

# 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](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 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 either Dustin Rand or Jon Lens). Some thesis examples are listed in the box below. 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](mailto: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.

## Timeline

The basic timeline is as follows:

### **Fall Junior Year**

1. Participate in a set of information sessions required for CEMS 101 (the junior HCOL course). If you are a sophomore ahead of schedule, be sure to contact the Dean to make sure you are getting the appropriate emails (NOTE: These did not occur for Fall 2020). These typically include:
  - a. Meeting with the Dept Chair to hear about the research available in the Department
  - b. Attending a research seminar in CEMS
  - c. Attending a research poster session or CS fair
  - d. Meet with your Dean or your faculty advisor to make sure your schedule is on track.
2. Identify an advisor – this is best done during the fall semester

### **Spring Junior Year**

1. Take CEMS 101. This is a 1 credit HCOL course that is a means for keeping you on track and providing some key information for research.
2. Work with your advisor to further advance the ideas for your project and ideally narrow it down to some key goals.
3. 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.
4. 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.

*Note1: Sometimes students change their thesis plans over the summer / early fall because they uncover something truly unique, so don't feel you are locked in. On the other hand, the earlier you can identify a topic, the more planning you can do!*

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

### **Fall Senior Year**

1. Register for XX193 under your advisor's name.
2. Meet weekly with your research advisor (up to you to schedule a time with them)
3. Prepare a written thesis proposal and submit it to your Honors Thesis Committee by October 1; Your advisor should notify you that your project is approved no later than November 1. Your advisor should notify the appropriate CEMS HCOL Representative that a thesis project has been approved. They are currently: Professor George Pinder for Engineering and Professor Jun Yu for CS, Math & Statistics
4. Complete a significant portion of your research / project.

### **Spring Senior Year**

1. Register for XX194 under your advisor's name.
2. Finish your research and write up your thesis by April 1. Provide it to your committee. This means getting a draft of your thesis to your advisor in early- to mid-March.

3. Complete a thesis defense by April 15. Set this date sometime in February 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.
4. Your thesis defense is open to the public.

## 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. Perhaps you could want to work with NRG systems to measure wind speeds on campus to determine if microturbines would work here. Perhaps you want to work with a new startup – Packetized Energy – to help them with their modeling or tool development.
4. Once you have clear goals, think through what you need to accomplish them. What control experiments are needed? What equipment would need to be ordered? What set of experiments or models would answer your question and meet your goals. A good thesis means thinking through the details.
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 – DUE October 1

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 by October 1. Your advisor should notify you that your project is approved no later than November 1. Your advisor should notify the appropriate CEMS HCOL Representative that a thesis project has been approved.

## Thesis Defense – DUE April 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. 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

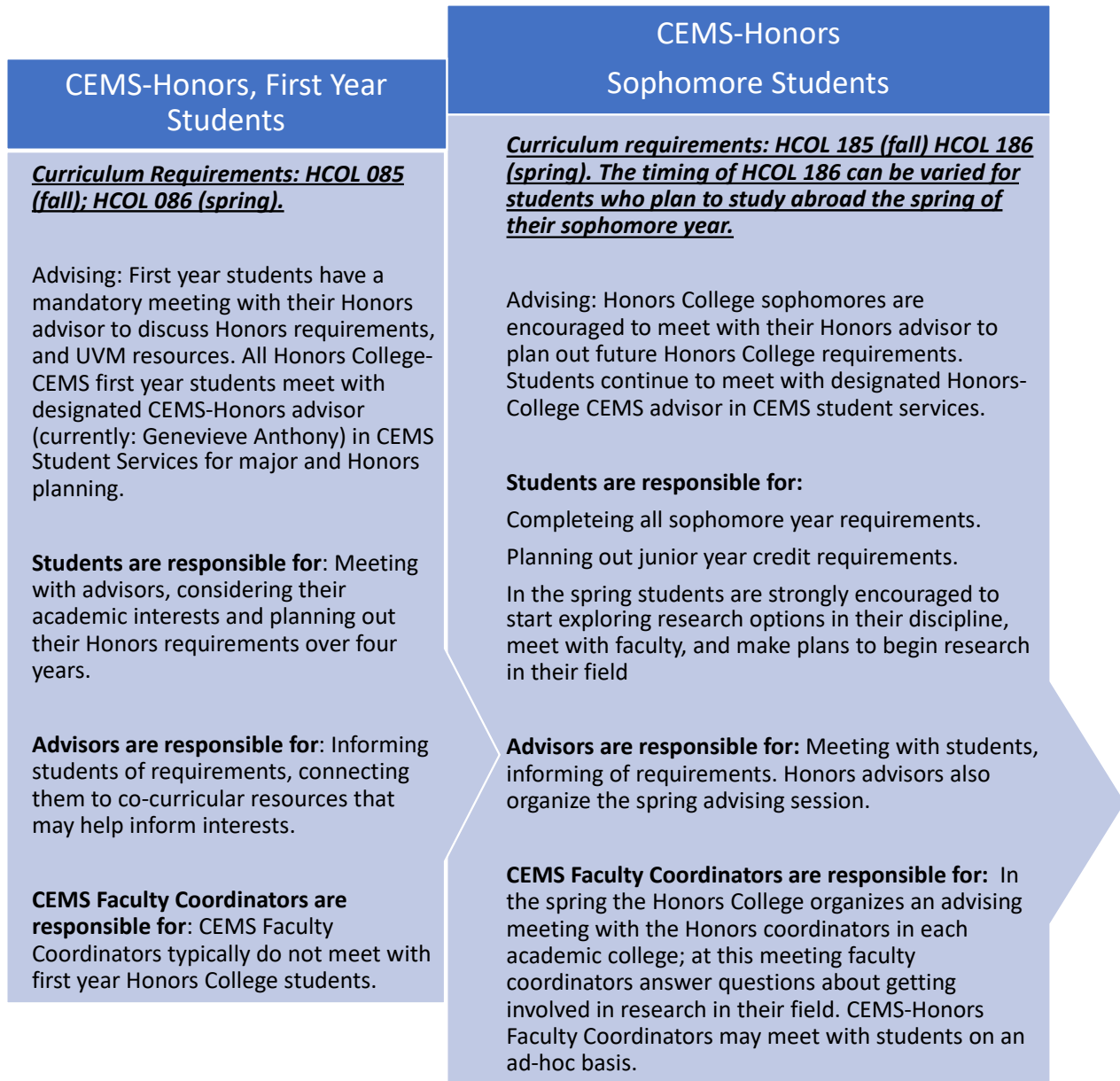
## Thesis Format – Pre-Defense final version DUE April 1 – Revised final version DUE April 30

