Graduate Programs in Biomedical Engineering

New Graduate Student Orientation
August 23, 2023

Catherine Whittington, Assistant Professor, BME
Haichong (Kai) Zhang, Assistant Professor, BME and Robotics

BMEGradProgram@wpi.edu
Introductions!

Hello My Name Is ___________________
Outline

• Graduate program contacts and Getting started
• Program Overview and Degree requirements
• Course information and Advising
• Additional program information and Final thoughts
• Q & A!!! (*but you can ask questions at any time*)
• Faculty research and MS project opportunities
How do I find information about the graduate program?

• Primary resource: https://wp.wpi.edu/bme/grad/

• All inquiries: BMEGradProgram@wpi.edu

• BME Graduate Committee

• BME Administrative Staff

• BME Department Leadership
BME Graduate Studies Committee

Dirk Albrecht
Associate Professor, BME

Songbai Ji
Professor, BME

Catherine Whittington
Assistant Professor, BME

Haichong (Kai) Zhang
Assistant Professor, BME and Robotics

Adam Lammert
Assistant Professor, BME

George Pins
Professor, BME

June Norton
Graduate Program Administrative Assistant
Feedback to the GSC (Grad Studies Committee)

- Are things going well? Or not so well? How can Grad Studies improve your experience?

- Let us know!
  - Speak to your Academic or Research Advisor
  - Come to GSC Office hours (dates/times TBD)
  - Use the GSC feedback form
    - Anonymous if needed
BME Administrative Staff

• June Norton
  – Graduate Program
  – 4017D
  – jnorton@wpi.edu

• Kate Harrison
  – Undergraduate Program
  – 4017E
  – Kharrison@wpi.edu

• Lynda Hammett
  – BME Department; Assistant to Department Head
  – GP 4009
  – lhammett@wpi.edu
BME Leadership

Kristen Billiar
Professor, BME
Department Chair

Karen Troy
Professor, BME
Associate Department Chair
Get involved! Build your network

- BMES Chapter, officers
- Local/Regional meetings
- BME and Gateway “Happy Hours”
- BME cookouts
- WPI BME DEI Committee (student rep)
Getting Started

- **Lab Access**
  - Lab areas always require card access
  - For access forms, see Lynda Hammett
  - MUST COMPLETE LAB SAFETY TRAINING (access via CEMS system → Training → Next training 8/24, 8-10am!)
    - [https://www.wpi.edu/offices/environmental-health-safety/laboratory](https://www.wpi.edu/offices/environmental-health-safety/laboratory)
WPI BME Program Overview and Graduate Degree Details
Program Expectations

• Work more independently than undergraduate research

• Original research is primary focus in thesis- and project-based graduate programs

• GPA > 3.0 to graduate

• No more than two C grades

• Academic Integrity
  – WPI Academic Honesty Policy
  – https://www.wpi.edu/about/policies/academic-integrity
Advising

• BME core faculty are eligible to advise
  • Initially assigned an academic advisor in the BME department
  • Thesis/Dissertation Advisor will become your primary advisor
• “Plan of Study” forms help you plan your courses and research to meet degree requirements
  • Useful tool for reviewing course selections with advisor
  • Helpful to ensure that you are staying on track
• Your advisor is a RESOURCE…meet with them!
Master of Engineering (M.E.)

- Course-based degree (no research requirements)
- 33 credits total
- Usually 1-2 year beyond B.S. degree
- Graduate-level coursework that enhances academic backgrounds from undergraduate degrees in BME or related fields.
  - Courses can be focused to build on individual professional and academic experiences in preparation for engineering careers.
Course Requirements – Master’s of Engineering

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BME</td>
<td>12</td>
</tr>
<tr>
<td>Life Sciences</td>
<td>3</td>
</tr>
<tr>
<td>Advanced Math</td>
<td>3</td>
</tr>
<tr>
<td>Life Sciences or Advanced Math</td>
<td>3</td>
</tr>
<tr>
<td>Electives</td>
<td>12</td>
</tr>
<tr>
<td>BME 591: Graduate Seminar (x 2)</td>
<td>0</td>
</tr>
</tbody>
</table>

