GRADUATE SCHOOL
An important career path

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MAE application deadline for Fall 2017 admission: December 1, 2016
Outline of lecture

• The essence of graduate school
• Career paths enabled by graduate studies
• Preparation as an undergraduate
• MS, PhD degrees and their requirements
• The job of a Graduate Student Researcher
• Financial support
• The application process
Decision time

• In the 1-2 years before graduation, you will be making critical decisions about your professional path that will impact your career and livelihood.

• Even earlier, your academic performance will be a determinant as to which doors are open or closed.

• To make the right decision for you, you need to be informed and proactive.

• Your education at UCI is meant to prepare you to **aim high**, to seek the very best positions in industry, government or academia.

• You should not accept mediocrity.

• This lecture will try to outline your options regarding graduate school.
The immediate dilemma: industry or graduate school

- Industry (Corporation):
  - BS degree:
    ~ $80K / year
  - Graduate School:
    ~ $24K / year
  - If supported:
    ~ $24K / year
Why graduate school?

• Because you want to learn more.

• Making a personal investment in knowledge, scholarship, and advanced skills.

• Making contributions that will have long-lasting impact in your profession and benefit society.

• Being surrounded by some of the smartest, most accomplished scholars in the world.

• Becoming expert and leader in a technical field.

• Expanding your career options.

• Achieving competitive positions and salaries.
Graduate program philosophy

• Commitment to scholarly excellence, research of the highest quality and relevance, and publication in the top venues.

• Creation of an intellectually rich and stimulating environment, supported by experimental and computational infrastructure of the latest technology, that fosters the above values.

• Developing technology that benefits society.
Critical decisions

- Final degree (MS vs. PhD)
- Research area
- Faculty advisor
MS Path

Courses-only (comprehensive exam) option
Typically 9-15 months (3-4 academic quarters)

Thesis option
Typically 24 months

Limited opportunities in Government
PhD Path

Typically 5 years past BS, 3 years past MS
A research career can be extremely rewarding
But it is not for everyone

• The rewards are primarily intellectual. It is the thrill of discovering something new, developing a novel technology, raising your stature in the scientific community, becoming a leader in a field.

• You will be interacting with the very top people in your field, nationally and internationally. It’s the top 1% of the top 1%. These people will be your friends and colleagues. They can also be your competitors.

• There can also be significant financial rewards. Competitive salaries and income from intellectual property (licensing of patents).

• Scientific discovery is a highly non-linear and unpredictable. There can be many setbacks until something works. It requires passion, commitment, perseverance, a bit of insanity…

• You will be constantly assessed by your peers. These are the top people in your field. You will experience rejection (papers, proposals).

• Research is dramatically different from the linear, predictable experience of undergraduate studies.
The job of a Graduate Student Researcher

• By definition, research means going into unexplored areas and discovering new things. This is the most exciting aspect of graduate study. It is also non-linear and unpredictable; you fail several times until you succeed. And you have to work hard.

• GSRs conduct research under the supervision and mentorship of a faculty advisor. This is a critical relation that requires careful selection from both parties.

• The research has a sponsor, or sponsors, who have certain expectations and “deliverables”. The GSR shares in the responsibility to meet these expectations.

• Presenting, publishing, communicating research results is an integral aspect of the job.

• It is not a 9-5 job.
Research in world class laboratories
Communicating with the outside world
An integral aspect of the research experience

Orally, at conferences

Conference papers, peer-reviewed journal publications
The faculty advisor
A extremely important relationship that can last for a lifetime

• The faculty advisor is your supervisor and mentor. He/she will provide guidance for your research project, advise you on your career, pick you up when you are down.

• The advisor is also the person responsible with raising the funds that support you and your research project.

• Taking on a student for 5 or so years is a big commitment. The advisor invests a lot of time and resources in a student, particularly for the PhD degree.

• So it’s a bit like marriage. It entails commitment, understanding, communication, compatibility. And a very careful selection.
Research area

• It should be an area that you have, or develop, a passion for. An area in which you want to make a lasting impact, become a leading expert and scholar.

• There are many factors that play a role in what is ultimately the topic of your thesis (MS, and especially PhD).
  - Your interests and vision
  - Your advisor’s interests and vision
  - Research funding
  - Available infrastructure.

• What is perhaps most important is demonstration of your ability to conquer intellectual challenges, push the state of the art, and develop new things that will benefit your profession and society at large.

