

# **GRADUATE HANDBOOK**

**Department of Biomedical Engineering  
College of Engineering and Applied Science  
University of Cincinnati**

**2023/2024**

**Updated August 2023**

Dear BME Graduate Students,

Welcome to the Graduate Program in Biomedical Engineering (BME) at the University of Cincinnati, part of the BME Department within the College of Engineering and Applied Science (CEAS). We are proud to offer you the opportunity to study with our diverse BME graduate faculty, who span the disciplines of engineering and medicine, including regenerative medicine, biomechanics, medical imaging, bioinformatics, image-guided therapeutics, and medical device innovation and entrepreneurship. These faculty also span the UC campus, including the Colleges of Engineering and Applied Science, Medicine, Arts and Sciences, and Allied Health Sciences, as well as Cincinnati Children's Hospital Medical Center.

Our Graduate Committee has conducted a rigorous evaluation process in selecting you to join a superb group of graduate students in these technical focus areas. Our aim is to provide you with a personalized, rigorous graduate educational experience, centered on one-on-one mentoring by your faculty advisor. Our curriculum is designed to be focused, yet flexible enough to permit students to concentrate on their research and career interests, as well as areas requiring development. Our graduate program policies are designed to embody a firm commitment to academic excellence and maintain a reputation for high quality, thus increasing the value of your degree, while enabling faculty to advocate for your success with kindness and compassion.

This handbook documents general policies and procedures for our graduate program, as well as specifics of our Master of Engineering (MEng), Master of Science (MS), and Doctor of Philosophy (PhD) programs. In Chapters 1 and 2, we describe the application and admission process as well as registration procedures, graduate credit requirements, grading, and other general policies. The MEng (Chapter 3), MS (Chapter 4) and PhD (Chapter 5) Programs are also described in detail, including course requirements, minimum academic performance expected, and specific requirements for completion of each degree. The handbook concludes with Special Rules and Provisions. We encourage you to become familiar with this handbook, as it provides valuable information as you proceed through your personalized program of study. Additional relevant policies and procedures are found in the UC Graduate School Handbook, which can be found on the UC web site (<https://grad.uc.edu/fac-staff/handbook.html>).

Our hope and expectation is that you will be successful in your pursuit of a graduate degree at UC, and that your progress through our graduate program will provide the necessary foundation for a distinguished career in academia, industry, or medicine.

Best regards,

T. Douglas Mast  
Professor of Biomedical Engineering  
Director of Graduate Studies

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## PREFACE

All graduate students in the BME program should familiarize themselves with the contents of this handbook, including the latest available version. Our hope is that most questions will be answered, and difficulties will be avoided. It is recommended that graduate students retain the handbook for their personal use throughout their degree program. All students are expected to be thoroughly aware of, and conform to, all the requirements and regulations of the graduate Biomedical Engineering program.

Students are expected to follow guidelines from the handbook published at the time of first enrollment in their BME graduate program, but if there are discrepancies, students also have the option to follow the most recent version of the guidelines which can be found on the BME web site:

<https://ceas.uc.edu/academics/departments/biomedical-engineering/graduate-programs.html> .

If choosing to deviate from guidelines published at the time of their first enrollment, students must inform the BME Graduate Program Director and Coordinator of their choice.

Students are also required to follow all institutional policies described in the Graduate Handbook of the UC Graduate School: <https://grad.uc.edu/fac-staff/handbook.html> .

The policies of this handbook are intended to be entirely consistent with UC institutional policies, and any discrepancies should be brought to the attention of the BME Graduate Program Director. In some extenuating circumstances, petitions for exceptions to the requirements described in this handbook can be submitted to the UC Graduate School, after review and approval by the BME Graduate Program Director. Allowable exceptions are described in the Graduate Handbook of the UC Graduate School.

## Chapter One

### Application, Admissions, and Financial Aid

#### Application Process

All applicants to the University of Cincinnati BME Graduate Programs should refer to the UC Graduate School web site regarding the application process: <https://grad.uc.edu/admissions.html>

Answers from the UC Graduate School to frequently asked questions are available at the web site: <https://grad.uc.edu/admissions/faqs.html>

#### Application Materials

Materials should be uploaded to the online web site Catalyst (<https://grad.catalyst.uc.edu/apply/>), following the instructions provided there and in this handbook.

You must submit the following:

- Transcripts – Official transcript from every university attended for undergraduate and graduate coursework
- Application Fee – The application fee must be paid on-line at the time of the application with a credit card (Visa, MasterCard, or Discover) or electronic check. The application fee is \$75.00 for domestic students and \$80.00 for international students.
- Letters of Recommendation – Two letters of recommendation are required. It is optional to submit more than two. All letters submitted will be reviewed.
- Official Standardized Test Scores
  - GRE – This is required for some applicants (see below) and must be submitted electronically to UC. The average scores accepted for the GRE test are about: 155 Quantitative, 155 Verbal and 3.5 Analytical Writing. The University code for GRE is 1833, and a department code is not required. For testing information please go to the ETS website for GRE information: <https://www.ets.org/gre/>
  - International students must also submit proof of English language proficiency (See below).

#### Admission Requirements for BME Graduate Programs

##### MS and PhD programs

- BS, MS, or MEng in Engineering, Material Science, Biology, Computer Science, Physical Science (physics or chemistry), or other science-related majors
- Submission of GRE scores is optional for applicants with a BS, MS, or MEng degree from an accredited, US-based program in Engineering, Material Science, Biology, Computer Science, Physical Science (physics or chemistry), or other science-related majors with a GPA of 3.0 or higher
- For students not meeting above eligibility requirements: GRE score of 150 or higher (on both the verbal and quantitative sections); 3.0 or higher (analytical writing)
- 3.0 minimum grade point average (based on 4.0 scale)

##### MEng program

- BS in Engineering, Material Science, Computer Science, or Physics
- Submission of GRE scores is optional for applicants with a BS degree from an accredited, US-based program in Engineering, Material Science, Computer Science, or Physics with a GPA of 3.0 or higher
- Submission of GRE scores is mandatory for all other applicants

### English requirements for international students (all programs)

- Demonstration of English proficiency is required for students whose native language is not English, including those with F-1 visas and green cards.
- English requirements can be fulfilled by taking the Test of English as a Foreign Language (TOEFL), the International English Testing System (IELTS), the PEARSON Test of English (PTE), or the Duolingo English Test. Test of Spoken English (TSE) is not accepted.
- Test scores are valid for up to two years.
- Official scores of standardized tests must be submitted electronically to UC, institutional code 1833 (department code not required)
- Although applications for graduate program admission can be submitted before English tests are taken, application packages are not considered complete until required scores are received. It can take up to six weeks for UC to receive official test score results.
- Minimum English test score requirements for admission:
  - TOEFL (Internet based): 92 for BME program (UC institutional code 1833; department not required)
  - IELTS: overall score of 6.5
  - Pearson Test of English: score of 54
  - Duolingo English Test: score of 110

### **Admission Application Deadlines**

The deadline for applications is January 15<sup>th</sup> for applicants to be automatically considered for financial aid for Fall admission. The final deadline for Fall admission is March 31<sup>st</sup> for international students and June 1<sup>st</sup> for US citizens. Applications received after the January 15<sup>th</sup> deadline may be considered for financial aid if funding is still available. The current policy of the BME Graduate Studies Office is Fall semester admission only. However, we may also accept Spring admission for special circumstances, which are reviewed on a case-by-case basis.

PhD and MS applications received by December 5 will be given priority consideration for admission and for invitation to the in-person BME graduate recruitment event, held early the following year. In addition, PhD applications received by December 5 are eligible for a waiver of the required application fee.