**TOTAL:** 33 credits

- A 1/3 unit WPI undergraduate course taken for graduate credit is 2 credit hours of graduate credit
- May take directed research (max 6 credits), but not required
  - 0-3 credits can count for BME
  - 0-3 credits can count for Elective
Timeline to Graduation: MENG

*Assuming a Fall start for the MENGR program

**Year 1: Fall semester classes**
(Include Grad Seminar #1)

**Year 1: Spring semester classes**
(Including Grad Seminar #2)

**Summer Semester (Optional)**

**Year 2: Fall semester classes**

Graduation!

**NOTE:** Timeline may be faster for combined BS/MENG students or students with significant prior graduate coursework.
Master of Science (M.S.) – Project OR Thesis

- 30 credits total
- ~ 2+ years beyond B.S. degree

**Project**: Focused, credit-based independent project experience that builds on individual professional and academic experience.
- Facilitates development of experience, skillset, and mindset to contribute and lead in industry as engineers in various BME roles.

**Thesis**: Deeper, open-ended inquiry into a research area, in preparation for:
- Advanced research training (e.g., Ph.D. degree)
- Research-focused careers in a medical, academic, government, or industry laboratory settings.
Course Requirements – Master’s of Science (Thesis or Project)

<table>
<thead>
<tr>
<th></th>
<th>Thesis-based</th>
<th>Project-based</th>
</tr>
</thead>
<tbody>
<tr>
<td>BME</td>
<td>12 credits</td>
<td>BME</td>
</tr>
<tr>
<td>Electives</td>
<td>12 credits</td>
<td>Electives</td>
</tr>
<tr>
<td>BME 599 (MS Thesis)</td>
<td>6 credits</td>
<td>BME 597 (MS Project)</td>
</tr>
<tr>
<td>BME 591: Graduate</td>
<td>0 credits</td>
<td>BME 591: Graduate</td>
</tr>
<tr>
<td>Seminar (x 2)</td>
<td></td>
<td>Seminar (x 2)</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td><strong>30 credits</strong></td>
<td><strong>TOTAL:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>30 credits</strong></td>
</tr>
</tbody>
</table>

*In addition, the following requirements must be met for both MS Degree Programs*

<table>
<thead>
<tr>
<th>Technical Depth Requirements</th>
<th>15 credits (grad semester = 3 credits typically)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BME Core Competencies (5)</td>
<td>✓ Mathematics</td>
</tr>
<tr>
<td><em>(See grad handbook for details)</em></td>
<td>✓ Life science</td>
</tr>
<tr>
<td></td>
<td>✓ Regulation and controls</td>
</tr>
<tr>
<td></td>
<td>✓ Value creation, innovation, technology, commercialization</td>
</tr>
<tr>
<td></td>
<td>✓ Clinical needs analysis</td>
</tr>
</tbody>
</table>

Worcester Polytechnic Institute
Timeline to Graduation: MS Project (2 year)

Year 1: Fall semester classes
(Include Grad Seminar #1)

- Identify your MS project advisor(s) and meet with them

- Work with your advisor(s) to complete and submit the MS Project Proposal Declaration Form

Year 1: Spring semester classes
(Include Grad Seminar #2)

- Meet with your MS Project Committee.

Summers Semester (Optional)

- Work with your advisor(s) to form a MS Project committee to evaluate your project prior to graduation.

Year 2: Spring semester classes

- Present your final MS Project presentation and submit the project deliverable.

