A COLLECTION OF MECHANICAL ENGINEERING DESIGN SYLLABUS
BASED ON THE OUTCOMES-ORIENTED CAPSTONE DESIGN COURSE METHOD

REFERENCE: IMECE2014-63826

Mechanical Design: Process and Implementation (MENG 489)
Yale School of Engineering & Applied Science
Fall 2013

Course Objectives:
This is the capstone design course in the Mechanical Engineering program. This is a unique opportunity to apply and demonstrate your broad and detailed knowledge of engineering in a team effort to design, construct and test a functioning prototype engineering system. The lecture portion of the class provides guidance in planning and managing your project, as well other topics associated with engineering design. This course requires quality design, analyses and experiments to support the design effort, construction and testing of the designed system. Documentation and professional presenting your results to a technical audience is also required.


Format: Lectures/Teamwork Sessions TUES and THUR (10:30-11:20) - Design Lab FRI (1:00-4:00)

Instructor: V. Wilczynski (Deputy Dean, SEAS), assisted by the CEID/SEAS Teaching Support staff & the Teaching Assistants.

Fulfilling Mechanical Engineering Program Outcomes:
This capstone course in Mechanical Engineering represents the culmination of your undergraduate engineering education. The course provides the opportunity to apply what you have learned through course work and your life experience to the activity which is the essence of engineering, namely, DESIGN. This course is a measure of your success in fulfilling the educational objectives of your undergraduate program.

The accrediting agency for engineering programs, ABET, has specified the following as required outcomes of all undergraduate engineering majors:

Engineering programs must demonstrate that their graduates have:
1. An ability to apply knowledge of mathematics, science and engineering - demonstrated through the analysis requirement and notebooks.
2. An ability to design and conduct experiments as well as to analyze data - demonstrated through the experiment requirement.
3. An ability to design a system, component or process to meet desired needs - demonstrated through project completion/documentation that spans the concept, prototype and detailed design phases.
4. An ability to function on multi-disciplinary teams - demonstrated by team effectiveness and team process evaluations.
5. An understanding of professional and ethical responsibility - demonstrated by an ethics case study.
6. An ability to communicate effectively - demonstrated through presentations, team binders and project poster.
7. The broad education necessary to understand the impact of engineering solutions in a global and societal context - demonstrated by including references to societal impacts in presentations and reports.
8. Recognition of the need for and an ability to engage in life-long learning - subject of classroom discussions (and your FE Exam preparation).
9. Knowledge of contemporary issues - demonstrated by reference to contemporary engineering issues in the reports and presentations.
10. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - demonstrated by documenting the use of these techniques, skills, and tools in the project documentation and presentations.

Additional ABET requirements for graduates of Mechanical Engineering programs include:
1. Knowledge of chemistry and calculus based physics - demonstrated in the analysis requirement.
2. Ability to apply advanced mathematics through multivariate calculus and differential equations; - **demonstrated in the analysis requirement.**  
3. Familiarity with statistics and linear algebra - **demonstrated through the analysis and experiment requirements.**  
4. The ability to work professionally in both thermal and mechanical systems areas including the design and realization of such systems - **demonstrated through the project completion.**

Further, ABET specifies professional component requirements which state that students must be prepared for engineering practice through the curriculum culminating in a major design experience based on knowledge and skills acquired in earlier course work and **incorporating engineering standards and realistic constraints** that include most of the following considerations:

- Economic  
- Environmental  
- Sustainability  
- Manufacturability  
- Ethical  
- Health and Safety  
- Social  
- Political

MENG 489 is one of the Mechanical Engineering Program’s primary methods to address these requirements. These outcomes will be measured through the course and your scores recorded, with your performance evaluated against your peers. We will also ask you to evaluate each other with regard to contributions to the team effort at three points in the semester.

