Department of Chemical & Biological Engineering

Graduate Programs 2020-2021

Academic Requirements and Guidelines

Updated August 2020
This document describes the procedures, rules and regulations specific to graduate degree programs within the Department of Chemical and Biological Engineering. Another important document is the School of Engineering (SOE) Graduate Student Handbook, which contains general guidelines, rules and regulations for all engineering graduate students. The SOE Graduate Student Handbook may be downloaded at https://asegrad.tufts.edu/academics/graduate-student-handbook.

ACADEMIC ADVISOR

Each incoming graduate student is assigned an academic advisor who plays an important role in the development and administration of the student’s overall educational program. For the 2020-2021 academic year, Professor Matthew Panzer will serve as the academic advisor to all incoming Ph.D. and Chemical Engineering M.S. students, while Professor Kyongbum Lee will serve as the academic advisor to all incoming Bioengineering M.S. students.

RESEARCH ADVISOR SELECTION

The research advisor is the faculty member with whom the student collaborates closely on their research project. Most often, the student selects a project from among several that the professor may suggest as appropriate for the M.S. thesis or the Ph.D. dissertation. The student is expected to contribute to the direction of the work as the research progresses.

All Ph.D. students, as well as M.S. in Chemical Engineering (with thesis track) / M.S. in Bioengineering (with thesis track) students: new students in these programs must discuss potential thesis project topics with their prospective faculty advisors of interest. Incoming students are encouraged to contact potential faculty advisors as early as they wish, after declaring their intent to enroll at Tufts. Approximately three weeks after the start of the Fall semester, all new students will be required to submit to the Department the names of at least two (2) different potential faculty advisors with whom they have discussed possible thesis topics, in ranked order of preference. The Department’s Graduate Program Committee will then make research advisor assignments for all new students upon careful examination of student preferences and the availability of research projects; the Department’s best efforts will be made to give students their first choice of advisor, whenever possible. New graduate student-research advisor pairings will be announced by early October.

FINANCIAL SUPPORT

Only full-time Ph.D. candidates are eligible for financial support from the Department, which includes tuition scholarships, teaching assistantships, graduate fellowships, and research assistantships. Please refer to the SOE Graduate Student Handbook for a complete description of these different types of financial support. The most common mode of financial support for full-time Ph.D. candidates in the Department includes coverage during the first semester of study by the Department, followed thereafter by continuing coverage from the research advisor’s grants/contracts/discretionary funds for the duration of the candidate’s study. Candidates must remain in good academic standing and be making sufficient progress toward their degree in order to receive financial support.
Teaching Assistantship

Teaching assistants (TAs) play an important role in the Department’s educational programs. Teaching assistants are assigned to one or more undergraduate and/or graduate courses. Their duties include: reviewing and grading homework problems, grading reports and exams, making copies of sample homeworks and exams for ABET course folders, leading recitations and tutorials, planning and supervising laboratory experiments, and proctoring exams. While serving as a TA, students should expect to devote approximately, but not more than, 10 hours per week to TA duties. All full-time Ph.D. students who are financially supported by the Department during their first semester of study will serve as a TA for a minimum of three (3) course rotations during their residency in the program. Teaching assistants are allowed two weeks of vacation per calendar year; additional time is permitted only with consent from the Department’s Graduate Program Committee.

Teaching assistants should register for CHBE 405 (Grad Teaching Assistant). This zero-credit course is graded Satisfactory/Unsatisfactory by the course instructor; Unsatisfactory performance will constitute insufficient progress toward the degree and result in an academic warning (see pg. 10).

Research Assistantship

Research assistants are supported from research contracts or grants, and are supervised by the faculty member associated with the contract or grant. Research assistants are usually supported for periods of up to 12 months. Extension of the support period is contingent on satisfactory progress in their research project and availability of funds. Research assistants are allowed two weeks of vacation per calendar year; additional time is permitted only with consent from the research supervisor. Ph.D. candidates who are supported with research assistantships may be asked to perform teaching assistant duties at any time during their residency in the program.

Research assistants should register for CHBE 406 (Grad Research Assistant). This zero-credit course is graded Satisfactory/Unsatisfactory by the research advisor; Unsatisfactory performance will constitute insufficient progress toward the degree and result in an academic warning (see pg. 10).

