Chemical and Biochemical Engineering
Graduate Student Handbook

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Welcome to the Graduate Program in Chemical and Biochemical Engineering at UC Irvine

This handbook is designed to help you navigate your way through your graduate career and lists useful resources. I encourage you to become active in the ChEMS Graduate Student Association (GSA), as a way to get to know the other students and to have a voice in different aspects of graduate student life.

The first year of graduate school can seem very difficult at times, but we have a good track record of graduating highly successful students. Most of these students have found additional resources on campus that have helped them throughout their graduate studies. I will remind you that if you feel stressed, there are free campus resources available to you at the Counseling Center (949) 824-6457.

If you are in the Ph.D. program, you will be ‘matched’ with an advisor at the end of the winter quarter. Use the research rotation period wisely to help you decide which groups best meet your interests. We strongly encourage students to have co-advisors in cases where projects can benefit from the knowledge of two different advisors.

If you are an international student, we will expect that you will have passed the TSE/SPEAK test with a passing score of 50 or higher, or the TOEP test with a score of 5 by the end of the spring quarter of your first year (or have 26 or higher on the Speaking portion of the TOEFL iBT). You will then have demonstrated a good command of spoken English, and will be eligible to apply for TA-ships. TA training is offered in the fall, and is required for becoming eligible for a TA appointment.

I look forward to your success, and we hope this roadmap will make your drive to a graduate degree all that much easier and stress free.

Ali Mohraz
Associate Professor, Chemical Engineering and Materials Science
Graduate Advisor for Chemical and Biochemical Engineering

Department of Chemical Engineering and Materials Science (ChEMS)
Key Personnel and Other Useful Information

- Professor Vasan Venugopalan – Department Chair (ET916).
- Professor Ali Mohraz – Graduate Advisor (ET744F) – for questions on classes, research, and other academic matters.
- Grace Chau – Graduate Coordinator (ET916). Source for all graduate paperwork, answers on rules and regulations, submission of paperwork for signature by Graduate Advisor
- Yi-San Chang-Yen – Department Manager (ET916).
- Janine Le – Payroll/Personnel (ET916). Handles all appointments (TA, Reader, GSR). Faculty must initiate requests for support a month in advance.
- Elizabeth Randall – Front Desk/Business Office Analyst - Keys to labs
- Steve Weinstock – Lab Manager (ET944G).

Mailboxes for graduate students are located in 937A Engineering Tower. Desks are provided by research advisors for full time students conducting research.
**Course Selection** (see Schedule of Classes online)

You should become familiar with the Schedule of Classes online at UC Irvine. Each quarter check our department (both CBEMS and ENGRMSE) and other related disciplines to see if there are new courses that interest you.

The following CBE core courses are REQUIRED for all new students. The PhD preliminary exams and MS comprehensive exams are based, in part, on material covered in these required core classes.

**Core Courses Required for all CBE Graduate Students**

CBEMS 210 Reaction Engineering Spring 2018  
CBEMS 220 Transport Phenomena Winter 2018  
CBEMS 230 Applied Engineering Mathematics I Fall 2017  
CBEMS 240 Advanced Engineering Thermodynamics Fall 2017  

6 units of CBEMS 298 Department Seminar (Fall 2017, Winter 2018 and Spring 2018)

**Elective Courses for CBE Graduate Students**

PhD students and MS degree students taking the comprehensive exam option are required to take 5 additional graduate courses (3 units minimum/course) as electives. In some instances, an upper-division undergraduate course can be used to satisfy the elective requirements. Please DISCUSS WITH AND GET APPROVAL FROM THE GRADUATE ADVISOR if you wish to take elective courses that deviate from the official elective course requirements.

Modern research is increasingly multi- and inter-disciplinary. Your effectiveness as a scholar will improve if you are able to conceptualize and integrate principles from other fields into your own research. Examine the course offerings closely in Biomedical Engineering, Civil and Environmental Engineering, Electrical Engineering and Computer Science, Mechanical and Aerospace Engineering, Biological Sciences, Chemistry, Physics, and Mathematics for additional electives. You are encouraged to consider elective graduate classes outside the department, particularly if they are relevant to your research interests.

