

College of Engineering and Mathematical Sciences Honors College Thesis Guide

Note: This complements the information that can be found here:

https://www.uvm.edu/honorscollege/junior/senior_curriculum

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Introduction

Writing an Honors Thesis in CEMS is not only a means to graduating with Honors but is a way to explore a topic in depth that you are passionate about. Your thesis can be in your field, advised by someone in your home department, or it can be something that you pursue as a hobby or interest and be co-advised by other faculty on campus. It can be an applied project or a research project. If you are in engineering, it can also be an expansion of your senior design project reflecting your own independent work (please speak to the faculty teaching the capstone courses). Some thesis examples are listed in the box below (and many more can be found here: <https://scholarworks.uvm.edu/hcoltheses/>). This guide attempts to walk you through the timeline for your thesis and provides details for submission of a thesis proposal and completion of the thesis project. It is a living document, and thus your suggestions for improving it are encouraged (email Linda.Schadler@uvm.edu – the Dean of CEMS).

Refining a Phase Vocoder for Vocal Modulation

Vocal harmonies are a highly sought-after effect in the music industry, as they allow singers to portray more emotion and meaning through their voices. The chords one hears when listening to nearly any modern song are constructed through common ratios of frequencies (e.g., the recipe for a major triad is 4:5:6). Currently, vocal melodies are only readily obtainable through a few methods, including backup singers, looper-effects systems, and post-process overdubbing. The issue with these is that there is currently no publicly-available code that allows solo-artists to modulate input audio to whatever chord structure is desired while maintaining the same duration and timbre in the successive layers.

This thesis plans to address this issue using the phase vocoder method. If this modulation technique is successful, this could revolutionize the way vocalists perform. The introduction of real-time self harmonization would allow artists to have access to emphasized lyrical phrases and vocals without needing to hire and train backup vocalists. This phase vocoder would also allow for more vocal improvisation, as the individual would only need to know how to harmonize with themselves and would thus not be relying on interpreting how backup vocalists plan on moving the melody when creating more spontaneously.

Ergonomic Lacrosse Stick Design and its Effect on Faceoff Mechanics

Lacrosse is one of the only sports that provides an equal opportunity for possession after a stoppage of play. Subsequently, winning a faceoff is a key component of success for the sport. As faceoff specialization increases in the sport of men's lacrosse, players are looking for any advantage they can gain, often modifying elements of their sticks to best suit the faceoff procedure. This study looked at the implications of modifying the geometry of the shaft to increase the torque generated during the faceoff, using the most common faceoff clamping technique. The study found that three of the four geometric modifications yielded a statistically significant increase in torque generated during the faceoff. The method that generated the highest increase in torque was also deemed the most natural and comfortable for the participants.

Statistical Analysis and Graphic Representation of the Correlation of Bach and Chopin Preludes

This study uses statistical techniques to compare the Roman numeral analysis of the first phrase in each of the 24 preludes composed by Johann Sebastian Bach and 24 preludes of corresponding key composed by Frederic Chopin. Bach composed a book of 24 preludes, *The Well Tempered Clavier*, consisting of a prelude in each major and minor key. Chopin also composed 24 preludes in each key throughout his career. Initially, this study will use Roman numeral analysis and other music theory techniques to analyze the first phrase of these works. Statistical methods will then be used to describe and compare, by key, elements of each Chopin and Bach prelude. The music analysis will be done by hand for the first phrase of each of the 48 pieces. The statistical analysis will focus on certain musical features, specifically chord frequency, chord progression, and non-chord tone frequency and use hypothesis tests and confidence intervals to quantify their differences. The results will include a graphical summary of each separate piece, composer, and comparisons of each. The results will also include p-values that illustrate the closeness of the musical elements being studied. This study will show how the relationship of these specific components of the compositions can be portrayed, and will determine how much statistical similarity there is between the components being studied. It will generally demonstrate how elements of musical compositions can be observed and measured statistically.

Thesis Options

Select one of the following (Options 2 and 3 require significant pre-planning):

1. Traditional Research Thesis 3 credits Fall / 3 credits Spring of senior year. Please see the curriculum checksheets to see what courses the thesis replaces.
2. 3 credit industry internship for credit (CEMS 190 – or a new course for HCOL internships) followed by 3 credit thesis credits in the same topic. This would require coordination with industry partners & the supporting faculty member. This would be for summer junior year / fall senior year.
3. 3 credit HCOL REU experience in the spring of junior year followed by paid summer research and 3 credits of thesis in the fall of senior year. Or 3 credits HCOL REU in the summer followed by 3 credits of thesis in the fall of senior year.

Timeline

The basic timeline is as follows:

Fall Junior Year

1. Take CEMS 2010. This is a 1 credit HCOL course. It is designed to introduce you to big topics in the STEM fields and help you begin to think about a thesis.
2. Meet with potential faculty advisors and sketch out a thesis idea.
3. If you are planning on doing options 2 for your thesis, complete a detailed plan and be prepared to start your research in the spring of junior year.

Spring Junior Year

1. Take CEMS 2020. This is a 1 credit HCOL course which culminates in the completion of your thesis proposal.
2. Complete significant library research on the background of prior work needed to clarify your research/project goals and where there is need in the field for more work.
3. **Identify an Honors Thesis Committee.** The Committee is comprised of two faculty members, including your thesis advisor. At least one Committee member must be in your major department. Your committee may have more than 2 members.
4. If you plan on doing thesis option 3, work with your advisor and the industry partner to plan the thesis proposal and the work you will do in the summer.

Note 2: Sometimes students do some of their traditional thesis work over the summer between junior and senior year.