**Course Requirements:**
The primary requirement of this course is the successful completion and documentation of your group project. To facilitate the process and demonstrate fulfilling the educational objectives of the Mechanical Engineering Program, the following deliverables will be required during the course and used to determine your course grade:

- **Project Binder** - Each team must keep an indexed project binder that includes:
  a. **Reports** - must be indexed and include a copy of every report generated by the team.  
  b. **Drawings** - must have an index and include a copy of every uniquely numbered drawing used by the team to manufacture or procure parts for their project. Note, no fabrication should be undertaken without the presence of a properly formatted/dimensioned drawing.  
  c. **Reviews** – slides from each design review (listed below).  
  d. **Meetings** – meeting minutes (agenda/attendance/follow up tasks) in two indexed sections:  
     i. weekly administrative/management meetings  
     ii. all other design, decision, and problem solving meetings

2. **Individual Design Notebooks** - Your design notebook will be a record of your individual contribution to the project. The notebook will be a hardbound notebook, kept up to date daily, and detail all notes, rough calculations, and sketches. This notebook is effectively your record of the work in progress and has legal ramifications in the “real world”. Remember: “If it is not written down, it did not happen.” At the end of the course your design notebook must be submitted with the Team Project Binder.

3. **Formal Reports:** A series of formal reports will be required to guide your design process and include:
   a. **Problem Statement and Project Specification** - Customer identification, need statement, goal statement, constraints and weighted objectives (criteria).  
   b. **Alternative Solutions** - Proposed concept level solutions to the Problem Statement, including sketches, critical sub-component operations, scale, cost, weight, and basic analysis.  
   c. **Project Management** - The lecture portion of the course will include a module on project management tools as well as establishing a project budget. Teams will use these tools to develop an initial schedule and budget for the project. Once completed, the team must revise/update the initial plans to guide the project over the semester.  
   d. **Engineering Standards** (subgroups of 2) - Subgroups will identify an applicable engineering standard and document how their design project satisfies this engineering standard. A unique standard must be applied by each subgroup.
e. **Material and Component Selection** – Documentation to detail the design decisions made to select the fabrication materials (and methods) and the major system components (such as power sources/storage, motors and sensors).

f. **Design for Manufacturing** - A review of the project’s proposed manufacture/fabrication plan and its optimization for simplicity, assembly, cost, and maintenance.

g. **Preliminary Design Report** - Following from the previous week’s preliminary design presentation, the Preliminary Design Report details major product dimensions and sub-component designs. This report establishes the road map for the detailed design phase and highlights critical path design/fabrications issues.

h. **Engineering Analysis** (subgroups of 2) – Engineering fundamentals analysis of a critical component of the design. The analysis should be conducted to make a design decision and can include topics such as stress analysis, thermo/fluid analysis, machine design principles, or electric circuit design. Teams should consult with the Project Advisors to identify an analysis topic that has an appropriate scope and to ensure that the analysis is distinct to each subgroup.

i. **Engineering Experiment** (subgroups of 2) - Subgroups must identify, design, perform and analyze an experiment which will contribute to your design effort. The procedures and report must follow engineering experimentation protocols.

j. **Safety Through Design** (subgroups of 2) - The lecture portion of the course will include a module on risk based decision making. This report will apply risk based decision making to each specific project to illustrate the utility of safety planning in engineering design. The subgroup reports should be culled to produce a summary statement that identifies the resulting safety features (such as guards, interlocks and fail safe operating modes) that will be incorporated in the final design.

k. **Engineering Ethics** (subgroups of 2) - The lecture portion of the course will include a module on engineering ethics. Subgroups will create a case study that highlights the relevance of one aspect of the Engineering Code of Ethics to their project.

l. **Maintenance and Operating Manual** – Product manual that includes a parts list, exploded views of the product, and an operating guide suitable for shipment with the product.

m. **Executive Summary** - Summary of how the project specification has (or has not) been met. The report should also detail future developments required to advance the project. This report should reference the reports produced over the course of the semester but ultimately it should be a self-contained summary of the project.