**Departmental Seminar**

ALL FULL TIME STUDENTS MUST ENROLL IN CBEMS 298 each quarter during their first year. This is the Chemical Engineering and Materials Science Departmental Seminar, typically held once a week on Friday afternoons. You need to sign on the attendance sheet each week. You must attend at least 8 out of 10 seminars in order to obtain a passing grade. This will require you to be on time, and you are expected to stay for the entire seminar to receive credit.

**The PLAN OF STUDY Form**

This form codifies the courses that you plan to take to satisfy the requirements of your degree. You can obtain this form: [http://engineering.uci.edu/files/17-18-cbe-plan-of-study.pdf](http://engineering.uci.edu/files/17-18-cbe-plan-of-study.pdf). Completion of this form is required for ALL MS and PhD students by the end of the first quarter. You should submit your completed form to the Graduate Coordinator (Grace Chau) for approval by the CBE graduate
advisor. You can modify/re-file the form later if your course interests change. It is most important to have the required core courses listed.

**MS Degree Requirements:**

1. Students must file the Advancement to M.S. Candidacy **one quarter before** graduation quarter (just apply through Grace Chau, forms available at [http://www.grad.uci.edu/forms/](http://www.grad.uci.edu/forms/))
2. Complete the course requirements (see below under Option 1 and Option 2).
3. Discuss with your advisor early on whether the comprehensive exam or the thesis option best suits your interests. Students in the MS/PhD track may select either approach.

**Option 1: MS Degree with Thesis** (original research with an advisor and a written MS thesis)

- Must complete a MS thesis approved by a committee of 3 faculty members.
- Must complete the four CBE **core courses**, and five elective courses (3 units minimum/course) numbered 200-289 (or 200-295 if offered by other departments) approved by the CBE graduate advisor.
- Up to eight units of CBEMS 296 (MS Thesis Research) may count to substitute for up to two elective courses.
- In some instances, one of the elective courses may be substituted by an upper-division (numbered 100-199) undergraduate elective course, if approved by the CBE graduate advisor.
- All full time graduate students, including PhD students, must sign up for the departmental seminar, CBEMS 298, each quarter during their first year. (A total of 3 quarters, or 6 units, are required).

**Rule of thumb: 4 CBE Core Classes, 3 graduate elective classes, 8 units of MS research, plus the MS thesis = MS degree with Thesis option**

**Option 2: MS Degree with Comprehensive Exam**

- Must complete the four CBE **core courses**, and five elective courses (3 units minimum/course) numbered 200-289 (or 200-295 if offered by other departments) approved by the CBE graduate advisor.
- Must complete the written **comprehensive exam**. This exam is offered annually in the SPRING quarter. Exam is conceptual (not problem solving) and covers analysis of a recent research paper. Details will be provided in early 2018 (see page 11 for more).
- Research units **do not count** towards the degree requirements.
- In some instances, one of the elective courses may be substituted by an upper-division (numbered 100-199) undergraduate elective course, if approved by the CBE graduate advisor.
- All full time graduate students, including PhD students, must sign up for the departmental seminar, CBEMS 298, each quarter, during their first year. (A total of 3 quarters, or 6 units, are required).

**Rule of thumb: 4 CBE Core Classes, 5 graduate elective classes, plus passing score on Comprehensive Exam = MS degree with Exam option**


PhD Degree Requirements:

Incoming PhD students who have not selected a research advisor will enroll in 2 to 4 units of research (CBEMS 299). All ChEMS faculty will describe their research during Welcome Week, and you will have a chance to meet with the faculty and discuss your interests, and then select 2 research rotations for the year (one per quarter in Fall and Winter). As a placeholder, you may sign up under the CBE Graduate Advisor’s name (Professor Mohraz), until the research rotations are assigned in the first week of classes, at which time you can electronically add/drop the correct research supervisor’s name. At the conclusion of each research rotation, you must submit a Quarterly Research Rotation Report (see next page for rules and guidelines) to both your rotation supervisor and the CBE Graduate Advisor, unless exempted by the rotation supervisor.

