Graduate Program in Materials Science and Engineering (MSE)
The University of Pittsburgh

- Founded in 1787
- Over 32,000 students
- Top-20 public research university in USA
- Well-known Swanson School of Engineering with six departments and nine programs
- Global recognition – 37th ~ 116th in global university rankings (Times Higher-QS World University, Jiao Tong University, Newsweek, etc.)
Our Location …
It is the mission of the Swanson School of Engineering to produce highly qualified engineers and useful creative research and technology through academic excellence.

Five priorities support this mission:

1. Quality in undergraduate education;
2. Quality in graduate education;
3. Innovative research;
4. Revenue generation and
5. Diversity.
Oakland -
…cultural center and site of the main campus of University of Pittsburgh

Pittsburgh -
A friendly and beautiful place to study, work and live.
PITTSBURGH --- some data…

Fortune 500 Corporations
- Alcoa Inc.
- Allegheny Technologies
- H.J. Heinz Company
- Mellon Financial Corporation
- PNC Financial
- PPG Industries
- WESCO International
- US Steel

Fortune 1000 Corporations
- Allegheny Energy
- American Eagle Outfitters
- Consol Energy
- Dick’s Sporting Goods
- Kennametal
- Wheeling-Pittsburgh Steel

Other Major Employers include
- Alcoa Technical Center
- North American HQ’s of Bayer, GlaxoSmithKline, Lanxess
- Northeast US regional HQ’s of Nova Chemicals, FedEx Ground, Ariba, Rand, National City
- …84 Lumber, Giant Eagle, Highmark, Rue21, Genco, Mylan Laboratories, GNC, CNX Gas, Westinghouse Electric Corporation, The Bettis Bechtel Laboratory (Home of Naval Nuclear Propulsion Program); DOE National Energy Technology Laboratory, University of Pittsburgh Medical Center… & University of Pittsburgh
Who employs our graduates?

Job Titles:
Materials Engineer
Metallurgist
Glass Scientist
Technical Sales Engineer
Processing Engineer
Polymer Scientist
Project Engineer
Result of merging Departments of Mechanical Engineering and Materials Science and Engineering Since September 2006

- 30 full-time faculty and many adjunct and research faculty;
- All faculty active in research (over $6M external support);
- The largest department in the Swanson School of Engineering
- ≥ 600 undergraduates, ~ 300 graduate students
- Graduate Certificate Program in Nuclear Power Engineering, focusing on nuclear reactor operation and safety
Materials Faculty Tenure/Tenure Stream ~12…

- Ass. Prof. Markus Chmielus
- Prof. Anthony DeArdo
- Prof. Isaac Garcia
- Prof. Brian Gleeson
- Ass. Prof. Tevis Jacobs
- Assoc. Prof. Jung-Kun Lee
- Ass. Prof. Sangyeop Lee
- Prof. Scott Mao
- Prof. Gerald Meier
- Assoc. Prof. Ian Nettleship
- Assoc. Prof. Guofeng Wang
- Prof. Qing-Ming Wang
- Assoc. Prof. Jörg Wiezorek

…Expertise and research activities span the processing/synthesis/fabrication, simulation, structure/property characterizations of thin films, bulk and particulate systems based on metallic, ceramic and polymeric materials and device structures used in Energy, Information Technology, BioTech, Transportation and Chemical Industry sectors.

… also Adjunct Faculty, Research Faculty and Emeritus Faculty participate in research and educational activities in MSE.
Key Research Competencies of MEMS Department

• Advanced Manufacturing and Design
• Materials for Extreme Conditions
• Biomechanics and Medical Technologies
• Modeling and Simulation
• Energy System Technologies
• Quantitative and In Situ Materials Characterization
MSE Research Foci

Pitt-MSE Core Competencies

- Metallic Materials
- Materials in extreme environments
- Ceramics & Semiconductors
- Nanotechnology
- Materials theory and simulation
- Manufacturing of advanced materials
- Materials characterization and in-situ experiments
- Materials in extreme environments
- Nanotechnology
New Materials needed for Sustainable, Secure Energy Generation, Distribution, Storage ... and for more efficient utilization!

- Massive capacity Batteries
- Low Cost Solar Cells
- Corrosion-Resistant Alloys for High-T Power Conversion
- Light-Weight & Strong Composites for Wind-Turbines
- … more energy efficient ground, air TRANSPORTATION
Reducing the environmental impact of power generation from fossil fuels...e.g.

- Advanced High-T materials & coatings to enhance operating temperatures and pressures to increase efficiency (Ultra-Supercritical plants...)