Year 2: Fall semester classes

- Submit the MS Project Presentation Form at least 2 weeks before presenting

Graduation!
Timeline to Graduation: MS Thesis (2 year)

**Year 1: Fall semester classes**
(Include Grad Seminar #1)

- Identify a MS Thesis research advisor no later than end of 2nd semester (preferably end of 1st)
- Start interacting with faculty with common research interests to help you identify a research advisor

**Summer Semester (Optional)**

**Year 1: Spring semester classes**
(Include Grad Seminar #2)

- Work with your advisor(s) to form a MS Thesis committee

**Year 2: Spring semester classes**

- Submit and Complete a MS Thesis Proposal within 6 months of selecting an advisor/identifying line of research.

**Year 2: Fall semester classes**

- Meet with your MS Thesis committee.

**Graduation!**

- Public MS Thesis presentation with closed session defense/examination
- Submit thesis document
# MS Project vs Thesis Recap

<table>
<thead>
<tr>
<th></th>
<th>Thesis</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Credits</strong></td>
<td>30 credits</td>
<td>30 credits</td>
</tr>
<tr>
<td><strong>Scope</strong></td>
<td>• Hypothesis-driven research</td>
<td>• May be more applied, design and/or objective driven</td>
</tr>
<tr>
<td></td>
<td>• Conducted in one the faculty research labs</td>
<td>• Not limited to research questions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Can be done in faculty research lab or outside of research lab (e.g., Co-op/Internship, Clinician)</td>
</tr>
<tr>
<td><strong>Final Deliverables/Outcomes</strong></td>
<td>1. Public thesis presentation and private examination</td>
<td>1. Public presentation* and private examination</td>
</tr>
<tr>
<td></td>
<td>2. Thesis document</td>
<td>2. Written document relevant to project (e.g., report, technical manual, SOP, etc.)</td>
</tr>
</tbody>
</table>

*If MS Project is conducted with a company or entity where confidentiality is required, arrangements can be made for a private presentation with appropriate confidentiality measures put in place.*

**FAQ: Project-Based MS or Thesis MS** - [https://wp.wpi.edu/bme/files/2022/05/Frequently-Asked-Questions-about-the-BME-MS-Program-Updated_5_2022.pdf](https://wp.wpi.edu/bme/files/2022/05/Frequently-Asked-Questions-about-the-BME-MS-Program-Updated_5_2022.pdf)
Doctor of Philosophy (PhD)

- **Two pathways**
  - 90 credits beyond B.S. degree (~5+ years)
  - **OR**
  - 60 credits beyond Master’s degree (~3+ years)

- Independent, in-depth open-ended inquiry and technical skill-building toward an expanded study in an area of research specialization

- Allows graduates to apply to highly specialized career opportunities, including the pursuit of original research in advanced academic, industry-based, or government careers.
# Course Requirements – PhD (90 credits beyond BS)

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</tr>
<tr>
<td>Responsible Conduct of Research</td>
<td>1</td>
</tr>
<tr>
<td>(usually satisfied by taking BB 551)</td>
<td></td>
</tr>
<tr>
<td>Dissertation Research (BME 699)</td>
<td>30</td>
</tr>
<tr>
<td>BME 591: Graduate Seminar (x 4)</td>
<td>0</td>
</tr>
<tr>
<td>Lab Rotations (optional)</td>
<td></td>
</tr>
</tbody>
</table>
Timeline to Graduation: PhD (90 credits beyond BS)

Example Timeline

Year 1: Fall classes (Grad Seminar #1)
OPTINAL: Lab Rotation #1

Year 2: Fall classes (Grad Seminar #3)
QUALIFYING EXAM! (advance to candidacy)

Year 3

Year 2: Spring classes (Grad Seminar #4)
Work with your advisor(s) to form a Dissertation committee

Year 4
DISSERTATION PROPOSAL!

