ME 495 Senior Honors Thesis
Fall 2021

Course Description: This course provides an opportunity for an individual senior Mechanical engineering student to undertake a year-long (in conjunction with ME 496) research project of their choosing. The student will work with a faculty advisor(s) and thesis committee to create a thesis topic which includes a significant design component. To assist in the timely progress towards a completed thesis in the Spring Semester, a written thesis proposal (departmentally approved), a proposal presentation to the thesis committee, and regular meetings with the thesis advisor should occur. This program is designed in accordance with the honors program of the College. Enrollment is limited to selected seniors in Mechanical Engineering. Students who take the honors sequence in place of the senior design sequence (ME 497/ME 498) must fully participate in the lecture portion of ME 497.

Common Hour Meeting Time and Location: Monday 12:10-1:00 pm, Hugel 100

Course Learning Outcomes:
After the course is complete, students will be able to:

- Write and publicly defend a proposal for the Senior Honors Thesis;
- Conduct independent scholarly work of professional or near professional quality in their field;
- Produce a clearly written thesis that analyzes a complex problem or addresses a significant research question with insight and imagination;
- Report research in oral and poster presentations in the format expected at professional academic conferences that is well organized, effectively delivered, knowledgeable, and appropriate for the audience.
- Demonstrate their ability to use the engineering design process to complete an element of their thesis.

Required Elements:
During the Fall Semester, the senior thesis honors candidate must:

- identify a thesis advisor(s),
- draft a thesis committee consisting of at least two Mechanical Engineering faculty members and at least one external (non-ME) member,
- create a thesis proposal in concert with the thesis advisor(s) and submit it to the ME department for approval by the end of the third week of classes,
- deliver a thesis proposal presentation to the thesis committee by the end of the fourth week of classes,and
- fully participate in the lecture portion of ME 497.
- Identify a significant design component that is part (or all) of your project and requires you to use the design process in order to creatively solve a problem.

Overview of Deliverables:

A) **Written Thesis Proposal** - Document submitted to both the thesis advisor(s) and the ME department which describes in detail the proposed thesis topic, the research question, an expected timeline of goals for the fall semester, and a description of the design component of the thesis. Should be provided to your advisor no later than Friday, September 10th. More details on the Thesis Proposal are included in this syllabus.

B) **Thesis Proposal Presentation** - oral presentation delivered to the thesis committee. Should occur prior to Friday, September 17th. More details on oral presentations are included in this syllabus.

C) **Design Component –** To quote from the ABET definition of design: "Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic science and mathematics and engineering sciences are applied to convert resources optimally to meet a stated objective. Among the fundamental elements of the design process are the establishment of objectives and criteria, synthesis, analysis, construction, testing and evaluation. Therefore, the design component should include the development of student creativity, an application that is an "open-ended problem", development and use of modern design theory and methodology, formulation of design problem statements and specification, consideration of alternative solutions, feasibility considerations, and a detailed system description. Further it is essential to include a variety of realistic constraints, such as economic factors, safety, reliability, aesthetics, ethics and social impact."[1]

The description of the design component **in both the proposal and the thesis** must include justification that the design component meets this definition. Additionally, the description of the design component (in the thesis proposal) should identify relevant published codes and standards that may apply. If none are found, this result should be stated. When you report your completed design component in your thesis, you should describe how published codes and standards influenced your design.

C) **Midyear Presentation**

D) You will give **five-minute update presentations** to your peers and all senior design instructors during the Monday common hour. There are six presentation dates during the academic year and each of you will present on three of those dates. The Fall semester presentation dates are:

- 10/4/2021
- 11/1/20210
- 12/6/2021

The dates for your individual presentations on one or more of the above presentation dates will be assigned one week in advance. These presentations ***must*** be at least four minutes long and no longer than five minutes. All slides/videos for each presentation will be uploaded to a common Google Slides document. The link to this document will be sent to all students the Friday before each scheduled presentation with placeholder slides for each project in the assigned presentation order. Five minutes will be allotted to each speaker. Only speakers who have provided slides in advance will be allowed to present during their assigned time.

E) Safety Plan and Review (due before "hands-on" work commences)
Describes a safety plan and risk assessment specific to your design component. This includes risks associated with fabrication of prototypes, conduction of experiments, and risks to any human participants in your project (e.g. any interactions with people outside of your team, including surveys or focus groups, will require IRB approval). This document must be completed and approved by your faculty advisor before any work is begun that would put people or property at risk. The safety plan must document the processes, constraints, and equipment that will be used to ensure the safety of all participants and the preservation of property.

F) Written Thesis – Your thesis is *not* due in the fall semester, but that certainly does not mean you cannot start writing! Some guidance on how to write a thesis is included in this syllabus.

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[1] Accreditation Board for Engineering and Technology, Inc. Annual Report, New York, 1988

Grading:
At the discretion of the thesis advisor.

Honors:
Honors will be awarded on the basis of the written thesis, oral presentations, and the student's grade point average. The student must earn an A for thesis work in ME495 and 496 to earn honors.
If any of these conditions are not met to the full satisfaction of the thesis advisor and the ME department faculty, the project may be converted to an Independent Study, and the student will no longer be eligible to graduate with honors.