• By definition, you will be tackling a complex, multi-faceted, intellectually challenging problem that nobody else has addressed. This prepares you to later on tackle equally or more complex problems, not necessarily in exactly the same line of your graduate research area.
Research thrusts in UCI - MAE

• Biomechanical Engineering
• Design and Manufacturing
• Dynamics, Controls and Robotics
• Energy and Environment
• Fluid Mechanics and Aerodynamics
• Mechanics of Solids, Structures and Materials
• Microsystems and Nanomaterials
• Power and Propulsion
MAE research thrust:
FLUIDS MECHANICS AND AERODYNAMICS

Research in this area includes incompressible and compressible turbulent flows, multiphase flows, chemically reacting and other nonequilibrium flows, turbomachinery, electrosprays, aeroelasticity, aerodynamic optimization and aeroacoustics. Computational approaches include direct numerical simulation and large-eddy simulation; laboratories include wind tunnels and high-speed jet facilities.
Research in this area encompasses aerospace propulsion and its environmental impacts, combustion and thermophysics. In aerospace propulsion, particular emphasis is placed on turbomachinery, spray combustion, combustion instability, innovative engine cycles, colloidal propulsion, compressible turbulent mixing and noise emissions. The topic of combustion and thermophysics addresses the fundamental fluid-dynamical, heat-transfer and chemical mechanisms governing combustion in diverse settings.
Research in this area encompasses combustion, fuel-cell technologies, and atmospheric physics and impacts. The topic of combustion addresses the fundamental fluid-dynamical, heat-transfer and chemical mechanisms governing combustion in diverse settings. Fuel-cell research encompasses the development of fuel-cell technology, hybrid engines and thermionic devices. The area of atmospheric physics and impacts comprises the modeling and controlling of chemical pollution, particle dispersion and noise emission caused by energy-generation and propulsion devices.
MAE research thrust: DYNAMICS, CONTROLS AND ROBOTICS

Research is conducted in the areas of dynamic systems optimization and control, robotics and machine learning. Advanced concepts in dynamics, optimization and control are applied to the areas of biorobotics, flight trajectory design, guidance and navigation, learning systems, micro sensors and actuators, flexible structures, combustion and fuel cells. The focus of robotics and machine learning is the creation of machines with human-like intelligence capabilities for learning. Cooperative robotics includes the development of distributed algorithm design for multi-agent systems.
Biomechanical engineering integrates physiology with engineering in order to develop innovative devices and algorithms for medical diagnosis and treatment. Areas of activity include biorobotics, neuromuscular control, rehabilitation, cardiovascular mechanics and respiratory fluid mechanics.
MAE research thrust: MICROSYSTEMS AND NANOMATERIALS

This area encompasses miniaturization engineering, micro-mechatronics and advanced nanomaterials. Miniaturization engineering is relevant to the development of small-scale mechanical, chemical and biological systems for applications in biotechnology, automotive, robotic and alternative energy applications. Mechatronic design focuses on the design, modeling and characterization of micro-electro-mechanical systems (MEMS). Research on nanomaterials focuses on uncovering new structure-property relationships for next-generation structural, electronic and energy components.
MAE research thrust:
MECHANICS OF SOLIDS, STRUCTURES AND MATERIALS

This field emphasizes analytical, computational and experimental approaches that contribute to a basic understanding of and new insight into the properties and behavior of condensed matter and engineered materials. General areas of interest are large-strain and large-rotation inelastic solids, constitutive modeling and fracture mechanics. Computational algorithms center on boundary-element methods and the new class of meshless methods. Studies in structural mechanics involve the analysis and synthesis of low-mass structures, smart structures and engineered materials, with emphasis on stiffness, stability, toughness, damage-tolerance, longevity, optimal life-cycle costs and self-adaptivity.
Research in design engineering involves the development of methodologies to address issues ranging from defining the size and shape of components needed for force and motion specifications, to characterizing performance in terms of design parameters, cost and complexity. Applications include automotive and aerospace systems. Research in subtractive and additive manufacturing focuses on enhancing the state of the art in microfabrication.
Ingredients for success

• Genuine desire to learn, discover new things
• Relationship with your faculty advisor
• Selection of an appropriate research area
• Focus, hard work
• Commitment to excellence
• Superior knowledge of the fundamentals
• Expertise on the state of the art
• Communications skills
• Thinking outside the box – development of new ideas
Admission and support

Criteria in typical order of importance:

1. GPA
   Transcript
   University reputation

2. Reference Letters
   GRE

3. Self Statement

4. Other factors
GPA

• Combined with the reputation of the university, it is the dominant criterion for selection.

• The formal admission cutoff is GPA=3.0/4.0, but in practice the threshold is higher at ~3.3 for MS and ~3.5 for PhD.

• Departmental support is provided only to Ph.D. applicants.

• We scrutinize the transcript and performance in engineering & science courses.

![GPA Graph](image)
Reference letters

• Very critical in the decisions to admit and support.

• Referees should be in a position to write something **meaningful and insightful** about your academic performance and potential for success in graduate school.

• It is highly desirable that the referees be **professors**.

• This means that you need to establish personal relations with your professors. Get yourself known (by doing good things).