Year 5...
Dissertation committee meetings every 6 months

• Public Dissertation presentation with closed session defense
• Submit dissertation document

OPTIONAL:
Lab Rotation #2

NOTE: Qualifying exam must be completed by end of 5th semester in the program.
Course Requirements – PhD (60 credits beyond MS)

BME 12 credits
Life Sciences 3 credits
Advanced Math 3 credits
Life Science or Advanced Math 3 credits
Electives 12 credits

Responsible Conduct of Research
(usually satisfied by taking BB 551) 1 credit
Dissertation Research (BME 699) 30 credits
BME 591: Graduate Seminar (x 4) 0 credits

Lab Rotations (optional)

*60 credit PhD students should document prior graduate-level coursework and consult their advisor about specific classes that may be beneficial to take.
Timeline to Graduation: PhD (60 credits beyond MS)

Year 1: Fall (Grad Seminar #1)
- Optional: Lab Rotation #1
- Year 1: Spring (Grad Seminar #2)
- Optional: Lab Rotation #2

Year 2: Fall (Grad Seminar #3)
- Qualifying Exam!
  (advance to candidacy)
- Year 2: Spring (Grad Seminar #4)
  - Work with your advisor(s) to form a Dissertation committee

Year 3
- Dissertation committee meetings every 6 months
- Year 4...

Graduation!

NOTE: 60 credit PhD students may end up taking their qualifying exam earlier than their second year because of needing to take fewer courses; Qualifying exam still has to be completed by end of 5th semester in the program.
Submitting Forms for Milestones

• Be proactive and submit early!

• Ensure you understand which forms are needed and when they should be submitted
  – Consult with your academic advisor first
  – Consult with the Graduate Committee second

• Send all forms to BMEGradProgram@wpi.edu
  – Copy your advisor on these emails!

• Check that all signatures are in place first!

• Check that the form is complete!

2 most common delays!
Course Information
Course Registration: How do I register for courses?

- Register Online (Workday) for most courses
- Some BME courses require special permission (e.g., BME 562, Small Animal Surgery)
- If a class is closed, you will need an “Add form” signed by the instructor (online form)
  - Suggest to contact the instructor
- See Registrar’s website for additional information and forms
  - https://www.wpi.edu/offices/registrar
Course Registration: Which courses should I take?

• Graduate Catalog (online) lists graduate course descriptions
  – http://www.wpi.edu/academics/catalogs/grad.html

• Special Topics courses (BME595*):
  – http://wp.wpi.edu/bme/grad/

• Some courses may be offered every other year ("Cat II", e.g. BME 550, Tissue Eng.)

• Undergraduate 4000-level courses:
  – Up to 6 credits of 4000-level courses can be taken for graduate program credit
  – Usually 7 week courses (ABCD term v. semester)
  – 1/3 unit (3 credit) undergraduate course = 2 credit graduate course
BME Courses – AY 23-24

• **BME (Fall 2023):**

  - BME 523  Biomedical Instrumentation  Shazeeb, Mohammad
  - BME 530  Biomedical Materials  Levey, Fiona
  - BME 532  Medical Device Regulation  Ferguson, Doug
  - BME 562  Laboratory Animal Surgery (LIFE SCI)  Flegal, Matthew
  - BME 591  Graduate Seminar  Ji, Songbai
  - BME 592  Healthcare Systems & Clinical Practice  Page, Ray
  - BME 593  Scientific Communication  Faber, Brent
  - BME 595  ST: Value Creation for Graduate Research  George Pins
  - BME 595  ST: Mechanobiology  Mensah, Solomon
BME Courses – AY 23-24

**BME (Spring 2024):**

- BME 531  Biomaterials in the Design of Medical Devices  Cornwell, Kevin
- BME 533  Medical Device Innovation & Development  Zheng, Yihao
- BME 550  Tissue Engineering  Whittington, Catherine
- BME 552  Tissue Mechanics  Hera, Adriana
- BME 560  Physiology for Engineers (LIFE SCI)  Shazeeb, Mohammad
- BME 580  Biomedical Robotics (Online)  Hata, Nobukiko
- BME 580  Biomedical Robotics (In-person)  Fischer, Gregory
- BME 583  Biomed Microscopy & Quant Imaging  Albrecht, Dirk
- BME 591  Graduate Seminar  Pins, George
Independent Research Credits

