Materials Science and Engineering M.S. and Ph.D. Student Handbook

Department of Chemical Engineering and Materials Science

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Welcome Message from MSE Graduate Advisor

I would like to welcome you to UC Irvine and to the graduate program in Materials Science and Engineering. This handbook is designed to help you navigate your way through your graduate career and lists useful resources.

I would encourage you to become active in the ChEMS Graduate Student Association (GSA), as a way to get to know other students and to have a voice in aspects of graduate student life. You can contact Nicole Ing (ingn@uci.edu) for more information – or just watch for announcements at the Friday Seminars and in your e-mail.

The first year of graduate school can seem very difficult, but we have a good track record of graduating highly successful students. Most of these successful students have found additional resources on campus that have helped them. I will remind you that if you feel stressed and at a loss as to how to balance competing demands on your time, there are free campus resources designed for you at the Counseling Center (949) 824-6457.

If you are in the Ph.D. program, you will be selecting an advisor by the end of the winter quarter. Use the research rotations wisely to help you decide which groups best meet your interests. We strongly encourage students to have co-advisors if their projects can benefit from the knowledge of two different advisors. It is important to balance excellence in your academic subjects with a strong performance in your research rotation, if you want to be the top candidate for research support in the group of your choice.

If you are an international student, we will expect that you will have passed the TSE/SPEAK/TOEP test with a score of 50 or higher 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 be eligible to apply for TA ships and have demonstrated a good command of spoken English. The TA training is offered each in fall, and is required for eligibility for a TA appointment.

Lastly, feel free to e-mail me or set an appointment with me to meet and discuss your graduate program.

Professor Regina Ragan **ET744E**
Graduate Advisor for Materials Science and Engineering

Key Personnel in Chemical Engineering and Materials Science (ChEMS)

(916 Engineering Tower)

- Grace Chau – Graduate Coordinator
  Source for **all graduate paperwork**, answers on rules and regulations. Exceptions require the Graduate Advisor's written approval but see Grace for proper forms and protocols first.

- Janine Le – Employment/Fellowship
  Handles all funding (TA, Grader, GSR) and fellowships.
  Faculty must initiate requests for support a month in advance.

- Elizabeth Randall – Administrative Assistant/Front Desk (916) - Keys to labs.

- Yi-San Chang-Yen – Department Manager
- Steve Weinstock (ET 944G) – Lab Manager
- Professor Vasan Venugopalan – Department Chair

Purchasing and Travel Reimbursement - Use School of Engineering forms (http://intranet.eng.uci.edu/intranet/school-information/purchasing) for all purchases of lab supplies. There is a box to submit these forms in ET 916.

YOUR STUDENT MAILBOX is in room 937A Eng. Tower. Be sure to check it regularly.

The faculty and staff in the Department and School will regularly send important messages to your **@uci.edu** e-mail, so check it daily. You must activate your student ID. Check your electronic directory listing at UCI to be certain that you can be e-mailed by faculty and other students.

Information on filing for Advancement to Candidacy for the M.S., Ph.D. and other forms can be found at http://www.grad.uci.edu/forms

COURSE SELECTION

Required Classes

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

The following MSE core courses are REQUIRED for all new students, unless you have taken the equivalent graduate course elsewhere. You must seek approval before the quarter the class is offered to receive credit for a course taken elsewhere. The Ph.D. preliminary exams and M.S. comprehensive exams are based on material covered in these required core classes.

- MSE 200 Crystalline Solids **FALL 2015**
- MSE 265 Phase Transformation **Winter 2016**
- MSE 256A Mechanical Behavior of Engineering Materials (substituted by MAE 259 – Atomistic Theories in **Fall 2015**)
- MSE 205 Materials Physics **WINTER 2016**
- 6 units of CBEMS 298 Department Seminar (Fall 2015, Winter 2016 and Spring 2016)

MSE 200 assumes you have learned the material presented in a basic Introduction to Materials Science and Engineering undergraduate course (ENGR 54 at UCI). If you have not taken such a course you should review on your own the material covered in an undergraduate Introduction to Materials Science and Engineering textbook. Several different textbooks on MSE are available in the Science Library. Materials Science and Engineering: An Introduction by William D. Callister is the book used for E54.

MSE 265 assumes knowledge of the fundamentals of phase diagrams, phase equilibria, and transformation kinetics taught at the undergraduate level. MSE 265 will have a test on the first day of to ensure that you have the appropriate undergraduate background. If you do not pass the test, you will have to take the undergraduate course in phase transformations (CBEMS 165) in the spring, and take MSE 265 the following academic year 2016-17.

MSE 256A (substituted by MAE 259 Atomistic Theories in Fall 2015) requires a basic understanding of mechanical behavior of materials. You should review an undergraduate textbook if you lack an undergraduate course in strength of materials or mechanical properties of materials.

MSE 205 assumes you have a strong understanding of electromagnetics acquired in an undergraduate physics course required for all engineering and physical science majors. If you have forgotten this material you should review relevant sections of an introductory undergraduate physics textbook. In addition, this course will build on the material taught in MSE 200.

Research Units

Incoming Ph.D. students who have not selected a research advisor will enroll in 2 to 4 units of research (CBEMS 299). As a placeholder, you may sign up under my name (Ragan), 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/Ragan's name. All faculty will describe their research during Welcome Week, and you will have a chance to meet with faculty and discuss your interests, and then select 2 research rotations for the year (one per quarter in Fall and Winter).

If you are a Ph.D. student with an M.S. who has selected an advisor, with approval of that advisor and graduate advisor you may sign up for up to 14 units of CBEMS 297, Ph.D. Dissertation Research.