4. **Optional Individual Reports (OIR)** – OIRs are essential to document each step of the design process. Any work that you do on the project should ultimately end up in an OIR (or one of the Formal Reports). In order to get credit for undertaking any work on your project it must be documented. For example, if you fabricate a bracket to hold two components together, include drawings of the bracket, photographs of its fabrication, basic calculations (stress, geometry etc) and an explanation of the choice of material and operating loads/conditions that the part will be subject to.

The only standard element of an OIR is the cover sheet. The OIRs are the heart of your project and should be referenced by other reports as the project progresses. The reports are not intended to be onerous but rather are intended to they are ultimately there to save you time, keep the project focused and to prevent mistakes from being made.

5. **Reviews** - A series of team presentations (that need to included in your Report Binder) to guide your design process:
   a. **Conceptual Design Review** – presentation of concepts that were examined to identify leading candidates to advance to prototype review. Presentation will highlight the idea generation methods as well as idea evaluation techniques used by the team to make design decisions.
   b. **Preliminary (aka Prototype) Design Review** - presentation of the prototypes of each of the system’s subcomponents to demonstrate the feasibility of the proposed concepts. At this design review, prototypes of the subsystems associated with your designs must be presented and archived. The output of this review identifies the overall design solution that will advance to the detailed design phase (and ultimate project completion).
   c. **Detailed Design Review** - presentation of the completed final design. This review will be evaluated to determine how the project met the established project goals, objectives and functional requirements.

6. **Poster** - Each team must produce a poster display describing the product. This display should be completed in time for the Final Project Presentations.

**Grading:**

Your final course grade will be based on instructor evaluations of your performance in all aspects of the course, peer evaluations. For superior performance, a student is expected to take ownership for the successful completion of the team project. He/she must
complete assignments on time and ensure the quality of not only their own work but also their colleagues. In addition each student is expected to contribute to successful coordination of the team effort, maintain effective communication with the Project Advisors, and be recognized as a quality performer by faculty and team members. Each deliverable will be evaluated and scored against the class performance.

A team grade will be awarded and each student’s grade adjusted relative to the team grade by evaluation of their individual contributions. These will include:

- Quantity and quality of issued reports, drawings, and sketches/CAD models.
- Parts manufactured, assembled and procured.
- Design notebooks and presentation contributions.
- Peer evaluations.
- Project advisor evaluations.
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<th>Deliverable</th>
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<td>9/6 L</td>
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<td>Subcomponents: Prototype Design/ Procurement</td>
<td>Formal 4: Engineering Standards</td>
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<td>Detail Design (Power Transmission)</td>
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<td>8</td>
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<td>Formal 6: Design for Manufacturing</td>
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<td>9</td>
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<td>(October Recess starts on 10/23)</td>
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<td>Detailed Design/Procurement</td>
<td>Formal 7: Preliminary Design Report</td>
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<td>Engineering Safety</td>
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<td>Engineering Safety Applications</td>
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<td>Detailed Design Fabrication</td>
<td>Formal 8: Engineering Analysis</td>
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<td>Detailed Design Fabrication</td>
<td>Formal 9: Engineering Experiment</td>
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<td>12/3</td>
<td>Detailed Design Presentation Planning</td>
<td>Formal 12: Maintenance and Operating Manual</td>
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<td>Design as a Process Summary</td>
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<td>Detailed Design Integration and Testing</td>
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<td>12/10</td>
<td>Detailed Design (aka FINAL) Presentations (1:00 – 4:00)</td>
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<td>Formal 13: Executive Summary</td>
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<td>Poster</td>
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<td>Team Contribution Review III</td>
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Course Objectives:
This is the capstone design course in the Mechanical Engineering program. This is a unique opportunity to apply and demonstrate your broad and detailed knowledge of engineering in a team effort to design, construct and test a functioning prototype engineering system. The lecture portion of the class provides guidance in planning and managing your projects, as well as assorted topic coverage as required during the progression of the unique projects. This course requires quality design, analyses and experiments to support the design effort, construction and testing of the designed system. Documentation and professional presenting your results to a technical audience is also required for overall success.