- The initial course requirements are the same as the MS degree with the comprehensive exam option (see previous page).
- PhD students must take two additional elective courses beyond the MS degree requirements.
- The PhD Preliminary Exam (see below).
- ‘Matching” with faculty advisor(s) to guide your doctoral research.
- The PhD Qualifying Exam (advancement to candidacy); should be completed by the end of year 3 (see below).
- Written dissertation with oral defense (see below).
- All students must take a minimum of 12 units per quarter (Fall, Winter and Spring) to be considered full time. You can enroll up to 16 units per quarter.

Preliminary Exam

- All 1st year MS/PhD and PhD students are required to take the Preliminary Exam, which will be offered during the SPRING quarter.
- Passing of the Preliminary Exam is required to remain in good standing.
- Students register with a form obtained from the Graduate Coordinator (Grace Chau).
- The Preliminary Exam is an oral exam where the student will present and be examined on a journal paper related to one of the following topics chosen by the student: (a) Biotechnology; (b) Nanomaterials (c) Energy and Environment.
- Passing will be determined based on: 1) performance on the oral exam; 2) performance in core courses; 3) performance in research rotations.

Qualifying Exam

- The Qualifying Exam covers dissertation ideas and results of preliminary research.
- The committee must be comprised of 4 ChEMS faculty (with at least 2 holding primary appointments in ChEMS) and 1 faculty member not affiliated with ChEMS (outside member). Your research advisor will be on your exam committee. Nomination form needs to be approved 2 weeks before the exam date: [http://engineering.uci.edu/files/qualifying-exam-nomination-form-6-30-16.pdf](http://engineering.uci.edu/files/qualifying-exam-nomination-form-6-30-16.pdf)
- Taken after passing the Preliminary Exam, no earlier than the end of the 1st year, and no later than the end of the 3rd year in the MS/PhD program.
- A written research proposal (dossier) of approximately 30-40 pages in length must be submitted to the committee members at least one week prior to the exam.
- The exam will take approximately 90 minutes – your research presentation should be 40-50 minutes and reviewed by your advisor before your exam.
Oral Defense
- An oral presentation at the completion of your PhD dissertation is required.
- Committee members for the PhD dissertation (3 including advisor) are invited as well as the entire department faculty and students. Visitors are welcome.
- A 45-minute presentation should summarize your major research findings.
- The oral exam will involve questions from the committee. The committee may request a closed session for their questions.
- Best if written dissertation has been approved by the committee.

Dissertation
- Copies of past dissertations are available in the UCI library.
- Have your advisor approve the dissertation first, then the two other committee members.
- Note that writing will take a minimum of 3 months. Plan ahead!
- Tip – use your publications as a base.

Quarterly Research Rotation Reports – Rules and Guidelines

1. Reports, both electronic and hard copies, are due each quarter to the research supervisor before grades are due, unless exempted by the rotation supervisor. Specific deadlines will be set by the research supervisor. Supervisors may ask for advance drafts and require revisions prior to assigning a grade for the research rotation.

2. Students are also expected to provide electronic copies of all data to the research supervisor, and copies of lab notes at the same time the report is submitted.

3. Students must provide a paper copy of each quarterly report to the CBE Graduate Advisor, unless exempted by the rotation supervisor. These reports will be part of the assessment process for first year students by the graduate committees, which is why the CBE Graduate Advisor will be collecting a copy.