If you are an M.S. student who wants to conduct M.S. thesis research, you will have an opportunity to sign up for CBEMS 296 after the faculty describe their research and you have discussed thesis research with the faculty member and together defined a project. As a placeholder, you may sign up under my name (Ragan) and change to your real research supervisor during the second week of the quarter. For the M.S. comprehensive option, research units do not count toward your degree.

Departmental Seminar

ALL FULL TIME STUDENTS MUST ENROLL IN CBEMS 298 during their first year. This is the Chemical Engineering and Materials Science Departmental Seminar, typically held once a week on Friday afternoons. You will sign up for this class each quarter. You must attend 80% of the seminars in order to obtain a passing grade. This will require you to be on time. (Also, it seems silly to say this, but you are expected to stay for the entire seminar to receive credit.)

Units for Weekly Research Group Meeting

Your research supervisor for CBEMS 296, 297 or 299 might also want you to add a one-unit group meeting, listed as CBEMS 295 (Seminar in ENGR). Check with your research supervisor once research rotations have been assigned.

Selection of Elective Courses

Select elective courses based on the advice you receive from rotation supervisor if you want to be competitive to work in that group. You can select **elective** courses for a total of 12-16 units/quarter. Courses numbered 100-190 **may** count for up to 8 units **IF** these courses are not required for the undergraduate MSE degree. To check on this, look at the current copy of the UCI catalogue online:
http://catalogue.uci.edu/thehenrysamuelischoolofengineering/departmentofchemicalengineeringandmaterialsscience/#gradmse

If you find a course you wish to take is NOT on the list, e-mail Prof. Ragan for verification that the course will count for the fulfillment of the degree requirements. Undergraduate courses may have prerequisites, and you should always contact the instructor for permission to enroll and to assess whether you will be able to perform at a minimum of a B level in the course, as to not jeopardize your standing in the graduate program.

Ph.D. students take 2-4 units of a **research rotation** (CBEMS 299) each quarter in the first year, from two different faculty members. The research rotation allows Ph.D. students to sample two different research laboratories before committing to a laboratory. In addition, many faculty offer group meetings that they may wish to have you enroll in for 1 unit. The maximum number of units you may enroll in is 16 units. You may petition to take extra units if needed.

Check the Schedule of Classes for elective courses in other Engineering departments and Chemistry and Physics. Appendix IV lists elective courses as of the printing of this document, but there may be more later additions each quarter.

FAQ REGARDING GRADUATE COURSEWORK

What is a passing grade in a course taken as a graduate student?

A passing grade is a B or better. C/C+ grades are failing. **B- grades in required classes are also failing.** For elective classes, only one B- grade may be allowed to count toward graduate degree requirements and a petition must be filed to have that one B- grade possibly count as passing.

How can I find if other courses are offered in winter and spring?

Classes that are offered each quarter can be found using the **Schedule of Classes** on the UCI website. Use the search function at www.uci.edu and type in "Schedule of Classes." Our department offers courses under two designations: **CBEMS** and **ENGRMSE**. You may take classes outside our department only with permission of the instructor and the graduate advisor.

How many total units should I take?

Full time students must take at least 12 units, and you can take up to 16 units (or up to 18 units with petition). You will need to fill in your schedule with elective courses. All full time M.S. and M.S./Ph.D. first year graduate students are expected to take 3-4 courses each quarter in order to remain in good standing. A typical comprehensive exam **M.S.** student schedule would be 4 lecture classes/quarter and the departmental seminar. A typical **M.S. thesis** and a typical **M.S./Ph.D.** student schedule would be 3 lecture classes/quarter and 4 units of research /quarter and the departmental seminar (~18 units).

Part time M.S. students, not continuing for the Ph.D., can enroll in fewer units up to a maximum of 8 units. Financial support is not allowed for any student with less than 12 units.

Will ESL or Physical Education classes count for my graduate degree?

English as a Second Language classes **do not** count as units for the Ph.D. or M.S. degree requirements and should be taken as extra units above the required 12 minimum units. These courses are strongly recommended for international students who want to improve their English skills. Sports or Physical Education classes help you balance your life, but also will not fill requirements and can only be added above the 12 minimum units.

Do I need to take a full load of courses if I am a Teaching Assistant?

If you are serving as a Teaching Assistant you may enroll in **ENGR 399** for 3-6 units if you need additional units to reach 12 units; thereby you may take fewer regular classes and/or research units that quarter.

Can I take undergraduate courses for my M.S. degree?

Up to 8 units (or 2 courses) of undergraduate upper division (100-189 level) courses may count for your degree **IF** approved by MSE graduate advisor. **Under no circumstances will courses that are required for the MSE undergraduate degree be used to fill graduate degree requirements (see above).** However, there are many elective classes that would be acceptable.

MATERIALS SCIENCE & ENGINEERING DEGREE REQUIREMENTS

There are two options, the thesis option and the comprehensive exam option for the M.S. degree. Students who will not perform thesis research, and those who are in the M.S./Ph.D. program and complete an M.S. along the way, are subject to the comprehensive exam option.