Attendance Policy:
Your success in this course hinges upon your ability to collaborate. Therefore, it is required that you attend all scheduled classes. If you must miss a Common Hour Meeting, *coordinate with any of the ME 497 instructors* ahead of time. In the event of an illness, please provide documentation for an excused absence as per Lafayette policy.

Academic Honesty:
You must abide by Lafayette's academic honesty policy. All individual work must be your own. When others work is utilized, it must be clearly cited and noted.

Members of the Lafayette community are expected to bear individual responsibility for their work, to learn and follow the rules and definitions that underlie the practice of academic integrity, and to uphold its ideals. Our community does not tolerate acts of academic dishonesty and will report incidents of alleged academic dishonesty for investigation; examples of unacceptable academic conduct that violate our shared standards include (a) using ideas, text, images, calculations or software received from others, including classmates or other resources, without proper acknowledgment; (b) soliciting unauthorized assistance or copying answers from other students; or (c) obtaining, using, or copying the textbook author's or an instructor's solutions without authorization (d) misrepresenting your contribution to a team accomplishment. Because faculty will define the parameters for any acceptable academic collaboration in their syllabi, ignorance of the standards is not an acceptable excuse for violating them.

Federal Credit Hour Statement:
The student work in this course is in full compliance with the federal definition of a four-credit hour course. Please see the Registrar's Office web site (http://registrar.lafayette.edu/.../cep-course-proposal/) for the full policy and practice statement.

Diversity and Inclusiveness Statement:
Lafayette College is committed to creating a diverse community: one that is inclusive and responsive, and is supportive of each and all of its faculty, students, and staff. The College seeks to promote diversity in its many manifestations. These include but are not limited to race, ethnicity, socioeconomic status, gender identity and expression, sexual orientation, religion, disability, and place of origin.

The College recognizes that we live in an increasingly interconnected, globalized world, and that students benefit from learning in educational and social contexts, in which there are participants from all manner of backgrounds. The goal is to encourage students to consider diverse experiences and perspectives throughout their lives. All members of the College community share a responsibility for creating, maintaining, and developing a learning environment in which difference is valued, equity is sought, and inclusiveness is practiced.

Religious Observances:
If you plan to be absent from class due to the observance of a religious holiday, please let your instructor know at least one class meeting in advance.

Learning Needs and Accessibility:
Lafayette is committed to providing support and reasonable accommodations for students with disabilities who self-identify with Accessibility Services. Students requesting accommodations to alleviate the impact of their disability should register their needs as soon as possible with the Accessibility Services Office, which is housed in the Academic Resource Hub (resourcehub@lafayette.edu). Once registered, students should request their accommodation letters to provide notification of their needs to their professors, on a semester by semester basis. If

you have questions or concerns pertaining specifically to your accommodations within this course, please contact the instructor to discuss them.

Privacy: Moodle contains student information that is protected by the Family Educational Right to Privacy Act (FERPA). Disclosure to unauthorized parties violates federal privacy laws. Courses using Moodle will make student information visible to other students in this class. Please remember that this information is protected by these federal privacy laws and must not be shared with anyone outside the class. Questions can be referred to the Registrar's Office.

Proper Usage of Course Materials and Classroom Recordings: At Lafayette College, all course materials are proprietary and for class purposes only. This includes posted recordings of lectures, worksheets, discussion prompts, and other course items. Reposting such materials or distributing them through any means is prohibited. Such materials should not be reposted or distributed through any means. You must request my permission prior to creating your own recordings of class materials, and any recordings are not to be shared or posted online even when permission is granted to record. If you have any questions about proper usage of course materials please ask me. Please also be in contact with me if you have any concerns with being recorded during the course.

Online discussions in Moodle occurring during synchronous class sessions should also remain private and not be shared outside of the course. Courses using Moodle will make student information visible to other students in this class. Student information in courses is protected by the Family Educational Right to Privacy Act (FERPA). Disclosure of student information to unauthorized parties violates federal privacy laws and it must not be shared with anyone outside the class. Questions can be referred to the Registrar's Office.

Thesis Proposal Requirements:

The **Honors Thesis Proposal** includes (1) a brief **written proposal** (2-4 pages) describing the problem to be considered and the methods to be used, and the design component, to be submitted by the end of the second week of the fall semester, as well as (2) an **oral proposal presentation** given by the end of the third week. During the first two weeks of the semester, a **reading committee** should be formed, consisting of the advisor and one additional ME faculty member, and one faculty member from outside the ME department, chosen by the student and advisor.

The written proposal and the oral proposal presentation will be reviewed by members of the reading committee and the ME department faculty, who will ask questions, and who may request clarification or alteration before approving it. The thesis student and faculty advisor should schedule the presentation, allotting 15 minutes for the student to present their proposed thesis project and at least 15 minutes for questions and discussion. At this time, a written timeline and budget proposal should be submitted to the ME Department Head.

NOTE: If the student would like to substitute ME 495/6 for ME 497/8, the proposal must contain a description and justification of the planned **design component** of the project.