4. Reports should be at least 5 pages in length, excluding the title page, references and appendix and should have the following sections formally indicated.

a. **Title Page:** Title of project, name, date, research supervisor’s name.

b. **Abstract:** 100-300 words.

c. **Introduction:** Literature review of articles read regarding the research project, context for the research, hypothesis or main problem to be addressed, and approach to solve the problem.

d. **Methods:** Description of experimental or computational techniques utilized.

e. **Results:** Relevant results with tables, micrographs, and Figures as appropriate, briefly described.

f. **Discussion:** Discussion of the implications of these results, comparisons with prior published research and suggestions for future work.

g. **Conclusions:** Short (one paragraph) description of major findings.

h. **References:** Provide references at the end for all literature cited in the report and for any facts that need references. References must include the following information – full list of authors, full article title, journal title, volume, issue, pages, and year. Websites are generally not appropriate references and Wikipedia and popular science magazines are never accepted as primary references. Peer reviewed archival journals (can be found on Web of Science, SciFinder and other library databases) are the gold standard. Occasionally reference books are cited also.
i. **Appendix:** Extra figures and extended tables of raw data may be included.

### Means of Support

- All support is given competitively, and based on continuing good standing.
- Fellowships (usually to new students for recruitment).
- GSR – Research Assistantships, funded from faculty research grants.
- Hours worked are in ADDITION to units earned for research credit.
- All U.S. citizens and Permanent Residents must fill out the FAFSA each year, due March 2, [http://www.fafsa.ed.gov/](http://www.fafsa.ed.gov/) in order to be eligible for certain financial awards such as GAANN Fellowships and Work Study awards.

### Advisors

MS students taking the comprehensive exam option do not need an advisor other than the CBE Graduate advisor. MS students selecting the thesis option should select a research advisor as soon as possible. PhD and MS/PhD students should match with a research advisor during the matching process after 2 research rotations.

PhD and MS/PhD students who cannot match with a research advisor at the time of the matching process will be required to find and successfully match with a research advisor during the following quarter, or will no longer remain in good standing in the program.

Below is a list of ChEMS faculty followed by a list of affiliated faculty. ChEMS affiliated faculty (primary appointment outside of ChEMS) have their home departments listed after their names in parenthesis. ChEMS affiliated faculty can advise graduate students as approved by the Department Chair.

### ChEMS Faculty

- **Nancy Da Silva:** Molecular biotechnology including yeast metabolic engineering, synthetic biology, protein synthesis and secretion in eukaryotes.

- **James C. Earthman:** Fatigue behavior and cyclic damage, automated materials testing, high-temperature fracture, biomaterials, nanocomposites.

- **Alon Gorodetsky:** Organic photovoltaics, electrical biosensors, nanotechnology, DNA, materials chemistry

- **Allon Hochbaum:** Nanoscale materials and hybrid bio-inorganic devices for applications in clean energy.

- **Enrique Lavernia:** Nanostructured materials, additive manufacturing, powder metallurgy, mechanical behavior

- **Han Li:** Molecular biotechnology
• Martha L. Mecartney: Grain boundary engineering of ceramics, solid oxide fuel cell electrolytes, ceramics for nuclear waste and nuclear fuels, superplastic ceramics.

• Ali Mohraz: Soft materials and complex fluids engineering, guided and self-assembly of colloids and nanostructured materials for energy and biotechnology applications.

• Daniel R. Mumm: Thermo-mechanical behavior of materials, interfaces and microstructure, materials for power and propulsion, cellular materials, morphing structures, micro/nano-mechanics.

• Mikael Nilsson: Fundamentals and applications in chemical separation processes for used nuclear fuel; radiation chemistry and solvent degradation by radiolysis; preparation of radioisotopes for medical purposes; nuclear forensics and detector systems.

• Xiaoqing Pan: Atomic-scale structure, properties and dynamic behaviors of advanced materials including thin films and nanostructures for memories, catalysts, and energy conversion and storage devices.

• Regina Ragan: Scanning tunneling microscopy and nanostructures for sensor applications

• Elizabeth Read: Dynamics of complex biochemical systems and regulation of immune responses

• Julie Schoenung: Materials selection, green engineering, materials processing and characterization, nanostructured materials, structure-property relationships

• Frank G. Shi: Optoelectronic device (LED, solar cells, etc) packaging technologies; Optically transparent device encapsulation materials; Electrically conductive polymer pastes and adhesives; Transparent functional coating materials.

