Department of Chemical Engineering

Honors Thesis Guidelines

This document is intended for honors students in Chemical Engineering, their honors advisers, and their thesis advisers. It presents guidelines and suggestions for finding a thesis adviser, selecting a project, pursuing research, and writing the thesis. This document is intended to supplement the more general policies and information available from the Schreyer Honors College.

Information from SHC

The Schreyer Honors College (SHC) web page describes the honors thesis, and offers advice about how to choose a topic, find an adviser, and plan a timeline from project idea to finished thesis (https://www.shc.psu.edu/academic/thesis/). There, you can find:

- Advice about planning the thesis project
  https://www.shc.psu.edu/academic/thesis/project.cfm

- Thesis deadline dates
  https://www.shc.psu.edu/academic/resources/dates.cfm

- Honors thesis format
  https://www.shc.psu.edu/academic/thesis/formatting.cfm

- Thesis submission procedures
  https://www.shc.psu.edu/academic/thesis/submission.cfm

- Archived honors theses
  https://honors.libraries.psu.edu/search/

Advisers

An SHC undergraduate has an “honors adviser” and a “thesis adviser”. The honors adviser is a faculty member in his/her major department, who has been approved as an honors adviser by the department and SHC. The honors adviser is responsible for advising the student generally, and monitoring student progress on the thesis.

The thesis adviser is a tenure-stream, full-time faculty member who mentors the student in research. The thesis adviser is primarily responsible for ensuring that the student progresses in research, and for the quality of the thesis. Typically, the thesis adviser is a faculty member in Chemical Engineering. If the honors adviser and the thesis adviser are the same person, the student and adviser must find an additional faculty member to serve as “second reader” (see SHC website for details).
It is possible (but less common) for a student to do research and write an honors thesis in a department other than his or her major department. In such a case, the diploma reads “B.S. in Chemical Engineering, with honors in <honors department>”. It is also possible for a student to graduate with honors in Chemical Engineering, with a thesis adviser from a related department (e.g., Chemistry, Physics, Materials Science). In such a case, the student must also have a thesis co-adviser in Chemical Engineering, typically a collaborator or colleague of the thesis adviser. Students interested in either of these options should consult their ChE honors adviser for further guidance.

Finding a thesis adviser

The first task for an honors student beginning research is to find an appropriate thesis adviser. Our department has many research-active faculty who regularly mentor honors undergraduates, covering a wide range of research areas. Students should also bear in mind that faculty may differ considerably in their approach to undergraduate honors research. To identify which faculty members might be a good match, students should:

- Discuss their interests with their honors adviser, or with faculty they know from the classroom, who can suggest various colleagues whose research may interest them.

- Read the research webpages of potential thesis advisers, to learn about their research. Read some recent publications from the research group. Bear in mind that research papers were not written with an undergraduate reader in mind! Aim to grasp the motivation, main ideas, and conclusions of the work.

- Meet with potential thesis advisers to discuss possible projects. A good adviser should be able to clearly explain the proposed project, why it is interesting and important, and how it fits into the group’s research.

- Meet with graduate students and other undergraduates in the research group of a potential thesis adviser, to get a sense of the group interests and atmosphere. One indication of a dynamic group is energetic and talented students who can explain their work and how it fits into the overall group research.

Research project

At the same time as a student is identifying a thesis adviser, the student and potential adviser are discussing and selecting a research project. For undergraduate research, formulating an appropriate research project is predominately the responsibility of the thesis adviser. For a research project to be most successful, it should be:

well defined enough to have a good chance of success. Undergraduate research projects should be at least as well defined as graduate student “warmup projects” — you know what to try, and how to try it, to answer the question.
within the capabilities of a talented and energetic undergraduate. Our best undergraduates are amazing, and can learn many things “on the fly” outside the classroom, but allowances must be made for the time required to “come up to speed”.

related to overall research goals of the group. Research undergraduates thrive if their work connects to that of fellow undergraduates and graduate students, from whom they can learn.

interesting and important enough to be published. While it is not required that work from an honors thesis be published, this is an appropriate standard for the scope of a good honors thesis.

actively mentored by the adviser. Thesis advisers should be actively involved in mentoring research undergraduates, with regular meetings, interim reports, and written expectations each semester. This can be done through ChE 494H (see below).

c o-mentored by a graduate student or postdoc. A group member can provide more detailed direct help, is sometimes more “approachable”, and benefits from the mentoring experience.

Research courses

Students exploring research with an adviser but not yet fully engaged in a research project may register for 1-2 hours of ChE 294H (which can count as professional elective). This course is typically taken only by freshmen or sophomores.

Students pursuing honors research in Chemical Engineering should take ChE 494H (honors thesis research). SHC students can take six hours of ChE 494H for credit in the major (three hours can count as ChE elective, three as professional elective). ChE 494H serves several functions. The chemical engineering major is very demanding; during the semester, a student’s commitment to research is often in conflict with the urgency of homework, projects, and exams. Registering for 494H is a commitment to spend time on research equivalent to a technical course of comparable credit hours.