### **ACCEND Programs**

BME also offers MS and MEng admission through the CEAS Accelerated Engineering Degree (ACCEND) program, which provides CEAS undergraduate students the opportunity to earn a BS plus a Master's degree within 5 years. Undergraduate students can apply for the ACCEND program after completion of two academic terms and through their fourth (junior) year with a cumulative GPA of at least 3.2.

Students within the BME ACCEND Master's programs can complete graduate coursework in parallel with their undergraduate coursework. Requirements for completion of the MS or MEng degree are the same as for other students in those programs, as described in following chapters. Courses used toward fulfillment of undergraduate degree requirements cannot be applied toward graduate degree requirements (e.g., a required undergraduate co-op semester cannot be counted as an MEng capstone project). Further information is provided at the site:

<https://ceas.uc.edu/academics/degrees-programs/undergraduate/accelerated-engineering-degree.html>

### **Financial Aid**

Terms and conditions of financial aid will be stated in your offer letter at the time of your initial admission. Offer letters are then issued for annual appointments in subsequent academic years of your studies.

There are five types of financial aid offered by UC:

- Graduate Incentive Award (GIA)  
This is a scholarship that covers a major portion of tuition costs for the student. After the period of the student's initial offer, applications for GIA must be submitted annually to the CEAS Graduate Studies office.
- Research Assistantship (RA)  
This assistantship provides a monthly stipend to provide research assistance to faculty.
- Teaching Assistantship (TA)  
This assistantship provides a monthly stipend to provide teaching assistance to faculty.
- Graduate Assistantship (GA)  
This assistantship provides a monthly stipend to provide research, teaching or departmental duties.

Financial aid is not normally terminated during the period for which it has been granted. However, for serious reasons such as poor academic performance (e.g., less than 3.0 GPA), teaching or research duties, or moral turpitude, a dismissal hearing by the Graduate Committee may be convened. If the dismissal hearing warrants it, the Graduate Program Director may terminate a student's support prematurely.

### **Health Insurance**

For students supported by graduate assistantships or fellowships, the UC Graduate School also offers support for student health insurance via the Graduate Student Health Insurance (GSHI) award. The award amount varies from year to year, but typically covers a majority of the UC student health insurance fee for Fall and Spring semesters. Applications for GSHI awards are due early in fall semester for the current academic year. Further information is given at the web site:

<https://grad.uc.edu/student-life/awards/gshi.html>



## Chapter Two

### General Policies

#### Registration Requirements

A graduate student must be registered in the UC Graduate Division in order to earn graduate credit. However, unclassified students may be eligible to apply specific course credits towards their degree if later admitted into the Graduate Program.

Within CEAS programs, graduate courses are numbered at the 6000 level and above, while CEAS courses listed at the 1000 through 5000 levels are strictly undergraduate courses. Students taking courses at the 5000 level or above from other UC colleges should verify that these courses will be counted toward their graduate degree.

All MS and PhD students are expected to register for at least **fifteen (15)** graduate credit hours (courses at the 6000 level or above) per semester for Fall and Spring semesters for the first year and a half. BME students, if not taking summer courses, can maintain full-time status without registration in summer semester. The recommended course load is 15 graduate credit hours per semester.

Most international students, under the terms of their visas, must be enrolled as full-time students in all semesters (Fall and Spring).

All full-time students receiving the GIA scholarship should register for at least 15 credit hours each Fall and Spring semester. Students do not need to register for summer semester if not taking summer courses. The 15-credit-hour policy applies to students funded on grants or other funding (e.g. UGA, URA, and UTA).

However, students that are not supported by grants or other funding, have completed all required course work, and have the required number of research/thesis/dissertation hours can register for one credit hour each academic year, or one credit hour for Fall/Spring semesters if using University facilities or resources. International students have to submit an online request for reduced course load, and must register for at least one credit hour for Fall and Spring semesters and also while on Curricular Practical Training (CPT) if authorized for CPT. There are two steps to this process:

(1) Submit a request for reduced course load on iBearcatsGlobal:  
<https://www.uc.edu/about/international/ibearcatsglobal.html> ,  
listing the BME Graduate Program Coordinator for the “advisor” name and email

(2) Submit a request on iEngineering via the CEAS website:  
<https://www.ceas3.uc.edu/iEngineering/> .  
This is an official approval process to ensure that international students remain in status with their visa.

The Ohio Board of Regents denies state subsidy for graduate students who have earned 174 or more graduate credit hours. Graduate students that have accumulated 174 or more graduate credit hours are not eligible for financial aid from general funds (GIA, TA and GA), and may register for only one credit hour each academic year, or one credit hour for Fall/Spring semesters if using University facilities or resources.

Further information on registration is available from the UC registrar site:  
<https://www.uc.edu/about/registrar/registration.html>

#### Course Credit Requirements

Each graduate program has specific requirements for minimum completion of course credits, including limits set on the amount of work completed at other institutions that can fulfill UC graduate degree requirements,

subject to the approval of the Director of BME Graduate Studies. Policies for credit requirements are as follows:

#### Master of Engineering Degrees (MEng)

The minimum requirement for this degree is one academic year of full-time graduate study, or its equivalent. Eligibility for graduation requires a minimum of 30 graduate credit hours, the latter half (or 15) of which must be completed while in residence at the University of Cincinnati. The capstone project can be between three-six (3-6) credits. No thesis is required for this degree. Unless otherwise specified in the MOU between UC and the student's previous institution, a student with previous graduate work at another institution that has not been used towards a degree may petition the Graduate Program Director to transfer up to 9 semester credit hours of relevant course work with grades of 'B' or better.

#### Master of Science Degrees (MS)

The minimum requirement for this degree is one academic year of full-time graduate study, or its equivalent. Eligibility for graduation requires a minimum of 30 graduate credits, the latter 15 of which must be completed while in residence at the University of Cincinnati. At least 9 credit hours of MS thesis research must be completed at UC. A student who has previous graduate work at another institution that has not been used towards a degree may petition the Graduate Program Director to transfer up to 6 semester credit hours of relevant course work with grades of 'B' or better.

#### Doctoral Degrees (PhD)

This degree is conferred on the basis of extensive study and high scholarly attainment in a special field of learning. In no case, however, will the degree be granted for less than three years of full-time graduate study or its equivalent. Eligibility for graduation requires a minimum of 90 graduate credits. At least the last 30 graduate semester credits, including at least 15 semester credit hours of relevant course work, must be completed under the direction of UC Graduate Faculty. A student who has previous graduate work at another institution that has not been used towards a degree may petition the Graduate Program Director to transfer up to 18 semester credit hours of relevant course work with grades of 'B' or better and up to 10 dissertation research credit hours.

#### PhD Degrees in the MSTP program

This degree is offered by BME with the cooperation of the Medical Scientist Training Program (MSTP, <https://med.uc.edu/education/medical-student-education/dual-programs/mstptraining/>) supported by the UC College of Medicine and Cincinnati Children's Hospital Medical Center. PhD students typically complete their first two years of medical school and then shift their study to graduate school training in one of the UC graduate programs (e.g. BME program), with a target of completing PhD studies within 3.5 to 4 years. Upon successful completion of a PhD dissertation, students then return to medical school and complete their final two years of clinical training. With approval of the MSTP program director, this path may be modified under special circumstances. The requirements for a PhD degree for students undergoing the MD/PhD route are essentially the same, except that for MSTP students, the General Medical Sciences and Approved Technical Electives coursework requirements can be met by courses taken within their MD program curriculum.