Format: Lecture/Discussion - 2 lectures Tues and Thurs 10.30 -11.20 Design Lab - TBD

Instructor: Prof. Foley, with the assistance of the Project Advisors, Teaching Assistants

Fulfilling Educational Objectives:
The capstone course in Engineering represents the culmination of your undergraduate engineering education. The course provides the opportunity to apply what you have learned through course work and your life experience to the activity which is the essence of engineering, namely, DESIGN. This course is a measure of your success in fulfilling the educational objectives of your undergraduate program.

The accrediting agency for engineering programs, ABET, has specified the following as required outcomes of all undergraduate engineering majors:

Engineering programs must demonstrate that their graduates have:
1. An ability to apply knowledge of mathematics, science and engineering - demonstrated through the analysis requirement and notebooks.
2. An ability to design and conduct experiments as well as to analyze data - demonstrated through the experiment requirement.
3. An ability to design a system, component or process to meet desired needs - demonstrated through project completion, presentation and documentation.
4. An ability to function on multi-disciplinary teams - demonstrated by team effectiveness and team process evaluations.
5. An understanding of professional and ethical responsibility - demonstrated through completion of an ethics essay.
6. An ability to communicate effectively - demonstrated through presentations, project folders, poster displays, and web page development.
7. The broad education necessary to understand the impact of engineering solutions in a global and societal context - demonstrated by including knowledgeable references to societal impacts of the project related activities in presentations and reports.
8. A recognition of the need for and an ability to engage in life-long learning - subject of classroom discussions (and your FOE Exam preparation)
9. A knowledge of contemporary issues - demonstrated by reference to contemporary engineering issues in the design report and presentation.
10. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - demonstrated by documenting the use of these techniques, skills, and tools in the project documentation and presentation.

Additional ABET requirements for graduates of Mechanical Engineering programs include:

1. Knowledge of chemistry and calculus based physics - demonstrated through use in the analysis requirement.
2. Ability to apply advanced mathematics through multivariate calculus and differential equations; - demonstrated through use in the analysis requirement.
3. Familiarity with statistics and linear algebra - demonstrated through use in the analysis and experiment requirements.
4. The ability to work professionally in both thermal and mechanical systems areas including the design and realization of such systems - demonstrated through the project completion.

Further, ABET specifies professional component requirements which state that students must be prepared for engineering practice through the curriculum culminating in a major design experience based on knowledge and skills acquired in earlier course work and incorporating engineering standards and realistic constraints that include most of the following considerations:

- Economic
- Environmental
- Sustainability
- Manufacturability
- Ethical
- Health and Safety
- Social
- Political

The Capstone Design Experience is the Program’s method of addressing these requirements.

Course Requirements:
The primary requirement of this course is the successful completion and documentation of your group project. To facilitate the process and demonstrate fulfilling the educational objectives of the Mechanical Engineering Program, the items listed below will be required during the course and are used as assessment tools to determine your course grade:

7. Team Project Binders.
   Each project team must keep the following indexed project binders.
   
   A. Report Binder.
      Binder to have index and a copy of every issued report generated by the team.
   
   B. Drawings Binder.
      Binder to have an Index and a copy of every uniquely numbered drawing used by the team to manufacture or procure parts for their project. No fabrication should be undertaken without the presence of a properly formatted/dimensioned drawing.
   
   C. Meetings Binder.
      Binder to have two indexed sections.
      (i) Section for weekly administrative/management meetings.
      (ii) Section for all other design, decision, problem solving meetings.

8. Individual design notebooks.
   This design notebook will be a record of your individual contribution to the project. The notebook will be a hardbound notebook as specified by the instructor and will be kept up to date daily. All notes, rough calculations, sketches etc should be keep in your notebook. It is effectively your work in progress record and has legal ramifications in the “real world”. Remember: “If it is not written down, it did not happen.” At the end of the course your design notebook must also submitted with the above Binders.