- Includes Directed Research, Lab Rotations, and Thesis/Dissertation Credit
- Must be arranged individually with faculty research advisor
- Register online: [https://www.wpi.edu/offices/registrar/forms](https://www.wpi.edu/offices/registrar/forms)
- “Courses”
  - BME 598 = Directed Research
  - BME 599 = Master’s Thesis
  - BME 699 = PhD Dissertation (only after passing Qualifying Exam)
Laboratory Rotations

• No formal rotation program
  • OPTIONAL!!
  • Must be arranged individually with faculty research advisor for timing and number of credits
  • Usually 2 rotations (1 rotation per semester)
  • Identify research advisor at end of 2nd rotation
Additional Program Information and Final Thoughts
Financial Aid, Fellowships

• Apply for graduate funding if eligible!
  – Gives you flexibility: conference travel, research directions, materials, etc.
  – Great for your CV!
  – Lists available on.... [https://wp.wpi.edu/bme/grad](https://wp.wpi.edu/bme/grad)

• BS/MS – consider your courses to ensure maintaining status required for financial aid

• Teaching Assistantship and Peer Learning Assistant opportunities
Expectations & Advice

- Nothing worth having comes easily.
- Keep your eyes on the prize.
- Follow through to tangible milestones.
- Socialize and build friendships and work colleagues.
- Difficult experiences are learning experiences.
- Hang in there. It will get tough, and will get better!
- Best students will feel the most pressure.
- Consider every opportunity and take advantage.
- Ask for help, but be mindful of others.
Questions??

- Don’t forget to check FAQ’s on [http://wp.wpi.edu/bme/grad](http://wp.wpi.edu/bme/grad)!
  - Bookmark this!
  - E.g. BS/MS what to double count, etc.
Extra Slides
Degree Milestones, Graduation Requirements, and Additional Information
Master’s Thesis Proposal

Purpose: Committee approves plan for completing MS Thesis

Prepare a document and presentation with proposal of plans (within 6 months of identifying research advisor)

Present plans to committee for review and undergo examination from committee

Outcomes: Pass or Repeat
PhD Qualifying Examination (QE)

• Prepare an original NIH-style research proposal and presentation to defend to your Qualifying exam committee
  • Demonstrate proficiency in: Biomedical Engineering (2 areas), Life Science (1 area), and Mathematics (1 area)

• Outcomes: Unconditional Pass, Conditional Pass, Fail (with opportunity to re-take exam within 6 months)

• Other details:
  • Must pass QE to advance to candidacy
  • Taken before start of 5th semester enrolled (usually by summer after 2nd year)
  • 4 QE committee members selected by the Graduate Studies Committee

Detailed information in the BME Graduate Program Handbook
PhD Qualifying Examination

• Process

Step 1: Specific Aims meeting
• Aims page sent 24 hours prior to meeting
• Meet with QE committee
• 1 hr session – 15-20min Presentation with feedback (not Q&A)

Step 2: Send full proposal
• 3 weeks after initial Aims meeting
• Submit Aims page + 12 page proposal

Step 3: Examination
• ~1 week after submitting proposal document
• 2 hr session – 20-30 min Presentation + Proposal defense/Q&A
PhD Qualifying Examination

• Possible outcomes
  – **Pass** – advance to candidacy
  – **Conditional Pass** – must fulfill some requirement, as determined by the committee, before advancing to candidacy
    ▪ E.g., Take an additional course; Update document, etc.
  – **Fail** – repeat the QE process entirely within 6 months
    ▪ Only possible outcomes after re-do are Pass or Fail
    ▪ If QE is unsuccessful the 2\textsuperscript{nd} time, student will exit the PhD program

• Detailed information in the BME Graduate Program Handbook ([https://wp.wpi.edu/bme/grad/](https://wp.wpi.edu/bme/grad/))
# Additional PhD Milestones/Requirements

## Committee Meetings
- Feedback opportunities
- Within 6 months of QE
  - Select committee members
- Have first committee meeting
- Meet with committee every 6 months