Grading of ChE 494H provides a mechanism to evaluate student progress in research and towards the thesis. Honors students should sign up for at least one semester of 494H, so that thesis work can be graded. A grade of B or better in 494H courses is required by SHC for graduation with honors.

Grades in ChE 494H should be based on a written statement of expectations, agreed upon by the student and thesis adviser at the beginning of the semester. The statement of expectations may contain:

• Overall goals for the semester. Possible goals include: experiments, calculations, simulations, modeling, or data analysis to be performed; or techniques to be learned; or literature search to be carried out; or draft of chapters or paper to be written.
• **Schedule of meeting times.** Regular meetings of students, thesis advisers, and co-mentors help to keep everyone apprised of progress, and allow for frequent feedback.

• **Interim “milestones”**. Brief written progress reports at regular intervals with figures indicating new results are a good way to document student progress, and to provide material on which an overall grade can be assigned.

• **Required resources.** Research students may need access to experimental resources (hoods, bench space, lab instruments, time on central facilities) or computing resources (workstations, cluster queues).

**Thesis**

SHC describes the thesis as “a scholarly piece of writing in which the writer is expected to show a command of the relevant scholarship in his (or her) field and contribute to the scholarship. It should confront a question that is unresolved and push towards a resolution.”

In chemical engineering, this means: the thesis describes the student’s original work in experiment, design, theory, simulation, or modeling, applied to a research problem of current interest in chemical engineering. The thesis includes a discussion of the motivation for the work, and the state of knowledge of the research community.

At a minimum, the scope of thesis research should be equivalent to a significant contribution to one or more published papers. This implies a standard of originality: in engineering and science departments, a thesis cannot simply be a literature review — the thesis must include original work.

For students applying to graduate school, publishable research is a mark of distinction above and beyond completing an honors thesis. Ideally, a first-author paper should be published from the completed thesis. In such cases, a paper can first be prepared for submission, and then modified to conform to the thesis style and content. Thesis chapters may then correspond to the Introduction, Background, Methods, Results, and Discussion sections of a typical journal article.

Honors theses vary considerably in length. As a rough guideline, theses may be as short as 25 pages of text and figures, or may extend to as many as 100 pages, depending on the substance and scope of results obtained. In short, the thesis needs to be long enough to describe the background, methods, and results at the level of detail of a published paper.

Theses should be written in a scholarly manner, with end notes to cite published work to which the thesis refers. Writing should be consistent with the style of journal articles.
Penn State theses must conform to a prescribed format; details are provided online at https://www.shc.psu.edu/academic/thesis/formatting.cfm. For students working in LaTeX, style files are available online at the this address.

Penn State honors theses are archived, and can be searched electronically and downloaded. To find relevant examples of honors theses, navigate to https://honors.libraries.psu.edu/search/ and search on “chemical engineering”. A particularly substantial recent example is that of Michael Howard (student marshal for Chemical Engineering in 2013), from which three first-author papers were published.

**Timeline**

*Doing the research for a good honors thesis takes a long time.* Entering students with considerable AP or other credits may be advanced in their coursework, so that they can begin research in their freshman year. Entering students less far along often start research as sophomores. Starting research as a junior is relatively late, but can be successful if the project is well defined and manageable.

*A good time to begin undergraduate research is the summer.* In the summer, students can focus on getting going with research without the competition of coursework and extracurricular activities. By the end of a summer, a student can be well acquainted with the project and methods, and possibly have useful preliminary results, so that work can continue during subsequent semesters. There are a number of mechanisms to provide summer support for undergraduate researchers. Students interested in summer research should discuss funding options with their research advisor.

*Progress reports accumulate materials for the thesis.* Regular progress reports — in which results of experiments, calculations, simulations, or literature searches are summarized along with relevant figures and tables — provide the raw materials from which the thesis can be written.

*Writing a good honors thesis also takes a long time, after research results are obtained.* The submission deadline for honors theses for graduating seniors is mid-April. A good goal is to complete the final draft several weeks before the deadline. Inevitably, as writing commences, new issues arise that suggest additional measurements, calculations, or literature searches. For least panic and best results, the student should be focused on writing — not getting new results — starting in the fall of the senior year.

**Proposal, submission, and approval**

By the end of the junior year (assuming a four-year path to graduation), students must file a Thesis Proposal with SHC via the online Student Records System.

SHC procedures for submission of the completed thesis are given online at https://www.shc.psu.edu/academic/thesis/submission.cfm.
Within the Chemical Engineering department, the honors thesis must be approved by both the honors adviser and the thesis adviser, who sign the completed thesis prior to submission.

Both advisers should ensure that the thesis meets the standard for an acceptable honors thesis, described above (see “Thesis”). The thesis adviser is primarily responsible for ensuring the quality of the thesis. Reading the thesis is not the time to discover that it is marginal or unacceptable — regular meetings, progress reports, and grades for ChE 494H allow ample opportunities for assessing student progress.

The department encourages thesis advisers to arrange for an honors thesis defense, in which the graduating student presents a talk based on his work to the research group and other interested members of the department. Thesis defenses highlight the accomplishments of our SHC undergraduates, and the significance of their research.

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February, 2015