9. Investigation Reports and Optional Individual Report (OIR’s)
   
   (i) Investigation Reports
   During the course of the semester your project advisor may assign specific investigation questions to each team member. These questions should be viewed as “homework” for the course and will be used to document your progress on the research aspects of the project. The questions may range from a survey of a broad topic assigned to the group, to a very narrow issue such as documenting the selection criteria for a material used in the project. The responses to these questions must be prepared in the standard report format and submitted at the next lab/weekly meeting to your Project Advisor.

   (ii) Optional Individual Reports (OIR)
These are key to your project. Any work that you do on the project should ultimately end up in a OIR of one form or another. In order to get credit for undertaking any work on your project it must be documented. e.g. If you fabricate a bracket to hold two components together. Include drawings of the bracket and photographs of its fabrication. Show any basic calculations (stress, geometry etc). Explain the choice of material and the operating loads/conditions that the part will be subject to. Include an estimate of the time taken to fabricate and what the part cost.

The only standard thing about an OIR is the cover sheet. The OIR’s are the heart of your project and should be referenced by other reports as the project progresses. The reports are not intended to be onerous they are ultimately there to save you time, keep the project focused and to stop mistakes from being made and certainly not repeated.

**FORMAL REPORTS**

1. **Project Specification**
   Customer Identification, Need Statement, Goal Statement, Constraints and Weighted Objectives.

2. **Alternative Solutions (one report per Team member).**
   Proposed solution to the Project Specification. Sketches, critical sub component operation, Approximates scale, cost, weight etc… Basic analysis.

3. **Preliminary Design Report.**
   Following on from a preliminary design presentation in the preceding week the Preliminary Design Report should detail major product dimensions, sub components materials etc. Sets the road map for the upcoming detailed design and highlights critical path design and fabrications issues. Should include a Gannt chart or similar project planning tool.

4. **Critical Component Analysis/ Design. (one report per team member.)**
   Report should apply analysis/theory skills from your other courses of study to your specific project. i.e. Stress Analysis, Thermo/Fluid Analysis, Machine Design, Electric Circuit Design etc…

5. **Design for Manufacture.**
   This report should document a review of your projects proposed manufacture/fabrication plan and its optimization for simplicity, assembly, cost, maintenance, etc.

6. **Reliability and Safety Report**
   A detailed review of safety features e.g. Interlocks, fail safe modes etc. Also the life expectancy and predicted reliability rates of the final product.

7. **Economics and Marketing Report.**
   Proposed customer base, sales price and profit margin etc for the product. A mini business plan.

8. **Maintenance and Operating Manual.**
   Polished maintenance manual with parts list and exploded views of product. Operating manual suitable for shipment with product.

9. **Poster Display**
   Each team must produce a full size poster display describing the product. This display should be completed in time for the Final Project Presentations and will be used in future Engineering Department displays.
10. **Executive Summary Report**
Summary of how the initial specification has or has not been met. The report should also detail future developments required to advance the project if applicable. This report should reference the various other reports produced over the course of the semester but ultimately it should be a self-contained executive summary of the project.

**Grading:**
Your final course grade will be based on instructor evaluations of your performance in all aspects of the course, peer evaluations. For superior performance, a student is expected to take ownership for the successful completion of the team project. He/she must complete assignments on time and ensure the quality of not only their own work but also their colleagues. In addition each student is expected to contribute to successful coordination of the team effort, maintain effective communication with the Project Advisor, and be recognized as a quality performer by faculty and team members.

Each deliverable (e.g. Team project folder, design notebooks, individual weekly progress binders, fabricated products, test and performance evaluations, assorted presentations etc) will be evaluated and scored against the class performance.