• Vasan Venugopalan: Radiative transport, photothermal and photomechanical phenomena. Laser applications for medical diagnostics, therapeutics, cellular micromanipulation and Bio-MEMS. Computational methods in biophotonics.

• Szu-Wen Wang: Biomolecular engineering, interfacial engineering, biomaterials, drug delivery.

• Albert Yee: Nanofabrication of soft materials, nanostructures for directing stem cell differentiation, nanostructured surfaces for preventing or encouraging deposition of proteins, cells, and bacteria in ophthalmology applications, nanomechanical properties of polymers and composites.

**Affiliated Faculty**

• Shane Ardo (Chemistry): Solar energy conversion and electrochemistry
• Elliot Botvinick (BME): laser microbeams, cellular mechanotransduction, mechanobiology

• Peter Burke (EECS): Quantum electronics and quantum information science

• Michelle Digman (BME): Quantifying spatial and temporal dynamics of proteins during cell migration and developing novel imaging technologies

• Stanley B. Grant (CEE): Environmental engineering, coastal water quality, coagulation and filtration of colloidal contaminants, environmental microbiology

• Anna Grosberg (BME): Computational modeling and tissue engineering applied to cardiomyocytes, cardiac function

• Zhibin Guan (Chemistry): Organic, biological, and macromolecular materials chemistry

• Jered Haun (BME): Targeted drug delivery, clinical cancer detection, nanotechnology, molecular engineering, computational simulations

• Michelle Khine (BME): Single cell analysis, shrinky-dink microfluidics, lab-on-a-chip microsystems

• Young-Jik Kwon (Pharmaceutical Sciences): Drug delivery and pharmaceutical sciences

• Matt Law (Chemistry): Nanoscale materials and devices, solar energy conversion

• Jaeho Lee (MAE): Nanoscale heat transfer and materials engineering, targeting impact on semiconductor devices and energy conversion systems via metrology development

• Guann Pyng Li (EECS): High-speed semiconductor technology, optoelectronic devices, integrated circuit fabrication and testing

• Mo Li (CEE): Responsive materials, multifunctional materials and structures, fracture mechanics, cement chemistry, industrial ecology, materials-structure-environment interaction

• Wendy Liu (BME): Cell and tissue engineering, biomaterials, microfabricated technologies, mechanotransduction

• John Lowengrub (Math): Mathematical modeling of phase transformation and materials

• Ray Luo (MB&B): Computational analysis of biomolecular sequence, structure, dynamics, and function

• Marc Madou (MAE): Miniaturization science (MEMS and NEMS) with emphasis on chemical and biological applications

• Diego Rosso (CEE): Water pollution, wastewater treatment
• Timothy J. Rupert (MAE): Nanoscale mechanics and materials

• Suzanne Sandmeyer (Biochem): Molecular genetics and biochemistry of retrotransposons and metabolic engineering in budding yeast

• Lizhi Sun (CEE): Micro/nano-mechanics of heterogeneous composite materials, with applications for civil, mechanical, aerospace, electronic, and biomedical engineering

• William Tang (BME): Micro-electro-mechanical systems (MEMS) nanoscale engineering for biomedical applications, microsystems integration, microimplants, microbiomechanics, microfluidics

• Lorenzo Valdevit (MAE): Mechanics of composite materials and lightweight structures

• H. Kumar Wickramasinghe (EECS): Nanotechnology, development of novel atomic force microscopies

• Yoojin Won (MAE): Multi-scale structures for thermal and energy applications, in particular fabrication, characterization, and integration of structured materials.

• Weian Zhao (PharmSci): Development of novel molecular, nano- and micro-engineered tools for stem cell therapy and regenerative medicine, diagnosis and in vivo imaging, and elucidating stem cell and cancer biology.

A Few Questions and Answers:
What do Teaching Assistants and Readers Do?

• TA’s grade homework and tests, run demonstrations, hold office hours, lead discussions, maintain class websites, maintain records of grades, and run labs.

• Readers grade homework and tests, also can hold office hours.