I. M.S. Thesis option: A minimum of 36 units is required

- 4 required graduate core courses (described in more detail in the following section):
    - (4 units) 1 Crystal Structure and Defects
    - (4 units) 1 Electrical and Optical Behavior
    - (4 units) 1 Mechanical Behavior
    - (4 units) 1 Thermodynamics and Kinetics
- 3 quarters of CBEMS 298 (Department Seminar) (6 units)
- 5 additional graduate elective courses (3 units minimum/course) numbered 200-289 (or 200-295 if offered by other departments) as approved by the graduate advisor.
- Up to 2 of these elective courses can be substituted by up to 8 units of CBEMS 296 (M.S Thesis Research), and 1 of these elective courses may be substituted by an upper-division undergraduate elective course approved by the MSE graduate advisor.
- M.S. Thesis is required.
- Students must file the Advancement to M.S. Candidacy **one quarter before graduation** (apply through HSSoE Graduate Affairs, forms available at **http://www.grad.uci.edu/forms/**)
- In addition to fulfilling the course requirements outlined above, it is a University requirement for the Master of Science degree that students fulfill a minimum of 36 units of study.

II. M.S. Comprehensive Exam Option: A minimum of 36 units is required

- 4 required graduate core courses: (described in more detail in the following section):
  - (4 units) 1 Crystal Structure and Defects
  - (4 units) 1 Electrical and Optical Behavior
  - (4 units) 1 Mechanical Behavior
  - (4 units) 1 Thermodynamics and Kinetics
- 3 quarters of CBEMS 298 (Department Seminar) (6 units)
- 5 additional graduate elective courses numbered (3 units minimum/course) 200-289 (or 200-295 if offered by other departments) approved by the graduate advisor.
- Up to 2 of these elective courses may be substituted by upper-division undergraduate elective courses if these courses are approved by the MSE graduate advisor.
- The MSE comprehensive exam must be passed in Spring Quarter or at the latest in December of the following academic year at either at the M.S. level or the Ph.D. preliminary exam for PhD students.
- Students must file the Advancement to M.S. Candidacy one quarter before graduation (just apply through HSSoE Graduate Affairs, forms available at **http://www.grad.uci.edu/forms/**)
- In addition to fulfilling the course requirements outlined above, it is a University requirement for the Master of Science degree that students fulfill a minimum of 36 units of study.

M.S. Core Courses

Crystal Structure and Crystal Defects

Course:	**Check**
• MSE 200 (Crystalline Solids: Structure, Imperfections, and Properties)	

Electrical and Optical Properties of Materials

Course:	**Check**
• MSE205 (Materials Physics) or equivalent course	

Mechanical Behavior

Course:	**Check**
• MSE256A (Mechanical Behavior of Engineering Materials) (substituted by MAE 259 Atomistic Theories in Fall ’15)	

Thermodynamics and Transport Phenomena

One course from:	**Check**
• MSE252 (Theory of Diffusion)	
• MSE265 (Phase Transformations)	

III. Ph.D. Requirements

- Course Requirements are the same as the M.S. comprehensive option. Students may be permitted to use M.S. degree graduate courses taken elsewhere, but you must submit documentation that they were graduate courses equivalent in content to UCI graduate courses and this must be approved in writing by the graduate advisor the quarter before the required class is offered.
- Select Faculty Advisor by the End of Winter quarter of the 1st year.
- Preliminary Exam taken in first year, pass by December of second academic year at the latest.
- Complete M.S. comprehensive degree requirements by the end of the second year.
- **Ph.D. students are required to take two** graduate elective courses numbered 200-289 (or 200-295 if offered by other departments) approved by the graduate advisor, after meeting **the M.S. degree requirements**, with these two elective courses relevant to your Ph.D. dissertation. These courses can be taken anytime prior to graduation, but are to be taken after the M.S. is completed. The two courses must be relevant to the student's Ph.D. dissertation topic and must be selected in consultation with the research advisor and approved by the MSE Graduate Advisor.
- Ph.D. Qualifying Exam completed and passed by the End of 3rd Year (advancement to candidacy). If not completed by this point a timeline with milestones to pass examination must be presented to MSE Graduate Advisor in consultation with your PhD mentor.
- Written dissertation no more than 9 quarters after passing advancement to candidacy.
- Oral defense of dissertation.
- 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.

IV. Good Academic Standing

- Students without good academic standing may be dismissed from graduate school. In order to remain in the Ph.D. or M.S. program, all students must **maintain good academic standing** including the following:
    a. Minimum GPA requirement of 3.0 with no grades below a B (one B- may be accepted for an elective course only with approved petition).
    b. Successful research rotations in the first year in M.S. thesis or Ph.D. dissertation units, with no grades of U (unsatisfactory)
    c. M.S. Comprehensive Exam students should successfully complete the Comprehensive Exam prior to the end of the 2nd academic year. Ph.D. students must successfully complete the Ph.D. Preliminary Exam by December of the second year.
    d. Full time M.S. thesis students are expected to complete the M.S. in two years.

e. Ph.D. students must have a research advisor willing to advise them after the 1st Winter quarter. If a student leaves a research group, the student must find another research advisor within one quarter to remain in good academic standing.
f. Ph.D. students should successfully complete the qualifying exam prior to the end of the 3rd year, and only with written permission should schedule the exam later than the fall of the 4th year (see above).
g. Failure to meet the above standards may result in academic probation or dismissal from the graduate program.
h. Any student who conducts **research fraud** or **plagiarism** may also be dismissed from the graduate program, after a review of the charges and a decision as to the validity of the charges by an impartial board constituted by the HSSoE Graduate Affairs Office and the HSSoE Graduate Affairs Faculty Committee.

FAQ FOR DEGREE REQUIREMENTS

What are the Ph.D. Course Requirements for MSE?

- All Ph.D. students must complete the M.S. comprehensive degree requirements for MSE if they do not already have an M.S. Two additional graduate classes 200-289 (or 200-295 if offered by other departments) approved by the graduate advisor are required past the M.S. These courses must be selected in consultation with the student's research advisor and approved by the Graduate Advisor.

When do I need to plan my coursework for the first year?