A final team grade will be awarded and a student’s grade adjusted relative to the team grade by evaluation of their individual contributions. These will include, amongst other things -

- **** Quantity and quality of issued reports and drawings, sketches etc.
- Parts manufactured, assembled and procured.
- Design notebooks and presentation contributions.
- Peer evaluations.
- Faculty advisors evaluation.
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<th>Week</th>
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<td>1</td>
<td>8/25- 8/31</td>
<td>Introduction, Syllabus, Team Assignment Project Proposal</td>
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<td>2</td>
<td>9/3 - 9/7</td>
<td>Project Description and Specification</td>
<td>Teams Formed. Roles Assigned Project Selected.</td>
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<td>Design for Manufacture</td>
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<td>Fabrication</td>
<td>Formal 5 : Design for Manufacture</td>
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<td>12</td>
<td>11/12 - 11/16</td>
<td>Fabrication / Testing</td>
<td>Formal 6 : Reliability/ Safety</td>
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<td>Formal 7 : Economics/Marketing Report</td>
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<td>13</td>
<td>11/19 - 11/23</td>
<td>Fall Recess</td>
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<td>Formal 9 : POSTER PRODUCTION</td>
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Course Objectives:
This is the capstone design course in the Mechanical Engineering curriculum. This course is an opportunity to apply and demonstrate your knowledge of engineering fundamentals in the context of a team effort to design, construct and test a practical mechanical system. The lecture portion of the class provides guidance in planning and managing your design projects, as well as an overview of several topics as they apply to engineering design activities. This course requires quality design, analyses and experiments to support the design effort, construction and testing of the designed system, and presenting your results to a technical audience.

Texts:

Format:
Lecture/Discussion - 2 units (2 hr/week), Design Lab - 2 units (6 hr/week)

Instructor: CAPT Wilczynski, with the assistance of the Project Advisors
Project Advisors: Dr. Caserto – Homeland Security Applications
                    LCDR Clippinger – Automatic Control of a Dirigible
                    Prof. Foley – Bio-diesel for the CG
                    Dr. Jansons – Mini Baja
                    CAPT Wilczynski – Robotics

Fulfilling Educational Objectives:
As the capstone course in your major, this course is the culmination of your undergraduate engineering education. This course will provide you with the opportunity to apply what you have learned through course work and your life experience to the activity which is the essence of engineering, namely, DESIGN. This course is a measure of your success in fulfilling the educational objectives of your undergraduate program.

The accrediting agency for engineering programs, ABET, has specified the following as required outcomes of all undergraduate engineering majors:

Engineering programs must demonstrate that their graduates have:
1. An ability to apply knowledge of mathematics, science and engineering - demonstrated through the analysis requirement
2. An ability to design and conduct experiments as well as to analyze data - demonstrated through the experiment requirement
3. An ability to design a system, component or process to meet desired needs - demonstrated through project completion, including concept-prototype-detailed design phases
4. An ability to function on multi-disciplinary teams - demonstrated by team effectiveness and team process evaluations
5. An understanding of professional and ethical responsibility - demonstrated through completion of an ethics essay
6. An ability to communicate effectively - demonstrated through presentations, written reports, poster displays, and web page development
7. The broad education necessary to understand the impact of engineering solutions in a global and societal context - demonstrated by including knowledgeable references to societal impacts of the project related activities in presentations and reports
8. A recognition of the need for and an ability to engage in life-long learning - subject of classroom discussions (and your FOE Exam preparation)
9. A knowledge of contemporary issues - demonstrated by reference to contemporary engineering issues in the design report and presentation
10. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - demonstrated by documenting the use of these techniques, skills, and tools in the design report and presentation

Additional ABET requirements for graduates of Mechanical Engineering programs include:

1. knowledge of chemistry and calculus based physics - demonstrated through use in the analysis requirement
2. ability to apply advanced mathematics through multivariate calculus and differential equations; - demonstrated through use in the analysis requirement
3. familiarity with statistics and linear algebra - demonstrated through use in the analysis and experiment requirements
4. the ability to work professionally in both thermal and mechanical systems areas including the design and realization of such systems - demonstrated through the project completion

Further, ABET specifies professional component requirements which state that students must be prepared for engineering practice through the curriculum culminating in a major design experience based on knowledge and skills acquired in earlier coursework and incorporating engineering standards and realistic constraints that include most of the following considerations:

- Economic
- Environmental
- Sustainability
- Manufacturability
- Ethical
- Health and Safety
- Social
- Political

These outcomes will be measured through the course and your scores recorded, with your performance evaluated against your peers. At the end of the semester, you will be asked to self-assess how well you have achieved these outcomes. We will also ask you to evaluate each other with regard to contributions to the team effort at three points in the semester.