Oral Presentations Requirements:

Proposal: The student will present a proposal of the thesis project, including the scope of the work, major goals, design component, and the approximate budget and timeframe, to the student's thesis committee members and ME department faculty.

(Optional) Design Reviews: When deemed appropriate by the faculty advisor, students completing thesis projects will present informal "status reports" on their work to their advisor and committee members. These Reviews are discussions between the student and committee members about the progress in the project, challenges faced, and future steps.

Fall: An oral presentation must be given by the student before the end of the fall semester. Typically, all ME seniors will give presentations on their design projects or independent work.

Spring: An oral presentation must be given by the honors candidate at or prior to the submission of the written thesis. The oral presentation must be announced so that interested students and faculty can attend. Typically, a Research Symposium will be organized in late April or early May to provide the opportunity for seniors to present their research.

At least two faculty members besides the advisor must attend the presentations. The faculty advisor and committee for the thesis will evaluate the final (spring) oral presentation and provide comments on the written thesis.

Thesis Definition and Guidance:

A thesis is an experimental, computational, and/or theoretical study of an important problem. In order for the thesis to substitute for Mechanical Engineering 497/8, it must contain a significant **design** component, which must be documented explicitly in the final thesis report as noted below, with justification of how this design component meets the ABET definition of design. Generally, topics are selected by the students from suggestions by the faculty.

The essence of any scholarly work is to establish the following:

- Definition of the problem; review of the literature
- Your particular contribution to this area
- Potentially rewarding areas of further research that others may use to guide their own work

The following questions may prove useful in organizing both your project effort and your writing:

What are you looking at?

You must begin by defining your problem. In the introduction of the thesis, you want to do this in a general way that gives the reader a sense of the project's scope and a basic understanding of your area.

Why are you looking at it?

Motivate your work. Establish who will benefit from your work and why.

Who else has looked at it?

Once your readers have a rough idea of what your problem is, you must clearly establish what the state of the art is in this area. This is particularly critical if you plan to claim that you have a better way of approaching or solving a problem than has previously appeared in the literature. If you are examining a problem that has been studied by others, but using a different technique that is of particular interest to you, say so and describe why you have chosen this approach.

How are you looking at it?

At this point, you should review your problem again but at a much higher level of detail, introducing any mathematical notation required and describing any subtle nuances of your problem that may in fact be the central component of your research but were too detailed to put in the introduction. It may be appropriate to describe one or more hypotheses which you feel your research will prove (or disprove). Not all work lends itself to initial statements of hypothesis; an implicit hypothesis that your method is better than others may be left implicit.

You should describe in detail your experimental design (or computational method): how you structured your data collection, problems you encountered, and how you conducted your experiments. Often, the design of the experimental facility itself may be a large component of your thesis work. This description should be sufficiently detailed to allow another researcher to duplicate your efforts. A key part of this description is a clear list of major assumptions you are making, and why you are making them. It will likely be useful to indicate which assumptions are perfectly reasonable and which are likely to affect your results but are required for time or budget reasons.

What are the limitations of your work?

One of the most difficult aspects of research is understanding exactly what you did *and what you did not do.* If you were limited by your data, explain how you think this might affect the generality of your conclusions. Discuss openly any shortcuts taken due to time, budget, or data availability constraints. Do not try to overstretch your work's relevance ("although measurements were taken only for Reynolds numbers << 1, the results may be applied to improve the design of supersonic aircraft") **or** believe you are getting off the hook by over-qualifying your work ("because of myriad restrictions, no valid conclusions can be drawn until more extensive experiments are carried out using incredibly expensive equipment.") Your job is to use what is available to you to make a meaningful contribution to your field of study; clearly drawing the line between what you did and did not do is central to the scientific method, since it helps define the state of the art.

What are your conclusions?

In view of the limitations considered above, what conclusions can you draw from your research? Because your conclusions are often inextricably entwined with the limitations of your research, both these questions are often answered simultaneously. In your thesis, your section on conclusions will typically be very brief, and should specifically and clearly describe your contributions to the field. Again, do not underrate your work, but do not claim to have solved problems that are not firmly substantiated in the body of the thesis.

What next?

Now that you are an expert in your particular area, you should have both a narrow understanding of a well-defined problem *and* a broader understanding of the field as a whole. It is now your responsibility to guide others in the field in directions that you feel will provide the greatest good. Such recommendations are

usually based on an evaluation of the major weaknesses in your own work, in which case you might recommend how others (possibly with more time and money than you enjoyed) could overcome these weaknesses.

What comprised the significant design component of your project?

This should be at least 500 words, and must describe how your work has met the ABET definition of design.

Honors Thesis Submission (in spring semester)**:**

The thesis must be submitted far enough in advance of the oral presentation for the entire reading committee to have time to read and evaluate it. In general, the student should expect to provide the faculty advisor and committee members with corrected final copies of the thesis.

Once you have written and revised (and revised) your thesis, incorporating the feedback from your advisor and committee members, you must collect the signatures of your committee on the Final Honors Nomination form (available from the Registrar's website) and submit this form to the Registrar's office.