### **Leaves of Absence**

Students may request a leave of absence from the program, for a period of up to one year. Assuming appropriate documentation is provided, the circumstances justifying a leave include but are not limited to personal or family medical conditions, call to active military duty, maternity leave, or death in the student's immediate family. The rationale must be documented by the applicant. Such requests must be made in writing to the Director of BME Graduate Program and must be endorsed by the student's advisor. Additionally, a request for an official leave of absence must be approved by the Graduate School by submitting a Request for Leave of Absence form via the online Grad Tracker system. Instructions can be found at the following link: <http://grad.uc.edu/student-life/policies/forms.html>. The request will go to the Graduate School for review and final approval. If an official leave of absence is approved by the Graduate School, the time away will not count towards the student's time-to-degree. Upon return to the program the student's status will be the same as when he/she began the leave. Students, however, are cautioned that

if they had financial aid at the time of the leave, there is no guarantee aid will be available when they resume their studies at the end of the leave.

Unofficial leaves of absence or vacations during the academic year may not be taken. Students who do so may have their financial aid withdrawn and/or may be placed on probation or dismissed from the program by the Graduate Program Director.

Requests for maternity/paternity leave must be made in writing to the Graduate Program Director. Under normal circumstances, it is anticipated that students who request maternity/paternity leave will be granted up to 8 weeks continuous absence. During such leave, necessary registrations will be maintained, and the stipend will be paid for the 8-week duration of the leave; however, it is anticipated that students afforded such leave will take no additional vacation leave for the balance of the academic year. Under exceptional circumstances the 8-week period can be extended, but the Graduate Program Director must be informed and medical certificates of justification provided in such instances. In no case will stipend be paid for more than an 8-week period of absence.

### **Absenteeism**

For extended absence greater than two weeks, communication with your research advisor or the Graduate Program Director is imperative. Without such communication or establishment of an official request for a leave of absence, automatic dismissal from the BME graduate program will precede one month after a probationary letter is sent warning the student of extended absenteeism.

### **Grading Practices**

The BME program uses the grading practices and scales specified by the UC Graduate School:

<https://grad.uc.edu/content/dam/refresh/grad-62/docs/policy/handbook.pdf>

<https://www.uc.edu/about/registrar/grades-and-transcripts/transcript-ordering/grading-scales.html>

UC graduate courses graded on a letter scale cover the range A (excellent) through C (satisfactory) for passing grades and F for failing grades. If a student receives a grade of F in a graduate course, the student must retake the course or its approved equivalent. Upon receiving a grade of A, B, or C after retaking the course, the F grade will remain on the student's record and will still be considered in calculating the student's grade point average.

Students in the UC BME graduate programs are expected to maintain a cumulative grade point average (GPA) of at least 3.0. Falling below this minimum requirement may cause the student to be placed on academic probation, following policies specified in the following chapters for each degree program.

### **BME Graduate Student Association**

The Graduate Student Government (GSG) at the University of Cincinnati is the primary organization representing all graduate students and strives to make the graduate student experience as beneficial as possible. Some roles of the GSG include advocating on behalf of the graduate student population and providing funding for activities (e.g., conference travel, research, and group events) that enhance the graduate student experience. The GSG is served by several member groups that represent each academic department at UC, also known as Graduate Student Associations (GSA). More description of the UC GSG can be found on their website: <https://www.uc.edu/campus-life/grad-student-gov.html>

The graduate students in Biomedical Engineering have their own GSA (BME GSA) that coordinates events, meetings including speakers of interest, and communications with BME leadership. BME graduate students may contact the current BME GSA officers with any questions or comments about graduate student life (contact information found on the GSG web site under "About us / GSG Member Groups List / Biomedical Engineering"). To familiarize themselves with available resources at UC, BME graduate students are

encouraged to attend orientation events conducted by GSG in August and by the BME GSA within in the first few weeks of fall semester.

### **Annual Progress Reviews**

All BME graduate students in the PhD, MS, and MEng programs are expected to complete an annual progress review, using the form provided in the Appendix. Forms should be completed by each graduate student with their faculty advisor and submitted to the BME Graduate Program Director by May 31 each academic year.

## Chapter Three

### Master of Engineering (MEng) Degree Program

The BME Program offers courses of study leading to the Master of Engineering (MEng) Degree in Biomedical Engineering. The MEng degree is distinguished from the Master of Science degree in that it is a practice-based Professional Master's degree with no research thesis requirement. Instead of a research thesis, students are required to complete a capstone project in an area of their interest. The MEng curriculum provides skills and expertise that enhance the individual's ability to contribute to the technical workforce. The degree is intended to provide professionals in the technical workforce an opportunity to continue their education and development in the context of an advanced degree. The MEng serves the practicing engineer to further his/her career in the context of an application of engineering knowledge, as opposed to a Master of Science degree in a research context, which is focused on discovering new knowledge.

BME MEng students must satisfy requirements of both the BME program, as described in this handbook, and the CEAS MEng program, as described in the College-level handbook, available from the site: <https://ceas.uc.edu/academics/degrees-programs/graduate/master-of-engineering.html>

If an apparent contradiction between these requirements is perceived, students should follow the BME requirements, but should also inquire with the BME Graduate Program Director and MEng Advisor to resolve any questions.

#### Master of Engineering Curricular Requirements

<i>Course</i>	<i>Semester Credit Hours</i>
<b>MEng Program Core Courses</b>	<b>4 – 8</b>
<b>BME Track Courses</b>	<b>10 – 15</b>
<b>BME-MEng Approved Technical Electives</b>	<b>6 – 9</b>
<b>BME-MEng Capstone Project (BME 8060)</b>	<b>3 – 6</b>
<b>Total Graduate Credit Hours</b>	<b>30</b>

Courses taken at Institutes under the quarter system will be counted toward the above curriculum requirements at a rate of 1.5 quarter hours per semester hour.

The required curriculum for BME MEng students is provided in the Appendix of this Handbook.

#### Planning the BME-MEng Degree Curriculum and Program of Study

For the purposes of planning the MEng curriculum, students should rely on the MEng Curriculum Courses section in the Appendix of this Graduate Handbook as well as the UC OneStop web site to ensure that the courses are actually being offered for the semester under consideration.

**MEng Core Courses** - BME-MEng students are required to take a minimum of 2 “MEng Core” courses (one from the Project/Task Management category and one from the Professional Skills category) that are common to all MEng students within CEAS. The MEng Core courses provide skills in the effective practice of engineering recognizing that for experienced practitioners, effectiveness includes technical skills, project and task management skills, and interpersonal skills. These courses should be chosen from the list provided in this handbook (see MEng Curriculum Section) or from updated lists provided by the CEAS MEng office. Note that this course list is not comprehensive, and new courses can be petitioned on a case-by-case basis to be added to this pool of core courses.

**BME-MEng Track Courses** - MEng students in the BME track are required to take a minimum of four BME-listed, graduate level courses (10-15 credit hours total). These can be chosen from the courses in all BME

focus areas, and specifically any BME-listed course at the graduate level (6000 or higher). This means that both “BME Core” and “BME Focus Area” courses with a BME designation can be used as a MEng BME track Course (see Table 1 and the MEng Curriculum Courses section of the Appendix for further clarification).

**BME-MEng Electives** - BME MEng students need to complete a minimum of 2 elective courses (at least 6 credit hours) as part of their MEng curriculum (refer to the MEng Curriculum section in the Appendix). These electives should provide breadth, depth, or interdisciplinary focus relevant to the student’s educational objectives. These can be graduate-level courses from any discipline, as long as they meet the students’ career goals and are approved by the BME MEng Program Advisor.