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/>

But – in general a thesis will 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. The prose should tell the reader what to notice in the graphs/images
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>)

## OVERVIEW OF HCOL CEMS PROCESS



**CEMS-Honors  
Junior Students  
Curriculum Requirements:  
CEMS 101**

Advising: Students may meet with Honors College advisors. Students will continue to meet with CEMS-Honors advisor in CEMS student services to complete major requirements & get deadlines for thesis process.

**Students are responsible for:** By spring semester:

- Identifying Thesis Advisor
- Students must also complete all requirements for CEMS 101 =

**CEMS Faculty Coordinators are responsible for:**

- Advising & helping students meet junior year responsibilities (i.e. provide assistance with meeting faculty and/or identifying research opportunities.).
- Contacting CEMS 101 instructor to receive list of faculty thesis advisors (typically done mid-February)
- Tracking Honors College juniors through junior requirements. Coordinators meet with the Honors College each spring to discuss student persistence.
- Advising faculty who are working with students on research (or considering working with students on research). Advocating for student placement, while also being sensitive to faculty needs.

**CEMS-Honors, Senior Students  
Curriculum Requirement – 6 credit Thesis!**

Advising: Students will receive thesis policy, procedures, dates, and deadlines from CEMS-Honors advisor. CEMS Student Services can answer student questions related to thesis policy/process/procedure.

**Students are responsible for:**

- Written Honors thesis proposal, due October 1
- Working with thesis advisor, and being in touch throughout the process. Sending updates to thesis advisor (as needed, to be worked out between thesis advisor and student)
- Applying for research funding through the Honors College or FOUR office, if needed.
- Submitting their thesis to their committee by the deadline.
- Arranging for all defense/presentation meetings (completed by April 15th).
- Ensuring all thesis revisions are submitted to their committee by the deadline (and no later than April 30)

**Faculty thesis advisors are responsible for:**

- Notifying CEMS Faculty coordinators of approved thesis projects (by Nov. 1)
- Monitoring student thesis progression throughout the year (see tab 2 on this spreadsheet)
- Providing thesis project support when needed
- Ensure final thesis grades submitted each spring.

**CEMS Faculty Coordinators are responsible for:**

- -Being point of contact for faculty thesis advisors, and reminding them of important deadlines (i.e. proposal deadline, approval deadline, defense deadline) and grading policies (note: Fall email critical)
- Monitoring student thesis progression throughout the year (see example tracking spreadsheet) and following up if missed deadlines
- Meeting with the Honors College in spring each year to discuss student persistence.
- Providing guidance to thesis faculty mentors who have questions about students.
- Mediating student-faculty thesis areas of conflict and acting as student advocate
- Ensuring faculty mentors submit thesis grades in a timely manner before commencement