- Carbon capture and sequestration, gas-separation membrane technologies

- High-Strength, corrosion resistant pipe materials
Materials are key to more Energy Efficient Transportation

- Reducing vehicle mass & changing from petroleum based fuels to alternative (electricity, hydrogen...) fuels;

- Implement use of Advanced High Strength Steels; Light Metal (Al, Mg, Ti) Alloys; Carbon Composites;

- Develop High Performance Magnets; Electrical motors; Batteries for Energy Storage; Fuels Cell Catalysts and Membranes;
Materials advances needed …

- identify non-toxic, low-cost materials;
- nano-surface designs to extend capture to full solar spectrum
- materials aging & degradation in photovoltaic systems;
- more durability, low-cost reflector and absorber materials;
- improved molten-salt corrosion resistance;

“...put my money on the sun and solar energy. What a source of power! I hope we don’t have to wait till oil and coal run out before we tackle that.”
- Thomas Edison
Faculty and Staff for MSE Program

• Department Chair: Professor Brian Gleeson
  bmg36@pitt.edu

• Graduate Program Coordinator: Associate Professor Jung-Kun Lee
  jul37@pitt.edu

• Graduate Student Admission: Associate Professor Guofeng Wang
  guw8@pitt.edu

• Graduate Administrator: Ms. Carolyn Chuha
  cac90@pitt.edu
Graduate Students in MSE

- 61 graduate students in MSE program currently as of Spring 2016.

- MS Students in Materials Science & Engineering – 38 (including 17 PT student)

- PhD Students in Materials Science & Engineering – 23 (including 1 PT student)
  - Part/Full Time ~ 4%/96%

- Most FT PhD students are supported by assistantships as GSR, TA/TF or other fellowships.
Academic Information

- **Master Degrees (≥ 30 credits):**
  1) Master Degree (Thesis): Typically for Full-Time Students
  2) Professional Master Degree (Non-Thesis) Part-Time Students only

- **PhD Degree (≥ 72 credits)**
  Research & Dissertation (Thesis) based degree: Typically for Full-Time Students

**Special Notes**
- Dual Degree MS-MSE / MBA
  … offered by Swanson School of Engineering and Katz School of Business

- Graduate Nuclear Engineering Certificate Program
  – Complete ≥ 5 of the 7 cross-listed courses currently offered as part of NECP (≥ 15 credits)
  – NECP fully compatible with MS and PhD in MSE
Compatibility between Programs

=> Interdisciplinary options via numerous
Cross-listed courses in ME/MSE and between MSE
and the Nuclear Engineering Certificate Program, e.g.

- ME 2003/MSE 2036 Continuum Mechanics
- ME 2010/MSE 2037 Nanomechanics, Materials & Devices
- ME 2033 Fracture Mechanics for Product Design / MSE 2032 Failure of Materials
- ME 2022/MSE 2038 Applied Solid Mechanics

- ME/MSE2110 Nuclear Materials
- ME/MSE2115 Nuclear Plant Heat and Mass Transfer

- Can obtain MS or PhD MSE & Graduate Certificate in Nuclear Engineering without additional course-load.
Master Degrees (30 credits):

- **Professional Master Degree (Non-Thesis): Part-Time only**
  - ≥ 30 credits ~ 10 courses;
  - ≤ 9 credits (3 courses) non-MSE technical courses (math, science, engineering);
  - ≤ 9 credits (3 courses) in transfer credits;

- **Master Degree (Thesis): Typically for Full-Time**
  - ≥ 21 course credits (7 courses) plus research (3 credits) & thesis (6 credits);
  - ≤ 9 credits (3 courses) non-MSE technical courses (math, science, engineering);
  - ≤ 6 credits (2 courses) in transfer credits;
# TIMELINE => MS-Degree Thesis Option (Full-Time):

<table>
<thead>
<tr>
<th>What?</th>
<th>When?</th>
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</thead>
<tbody>
<tr>
<td>Choose Advisor</td>
<td>=&gt; During 1st term;</td>
</tr>
<tr>
<td>Plan of Study (courses), consult w. advisor</td>
<td>=&gt; by END of 1st term;</td>
</tr>
<tr>
<td>Begin Research</td>
<td>=&gt; During 1st term (no later then 2\textsuperscript{nd} term)</td>
</tr>
<tr>
<td>Complete Independent Research &amp; Thesis</td>
<td>=&gt; During 2\textsuperscript{nd}, 3\textsuperscript{rd}, 4\textsuperscript{th} terms and summer;</td>
</tr>
<tr>
<td>Apply for Graduation and Defend Thesis</td>
<td>=&gt; During Final term (typically 4\textsuperscript{th} or summer);</td>
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- The MS-level research must at least be a thesis type report and discussion of independently conducted student research.
- All requirements for thesis based MS degree are typically completed in 2 years (4 terms plus one summer).
Some Logistics for PhD.

**Doctoral Students:**

- Submit plan of study: (first term)
- Minimum of 72 credits beyond BS level, of which at least **36 course credits** beyond BS level.
- **Minimum Course Requirements (≥36 course credits, with ≥3.3 GPA)**
  - Materials core courses (six required courses students must take in the first year of enrollment)
    1) MSE 2067: Elements of Materials Science and Engineering 1 (Fall),
    2) MSE 2003: Structure of Materials (Fall),
    3) MSE 2011: Thermodynamics of Materials/Energetics (Fall),
    4) MSE 2013: Kinetics in Materials Science (Spring),
    5) MSE 2015: Electromagnetic Properties of Materials (Spring),
    6) MSE 2030: Mechanical Behavior of Materials (Spring).