**BME MEng Capstone** - BME MEng Students are required to complete a capstone experience per CEAS MEng handbook requirements (3-6 credit hours). In BME, it is expected that the capstone will demonstrate applications of biomedical engineering skills and synthesis of knowledge acquired in course work. If additional capstone credit hours are taken above the 6 credit hours maximum, they do not count toward the student’s other course requirements. With the College MEng advisor’s approval, students can choose to: (1) complete a project, (2) perform an internship, or (3) prepare a written paper under the supervision of the capstone advisor. Please see the CEAS MEng handbook (included as an Appendix to this handbook) for guidelines on approval and reporting for all these capstone options.

- **Project** – A capstone project, performed with the supervision of UC faculty to be identified by the student, is focused on the application of principles and the practice of engineering and is not meant to be a mini-thesis. Capstone projects provide a mechanism to demonstrate a synthesis of knowledge and the application of advanced concepts learned in class to a specific problem. A project includes a written report and a final presentation. The report will be read by the BME MEng Program Advisor and the CEAS MEng Advisor, either of whom may require changes before approval. If the project is performed in conjunction with work duties, the report and presentation should also be given to the student’s employer.
- **Internship** – Students can choose to perform an internship if this furthers their learning and career goals. Internships comprise employment related to biomedical engineering practice. Placement in internships is not guaranteed; identification of an employer is the student’s responsibility. Students are encouraged to contact the director of the CEAS MEng Internship Program for help with identifying and applying for internship opportunities.

Students selecting this option will also prepare a report, to be approved by the BME MEng Program advisor and the CEAS MEng advisor, that describes knowledge gained through the work experience and how this furthered their career goals. Internships are typically approved for 3 to 6 months. International students can be approved for Curricular Practical Training (CPT) to participate in an internship. Students cannot apply for CPT until two semesters of study are completed. CPT can only be provided prior to graduation and terminates upon graduation. The maximum duration for which CPT will be approved is 25 weeks.

- **Paper** – A written paper can be completed under the supervision of the student’s capstone advisor and must be approved by the BME MEng Program advisor. The paper will address a topic related to the discipline (focus area) and requires the integration of multiple topics within that discipline. These papers should have a substantial technical content and address a topic area with significant analysis and technical rigor. Simple literature review papers are not deemed acceptable.

### **Capstone Project Planning:**

- In Fall semester of their first year, students should begin planning of their capstone project including the identification of a project topic and a supervisor for the capstone project, internship, or paper.
- Students should register for their Capstone Project as a 3 to 6 credit-hour course in Spring semester of their first year, to start work on the project and either complete it for Spring

graduation, or alternately complete the project in the summer or Fall term if needed. If the capstone project is not completed in the Spring term, the student may receive a “P” (pass) grade to fulfill UC grading requirements; however, the student’s graduation will not be certified until the Capstone Project has been approved by the BME MEng Program advisor and the CEAS MEng advisor.

A detailed summary of MEng Curricular Requirements is provided in Table 1 below, which also shows how the CEAS MEng curriculum structure can be mapped to the BME curriculum.

**Table 1. Typical plan for a full-time BME MEng student**

	Fall Semester	Spring Semester	Comments/Clarification
<b>MEng Core Courses</b>	Core Course #1	Core Course #2	These should be picked from the MEng Curriculum Courses section of this handbook.
<b>BME MEng Track Courses</b>	Track Course #1	Track Course #3	These should be picked from the BME-MEng Curriculum Courses section of this handbook
	Track Course #2	Track Course #4	
<b>MEng Elective Courses</b>	Elective #1 Elective #2	Elective #3	These can come from any available graduate level engineering, science, medicine, business, or law course that is relevant to the student’s career goals as determined via discussion with the Graduate Program MEng advisor, and approved accordingly by the advisor.
<b>MEng Capstone Project</b>		Capstone Project	See section above on BME Capstone Requirement
<b>Total Minimum Credit Hours per semester</b>	<b>15</b>	<b>15</b>	

### Minimum Academic Performance

The MEng Graduate Handbook of the UC College of Engineering and Applied Science states that a student must maintain a grade point average (GPA) of at least 3.0 to obtain a Master of Engineering degree at the University of Cincinnati. In addition, at least two-thirds of the minimum graduate credits for the degree must be at the level of 3.0 or higher.

The Biomedical Engineering program has also established the following requirements:

An MEng student must achieve an overall average of B on all graduate coursework. A student in the BME program failing to maintain this B average will be placed on probation for one semester and may be dismissed if his/her overall technical coursework GPA is not restored to a 3.0.

If coursework is repeated, all grades of a repeated course count toward these GPA requirements, but only one instance of the course counts toward the student’s curriculum requirements.

The Graduate Program Director will review graduate students’ grades once they become available after the end of each semester. All graduate students with grade deficiencies will be notified by the Director and reminded of the above requirements. A notice of probation will follow if GPA Falls below the minimum (3.0). Students will have one semester to comply with the terms of probation. If not corrected, a letter of dismissal will be sent.

Please note that remaining in good academic standing (3.0) does not guarantee financial support.

## **Time Limitations**

A minimum requirement for the MEng degree is the equivalent of one academic year of full-time graduate study, consisting of at least 30 graduate credits in one program completed to the satisfaction of the program. All MEng requirements must be completed no later than five years from the date of first registration in the degree program.

## **Other Issues**

For other MEng-related issues, please refer to the CEAS MEng Graduate Student Handbook, available from the page: <https://ceas.uc.edu/academics/degrees-programs/graduate/master-of-engineering.html>

If there is any apparent discrepancy between these two handbooks, BME students should follow the BME graduate handbook, but should also notify the BME Graduate Director and MEng Advisor so that any discrepancies can be resolved.



## Chapter Four

### Master of Science (MS) Degree Program

The BME program offers courses of study leading to the Master of Science Degree in Biomedical Engineering. The research focus areas include:

Medical Imaging and Bioinformatics  
Medical Device Innovation and Entrepreneurship  
Regenerative Medicine and Biomechanics

Master of Science Curricular Requirements:

<b>Course</b>	<b>Semester Credit Hours</b>
Core BME Courses	6
Primary BME Focus Area	6
General Medical Sciences	3
Mathematics	3
Approved Technical Electives	3
Thesis Research (BME7099)	9
<b>Total Graduate Credit Hours</b>	<b>30</b>

Courses taken at institutes under the quarter system will be counted toward the above curriculum requirements at a rate of 1.5 quarter hours per semester hour.

After credit hour requirements for one of the specific categories above (core BME courses, focus area courses, general medical sciences, or mathematics) have been met, additional course credit hours from the completed category may be counted toward the approved technical electives requirement. Any substituted courses for any of the curricular requirements must petition to Graduate Program Director for approval.

The individual curriculum outline (list of courses) for each focus area can be found at the end of this Handbook.

#### Minimum Academic Performance

The Graduate Handbook of the Graduate School (<https://grad.uc.edu/fac-staff/handbook.html>) states that a student must maintain a grade point average (GPA) of at least 3.0 to obtain a Master's degree at the University of Cincinnati. In addition, at least two-thirds of the minimum graduate credit hours for the degree must be at the level of 3.0 or higher.

The Biomedical Engineering program has also established the following requirements:

An MS student must achieve an overall average GPA of 3.0 on all graduate coursework. A student in the BME program failing to maintain a 3.0 GPA will be placed on academic probation for one semester and may be dismissed if his/her overall technical coursework GPA is not restored to a level above 3.0.

If coursework is repeated, all grades of a repeated course count toward these GPA requirements, but only one instance of the course counts toward the student's curricular requirements. Typically, a course is repeated only if a student failed the first attempt, in which case the grade received after the second attempt (assuming a passing grade) will be the instance counted toward the curricular requirements.