- A Plan of Study is required for first year M.S. and Ph.D. students
- Fill this out by the **end of the first quarter** and turn in to **graduate coordinator, Grace Chau.**
- If appropriate, it will be evaluated and approved by the MSE Graduate Advisor
- Can be modified! Most important is to list required core courses in your plan.

Where can I find additional information regarding the degree requirements for MSE M.S. and Ph.D.?

In addition to this handbook, you can find information regarding the degree requirements for the MSE M.S. and Ph.D. degrees in the UCI catalogue, which is available on-line. Use www.uci.edu - type in "catalogue" in the search box, find the Henry Samueli School of Engineering (click), then the Department of Chemical Engineering and Materials Science (click). Or go to http://www.editor.uci.edu/catalogue/

What if I have an M.S. in MSE already and have completed the core requirements?

If you have an M.S. degree from another university that covers the same material as these core courses you may petition for exemption **PRIOR** to the quarter the class is offered. Ph.D. students with an M.S. in MSE are required to take ***2 additional elective*** graduate classes sometime before completing their Ph.D., but these classes should be selected based upon their research interest and upon consultation with their research advisor. The Ph.D. preliminary exams and M.S. comprehensive exams are heavily based on material covered in the four required classes, so some students decide to take them again even if they have already taken similar courses to ensure adequate preparation for the preliminary exams.

How long will it take me to complete my M.S.?

M.S. thesis students should assume approximately 15-18 months to complete the degree with a research thesis. It is possible for M.S. comprehensive exam students to complete their degree in 9 months. There is rarely any financial support offered for terminal M.S. students as most of the financial support is for students who elect to continue on to the Ph.D since it is mainly tied to long-term research funding.

What is the Ph.D. Preliminary Exam/M.S. Comprehensive Exam?

- Both exams cover basic concepts in MSE core courses and test your comprehensive knowledge of MSE.
- The preliminary exam also tests your ability to evaluate and understand scientific data and communicate this understanding. It also tests your ability to understand the technical/societal significance of scientific research.
- It is strongly recommended that the preliminary exam be taken after all of the core courses have been completed, as these are good preparation and/or review.
- Both exams will be oral. A panel of MSE examiners will hold all exams during a one week period.
- The Preliminary Exam will be offered twice yearly, during Spring Quarter and in December after Final Exams. The December exams are scheduled only for students who did not pass the exam in the Spring Quarter of the first year.

The Ph.D. Preliminary Exam and M.S. Comprehensive Exam will cover these topics.

- Structure and Defects
- Thermodynamics and Kinetics
- Mechanical Behavior
- Electrical/Optical/Magnetic Properties

How can I find out more about the Preliminary/Comprehensive Exam?

- Look at **Appendix II** of this Handbook. This list is updated every year.

What is the Ph.D. Qualifying Exam?

- The Qualifying Exam covers dissertation ideas and preliminary research.
- The committee is composed of 5 members, consisting of at least 3 ChEMS faculty and 1 faculty member not affiliated with ChEMS (outside member). 2 faculty must have their primary appointment in ChEMS. Your advisor will be on your qualifying exam.
- Taken after passing the Ph.D. preliminary exam. If a student expects to graduate in 4 years (entered with an M.S. in MSE), then the qualifying exam can be taken as early as the beginning of the second year. If a student expects to graduate in 5 years, then the exams should be taken no earlier than the end of the second year.
- The qualifying exam should be taken no later than the end of the 3rd year in M.S./Ph.D. program.

- This exam includes a research dossier and a 1.5 hour oral exam where you present your research plan in a 40 minute presentation. The research dossier and the PowerPoint presentation must be reviewed by your advisor prior to dissemination.
- Students should be aware that passing this exam is "Advancement to Ph.D. Candidacy" and three years after advancement to candidacy all financial support from fellowships and TAship may end. Thus students should take the qualifying exam NO EARLIER than 3 years before their intended graduation date, and should plan on receiving no financial support 3 years after they advance to candidacy.

How can I find out more about the Ph.D. Qualifying Exam?

- Look at **Appendix III** of this Handbook

What is the Ph.D. Oral Defense?

- Oral presentation at the end of Ph.D. dissertation is required when your PhD advisor agrees you are ready.
- Schedule when the written dissertation has already been approved.
- Committee members for Ph.D. dissertation (3 including research advisor) are required to attend and the entire department faculty and students are invited.
- The candidate presents a 45 minute presentation summarizing research results and significance.
- Questions from committee (closed session at this point) must be answered with an authority on the topic.

What is the Ph.D. Dissertation?

- This document shows your original research in MSE.
- Check out copies of past dissertations in UCI library.
- Format guidelines are available at http://www.grad.uci.edu/forms/
- Have advisor approve first, then the two other committee members
- Writing will take at least 3 months
- Tip – use your publications as a base for chapters and use the dossier from the Ph.D. qualifying exam to help outline the introduction.

Where can I find forms that I need?

http://www.grad.uci.edu/forms/ and contact the graduate counselor if you cannot find what you need on this website.

FAQ ON ADVISING AND SUPPORT

When should I select an advisor?

Ph.D. and M.S./Ph.D. students should select a research advisor by end of the 2nd quarter (Winter quarter) of the first year. A few students who are fully supported by a GSR appointment from one faculty member do not conduct research rotations if they permanently match with that faculty member at the beginning of the first year. M.S. students selecting thesis option should select advisor by end of the 1st quarter. In the fall, first year students will select their research rotations after the welcome week orientation and after they meet with faculty. Terminal M.S.

students are discouraged from conducting research rotations, instead, M.S. students should find one advisor for research from the start.

Who can serve as my research advisor?