DOCTORAL PROGRAMS

The Doctor of Philosophy (Ph.D.) degree is awarded for high achievement in an advanced field of study. It requires competence in independent research and a demonstration of creativity and originality. The Ph.D. degree is not awarded simply for the fulfillment of a residence period or the accumulation of credits.

The Department offers a Ph.D. in Chemical Engineering and a Ph.D. in Biotechnology Engineering. Specific core course requirements for each degree program are listed below.

Core course requirements

Ph.D. in Chemical Engineering:

All Ph.D. in Chemical Engineering candidates are required to successfully complete the following core courses by the end of their second academic semester:
• CHBE 201 Mathematical Methods in Chemical Engineering
• CHBE 202 Advanced Kinetics and Reaction Engineering
• CHBE 203 Advanced Thermodynamics
• CHBE 204 Advanced Transport Phenomena

**Ph.D. in Biotechnology Engineering:**

The core course requirements for the Ph.D. in Biotechnology Engineering program are designed to accommodate the diversified academic program base of our applicants. Candidates must complete the following core courses by the end of their second academic semester:

• CHBE 160 Biochemical Engineering
• CHBE 161 Protein Purification
• CHBE 166 Principles of Cell & Microbe Cultivation
• One (1) course chosen from the following:
  o CHBE 167 Metabolic & Cellular Engineering
  o CHBE 193 Synthetic Biology

**Additional academic requirements and policies common to both programs:**

Students who have completed one or more equivalent core courses prior to their matriculation at Tufts and have earned a grade of B or higher may petition to transfer the course credit into the Tufts program. Students can request the transfer of credits in SIS, and this should be done as soon as possible following their matriculation at Tufts. Please note that transfer credits will not be approved for courses that were completed in order to fulfill the requirements of a previously awarded degree (e.g. a B.S. or M.S. degree).

While not accepted for transfer credit, students who have completed a core course as part of a previously awarded M.S. degree may petition the Department to obtain a waiver from completing the course at Tufts. A request to waive any core course(s) must be submitted by the student to the Graduate Program Committee no later than 30 days following their matriculation. A grade of A- or higher is required for consideration. A maximum of two (2) core course waivers may be allowed. The Graduate Program Committee will inform applicants in writing of all petition decisions. An approval to waive a core course requires the applicant to complete an additional graduate-level elective course in its place.

In addition to the core courses requirement, Ph.D. students must complete an elective course sequence. Ph.D. students entering with an M.S. engineering degree must successfully complete four (4) elective graduate-level courses, while those with a B.S. engineering degree must successfully complete six (6) graduate-level elective courses. A minimum of two (2) of the elective courses must be CHBE graduate course offerings. All individual elective courses, as well as the overall course program, must be approved by the student’s research advisor. The selection of
elective courses affords the student an opportunity to focus one’s academic studies in an area consistent with their thesis research.

Students entering the Ph.D. or M.S. program without an academic background in chemical engineering may choose up to one (1) of the following upper-level undergraduate CHBE courses as a potential graduate elective:

- CHBE 102 Reactor Design
- CHBE 109 Process Dynamics and Control

All Ph.D. students are required to complete a total of twenty-four (24) Doctoral Thesis Research credits. Full-time students will typically complete this requirement by registering for 6 credits per semester of CHBE 297 (Fall) and CHBE 298 (Spring) during their 3rd and 4th years.

All full-time graduate students must register for the CHBE Department’s seminar series each semester, CHBE 291 (Fall) and CHBE 292 (Spring). Although these are zero-credit courses, a Satisfactory/Unsatisfactory grade will be assigned on the basis of attendance and participation; Unsatisfactory performance will constitute insufficient progress toward the degree and result in an academic warning.

**Qualifying procedure**

Candidacy for continuation on the path toward the Ph.D. degree beyond the first academic year is established by the successful completion of the following two (2) requirements:

- [1] Students must pass a preliminary oral examination. A critical analysis of a technical paper from the literature must be presented by the student to the Department’s faculty. The preliminary oral examination will be held in January. A collection of approved journal articles will be made available to the student at least two weeks prior to the examination. Students should select one of the articles from this collection to analyze and present to the faculty. Additional, specific guidance regarding faculty expectations for what students should be prepared to demonstrate during the examination will be provided in a memo sent to students via email. The format of the examination will be as follows:

  (a) Each student will give a presentation to the faculty. Each presentation will be limited to a maximum of 20 minutes and will be followed by a 25 minute Q&A session.