The Graduate Program Director will review graduate students' grades once they become available after the end of each semester. All graduate students with grade deficiencies will be notified by the Director and reminded of the above requirements. A notice of probation will follow if GPA falls below 3.0. Students will have one semester to comply with the terms of probation. If not corrected, a letter of dismissal will be sent.

Please note that remaining in good academic standing does not guarantee financial support.

## **Time Limitations**

A minimum requirement for the MS degree is the equivalent of one academic year of full-time graduate study, consisting of at least 30 graduate credits in one program completed to the satisfaction of the program.

CEAS has specified the following policies for MS degree completion. After completing three academic years (9 total semesters, including summer) as an MS student, the student and their advisor must either: (1) formalize a plan for completing the MS thesis within the next academic year, or (2) convert the student's program of study to an MS non-thesis degree. Either plan must be approved by the BME Director of Graduate Studies and the CEAS Graduate Studies Office. If choosing the non-thesis degree, the student will then be provided one more GIA scholarship semester to satisfy their degree requirements. For BME, non-thesis MS requirements are equivalent to the required coursework for standard thesis MS students plus 6 additional credit hours of approved technical electives (27 credit hours total), plus 3 credit hours for a non-thesis MS project, to be supervised by a member of the BME graduate faculty and approved by the BME Director of Graduate Studies. Credits taken by the student for Thesis/Dissertation research will not count towards a non-thesis degree.

Students enrolled in the BME MS program for less than 9 semesters cannot transfer to the MS non-thesis program, but can transfer to the BME MEng program under rules described in the CEAS MEng Graduate Student Handbook, available from the page

<https://ceas.uc.edu/academics/degrees-programs/graduate/master-of-engineering.html>

Transition from an MEng to an MS degree program can be approved for students with a GPA of 3.5+ and a faculty member committing to advise the student for their MS thesis. If this transfer is made, time spent in the MEng program counts toward time-to-degree with respect to BME, CEAS, and UC Graduate School policies.

By the rules of the UC Graduate School, all MS requirements must be completed no later than five years from the date of first registration in the degree program.

## **MS Thesis Requirements**

### Thesis Advisors

MS students must formally identify a research advisor to supervise their MS thesis research. For students who have not been assigned a research advisor before admission, the process is to meet with faculty, discuss research interests and available projects, and mutually agree on a plan to complete the student's MS studies with the faculty member as advisor.

Once a new advisor is identified, the student must complete and submit an Advisor Change Form, available on the CEAS Student Portal (<https://ceas.uc.edu/about/info-current-students/grad/forms.html>), signed by the new advisor and the BME Director of Graduate Studies. This form must be submitted to the Graduate Studies Office either by email ([engrgrad@uc.edu](mailto:engrgrad@uc.edu)) or in hard-copy form (801 Mantei Center).

If the student has not identified an advisor within one calendar year (from the first day of classes in the semester in which you were admitted) the student may be subject to dismissal from the thesis MS program.

If an advisor and/or student is notified of a termination in advising, a meeting with the student will be held by the advisor and department graduate director. The student will have two full, contiguous semesters (spring, fall, or summer semesters) to secure a new advisor, or may be subject to dismissal from the program. For example, if a student is notified of termination of advising during Spring semester 2023, the student must have an advisor identified no later than the last day of Fall semester 2024.

### Thesis Research Projects

In consultation with their MS thesis advisor, the student will select a Research Advisory Committee (RAC). This committee has a minimum of three members of the UC Graduate Faculty, and normally consists of the research advisor (BME primary or secondary faculty) and at least two other appropriate representatives. At least two members of the RAC must belong to the BME Graduate Faculty. The student will then select a research project in consultation with the research advisor and with approval from his/her RAC.

The advisor and the RAC have the responsibility to see that the project is carried out under currently accepted scientific standards. Upon completion of the research, the student's Master of Science thesis will be prepared and defended orally in public.

Meetings between the MS student and their Research Advisory Committee should be scheduled at least once per year, not including the student's thesis defense.

### Thesis Preparation

The Office of the Division of Graduate Education and Research provides graduate degree candidates with detailed information online concerning the written form of the thesis and requirements for preparing the final draft and abstract. Information regarding binding a thesis is available online. Further information on thesis preparation is available at the Electronic Thesis Dissertation FAQ page:

<https://grad.uc.edu/student-life/etd/faq.html>

Other graduation documents required by the Graduate School are available on the student's graduation checklist.

It is the responsibility of the student to ensure their own compliance with these regulations.

A student must submit his/her thesis to the RAC and notify the BME Graduate Program Coordinator no later than two weeks prior to the oral defense.

### Thesis Defense

Prior to graduation, the thesis student will give an oral defense, which is opened to the public. In this defense, the student will give a 30 to 45 minutes presentation of his/her thesis to the RAC. After the thesis presentation, the student will be questioned by the committee on both the thesis, and the subject matter related to the thesis topic. The committee will then meet in private and vote to reach a pass/fail decision. For the student to pass the defense, each member of the Advisory Committee must concur, as affirmed by signing the CEAS "Record of Oral Defense" form.

PDF forms documenting the defense must be submitted by the student to the CEAS Graduate Studies Office (665 Baldwin), and are available at the CEAS student forms portal (scroll down the page to the CEAS Thesis Defense Form):

<https://www.ceas3.uc.edu/CeasStudentPortal/login.html>

Before approving the student's thesis, any committee member may require revisions to the thesis document. Once approved, each committee member will sign the signature form page of the student's dissertation. The student is encouraged to meet with each committee member to be sure that all concerns are understood and resolved. It is the student's responsibility to allow sufficient time for any required revisions after the oral defense and before the deadline for Electronic Thesis/Dissertation submission in the student's desired semester of graduation.

If the defense is failed, the student may repeat the defense at a later date to be arranged through his/her Advisor. A second failure of the defense is disqualifying.

## Publication Permissions

If you plan on including papers you have published in your dissertation, you should obtain permission from the publishers to reprint the articles, either in their entirety or in excerpted form. This will avoid plagiarism flags. Most publishers will be happy to allow you to include your published papers in your dissertation, but you must get permission beforehand. It is also a good idea to preface each inclusion in your dissertation with the phrase, “reprinted with permission from ....” and insert the name of the publisher.

## **Graduation**

**There are also applicable College of Engineering and Applied Science graduation requirements and Graduate School requirements. Please refer to both to ensure that you meet all requirements.**

**CEAS graduation requirements:**

<https://ceas.uc.edu/about/info-current-students/grad/graduation-requirements.html>

**Graduate School graduation requirements:** <https://grad.uc.edu/student-life/graduation.html>

## **Graduation Deadlines**

You must meet the following two University deadlines to graduate: the application to graduate deadline and the Electronic Thesis/Dissertation submission deadline. Failure to do so will delay your graduation to the next semester. The deadlines are firm; the Graduate School does not make exceptions to graduation deadlines. Further information on ETD submission is given at the site:

<https://grad.uc.edu/student-life/etd.html>

To allow sufficient time for review and approval, the final version of the thesis should be distributed to the Advisor and committee members at least two weeks before the ETD submission deadline for that semester.

Graduation deadlines set by the Graduate School for each semester are listed at the site:

<https://gradapps.uc.edu/graduationdeadlines/graduation-deadlines.aspx>

## **Graduate School Checklist**

Please refer to your graduation checklist from the UC Graduate School, accessible from the site:

<https://grad.uc.edu/student-life/graduation.html>

Refer to the submission information listed above to meet deadlines.

## Chapter Five

### Doctoral (PhD) Degree Program

#### Course of Study

The BME Program offers courses of study leading to the PhD degree in Biomedical Engineering. A prospective candidate for the doctorate follows a plan of full time study that ordinarily lasts three (3) years beyond a Master's Degree, or 4-5 years without a Master's degree.

