
- \* Assumptions
- \* Calculations
- \* Conclusion/Answer
- \* Comments

**4. TESTS / MEASUREMENTS** - supporting experiments and their results (each stands alone).

- \* Problem Statement
- \* Apparatus
- \* Conditions of Test
- \* Data/Results
- \* Conclusion/Answer
- \* Comments

**5. VENDOR LITERATURE** -

Information from companies regarding parts and instruments.

- \* Contacts and Literature
- \* Costs and Delivery Schedule
- \* Subcontractors

**6. PRELIMINARY DESIGN** - Your considered design ideas (supported by analysis and measurements).

- \* Drawings
- \* Descriptions
- \* Comments

**7. FINAL DESIGN** - The final product.

- \* Conclusions in Bullet Form
- \* Design Drawings
- \* Descriptions
- \* Cost Analysis

**8. PROJECT PROGRESS**

- \* Agendas
- \* Minutes
- \* Progress Reports
- \* Chronological Record of Miscellaneous
- \* Comments

**9. MIDTERM PRESENTATION**

- \* Outline of Presentation
- \* Hardcopy of Overheads

**10. FINAL PRESENTATION**

- \* Outline of Presentation
- \* Hardcopy of Overheads



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