  (b) The faculty will meet after all student presentations have been completed to determine an outcome for each student. A positive faculty vote (simple majority, taken by secret ballot) is required in order to pass the exam. If the majority vote is not positive for a particular student (*i.e.* a failed exam), a second faculty vote by secret ballot will then be taken to decide whether or not the student in question will be offered an opportunity to re-take the oral exam later in the same semester; a simple majority is required to allow a re-take. If allowed to re-take the exam by faculty vote, a student may only do so once. Students will be given written notice regarding their exam performance within 48 hours after the faculty discussion.
[2] Students must satisfactorily complete the core course requirements for their degree and earn a minimum average GPA of 3.00 across the core courses taken at Tufts. Please note that any core course transfer credits will not be factored into computing this value for candidacy. In the extremely rare event that all four core courses cannot be offered by the Department during the student’s first two semesters, the GPA minimum will be applied only to those core courses taken during the first two semesters.

It is the responsibility of the student to complete all doctoral qualification procedures in a timely manner during the first academic year, as described above. Students who fail to meet either of the two Ph.D. qualification requirements (preliminary oral exam and core course GPA minimum) as described above are not considered to be making sufficient progress within the Ph.D. program, and may lose their financial support as early as May 31 of their first full academic year of enrollment. Students who are not allowed to continue in the Ph.D. program because they have not met the qualifying procedure requirements may be invited to transition to a Master’s degree program.

Research progress report and presentation

At the conclusion of the summer following their first full academic year in the Ph.D. program, all Ph.D. candidates who have successfully passed the qualifying procedure requirements must submit and orally present a research progress report, which describes their individual research contributions/findings to date. The research progress report should be no longer than five (5) pages, not including a title page or list of references cited in the page count. An electronic copy (pdf version) of the research progress report must be submitted via email to the Graduate Program Chair and the student’s faculty advisor by September 1. In mid/late-September, each student will also give an oral presentation of their initial research activities and findings to the faculty. Each presentation will be limited to a maximum of 15 minutes and will be followed by a 20 minute Q&A session. Students will be provided with feedback on both their research progress report and oral research presentation.

Thesis committee

After completing the Ph.D. qualifying procedure and submitting/presenting their research progress report, each candidate, in consultation with their research advisor, should select a thesis committee. The thesis committee is composed of at least 4 members, including: one member from the Chemical and Biological Engineering department in addition to the thesis advisor(s), one member from another Tufts department, and one member from outside Tufts (who holds a Ph.D. in a relevant field). The research advisor serves as the chair of the thesis committee. Each member of the thesis committee should be given a copy of the Research Progress Report prepared during the qualification procedure.

The thesis committee is responsible for monitoring the quality and progress of the research. The candidate should meet with the thesis committee at least once a year and provide oral and written Progress Reports. A printed copy of the PhD Thesis Committee Meeting Record form (http://engineering.tufts.edu/chbe/graduate/forms.htm) that includes the names of each committee
member in attendance should be submitted to the Department’s Graduate Program Committee after each meeting (there is a separate form used for the first committee meeting, see the next section).

**Thesis proposal**

Doctoral candidates are required to prepare and submit a written thesis proposal, ideally within one year after completing the research progress report. The thesis proposal should be submitted to the thesis committee and then defended orally at the time that the committee is first convened. Failure of a full-time Ph.D. candidate to complete this oral presentation *by the end of the sixth semester* after entering the program is considered unsatisfactory progress towards the doctoral degree and may result in an academic warning (see pg. 10). Part-time Ph.D. candidates must complete this milestone by the end of their eighth semester. If the thesis committee does not approve the proposal, a period of up to three months is allowed to submit and defend a new proposal. Completion of the research proposal benchmark requires submission of a signed Thesis Proposal Form (http://engineering.tufts.edu/chbe/graduate/forms.htm) to the Graduate Program Chair.