Students must score **at least a B (3.0) in each of these six classes**. If a student does not get at least a letter grade of B, the class must be taken a second time. These classes must be successfully completed before the student can apply for admission to PhD Candidacy.
– Advanced and Technical Elective Courses (≥12 credits): a group of courses tailored for each student's research and as required technical broadening beyond the MSE focus

– Courses to address mathematical/numerical skills: six (6) credits beyond those required for the materials science and engineering Bachelor of Science degree. This requirement may be waived if it was met in a previous program.

– PhD Research and Dissertation credits: each student must have at least six (6) credits of MSE 3997 (PhD Research); at least 12 credits of MSE 3999 (PhD Dissertation);

Registration for MSE 3999 is allowed only after the student has passed the Comprehensive Examination and defended the PhD Proposal, which qualifies the student for the status of PhD Candidacy.
To advance towards preparation for the PhD dissertation proposal and the
Comprehensive exam the student has to
(i) Achieve academic excellence in the six (6) MSE core course sequence (grades of
letter grade of B (3.0) or better in each of them, see above)
AND
(ii) Pass the PhD qualifying examination.

**Preliminary Qualifying Exam**
A literature review based mini-proposal in a general topic area suited to each
student’s anticipated research project.
: Writing a paper + Oral presentation (30 minute presentation) to the committee.

Appropriate topic descriptions should be developed by the advisor and submitted to
the Qualifying Exam committee for review in advance.
Written document:
✓ The written document must be submitted two (2) weeks prior to the oral presentation. The written document should be no more than 15 pages long (1 inch margins, single spaced, including any necessary figures).

✓ Motivational section + Background/Introduction section + Remaining Questions section (describing the major issues that still need to be addressed + a Research Plan (describing experiments and methods of interpretation that can be used to address these open questions) + A list of References

Oral exam:
✓ The examining committee consists of 3 faculty, 1 of whom is the coordinator for the entire qualifier process for that year – this person sits on all the committees. The other two members are independent faculty (not to include the advisor).
Timing:

The qualifier will be given once per year at the end of the spring term – all new PhD degree students must take the exam in the first year. Special students (less prepared) may delay until the second year if the advisor petitions the graduation committee.

Second attempts:

If the student does not pass the exam, a retake is allowed if the advisor petitions the graduate committee and commits to continuing to support the student for the 2nd year. The second attempt can occur the following spring semester or earlier in the fall.
Comprehensive Exam and Thesis Proposal => Ph.D. CANDIDACY

Thesis document preparation and Thesis Defense

- Comprehensive Exam (held at same time as Dissertation Proposal):
  - Part of the PhD Dissertation Proposal Conference
  - Tests students' command of specialized knowledge required to successfully complete the proposed doctoral degree research;
  - Completed after courses finished with $\geq 3.3$ GPA, typically two to three terms after passing the preliminary qualifying exam;

- Dissertation Proposal (held at same time as Comprehensive Exam):
  - Apply for PhD Candidacy (chose committee by one term after passing the Preliminary Qualifying Exam and at least one month prior to proposal meeting);
  - Includes public presentation as a form of Department Seminar;
  - Students may not take MSE 3999 until passing the proposal stage and admission to PhD candidacy;

- Dissertation Defense:
  - Typically, at least one term must elapse between successful completion of Dissertation Proposal and the Dissertation Defense;
  - PhD committee meeting to assess quality of scholarship, research and originality;
  - Apply for Graduation in final term;
TIMELINE to a PhD-Degree:

What? When?
Choose Advisor; During 1st term;
a) Plan of Study (courses), by END of 1st term;
consult w. advisor;
Begin Research During 1st term (no later then 2nd term)
b1) Complete Prelim-Qualifying Exam At the end of 1st year
c) Complete PhD Dissertation Proposal /Comprehensive Exam End 2nd Year or in 3rd Year (recommended) => Progress to PhD Candidacy!
Complete Research and Dissertation Within 4 to 5 years
d) Apply for Graduation and Defend Thesis During Final term
Graduation is not an automatic process. You must submit a Graduation Application Form to school’s administrative office (room 151 BEH) before their deadline.

You can download a Graduation Application Form from MEMS department’s webpage or from the registrar’s page.

Application deadline changes every year. They are posted on the TV screens every term. Please submit your application at the beginning of the semester of the term that you want to graduate in and you must also be registered in the term that you graduate.
Statute of Limitation

- All requirements for MA and MS degrees must be completed within a period of four consecutive calendar years; all requirements for professional master's degrees, in five years.

- All requirements for the PhD degree must be completed within a period of ten years or eight years if the student has received credit for a master's degree appropriate to the field of study.
Some Statistics for graduate student performance

- 3 ~ 8 PhDs were produced per year for the last few years.

- All students completed the PhD degree studies **within 4.5 years**. A time of about four years (±0.5 years) is considered the goal for the average within the MSE program in MEMS.

- All students had at least two papers accepted by a recognized journal and/or presented at a national conference. In average, their publication performance is equivalent to **3-4 journal papers**.