- The first year of study is generally directed toward completing most of the course work in the major area of study.
- The second year of study is generally aimed toward completing all course work, passing the PhD Qualifying Examination, and initiating a dissertation research project.
- The third year and any subsequent years of study are generally focused on completing the PhD Dissertation Proposal and completing the dissertation.

The student's Dissertation Advisor and Dissertation Committee (see requirements below), together with the student, will prepare the student's program of study and submit it to the CEAS Graduate Studies Office for their information and review. The student and his/her committee will endeavor to draft a program with a central emphasis on a particular focus area within Biomedical Engineering, with mathematics and/or other appropriate fields of study in supporting roles.

An important function of the Dissertation Committee is to supervise the study program of the student. The student should request meetings with their Dissertation Committee at least twice per year (not including the dissertation proposal and defense), or when there is an important academic matter to discuss.

A BME PhD student is required to satisfactorily complete a minimum of ninety (90) semester credits beyond the Bachelor's degree and a minimum of sixty (60) semester credits beyond the Master's degree requirements, whichever is greater. Curricular requirements are summarized below.

	PhD ( <i>post MS</i> )	PhD ( <i>Without MS</i> )
<i>Course</i>	<i>Semester Credit Hours</i>	<i>Semester Credit Hours</i>
Core BME Courses	3	9
Primary BME Focus Area	3	9
General Medical Sciences	3	6
Mathematics	3	6
Approved Technical Electives	3	6
Dissertation Research (BME 8099)	45	54
Total Graduate Credit Hours	<b>60</b>	<b>90</b>

Courses taken at institutes following the quarter credit hour system will be counted toward the above curriculum requirements at a rate of 1.5 quarter hours per semester hour. If approved by the BME Graduate Program Director, some courses taken by students toward an MEng degree can also be waived from PhD program requirements, with the exception of the credit hours accrued for the MEng Capstone project.

After credit hour requirements for one of the specific categories above (core BME courses, focus area courses, general medical sciences, or mathematics) have been met, additional course credit hours from the completed category may be counted toward the approved technical electives requirement. Any substituted courses for any of the curricular requirements must petition to Graduate Program Director for approval.

Students in the MSTP (MD/PhD) program may petition to fulfill their curriculum requirements for General Medical Sciences and Approved Technical Electives from course credits earned in their first two years of

study in the medical school portion of the MSTP program, thus reducing their required number of coursework credits by up to 12. The requirement of 90 total semester credit hours remains the same, and can be fulfilled by completing additional dissertation research credits or technical electives.

The individual curriculum outline (list of courses) for each focus area can be found at the end of this Handbook. The research focus areas include:

Medical Imaging and Bioinformatics  
Medical Device Innovation and Entrepreneurship  
Regenerative Medicine and Biomechanics

## **Minimum Academic Performance**

The Graduate Handbook of the UC Graduate School (<https://grad.uc.edu/fac-staff/handbook.html>) states that a doctoral student must maintain a grade point average (GPA) of at least 3.0 in all doctoral course work.

The BME program has established the following requirements: A doctoral student must achieve an overall average of B (GPA 3.0) on all graduate coursework. A 3.0 average or greater GPA is also required for coursework in the BME core courses and the primary focus area courses. If coursework is repeated, all grades of a repeated course count toward these GPA requirements.

A student in the BME Program failing to maintain this 3.0 GPA average will be placed on probation for one semester and may be dismissed if his/her overall technical coursework GPA is not restored to a 3.0.

Graduate students' grades will be reviewed by the Director once they become available after the end of each semester. All graduate students with grade deficiencies will be notified by the Director and reminded of the above requirements. A notice of probation will follow if the GPA falls below the minimum 3.0. Students will have one semester to comply with the terms of probation. If not corrected, a letter of dismissal will be sent.

## **Residency**

The Graduate Handbook of the Graduate School (<https://grad.uc.edu/fac-staff/handbook.html>) stipulates that all doctoral students must meet a residency requirement. Prior to admission to doctoral candidacy, all doctoral students must enroll in at least 10 graduate credit hours per semester for two out of three consecutive semesters of study (including summer). Exceptions to this policy must be submitted for approval to the Graduate Council.

Per CEAS rules, all students must enroll in at least 15 graduate credit hours in Fall and Spring semesters if receiving a University Graduate Scholarship, Graduate Assistantship, or other funding support.

## **Dissertation Advisor**

BME PhD students must formally identify a research advisor to supervise their PhD dissertation research. For students who have not been assigned a research advisor before admission, the process is to meet with faculty, discuss research interests and available projects, and mutually agree on a plan to complete the student's PhD studies with the faculty member as advisor. In some cases, this process is facilitated by assignment of research rotations within the laboratories of BME graduate faculty within the student's first year.

Once a new advisor is identified, the student must complete and submit an Advisor Change Form, available on the CEAS Student Portal (<https://ceas.uc.edu/about/info-current-students/grad/forms.html>), signed by the new advisor and the BME Director of Graduate Studies. This form must be submitted to the Graduate Studies Office either by email ([enrgrad@uc.edu](mailto:enrgrad@uc.edu)) or in hard-copy form (801 Mantei Center).

If the student has not identified an advisor within one calendar year (from the first day of classes in the semester in which you were admitted) the student may be subject to dismissal from the PhD program.

If an advisor and/or student is notified of a termination in advising, a meeting with the student will be held by the advisor and department graduate director. The student will have two full, contiguous semesters (spring, fall, or summer semesters) to secure a new advisor, or may be subject to dismissal from the program. For example, if a student is notified of termination of advising during Spring semester 2023, the student must have an advisor identified no later than the last day of Fall semester 2024.

## PhD Qualifying Examination

All doctoral students in the Biomedical Engineering PhD program are required to pass a Qualifying Examination, in accordance with the rules and guidelines of this BME Graduate Handbook. In order to take the exam, a student must have at least a 3.00 overall GPA.

The Ph.D. Qualifying Examination consists of two parts: (i) Written examination: a research proposal identifying an important problem and demonstrating knowledge of a broader area of research and (ii) Oral examination: an oral presentation based upon the same proposal. Outcome of the Qualifying Examination is based on the qualifying examination committee's assessment of the student's attainment of the following:

1. Understanding of general engineering and biomedical engineering concepts and ability to apply these concepts in research and design.
2. Ability to critically analyze an engineering problem
3. Ability to organize and communicate a body of knowledge
4. Ability to answer questions related to a defined body of knowledge

It is expected that the student should show a thorough understanding of underlying physical and mathematical concepts, and demonstrate the ability to successfully complete an original research dissertation.

Failure to meet any of the requirements described below is justification for failure of the Ph.D. Qualifying Examination.

### Qualifying Exam Committee

Each student's Qualifying Examination is administered by Qualifying Exam Committee convened by the student, with consultation and approval from their research advisor. The Qualifying Exam Committee should consist of at least three members of the UC Graduate Faculty, at least one of whom must be a BME Primary faculty member:

- Research Advisor (Primary or Secondary Faculty in BME)
- One BME Faculty (Primary or Secondary) outside the technical focus area of the research advisor
- One BME faculty (Primary or Secondary) in the research focus area
- Additional members (optional)

### Written Examination

For the written portion of the exam, an application to take the Ph.D. Qualifying Examination must be completed and returned to the graduate office no later than ten days before the published due date of the written examination. The exam topic (proposal title) and Qualifying Exam committee members are specified on the application.