First Semester of Thesis (Often Fall Senior Year)

1. Register Thesis credits under your advisor's (or sometimes Dept Chairs) name.
2. Meet weekly with your research advisor (**up to you to schedule a time with them**)
3. Complete a significant portion of your research / project.

Second Semester of Thesis (Often Spring Senior Year)

1. Register for Thesis credits under your advisor's (or Dept Chairs) name.

2. Finish your research and write up your thesis by April 1 or November 1. Provide it to your committee. This means getting a draft of your thesis to your advisor in early- to mid-March or October.
3. Complete a thesis defense by April 15 or November 15. Set this date early to make sure you can coordinate everyone's schedule. The presentation should be about thirty minutes long, and must be attended by the Honors Thesis Committee and announced publicly at least one week prior to the presentation date. No formal evaluation is associated with the presentation, but it should serve as a discussion of the thesis, with the goal of providing constructive suggestions towards improving the final manuscript. All revisions are due by April 30 or November 30.
4. Turn in the Scholarworks forms (see end of this document) when you have defended and turned in your thesis.
5. Your thesis defense is open to the public.

Thesis Credit Course Numbers

BME 2996 College Honors

CEE 2996 College Honors

CS 4996 Undergraduate Honors Thesis

EE 2996 College Honors

MATH 4996 Undergraduate Honors Thesis

ME 2996 College Honors

PHYS 4996 Honors

STAT 3996 Undergrad Honors Thesis

The Keys to a Successful Thesis Experience

1. Find a topic you are passionate about. This may be the hardest part, but figuring out what you are passionate about is important for when you look for jobs or apply to graduate school as well.
2. Find an interesting question that has not been answered before. This is why it is important to read the literature and ***talk to a bunch of people***. Look at those projects on the first page. Very few of them are standard research projects on some professor's area of interest! You are Honors College students – be creative!
3. Set some clear goals that can be accomplished. You may be passionate about wind energy, but building a wind turbine at UVM is likely not possible. However, you could work with someone who has all the data on wind speed and trajectories in New England and your project would be about finding local sites for potential wind turbines and predicting how they would impact the grid.
4. What research approach is appropriate to your question? Are controlled experiments needed (quantitative) or does your question require you to gather more qualitative data (interviews, surveys, etc)? What materials or equipment need to be ordered? What qualitative instruments need to be developed and how will they be implemented? What experiments, models, or analyses need to be completed to meet your goals and answer your question? A good thesis means thinking through the details. Here is a [good text](#) if you are interested.
5. Consider applying for funding to support your thesis research. UVM and CEMS have a number of opportunities to support the research, writing, and presentation of thesis projects. As your ideas about a topic coalesce, you should also reach out to the Office for Fellowships, Opportunities, and Undergraduate Research to explore what, if, any funds are available for your project: (four@uvm.edu).

Thesis Proposal Format

The thesis proposal is 5 pages long (at least). It should include the following sections:

1. **Introduction** – introduce the research question or the project motivation.
2. **Background** – This should review the relevant literature. It should not just be a summary of papers, but a critical review of the current literature that shows where the holes are that your thesis will solve or contribute to solving.
3. **Goals** - The thesis goals should follow directly from the background / literature review.
4. **Specific workplan with timelines.** It is often helpful to organize this around your thesis goals. This section should include a budget if there are significant costs.

This proposal should be submitted to your Honors Thesis Committee in CEMS 2020.

Thesis Defense – DUE April 15 or November 15

The thesis defense should be about 30 minutes long (~30 slides) and should give the motivation and background for the work, the experimental approach or design approach, the results and any discussion of the results and conclusions. The thesis defense is public, and you should notify your department of the date and time of your defense, so that they can share that information with the CEMS community. Key suggestions:

1. Put any references used on the slide (can be in small font)
2. No fonts (except for references) smaller than 18 point
3. Try not to have any slides with just words; the more pictures/images/graphs the better
4. Put the key take away for each slide somewhere on the slide

Thesis Format

Pre-Defense final version DUE April 1 or November 1 to your advisor – Revised final version DUE April 30 or November 30

The best thing to do is to go look at a bunch of theses. UVM HCOL theses are available here:

<https://scholarworks.uvm.edu/hcoltheses/>

For example – an experimental thesis would include:

1. An abstract that summarizes the work and results
 2. Background that provides all the relevant information for the audience to understand prior work and experimental or design tools.
 3. Experimental procedure, models used, methodology, or similar.
 4. Results – be sure that this includes prose as well as graphs/images/data tables. The prose should tell the reader what to notice in the graphs/images/ data tables.
 5. Discussion of the results – explaining what the results mean and how they are important.
- Summary and conclusions -A summary is different from conclusions. A summary summarizes the work. Conclusions are new understandings that develop as a result of the work or new questions/areas of exploration opened up by your research. (For a great example of a conclusion check out the open-ended 48 words that arguably won Crick and Watson a Nobel Prize in their 1953 description of the structure of DNA:

<https://www.exploratorium.edu/origins/coldspring/ideas/printit.html>)

What to do after you've defended your Thesis:

1. Upon completion of your Thesis defense, your committee will immediately share with you whether or not your defense was successful, or if you need to make further edits.
2. Once you have successfully defended, you will need to submit your Honors Thesis ScholarWorks@UVM.
3. Towards the end of the spring semester, a representative from PLHC will send you instructions on how to submit your Thesis to Scholar Works. Part of this process will be to fill out a form, to be signed by your Thesis Advisor, granting permission for your Thesis to be published on Scholar Works. Follow up with the Honors College team at Honors.College@uvm.edu if you need assistance or have questions with this.
4. Your Thesis Advisor will assign a final grade for your course, which signals to CEMS that you have successfully completed your Honors Thesis.