• Students are selected based on faculty nominations, match with course material, GAANN/CAREER grant priority, past experience.

• All students who want to be a TA or Reader must have completed the TA training in September.

What are the Language requirements for international students who want to serve as a TA?

• To be a TA, the international student must pass TOEP (with a score of 5), TSE or SPEAK test (with a score of 50) or a TOEFL iBT score of 26 or higher on the Speaking component.

• TOEP given at UCI to students who have taken TSE or SPEAK and obtained a score of 40, refer to:  www.humanities.uci.edu/esl/graduate/gradflyer1718.pdf  Classes offered through ESL can prepare graduate students for these exams and improve communication skills.

• Humanities 21A, 21B, 29 are for graduate students who are not native English speakers. Please meet with the Academic English Coordinator, Dr. Susan Earle-Carlin before enrolling in any of these classes. She will meet with you and evaluate your English to see what class level you need to enroll in.

What grades do I need to have to maintain good standing?
Students must have a 3.0 GPA minimum with no grades below a B to remain in good standing. MS/PhD and PhD students are generally expected to achieve GPAs greater than 3.5. A “B–” grade is considered failing and will not count for any course requirements. You need to have a GPA higher than 3.2 for certain types of fellowships, and a GPA higher than 3.1 for any TA position.

**What should I do if I want to change my research advisor?**

- Inform the CBE graduate advisor (Professor Mohraz).
- Talk with research advisor – if unable to do so, ask CBE graduate advisor to talk to research advisor
- Talk with other faculty in department about research projects
- If you have been fully supported financially by your advisor on a GSR, you can be required to finish up a project component (requiring no more than one extra quarter), before you can switch advisors. During this extra quarter you should be given financial support (GSR/TA/Reader/fellowship) equal to 49% GSR
- PhD and MS/PhD students who want to change research advisors must find and successfully match with a new advisor (with financial support) at the latest one quarter (Summer quarter not included) after they stop working with their old advisor, or will no longer remain in good standing in the program.

**Can I switch to another degree program at UCI if I find my interests are better matched by another degree program?**

Yes, you can apply to other degree programs at UCI. However, if you are accepted and decide to change your degree program, you cannot apply for readmission to the CBE program after the start of the next academic quarter in your new degree program. All financial support from the department will be terminated if you change degree programs midyear.

**CBE MS Comprehensive Exam Additional Information**

1. The MS comprehensive exam will be offered during the SPRING quarter. It is the student's responsibility to notify the Graduate Advisor of their plan to take the comprehensive exam at the beginning of their last quarter of studies.

2. The MS students will write a report on a research paper in one of the following topics of their choice: (a) Biotechnology; (b) Nanomaterials (c) Energy and Environment.

3. The research paper is chosen by the exam committee after the students pick the topic.

4. Successful completion is required for terminal MS students with Comprehensive Exam option.

**CBE Preliminary Exam Additional Information**

1. The preliminary exam will be offered during the Spring quarter.
2. Students will prepare a 20-minute oral presentation describing/analyzing the results of a research paper in one of the following topics of their choice: (a) Biotechnology and Biochemical Engineering; (b) Nanomaterials and Soft Matter; (c) Energy and Environment.

3. During and following the presentation, the student will be examined by a faculty committee on the topic of the paper, the related research area, and CBE core courses relevant to the research paper.

4. Student performance on the oral examination combined with performance in CBE core courses and research rotations will be considered to assess the student’s academic progress.

5. Students will be notified during the Spring quarter of their performance on the preliminary exam. For students that receive a conditional pass, a correction plan is requested to address the weaknesses identified during the exam.

**CBE PhD Qualifying Examination**

The purpose of the qualifying examination is to demonstrate that the student is capable of conducting PhD research and has a viable research plan for the doctoral dissertation. Feedback from the qualifying examination committee is very helpful in developing a viable dissertation topic and appropriate experiments.