The written portion of the exam consists of a 12-page (maximum for parts A-D) research proposal, double-spaced and 11 point Arial font with 1 inch margins. Although the proposed research plan can be related to the student's ongoing research (e.g., work ongoing in their advisor's laboratory), the proposal must not duplicate work already proposed or planned by the advisor's group, and should not describe future

dissertation research already planned by the student with their advisor. **It is of the utmost importance that the proposal be the product of only the student.**

Students are encouraged to consider writing their Qualifying Examination proposal on a topic suitable for a future application to the NIH Ruth L. Kirschstein National Research Service Award (NRSA) Individual Predoctoral Fellowship (F31) program, or to another predoctoral fellowship program.

The required format for the proposal comprising the student's written examination is as follows. Descriptions given for each section are adapted from proposal preparation instructions provided by the National Institutes of Health (NIH), e.g., those for the Research Strategy section of an F31 (predoctoral fellowship) or R21 (exploratory/developmental research grant) proposal.

*A. Specific Aims*

List the broad, long-term objectives and what the specific research proposed in this application is intended to accomplish, e.g., to test a stated hypothesis, create a novel design, solve a specific problem, or develop new technology. State concisely the goals of the proposed research and summarize the expected outcome(s), including the impact that the results of the proposed research will exert on the research field(s) involved. List succinctly the specific objectives of the research proposed, e.g., to test a stated hypothesis, create a novel design, solve a specific problem, challenge an existing paradigm or clinical practice, address a critical barrier to progress in the field, or develop new technology. **Two pages are recommended. (Excluded from the 12-page limit)**

*B. Significance*

Explain the importance of the problem or critical barrier to progress in the field that the proposed project addresses. Explain how the proposed project will improve scientific knowledge, technical capability, and/or clinical practice in one or more broad fields. Describe how the concepts, methods, technologies, treatments, services, or preventative interventions that drive this field will be changed if the proposed aims are achieved. **Two to five pages are recommended.**

*C. Innovation*

Explain how the application challenges and seeks to shift current research or clinical practice paradigms. Describe any novel theoretical concepts, approaches or methodologies, instrumentation or interventions to be developed or used, and any advantage over existing methodologies, instrumentation, or interventions. Explain any refinements, improvements, or new applications of theoretical concepts, approaches or methodologies, instrumentation, or interventions. **About one half to one page is recommended.**

*D. Approach*

Describe the overall strategy, methodology, and analyses to be used to accomplish the specific aims of the project, include how the data will be collected, analyzed, and interpreted. Discuss potential problems, alternative strategies, and benchmarks for success anticipated to achieve the aims. If the project is in the early stages of development, describe any strategy to establish feasibility, and address the management of any high risk aspects of the proposed work. Point out any procedures, situations, or materials that may be hazardous to personnel and precautions to be exercised. **Five to eight pages are recommended.**

*E. Bibliography*

The written proposal should contain a minimum of 20 references. This part does not count toward the 12-page limit.

*(Optional) Preliminary Studies*

Preliminary studies pertinent to the application may be described to demonstrate feasibility of the proposed research, clarify the proposed methods, or illustrate capability of the investigator to pursue the proposed project. Relevant previous published and unpublished results may be succinctly



described. Inclusion of appropriate figures and tables is encouraged. This optional information may be included within any of the sections B-D and is counted toward the 12-page length limit.

Upon a student delivering his/her written proposal to the qualifying committee, committee members will review it as if on an NIH study section. Each committee member will provide an independent pass/fail decision, although discussion amongst the committee members is allowed and recommended. The student must receive a majority approval to pass in order to schedule the oral exam.

If the student passes, he/she must take the oral exam before the end of the same academic semester. If the student fails, he/she must retake and pass both the written and oral exams by the end of the following semester. The advisor/committee chair should provide the student with the committee's comments regarding the written exam. The student is also encouraged to meet with the qualifying exam committee members individually to receive written and oral comments that can be used in preparation for the oral exam.

### Oral Examination

For the oral portion of the exam, a written seminar announcement must be distributed by the Graduate Program Coordinator to all members of the BME graduate faculty and all BME graduate students, stating the time and place of the presentation, at least two weeks before the scheduled date.

The advisor and student should schedule the oral exam in consultation with the other qualifying exam committee members. In addition, the student must provide the oral exam (title, topic, date, time, and location) to the Graduate Program Coordinator at least two weeks before the oral exam. The oral exam presentation should be advertised so that all BME faculty and students can attend. All BME graduate students are strongly encouraged to attend oral exams in all focus areas.

At the oral exam, the student should present for 30-45 minutes and then answer questions from the audience. This will be followed by a closed discussion between the student and the exam committee, in which the committee may ask questions about the student's written proposal, as well as questions about any other aspects of Biomedical Engineering relevant to the student's focus area and research. The committee should then convene separately, make a decision to pass or fail the student and provide that decision to the student at the end of the examination. If the student passes the oral exam, the committee chair will notify the BME Graduate Program Director and Coordinator to enter into the student's record. A unanimous vote is required to pass the exam.

If the student fails the oral exam, the BME Program Director and Coordinator should also be notified and the student must then reschedule and pass the oral exam before the end of the following semester. *Those students who fail the oral exam a second time will be required to leave the doctoral program by the end of the academic year. Funding is not guaranteed during the period following failure of the qualifying exam.*

### Time requirements

The Ph.D. Qualifying Examination is to begin during the second year of the program and to be completed by the end of the first semester of the third year.

Phase One (by Friday of the 2<sup>nd</sup> week of the semester) – The Qualifying Exam Committee must be in place and the student must turn in the QE form (included at the end of this handbook) to the BME Graduate Program Director and Coordinator. This is notification to the Graduate Program Director indicating the student's intent to take the exam, the suggested topic area to be presented, and signatures of all committee members. The topic may be related to research performed by the student or in their advisor's laboratory.

Phase Two (by Friday of the 6<sup>th</sup> week of the semester) – The student must submit their written proposal to PhD Qualifying committee with a copy to the BME Graduate Director and Coordinator.

Phase Three (by Friday of the 8<sup>th</sup> week of the semester) – The Qualifying Committee Chair will provide their decision (pass or fail) about the written exam to the student and the BME Graduate Program Director and Coordinator. If the student passes, he/she will schedule an oral presentation. If the student fails, he/she will receive a written critique and be permitted to resubmit the written portion of the qualifying exam by the next semester.

Phase Four (by the end of semester) – Deadline for student to successfully complete the oral examination related to the written proposal. A decision (pass or fail) must be provided by the Committee Chair to the student and the Graduate Program Director and Coordinator within one week after the examination.

Students subject to TOEFL requirements (see Chapter 1, Application and Admission) are urged to pass the Oral English Proficiency Test (OEPT) before taking the PhD Qualifying Examination because of the inherent language skills required for the oral portions of the exam. The OEPT typically is given only twice a year (August and March).

A student wishing to depart from these time requirements must notify by petition the BME Graduate Director of his/her intentions. This **written petition**, detailing the reasons for the delay, should be approved **prior** to the scheduled phase of the qualifying exam.

If a student changes their focus area of study, the Qualifying Examination does not need to be repeated.

## **Ph.D. Candidacy**

Admission into PhD candidacy is conferred on students after passing their Dissertation Proposal Defense, following the guidelines described below.

All doctoral students in the Biomedical Engineering program who have passed the Ph.D. Qualifying Examination must have a Dissertation Proposal accepted before they can be admitted into candidacy in accordance with the rules and guidelines of the Division of Graduate Studies and Research as set forth in the UC Graduate Handbook: <https://grad.uc.edu/fac-staff/handbook.html>

The purpose of the Dissertation Proposal is to ascertain the appropriateness of the student's proposed research to constitute a Doctoral Dissertation, as well as the student's ability to carry through with the proposed research. The following specific rules and regulations govern the Dissertation Proposal in the Biomedical Engineering graduate program.