All ChEMS faculty, including joint appointments, can advise your thesis research. Students can have co-advisors from outside the department who are not affiliated with ChEMS as long as they have a primary advisor affiliated with ChEMS. M.S. students on comprehensive exam status do not need an advisor other than the MSE graduate advisor. We recommend you rotate with a ChEMS faculty with a primary appointment, listed below in **bold**, in the first quarter to become familiar with the department.

Shane Ardo	Solar energy conversion and electrochemistry
Elliott Botvinick	Laser microbeams, cellular mechanotransduction, mechanobiology
Peter Burke	Nanotechnology; quantum electronics, quantum information science and high-speed semiconductor devices
Michelle Digman	Quantifying spatial and temporal dynamics of proteins during cell migration and developing novel imaging technologies
Nancy A. Da Silva	Molecular biotechnology, metabolic engineering, environment biotechnology.
James C. Earthman	Fatigue behavior and cyclic damage, automated materials testing, high-temperature fracture, biomaterials, nanocomposites.
Aaron Esser-Kahn	Microvascular materials for biological and energy applications. Current work focuses on building 3-dimensional systems for tissue engineering and cellular growth
Alon Gorodetsky	Organic photovoltaics, electrical biosensors, nanotechnology, DNA, materials chemistry
Stanley B. Grant	Environmental engineering, coastal water quality, coagulation and filtration of colloidal contaminants, environmental microbiology
Anna Grosberg	Applying multiscale computational modeling and tissue engineering to stem cell-derived cardiomyocytes (heart muscle cells), cardiac morphogenesis (development of structure), and cardiac function
Zhibin Guan	Organic, Biological, and Macromolecular Materials Chemistry
Jered Haun	Targeted drug delivery, clinical cancer detection, nanotechnology, molecular engineering, computational simulations
Allon Hochbaum	Nanoscale materials and hybrid bio-inorganic devices for applications in clean energy.
Michelle Khine	Single Cell Electroporation, Shrinky-Dink Microfluidics, Microsystems for Stem Cell Differentiation, Canary on a Chip, Quantitative Single-Cell Analysis of Receptor Dynamics and Chemotactic Response on a Chip
Young-Jik Kwon	Drug delivery, biomaterials, pharmaceutical sciences
Enrique Lavernia	Nanostructured materials, additive manufacturing, powder metallurgy, mechanical behavior
Matt Law	Nanoscale materials and devices, solar energy conversion
Guann Pyng Li	High-speed semiconductor technology, optoelectronic devices, integrated circuit fabrication and testing.

Han Li	Molecular biotechnology
Wendy Liu	Cell and tissue engineering, biomaterials, microfabricated technologies, mechanotransduction
John Lowengrub	Mathematical modeling of materials
Ray Luo	Computational analysis of biomolecular sequence, structure, dynamics, and function
Marc Madou	Miniaturization science (MEMS and NEMS) , polymer actuators (for drug delivery), C-MEMS and CD based fluidics.
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, guided and self assembly of colloidal structures, nanostructured materials for energy and biotechnology applications.
Daniel R. Mumm	Materials for energy and propulsion systems, degradation in extreme environments (oxidation, hot corrosion, coatings), inorganic materials for electrochemical applications (fuel cells, batteries, supercapacitors), surface, grain boundary and interfacial structure/property relationships, thermo-mechanical behavior & nano-mechanics.
Hung Nguyen	Biocomputation and modeling of biochemical processes
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	Self-assembly andn optical characterization of plasmonic and metamaterials and fabrication and scanning probe microscopy of catalytic and electrochemical systems for sensor and energy applications; Biomimetic devices.
Elizabeth Read	Dynamics of complex biochemical systems and regulation of immune responses
Diego Rosso	Water pollution, wastewater treatment, water reclamation and reuse, carbon and energy footprint analysis
Timothy Rupert	Nanoscale mechanics and materials
Suzanne Sandmeyer	Molecular genetics and biochemistry of retrotransposons and metabolic engineering in budding yeast
Kenneth Shea	Biomaterials, polymeric materials development, hybrid materials, sol-gel science
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
Lizhi Sun	Micro/nano-mechanics of heterogeneous composite materials, with applications for civil, mechanical, aerospace, electronic, and biomedical engineering
Lorenzo Valdevit	Mechanics of composite materials and lightweight structures
Vasan Venugopalan	Application of laser radiation for medical diagnostics therapeutics and biotechnology; laser-induced thermal, mechanical, and radiative transport processes.
Szu-Wen Wang	Biomolecular engineering, interfacial engineering, biomaterials, drug delivery.
Kumar Wickramasinghe	Nanotechnology, development of novel atomic force microscopies
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.

How are continuing graduate students supported?

- All support is given competitively, and based on **continuing good standing**.
- Teaching Assistantships
- Internal Fellowships (usually to new students for recruitment) and External Fellowships
- GSR – Research Assistantships funded from faculty research
- Hours worked are in ADDITION to units earned for research credit
- Students who are U.S. citizens or Permanent Residents must fill out the FAFSA each year, due March 2, 2016 http://www.fafsa.ed.gov/ in order to be eligible for certain financial awards such as GAANN Fellowships and Work Study awards.

What do Teaching Assistants and Readers Do?

- TAs grade homework and tests, run demonstrations, hold office hours, lead discussions, maintain class websites, maintain records of grades, and/or run laboratories.
- Readers grade homework and tests; they also can hold office hours.
- Students are selected based on faculty nominations, match of knowledge with course material, GAANN/CAREER grant priority, past experience
- All students who want to be a TA or grader must have completed the IRC September TA training.