*Guidelines for preparing the Thesis Proposal*

a. The written portion of the thesis proposal should be in the form of a grant application (such as to NSF or NIH), with an introduction, objectives/specific aims, summary of previous work done on the problem, method of attack, potential problems with suggested solutions, and conclusions. It is not meant to be a document containing a significant volume of already completed research.

b. The proposal should be self contained and include sufficient material to demonstrate the value, originality and creativity in the proposed research.

c. The proposal should be developed independently. Faculty and other students may provide only limited assistance with specific technical problems.

d. A copy of the proposal should be given to each member of the thesis committee at least one week before its defense.

e. The statement of the problem must be precise and unambiguous. There should be no room for doubts as to what is meant.

f. The literature pertaining to the problem should be documented.

g. The method of attack should be described fully, including the feasibility of each step in the process proposed for solving the problem.

h. The probable results of the proposed research and the conclusions which would follow from each result should be fully described.

i. Assumptions and uncertainties should be stated explicitly.

j. An estimate of the time required to carry out the research should be made on the basis that the student would conduct the work.
Research presentation
During their 4th year of study, all Ph.D. candidates will be required to present a research seminar of their work to the Tufts CHBE community. Each student seminar will be limited to 30 minutes, followed by approximately 15 minutes of Q&A from the audience.

Thesis defense
The SOE Graduate Student Handbook specifies the thesis regulations that have been set by the Graduate School. Additional requirements for the thesis may be outlined by the research advisor. The Chemical and Biological Engineering Department requires, as part of the procedure by which a thesis is approved, a formal oral defense by the candidate before an examination committee. The oral presentation should be open to the public. The examination committee recommends action to the university regarding the thesis. The members of the thesis committee serve as the examination committee. Copies of the thesis must be delivered to the examination committee at least two weeks prior to the defense.

Possible actions of the examination committee:

a. Acceptance of dissertation/thesis
b. Acceptance with minor changes. This action requires the candidate to incorporate the minor changes, but allows for the signatures of all committee members at the conclusion of the defense with no further re-examination necessary.
c. Acceptance with major changes. This category requires a re-examination of the corrected thesis by the committee, but no repetition of the oral examination.
d. Rejection. This action requires the student to prepare a new thesis, and generally involves additional research work.

Schedule of committee meetings
Students enrolled in the Ph.D. programs are encouraged to regularly hold thesis committee meetings to seek guidance and to update the members of the committee on the progress of the thesis research. The minimum required number of thesis committee meetings is four (4), including the thesis proposal and final thesis defense meetings. The following table outlines a recommended schedule of thesis committee meetings and other important milestones.

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<th>Year 1</th>
<th>Qualifying procedure</th>
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<tr>
<td>1 Year 2</td>
<td>Thesis proposal</td>
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<tr>
<td>2 Years 2-n</td>
<td>Annual or other thesis progress meetings</td>
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<tr>
<td>Year 4</td>
<td>Departmental seminar</td>
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<tr>
<td>Year n</td>
<td>Final thesis defense</td>
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1The thesis proposal meeting must take place no later than the sixth semester after matriculation.
2At least two (2) thesis progress meetings, after the thesis proposal meeting, must be held before the final thesis defense.
MASTER OF SCIENCE PROGRAMS

The Department of Chemical and Biological Engineering offers the M.S. in Chemical Engineering and the M.S in Bioengineering: Cell and Bioprocess Engineering. The degree in Cell and Bioprocess Engineering is one of six (6) tracks in the Bioengineering program of the School of Engineering. Program requirements for Cell and Bioprocess Engineering include Common Core and Breadth courses in addition to departmental track-specific courses. All M.S. programs require the completion of a set of specific course requirements. For a M.S. degree with thesis, this includes a 9 credit thesis for the Chemical Engineering degree or a 6 credit thesis for the Bioengineering: Cell and Bioprocess Engineering degree. Alternatively, a course-only (non-thesis) track is available for each degree. The following courses are required for each program:

M.S. in Chemical Engineering

- CHBE 201 Mathematical Methods in Chemical Engineering
- CHBE 202 Advanced Kinetics and Reaction Engineering
- CHBE 203 Advanced Thermodynamics
- CHBE 204 Advanced Transport Phenomena

Graduate-level elective credits:

- Three (3) elective courses + 9 Thesis credits (CHBE 295 / 296) for thesis track
- Six (6) elective courses for non-thesis track