The CBE PhD qualifying exam committees follow the rules set by the Graduate Council. The student selects the qualifying exam committee consisting of 5 members, according to Graduate Council guidelines. At least one member must be from outside the department, and at least two members must have a primary appointment in the Chemical Engineering and Materials Science Department. While your thesis advisor will likely serve as the chair of the examination committee the expectation is that s/he will largely remain silent during the oral exam itself; thereby allowing a full and thorough evaluation of your research dossier by the other committee members. The committee should primarily be composed of faculty familiar with your area of interest, insofar as that is possible.

Qualifying Exam Nomination Form: see page 5

The PhD Qualifying Examination should be scheduled between the end of the 1st year and the end of the 3rd year of your PhD studies.

There are two required parts of the qualifying examination:

1. **Research Dossier**

   The Research Dossier must be reviewed and signed off by your research advisor before it is distributed to the other committee members. The Research Dossier must be distributed to the faculty at least one week prior to the scheduled Oral Presentation. The Dossier should use Times New Roman 11/12 point font or equivalent, and be 1.5 line or double-spaced. A suggested outline follows.

   1 page

   1) **Title Page** – Title, Name of Student, Degree Program, Date, Advisor's Name and Advisor's Signature.
The typical Research Dossier is 25-50 pages, including Figures and Tables. Document length does not necessarily correlate with quality. While it is likely that the research plan will evolve as the research progresses, the proposed research plan presented in the Qualifying Examination should be comprehensive and commensurate with the general expectations for the PhD. This document will serve as the basis for the PhD dissertation, and will save time later when writing the dissertation.

II. Oral Examination (Approximately 90 minutes)

The oral examination should summarize the written document in a PowerPoint presentation approximately 45 minutes in length, if uninterrupted. The exam will be approximately 90 minutes in length, and 2 hours should be scheduled in order to allow adequate time for questions. At this exam, examiners may return the Research Dossier with written suggestions in the text. The purpose of the oral exam is to evaluate the student's understanding of their research area and the proposed research.
I. Program Learning Outcomes

Core Knowledge. Students will be able to:
- Demonstrate general knowledge of core topics and theory in Chemical and Biochemical Engineering necessary for professional practice or PhD studies.

Research Methods and Analysis. Students will be able to:
- Understand the qualitative and quantitative methodologies typically used in Chemical and Biochemical Engineering practice and research.
- Demonstrate the ability to critically analyze research literature.

Professionalism. Students will:
- Participate in seminar series presented by professionals and academicians in Chemical and Biochemical Engineering and Materials Science and Engineering.

II. Assessment Plan

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<td>Core Knowledge</td>
<td>-GPA ≥ 3.0 in CBE core courses</td>
<td>Exit interview / Survey</td>
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<td>-MS Comp. exam</td>
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<td>Research Methods and Analysis</td>
<td>-MS Thesis</td>
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<td>-Independent Study</td>
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<td>-MS comp. exam</td>
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<td>Professionalism</td>
<td>-Participation in Seminar Series</td>
<td>Exit interview / Survey</td>
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III. Action Plan Timeline
PLOs are assessed at the time graduation for each student. Data are compiled annually and used for continuous improvement of the graduate program.
I. Program Learning Outcomes

Core Knowledge. Students will be able to:
- Demonstrate general knowledge of core topics and theory in Chemical and Biochemical Engineering necessary for professional practice and/or academic research.

Pedagogy. Students will be able to:
- Communicate effectively to large and small groups in pedagogical settings in lecture and/or discussion formats.

Scholarly Communication. Students will be able to:
- Structure a coherent academic argument that rigorously presents and evaluates research data.
- Make clear and cogent presentations, and professional documents that summarize their research and its significance.

Independent Research. Students will be able to:
- Develop and carry out independent research projects with theoretical and methodological rigor.

Broader Impacts. Students will be able to:
- Understand the technological and societal impacts of their research.

II. Assessment Plan

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<td>Teaching Assistantship or Tutorial Seminar</td>
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<td>Scholarly Communication</td>
<td>Research Paper Conference Presentations PhD Defense</td>
<td>Exit interview / Survey</td>
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