What are the requirements for spoken English for international students who want to TA?

- To be a TA, the international student must pass TOEP, 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 only to students who have taken TSE or SPEAK and obtained a non-passing score of 4, refer to: http://e3.uci.edu/programs/esl/toep.html
- 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 should I do if I want to change research advisors?

- Let the MSE graduate advisor know (Professor Ragan) immediately.
- Talk with your research advisor – if unable to do so, ask MSE graduate advisor to talk to your advisor
- Talk with other faculty in the department about research projects and find a new advisor within one quarter.
- 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/grader/fellowship) equal to a 49% GSR.

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 decide to change your degree program, you **cannot** apply for readmission to the MSE 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.

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. A “C” grade is considered failing and will not count for any course requirements. Only **one** grade of B- (not in a required course) can be counted **by petition** for the M.S. degree requirements. You need to have a GPA higher than a 3.2 for certain types of fellowships, a GPA higher than 3.7 or 3.8 for campus wide competitive fellowships, and a GPA higher than 3.1 for any TA positions. In addition, see the non-grade requirements to remain in good standing in section IV on Page 8 of this handbook.

How Hard Should I Work at UCI?

- Coursework at the level of 12 units requires up to 24-30 hours of homework and studying to pass classes.
- Research should be performed about 20 hours a week, if taking a full load of classes and a minimum of 40 hours a week if not taking a full load of courses.
- Fellowships expect that a student is working FULL TIME on research and coursework (at least 40 hours a week).

Appendix I

Quarterly Research Rotation Reports

1. Reports, both an electronic and paper copy, are due each quarter to the research supervisor before grades are due. 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 also must 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 also must provide a paper copy of each quarterly report to the MSE or CBE graduate advisor in the ET 916 mailboxes. These research reports/papers will be part of the assessment process for first year students by the MSE or CBE graduate committees, which is why the respective CBE or MSE graduate advisors will be collecting a copy.

4. Reports should be at least 5 pages and no more than 8 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**: Summary regarding the current state of knowledge of the research project, challenges in the field, motivation for the research (note that this requires an extensive literature search), hypothesis to address main problem/challenges and rational for approach to solve the challenges.
    d. **Experimental Approach**: Experimental or computational techniques used to address challenges, and descriptions of experimental/computational process.
    e. **Results**: Relevant results with tables, images, and graphs as appropriate, briefly described.
    f. **Discussion**: Discussion of the implications of these results, comparisons with prior published research.
    g. **Conclusions:** Short (one paragraph) description of major findings and suggestions for future work.
    h. **References:** Provide references at the end with footnotes in the text for all literature cited in the report. References must include the following information – full list of authors, full article title, journal title, volume, pages, and publication year. Websites such as Wikipedia are not appropriate references, nor are popular science magazines; these 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 and/or peer-reviewed review articles may be cited also.
    i. **Appendix:** Extra figures and extended tables of raw data may be included.

Appendix II

MSE Ph.D. Preliminary Exam and M.S. Comprehensive Exam

The exams for MSE first year students will be held in Spring Quarter 2016. All Ph.D. students who entered in the Fall of 2015 or earlier are required to take the prelim exam in Spring Quarter 2016. Attached is a list of exam topics. Examiners are faculty affiliated with the department with MSE expertise and are determined by the MSE Graduate Advisor.

The preliminary exams are oral, with a minimum of 2 department faculty members quizzing students.

Preliminary Exam Guidelines

A peer-reviewed scientific publication will be assigned for critical analysis.

Critical and Scientific Analysis of Publication: 60% of grade

There should be no more than 12-15 slides with 20 point font Arial for text. Make sure figures are legible. The slides are only outlines to the above points and discussion on the above points will be guided by examiners.

The remaining 40% of grade is related to answers to questions based on coursework. These questions are related to research paper and core courses.

Thus, you need to put some thought into how the material in the paper intersect with courses that you have taken, especially the core courses (see topics for MS Comprehensive Exam for guidelines).

Many of the course work topics (see below) can be initially reviewed using an Introduction to Materials Science and Engineering textbook and your core course syllabi as a start. You are encouraged to form study groups and orally quiz each other on the topics in a mock exam format in Fall Quarter. An updated list of topics may be given to you by the beginning of winter quarter if changes are introduced, however the content is not expected to change significantly if at all.

M.S. students taking the comprehensive exam option may only take the same exams as the Ph.D. preliminary exam students with approval of the graduate advisor and with a strong letter of recommendation from a faculty that has supervised the student's research abilities. However, the standards for passing a M.S. comprehensive exam are not as high as for the Ph.D. preliminary exam. M.S. students entering Fall 2015 must take the comprehensive exam either in Spring 2016 or Fall 2016. The exam is not offered in Winter Quarter or Summer.

Preliminary and MS Comprehensive Exam Topics

1. Structure of Materials
    - Atomic structure and hydrogenic electron orbitals

- Chemical and non-chemical types of Bonding
- Bonding Based on Location in the Periodic Table
- Crystal lattice and basis
- Unit Cells
- Miller Indices/Directions
- Crystal Systems
- Bravais Lattices
- Reciprocal lattice space
- Close-packed Structures
- Interstitial filling of close-packed structures
- Eutactic structures
- Common Metallic and Semiconductor Crystal Structures
- Surface Bonding and Energies
- Ionic Crystal Structures/Pauling's Rules
- Point Group and Space Group Symmetry
- X-ray Diffraction and Ewald Sphere
- Structure Factor Calculations
- Microscopy Techniques
- Point defects in Metals and Ionic Solids, Calculations of Defect Concentrations
- Line Defects, Plane Defects, Volume Defects