• Typically 3 letters are required (UCI requires 3).
Statement of purpose

• Needs to be very well crafted so that it conveys clearly your qualifications, aspirations, and career goals.

• You need to impress upon people that you have a direction, that you know what you want.

• Describe research/project experiences as an undergraduate and how they shape your outlook as a researcher.

• Describe relevant life experiences that will impact your path as a graduate student.

• English grammar and syntax need to be perfect. Mistakes and typos are a NO-NO as they indicate lack of seriousness of the applicant.
Financial support

• The majority of our PhD graduate students are fully supported*.

• Support is contingent on satisfactory performance in courses and research.

• B- is a failing grade!

* For UCI Engineering, this means selecting the option of **PhD** when you apply. This indicates that you are interested in a PhD as your ultimate degree. It is not a commitment on your part to continue to the PhD degree, but should represent a genuine interest in pursuing a PhD degree. Note that several UCI Engineering departments (including MAE) require an MS degree on the way to the PhD degree.
Financial support mechanisms

• **Fellowships**
  Usually no strings attached but student is expected to conduct research under a faculty’s supervision. Given mainly to first-year students.

• **Research Assistantships**
  Student is supported by a faculty’s research funds. Must work on specific research projects and fulfill obligations of the contract/grant.

• **Teaching Assistantships**
  Student is assigned to specific course(s) for conducting discussion sessions, grading homeworks and exams, and helping students with their assignments. Foreign students must pass the language test.

• **External scholarships**
  Federal agencies (NSF, NASA, DoD, …) and private organizations provide competitive opportunities for student scholarships.
The annual cost of a graduate student

Numbers are approximate and subject to change

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<thead>
<tr>
<th>CA RESIDENT</th>
<th>NON-RESIDENT</th>
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<tr>
<td>Stipend: $24,000</td>
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<tr>
<td>Fees: $16,000</td>
<td>Fees: $31,000</td>
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<tr>
<td>TOTAL: $40,000</td>
<td>TOTAL: $55,000</td>
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The annual cost of a graduate student on a contract or grant

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<td><strong>Fees:</strong> $31,000</td>
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<tr>
<td><strong>Benefits:</strong> $400</td>
<td><strong>Benefits:</strong> $400</td>
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<tr>
<td><strong>Overhead</strong> $13,200</td>
<td><strong>Overhead</strong> $13,200</td>
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<tr>
<td><strong>TOTAL:</strong> $53,600</td>
<td><strong>TOTAL:</strong> $68,600</td>
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*Institutional overhead of 54% on salaries and benefits*
Sources of funding

- **Student**
  - University Fellowship, TA
  - Contract/Grant
  - Government: NSF, NASA, DOD, DOE, EPA, FAA, etc
  - Industry
  - U.S. Taxpayer

- **Professor’s research proposals**
  - Contract

* A very competitive process
The application process

• It is fairly straight-forward. These are the critical things that you will need to address:
  - Taking the GRE.
  - Getting reference letters (select the letter writers very carefully!).
  - Write a compelling statement of purpose.

• Pay attention to the deadlines. Most universities have a November-December deadline for admission in the Fall of the following calendar year. UCI MAE deadline is December 1.

• Do your homework. Visit faculty web sites in universities that have research areas that interest you. Become familiar with names of professors in those areas.

• Cast a wide net, apply to several top universities.

• The entire process is online (including reference letters).
UCI’s graduate application site
https://apps.grad.uci.edu/ogsa/
Preparation as an undergraduate

- Achieve and maintain a very strong academic record, high GPA.
- Become known to your professors (they will be the people writing reference letters).
- Gain some research experience by enrolling in MAE199s.
- Research the top graduate programs in areas of your interest. Learn what the professors in those programs are doing.
- You may contact professors doing research that interests you. Your emails should be professional and to the point. Your CV and other documents should be meticulously prepared.
- Take the GREs on time.
- Write an excellent statement of purpose (this takes significant preparation, it needs to be very well crafted).
- Keep track of the deadlines for application to graduate school.
- Be organized and methodical in your applications. Give professors ample time to write their reference letters.
• Graduate study is a once in a lifetime, invaluable opportunity to get an advanced education, conduct top level research, push the state of the art, become a leader in a technical field.

• It requires passion, commitment, intellectual curiosity, superior analytical skills, resilience, resourcefulness, out-of-the-box thinking.

• You will be surrounded by the smartest people in the world, and you will become one of them.

• To keep the option of graduate school, you need to start preparing early. Keep in mind the importance of an excellent academic record.
More information

School of Engineering graduate page
http://engineering.uci.edu/admissions/graduate

MAE graduate page
http://engineering.uci.edu/dept/mae/graduate

This lecture will be posted on
http://supersonic.eng.uci.edu

For questions, email me:
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