Course Requirements:
The primary requirement of this course is the successful completion of your group project. To facilitate the process and demonstrate fulfilling the educational objectives of the Mechanical Engineering Program, the items listed below will be required during the course and used as assessment tools to determine your course grade:

1. Design Project Notebooks and Weekly Progress Reports ( - individual)
   - You must keep all material related to your project organized in an individual design notebook. This design notebook must be the heart of your individual organization for the project. The notebook can be a 3 ring binder or a bound notebook where you attach extra information. Included in the notebook will be a section for your weekly project reports (electronic copy available at S:\Cadets-Departments\ME\MED – 06) and your Investigation Questions (described below). Weekly individual Progress Reports should include a log of your project activities for every day of the week, a discussion of where your part of the project stands relative to the planned schedule, a report on the specific time blocks devoted to project activities (as if you were charging your project time to a customer), planned activities for the next week, and appendices as necessary to document the achievements (sketches, drawings, analyses, brainstorming notes, interview notes, telephone conversation notes, research notes, test data, photos, etc.). Remember: “If it is not written down, it did not happen.” Progress Reports should be turned in every Friday to your Project Advisor. At the end of the course this notebook must be submitted to your Project Advisor.

2. Investigation Questions ( - individual)
   - Your Project Advisor will assign weekly investigation questions to each team member. These questions should be viewed as “homework” for the course and will be used to document your progress on the research aspects of the project. The questions may range from a survey of a broad topic assigned to the group, to a very narrow issue
such as documenting the selection criteria for a material used in the project. The responses to these questions must be prepared as “homework” and submitted the next lab period to your Project Advisor.

3. Engineering Analysis Report (- individual)
   - You must identify an analysis based on engineering fundamentals which will contribute to your design effort. You should consult with your Project Advisor to identify an analysis having an appropriate scope. This analysis must be submitted in a technical paper format. (No two team members can do the same analysis.)

4. Engineering Experiment Report (- subgroup of 2)
   - You must identify, design, perform and analyze an experiment which will contribute to your design effort. This can be done in groups of no more than two team members collaborating on the same experiment.

5. Preliminary Design Review (- team & individual)
   - The Preliminary Design Review will be your team’s opportunity to explain what you are planning for the final phases of your project. This review will give the faculty (and/or your customers) the opportunity to evaluate whether or not your ideas and plans look reasonable enough for you to proceed to the completion phase.

6. Project Management Assignment (- subgroup of 2)
   - The lecture portion of the course will include a module on project management tools. You will use these tools to develop an initial plan for your project. Once completed, your team must develop these initial plans more completely such that they are useful to plan your project.

7. Safety Through Design Assignment (- individual)
   - The lecture portion of the course will include a module on risk based decision making. Your assignment will be to apply this technique to your project to demonstrate the utility of safety planning in your project.

8. Engineering Economics Assignments (- individual)
   - The lecture portion of the course will include a module on Engineering Economics with written assignments which will require you to demonstrate an understanding of the fundamentals of engineering economics evaluations.

9. Prototype Phase Design Review (- sub-team)
   - The Prototype Phase Design Review will be your team’s opportunity to demonstrate that your concept designs are in fact feasible. At this design review, prototypes of the subsystems associated with your designs must be presented and archived.

10. Engineering Ethics Assignment (- individual)
    - The lecture portion of the course will include a module on Engineering Ethics with a written assignment.

11. Engineering Standards Report (- individual)
    - Each student will identify an applicable engineering standard and document how their design project satisfies this engineering standard. A unique standard must be applied by each member of the design team.