2. Thermodynamics and Kinetics
    - Calculation of Vacancy Concentrations as a function of Temperature
    - Kroger-Vink Notation and Defect Compensation in Ionic Solids
    - Diffusion Mechanisms
    - Diffusion Coefficient
    - Steady State Diffusion
    - Homogeneous Nucleation and Growth
    - Surface Energy, Volume Free Energy, Critical Radii for Growth
    - Gibbs Phase Rule
    - Gibbs Free Energy, Entropy, Enthalpy
    - Heterogeneous Nucleation
    - Epitaxial and Textured Films
    - Growth Rate
    - Precipitation
    - Crystallization
    - Glass Transition Temperature, Specific Volume
    - Liquid/Solid/Vapor phase equilibria and wetting angles
    - Grain Growth
    - Grain Boundaries and Interfacial Energy
    - Phase Equilibria and Interpretation of Phase Diagrams
    - Solid Solubility

3. Mechanical Behavior
    - Stress, Strain Definitions, Stress-Strain Curves
    - Elastic Deformation
    - Elastic Modulus, Poisson's Ratio
    - Plastic Deformation
    - Slip Planes and Slip Directions
    - Definition of Dislocations
    - Role of Dislocations in Deformation of Crystalline Solids
    - Interaction of Dislocations
    - Impeding the Movement of Dislocations
    - Orowan Stress
    - Methods to Detect Dislocations
    - Effect of grain size on mechanical properties of metals and ceramics (including properties of nanocrystalline materials)
    - Mechanical Behavior of Polymeric Materials
    - Methods to Measure Mechanical Behavior
    - Relative Values of E, H for metals, ceramics, polymers
    - Resilience, Toughness
    - Viscoelastic Behavior of Polymers
    - Fracture Mechanics
    - Stress Intensity Factor
    - Fracture Toughness
    - Low Temperature Behavior of Materials (Ductile to Brittle Transition)
    - High Temperature Behavior of Materials (Creep)
    - Fatigue
    - Thermally Induced Stresses

4. Electronic and Optical Properties
    - Reciprocal Lattice
    - Electrical Conductivity, Mobility
    - Hall Effect
    - Pauli Exclusion Principle
    - Fermi Energy
    - Fermi-Dirac and Maxwell Boltzmann distribution Function
    - Density of States
    - Electron Fermi Gas - Heat Capacity, thermal conductivity
    - Electronic Band Structures in Solids
    - Thermionic Emission
    - Intrinsic/Extrinsic Semiconductors
    - Temperature Dependence of Conductivity of metals and semiconductors
    - Diffusion, Conduction, and Continuity equations
    - Semiconductor Devices (Schottky junction, pn junction, LED, solar cell, MOSFET)
    - Optical Absorption
    - Dielectric Response to Electromagnetic Waves

- Optical Properties of Materials (Index of Refraction, dispersion)
- Transparency, Translucency, Opacity
- Luminescence and Fluorescence

Appendix III

MSE Ph.D. Qualifying Examination

The purpose of the qualifying examination is to demonstrate that the student is capable of conducting independent Ph.D. research and has a viable research plan for the Ph.D. dissertation. PhD faculty advisors provide guidance but do not dictate every step of research and students need to exhibit an ability for independent thinking to pass this exam. Feedback from the qualifying examination committee is very helpful in developing a viable dissertation topic and appropriate experiments.

The MSE Ph.D. qualifying exam committees follow the rules set by the Graduate Council. The student and the research advisor select the qualifying exam committee, with approval of the MSE Graduate Advisor. The committee should primarily be composed of faculty familiar with your area of research interest, insofar as that is possible, and two must have their primary appointment in ChEMS. Grace Chau has the forms for the selection of the Qualifying Exam Committee.

Requests for the Qualifying Exam Committee must be submitted two weeks in advance of the date scheduled for the exam, and this form requires multiple signatures, including the Dean's office.

a) Current guidelines require at least three faculty from ChEMS, where at least two examiners have their primary appointment in ChEMS.
b) One outside member who is not a member of the ChEMS department or in the Materials and Manufacturing Technology concentration is required.
c) A fifth member is required who can come from the department or any outside department.

For more information, check the Office of Graduate Studies website for the most current information. http://www.grad.uci.edu/forms/

Three members of the Qualifying Exam Committee will form your dissertation committee.

The Ph.D. Qualifying Examination should be scheduled between the beginning of the 3rd year and the beginning of the 4th year. If not completed by the end of the 3rd year, the student in conjunction with their faculty advisor must submit a plan with milestones for completing this exam in a timely manner. If the qualifying examination is not taken by the end of Winter quarter of the 4th year, the student is no longer in good academic standing and may not be eligible for financial support. After completion of this exam, the student is considered Advanced to Candidacy for the Ph.D.

There are two required parts of the qualifying examination:

I. Written Dossier
II. Oral Presentation (30-35 minutes)

The written dossier must be approved and signed off on the title page by the advisor before the dossier is distributed to the committee members and **before the qualifying examination can be scheduled.** At the time of scheduling the oral examination, a copy of the dossier must be provided by the student to the graduate office with the signature of the advisor.

I. Written Research Summary (Dossier)

Use Times New Roman 12 font, 1.5 line spacing or equivalent. Pages are approximations.