## Dissertation Proposal
- Sign-off on dissertation plan
- Meet within 1 year of QE
  - Prepare NIH-style proposal of plans
  - Present plans to committee for review
- Outcomes: Pass or Repeat

## Publication Requirement
- 1 publication under review before graduating
  - First author
  - Topic – Related to your dissertation work
  - Review papers are great but do not count toward the requirement

## Dissertation Defense
- Time to graduate!
- Submit dissertation document to committee
- Public presentation + Q&A (1 hour)
- Private defense with committee (~2 hours)
Getting Around Gateway (50 & 60 Prescott)

• Visitor parking lot next to Life Sciences and Bioengineering Center (LSBC) building (West Lot next to 60 Prescott) – *but can’t park there!*

• Gateway parking lot & garage, with permit
  – [https://www.wpi.edu/offices/police/vehicle-registration-permits](https://www.wpi.edu/offices/police/vehicle-registration-permits)

• Gateway Shuttle runs to main campus during business hours and picks up behind LSBC (between building and parking garage)
Getting Around...

• Shuttles
  – Gateway Shuttle, 7a – 6p to main campus
  – SNAP: Nightly within 1 mi, 5 or 6p til 3am, between campus locations, pharmacies, Union Station via TransLoc app
  – Price Chopper supermarket, 4 – 8p
  – South Village, 7a – 6p

• Zipcar

• Bikeshare
Courses – Examples

See BME Grad Handbook!

• Life Science Requirements:
  – BME562* Laboratory Animal Surgery (Fall)
  – BME560* Physiology for Engineers (Spring)
  – BME564* Cell and Molecular Biology for Engineers (Spring)
  – Graduate courses in biology (BBT) or biochemistry (CBC)
  
  *Note: these courses count as Life Science, not BME or Engineering!

• Math Requirements:
  – MA501 Engineering Mathematics
  – MA511 Applied Statistics for Engineers and Scientists

• Other Engineering:
  – Graduate (500-level) courses in Materials Science, Mechanical Engineering, Manufacturing, Chemical Engineering, Electrical Engineering, etc.

• Other Electives:
  – MIS576 Project Management
  – BB551 Research Integrity (1 credit seminar)
  – Business/management courses, computer science, any grad course

New courses are always being added across campus, so if you have questions on if something counts, just ask!
Applying for Graduation

- Download and fill out a “WPI Graduate Student Application for Graduation”
- Registrar’s web site – Forms/Graduate Forms/Graduate Student Application for Degree
- Must be signed by Academic Advisor and Graduate Program Director
- **Note Deadlines!!!**
  - You are responsible, don’t wait for your advisor or the department to tell you
Research Spaces: Practice Point

“A space for engineers and researchers to test and iterate on new devices and health technologies in simulated point of care environments.”

- MRI Imaging Suite
- Patient Clinical Care Suites
- Home Health Suite
- Motion Capture Suite
- Neurotech Suite
- Manufacturing and Testing Instrumentation
Research Spaces: CERES

“State-of-the-art equipment for all of your cell engineering research needs.”

- Automated liquid dispensing systems
- Automated cell imaging and multimode plate reading
- Quantitative analysis of gene expression
- Flow cytometry (3-laser and 4-laser cytometers; analysis only, no sorting)
Other facilities around WPI

Lab for Education & Application Prototypes (LEAP)
Part of the national AIM Photonics initiative, LEAP@WPI/QCC supports the integrated photonics manufacturing sector

Rapid Prototyping (RP)
Includes technologies, including 3D printing. WPI has executive level RP machines managed by Academic & Research Computing (ARC) Center staff.
UMass Chan Medical School

- Less than 2 miles from LSBC
- Collaborative research groups
- BME graduate students can take classes (transfer credits)
- Core research facilities
  - 3D printing
  - Advanced MRI
  - Bioinformatics
  - Microscopy
  - Genomics
  - Flow cytometry
  - AND MANY MORE!