12. Detailed Design Review (- team & individual)
    - The team’s final design will be evaluated to determine how the project met the established project goals, objectives and functional requirements.

13. Final Project Presentation (- team & individual)
    - The Final Presentation will give your team the opportunity to explain to a technical audience both the product of your design effort and the process you went through. This is the “showcase event” of the senior design course.

14. Final Project Report (- team & individual)
    - The final report is the permanent record of the complete team effort. The specific format of this report will depend on the nature of individual projects. The final report must be submitted to the project advisor long enough before the end of the semester to allow for a revision cycle. For each section of the report, the individual responsible for that section must be identified (in an appendix that lists authors for each section).
16. **Poster Display (team)**
   • Each team must complete a multiple poster-board display describing the project process and product. This display should be completed in time for the Final Project Presentations and will be used in future Engineering Department displays. Three posters will be required for each team to introduce your project, document the sequential design experience, highlight analysis and experimentation, illustrate how the entire technical curriculum contributed to the project, and showcase your results.

17. **Web Page (team)**
   • Each team must prepare and install a web page which will be referenced in the ME Section Academy web site.

**Grading:**
Your final course grade will be based on instructor evaluations of your performance in all aspects of the course, peer evaluations, and self evaluations. For superior performance, a student is expected to take ownership for the successful completion of the team project. He/she must complete assignments on time, submit progress reports regularly on time with quality content, contribute to successful coordination of the team effort, maintain effective communication with the Project Advisor, and be recognized as a quality performer by faculty and team members.

Each deliverable will be evaluated and scored against the class performance.
<table>
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<th>Week</th>
<th>Class Topic</th>
<th>Text Chapter</th>
<th>Due</th>
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| 1/9   | The Design Process: Defining Objectives                                     | Ch. 1, 2     | Progress Report 1  
Project Objectives  
Investigation Questions |
| 1/17  | Defining the Problem & Creative Idea Generation & Functional Requirements (handout) | Ch. 2, 6     | Progress Report 2  
Creative Ideas to Address Project Objectives  
Investigation Questions |
| 1/23  | Project Management & Preliminary Design Review Requirements                  | Ch. 7        | Progress Report 3  
Functional Requirements  
Individual Responsibilities  
Investigation Questions |
| 1/30  | Formulating Solutions                                                        | Ch. 2, Ch. 9 | Progress Report 4  
Scheduling HW  
Investigation Questions |
| 2/6   | Safety Through Design                                                        | Ch. 4 Handout| Progress Report 5  
Preliminary Design Review Plan, Safety HW  
Investigation Questions |
| 2/13  | Modeling, Analysis, & Testing                                                |              | Progress Report 6  
Analysis / Testing Plan  
Investigation Questions  
Team Contribution Review I |
| 2/20  | Engineering Analysis: Example  
Engineering Experiment: Example                                                  | Ch. 6, 9     | Progress Report 7  
Preliminary Design Review 2/22 |
| 3/6   | Spring Break                                                                |              |                                                                      |
| 3/13  | Product Design Case Study & Patent Process                                   | Ch. 6, 9 Handout| Progress Report 8  
Investigation Questions |
Investigation Questions |
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<th>Subject</th>
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<th>Notes</th>
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| 3/27  | Engineering Economics            | Ch. 8, FOE Manual | Progress Report 10  
Engineering Economics HW  
Prototype Phase Design Review |
| 4/3   | Engineering Ethics               | Ch. 4   | Progress Report 11  
Engineering Ethics Case Study  
Investigation Questions  
Team Contribution Review II |
| 4/10  | Engineering Standards            | Ch. 4   | Progress Report 12  
Engineering Standards Report  
Experiment Report |
| 4/17  | Curriculum Review Report & Poster Preparation | Ch. 3   | Progress Report 13  
Poster & Web Display |
| 4/25  | Report Presentation              | Ch. 3   | 4/26 Final Presentations  
Notebooks  
Detailed Design Review  
Project Report  
Team Contribution Review III |