1 page	1) <u>Title Page</u> – Title, Name of Student, Degree Program, Date, Advisor and Advisor's Signature
1 page	2) <u>Abstract Page</u> – 100 word summary – include the <u>new</u> information obtained from experiments and/or theory/ <u>new</u> understanding provided to the research field/ major contribution that the dissertation will provide to the research community
1 page	3) <u>Introduction</u> –, brief discussion of current state of knowledge in the research field, rationale for research and how it adds to current knowledge, scientific content impact of research in technology and society, what <u>key</u> questions will be answered
2-3 pages	4) <u>Background</u> – Extensive discussion of prior research relevant to your research should be discussed to demonstrate a knowledge of the current state of the field and the rationale for challenges addressed by your research.
3-5 pages	5) <u>Preliminary Experiments</u> – a summary of your work to date, including research methods and interpretation of data obtained by the P.D. candidate. Include figures, graphs, and tables and the development of any models. Explain the science and technology associated with the data.
2-4 pages	6) <u>Future Research Plan</u> – a thorough discussion of the experiments the students plans to complete for his/her thesis. Explain how the experiments will provide critical information for the dissertation and define significant contributions to the research field.
1 page	7) <u>Timeline</u> – Provide an estimated timeline of when you will complete experiments, analysis, paper writing, and thesis document.
1 page	8) <u>Summary</u> of the new fundamental and technological research contributions that are expected from this proposed research

9) <u>References</u> – Author name/s, full title, journal, volume, page, year

The dossier, *excluding* References but including Figures and Tables will probably be about 15 – 25 pages. It is appropriate to change the research plan as experiments evolve, but the research plan presented in the qualifying examination serves to document the general expectations for the Ph.D.

This document can serve as a draft for the introductory chapters of the Ph.D. This document will serve as an outline for the Ph.D. dissertation, and you will save time later when writing the dissertation if you complete this properly. The introduction and background provide a good draft for the first chapter of the dissertation (with un update of the research field a few years later), and the preliminary experiments should be a draft of one chapter for the dissertation.

II. Oral Examination

During the oral examination the student should summarize the written document with less emphasis on published research by others than on the preliminary and future work of the examinee. This will be a PowerPoint presentation about 30-40 minutes in length. The five faculty members on the committee will question the student and offer suggestions for the Ph.D. dissertation. At least 1.5 hours should be scheduled in order to allow 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 the proposed research and his/her ability to conduct original, independent research.

APPENDIX IV
Courses for 2015-2016

FALL 2015

Chemical Engineering and Materials Science Department

Electives offered in other departments (you must get approval from instructor after informing them of your background before enrolling and forward that approval to the graduate advisor.)

EngrMSE 254 **Polymer Science & Engineering**
EECS 179 MEMS
ENGRCEE 250 Finite Element Methods for Engineering

ENGMAE 253 Advanced Biomems

You must check with the course instructor in advance to confirm you have the prerequisites to take the above courses. Please forward instructor approval via email to the graduate advisor, Professor Ragan. Up to 2 classes from the 100-190 level may be used for graduate coursework, with approval of the graduate advisor. There are additional graduate electives offered in each department, but again check with the instructor to ensure that you have the correct background to take the course, and then e-mail the MSE graduate advisor for approval.

<u>*Summary of Fall Required Course Enrollment for MSE First Year Graduate Students*</u>

First year M.S. Students NOT Conducting Research

ENGRMSE 200
ENGRMSE 256A (substituted by ENGRMAE 259 in Fall '15)

CBEMS 298
XXX and YYY – one (1) or two (2) more graduate classes?

First year M.S. Students Conducting Thesis Research (any student interested in continuing for the Ph.D. should take this route)

ENGRMSE 200
ENGRMSE 256A (substituted by ENGRMAE 259 in Fall '15)

CBEMS 298
XXX – one (1) more graduate class
CBEMS 296 – 3 units of thesis research (may be substituted with CBEMS 299 with graduate advisor's permission)

First year M.S./Ph.D. Students

ENGRMSE 200
ENGRMSE 256A (substituted by ENGRMAE 259 in Fall '15)
CBEMS 298
XXX – one (1) more graduate class

CBEMS 299 – 3 units

Ph.D. Students with an M.S. in Materials

CBEMS 298
XXX – one (1) graduate class (not required to take in fall if none interest you)
CBEMS 299 – 9-11 units if research advisor is not yet selected
CBEMS 297 – 9-11 units if research advisor is selected

Appendix V

Graduate Program Learning Outcomes

(MS in Materials Science and Engineering)

I. Program Learning Outcomes

Core Knowledge. Students will be able to:

- Demonstrate general knowledge of core topics and theory in Materials Science and 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 Materials Science and 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 Materials Science and Engineering and Materials Science and Engineering.

II. Assessment Plan

PLO	Direct	Indirect
Core Knowledge	-GPA≥3.0 in MSE core courses -MS Comp. exam	Exit interview / Survey
Research Methods and Analysis	-MS Thesis - Independent Study -MS comp. exam	Exit interview / Survey
Professionalism	-Participation in Seminar Series	Exit interview / Survey

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.

(PhD in Materials Science and Engineering)

I. Program Learning Outcomes

Core Knowledge. Students will be able to:

- Demonstrate general knowledge of core topics and theory in Materials Science and 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

PLO	Direct	Indirect
Core Knowledge	-GPA≥3.0 in MSE core courses -Preliminary Exam	Exit interview / Survey
Pedagogy	-Teaching Assistantship or Tutorial Seminar	Exit interview / Survey
Scholarly Communication	-Research Paper - Conference Presentations - PhD Defense	Exit interview / Survey
Independent Research	-Qualifying Exam -PhD Dissertation	Exit interview / Survey
Broader Impacts	-Qualifying Exam -PhD Dissertation	Exit interview / Survey

III. Action Plan Timeline

PLOs are assessed at the time of graduation for each student. Data are compiled annually and used for continuous improvement of the graduate program.