M.S. in Bioengineering: Cell and Bioprocess Engineering

Track requirements (4 courses):
- At least two (2) courses from the following list:
  - CHBE 160 Biochemical Engineering
  - CHBE 167 Metabolic Engineering
  - CHBE 193 Synthetic Biology
- CHBE 161 Protein Purification
- CHBE 166 Principles of Cell & Microbe Cultivation

Common core (4 courses):
- BIOE 291 and BIOE 292 Bioengineering Seminar I & II
- BIO 105 Molecular Biology or BME/CHBE/BIO 162 Molecular Biotechnology
- EE 104 Probabilistic Systems Analysis or BME 143 Biological Systems Analysis or CHBE 170 Design of Experiments or CHBE 194 Special Topics: Data Science in Biotechnology

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1 Alternative Math selection may be substituted by written petition
Breadth requirement (1 course)\(^2\):

- ONE 100- or 200-level SOE course outside of the CHBE catalog of courses. A course cross-listed with CHBE may also be used to fulfill this requirement. For example, one of the following of the courses may be used to fulfill the breadth requirement:
  - BME 153 Biomaterials and Regenerative Medicine
  - CS 167 Computational Biology
  - CEE 139 Bioremediation: Natural and Enhanced
  - EE 105 Control Systems
  - ME 103 MEMS

Thesis credits or Additional electives:

- Either 6 Thesis credits (CHBE 295 / 296) for thesis track,
- Or, 2 additional graduate elective courses for non-thesis track

Additional policies and requirements. All credits must carry a grade of B- or better. For the Chemical Engineering M.S. degree (either thesis or non-thesis track), a minimum of two (2) of the elective courses must be CHBE graduate course offerings. For students in the Chemical Engineering M.S. non-thesis track, a maximum of two (2) Engineering Management (EM) courses approved by the Graduate Program Committee may be counted toward the degree. For the Bioengineering M.S. in Cell and Bioprocess Engineering degree, no additional elective courses are required. The Department follows the standard University policy concerning transfer of credits.

All full-time Chemical Engineering M.S. students must register for the Chemical and Biological Engineering Department’s seminar series, CHBE 291 (Fall) and CHBE 292 (Spring). Although the credit value for these courses is zero, a Satisfactory/Unsatisfactory grade will be assigned on the basis of attendance and participation.

M.S. thesis

All students enrolled in the M.S. thesis program must complete a nine (9) or six (6) credit thesis research project depending on whether their degree is in Chemical Engineering or Bioengineering. Research for the thesis is supervised by the student’s research advisor. The M.S. thesis should be submitted to the examination committee at least two weeks prior to the defense, which is open to the public. The examination committee is composed of two members from the CHBE Department and one member from outside the department or outside the University.

Possible actions of the examination committee

a. Acceptance of thesis

\(^2\) Alternative Breadth selection may be substituted by written petition
b. Acceptance with minor changes. This action requires the candidate to incorporate the minor changes, but allows for the signatures of all committee members at the conclusion of the defense with no further re-examination necessary.

c. Acceptance with major changes. This category requires a re-examination of the corrected thesis by the committee, but no repetition of the oral examination.

d. Rejection. This action requires the student to prepare a new thesis, and generally involves additional research work.

ACADEMIC WARNING AND ACADEMIC PROBATION

Academic warning and academic probation are formal Departmental statuses a graduate student may be placed on, typically after the first full academic year of study, in the event they have not met the requirements to remain in good standing within the program. For example, failure to submit and present a thesis proposal by the indicated deadline will result in an academic warning. Before being placed on academic warning status, a student will be formally notified by their thesis advisor (if the reason for warning is related to research performance) or by the Graduate Program Chair (if the reason for warning is related to academic performance or missing a required benchmark deadline).

A student placed on academic warning status during the Fall semester or Summer term has one following semester to rectify the deficiency. A student placed on academic warning status during the Spring semester has the following Summer term to rectify the deficiency. If the deficiency is not rectified by the end of the warning period, the student may be placed on academic probation status. Students on academic probation status are not eligible to receive financial support in the form of teaching or research assistantships. A student placed on academic probation status has one semester/summer term (as described above) to rectify the deficiency. If not rectified by the end of the probationary period, the student may face dismissal from the graduate program.