### Dissertation Advisor and Committee

Within 3 months after passing the qualifying exam, the student, in consultation with the Dissertation Advisor, should form an advisory committee that includes a minimum of four committee members of the UC Graduate Faculty (inclusive of the advisor). At least three committee members (including the advisor) must be primary or secondary graduate faculty of the BME program. One of the committee members must be outside the technical focus area of the research advisor.

### Candidacy Examination: PhD Dissertation Proposal

The Dissertation Proposal is a typed document (see guidelines below) detailing the student's proposed Dissertation Research. The student is required to present orally the Dissertation Proposal to his/her Dissertation Committee. The written Dissertation Proposal must be distributed by the student to the members of his/her Dissertation Committee at least two weeks prior to the oral presentation.

After the oral presentation, the Dissertation Committee shall evaluate the Dissertation Proposal and unanimously accept or reject it. The evaluation criteria are:

- The scientific merits of the proposed research, in particular its originality and contribution to the state of the art in the discipline of the proposed research.
- The realism and reasonableness of the proposed research.

- The qualifications of the student to conduct the proposed research.

The result of this evaluation shall be documented by signed College of Engineering and Applied Science forms: <https://www.ceas3.uc.edu/CeasStudentPortal/login.html>

The student's advisor will provide the student with a decision letter documenting the outcome of their Dissertation Proposal defense. If the student has failed, the letter should state what changes are needed before defense of a revised proposal. If the student has passed, the letter should confirm that the Dissertation Committee approves the proposed content of the student's dissertation, while listing any additional expectations for the final dissertation.

***A student who has had a proposal rejected two times shall be asked to leave the BME doctoral program.***

#### Dissertation Proposal Guidelines

- The dissertation proposal is recommended to be completed within 2 years of passing the qualifying exam. The dissertation proposal should be organized in a format approved by the student's dissertation committee chair, and must include the following information:
- Introduction (one page), which can be written as an Abstract or a Hypothesis and Specific Aims page
- Research Plan, incorporating descriptions of each proposed dissertation chapter, including the following information:
  - Brief review of background and relevant literature
  - Preliminary results
  - Proposed additional studies
  - Titles, author lists, and publication records (if already published) or plans (if not yet published) for any journal articles corresponding to each dissertation chapter
- Bibliography (references cited)

The main body of the written proposal (including all sections above except the Bibliography) should be a maximum of 14 pages in length.

The typical expectation for BME students is that the contents of a doctoral dissertation should be equivalent to at least 3 first-authored journal articles, either already published or planned. However, the required content for an individual student's dissertation is to be decided by their dissertation committee.

The dissertation proposal should be presented orally to the student's dissertation committee as a slide presentation. The student should present for 30-45 minutes and then answer questions from the audience. This will be followed by a closed discussion between the student and the committee.

Outcome of the dissertation proposal defense, to be expressed in a written decision letter by the dissertation committee chair, should be either (if the proposal defense is passed) a summary of the content to be required for a successful dissertation, or (if the proposal defense is failed for the first time) on any revisions, additional information, or a second defense needed before the dissertation proposal can be accepted. If second dissertation proposal defense is failed, the student cannot enter PhD candidacy.

#### Candidacy and Time Limitations

As stated in the Graduate Handbook of the UC Graduate School (<https://grad.uc.edu/fac-staff/handbook.html>), a doctoral student shall be admitted into candidacy when he/she has:

- Achieved and maintained a GPA of at least 3.0 in all doctoral course work
- Acceptance of dissertation proposal

At least 7 months prior to graduation, the student must have a Dissertation Proposal presented to and accepted by his/her Dissertation Committee. A completion of PhD Candidacy form must be submitted to the Graduate Program Director at that time. Forms are available on the CEAS website: <https://www.ceas3.uc.edu/CeasStudentPortal/>

(Note: The Graduate School does not track time to candidacy. However, students must complete their doctoral degree—including graduation—within nine consecutive academic years of the date of matriculation into the program.)

A student who changes dissertation advisor and/or Dissertation Committee must still satisfy the last of these time requirements.

Typical timeline:

Year 1 – Select Advisor

Year 2 – Take and Pass the Ph.D. Qualifying Exam

Year 3 – Assemble Dissertation Committee and Prepare Dissertation Proposal

Years 4-5 – Complete Research, write dissertation and defend dissertation

A student wishing to depart from the time requirements listed above shall notify, by petition, the Director of Graduate Studies of his/her intentions. This written petition, detailing the reasons for the departure, should be received and approved prior to the expiration of the time requirements for which departure is requested.

The student who has completed all requirements for candidacy will be officially admitted into candidacy when the advisory department fills out the proper candidacy form, **including the Dissertation Advisor and Committee form**, that can be found at the CEAS student forms portal:

<https://www.ceas3.uc.edu/CeasStudentPortal/>

After completing the forms and obtaining all required signatures, the forms are submitted to the Graduate Program Coordinator for inclusion in the student's official student record. The candidacy forms should be submitted within one month after acceptance of the dissertation proposal.

The doctoral degree will be granted for no less than the equivalent of three (3) years of full-time graduate study.

The maximum time limit for doctoral degree completion is nine (9) years (from the first term matriculated in the PhD program, up to and including graduation).

Candidacy for the doctorate automatically terminates after the nine-year time limit. A student whose candidacy is due to expire may petition the Associate Dean of the Graduate School for an extension of time to attain his or her degree. A student whose candidacy has already expired (and, therefore, moved the student to inactive status) may petition the Associate Dean for a reinstatement into his or her program and extension of time to degree. If reinstatement is approved, **the student will be readmitted to candidacy only after satisfying the formal candidacy examination requirements administered by the department.**

Registration and fee payment for at least one graduate credit hour in each academic year is required for each student if his/her candidacy is not to lapse.

Students who interrupt their graduate studies by withdrawing from the University, either officially or by failing to register for an entire academic year, will be held responsible for the graduate program requirements in force and published at the time they re-enter that program.

## Dissertation and Defense

A student must submit his/her dissertation to the committee and notify the BME Graduate Program Director and Coordinator no later than two weeks prior to the final defense.

### Final Defense of Dissertation

After completing the dissertation, the candidate will give an oral presentation of the dissertation to the Advisory Committee and any other interested (or appointed) members of the Graduate Faculty of the University in an open seminar. The seminar date and place will be given by the student to the BME graduate Program Coordinator for distribution at least two weeks before the final defense.

After the defense presentation and public discussion, the student's Dissertation Committee will discuss the student's dissertation and defense in private and vote to reach a pass/fail decision. For the student to pass the defense, each member of the Advisory Committee must concur, as affirmed by signing the CEAS "Record of Oral Defense" form.

Before approving the student's dissertation, any committee member may require revisions to the dissertation document. Once approved, each committee member will sign the signature form page of the student's dissertation. The student is encouraged to meet with each committee member to be sure that all concerns are understood and resolved. It is the student's responsibility to allow sufficient time for any required revisions after the oral defense and before the deadline for Electronic Thesis/Dissertation submission in the student's desired semester of graduation.

If the defense is failed, the student may repeat the defense at a later date to be arranged through his/her Advisor. A second failure of the defense is disqualifying.

### Publication Permissions

If you plan on including papers you have published in your dissertation, you should obtain permission from the publishers to reprint the articles, either in their entirety or in excerpted form. This will avoid plagiarism flags. Most publishers will be happy to allow you to include your published papers in your dissertation, but you must get permission beforehand. It is also a good idea to preface each inclusion in your dissertation with the phrase, "reprinted with permission from ...." and insert the name of the publisher.

### ETD information

The Graduate School provides graduate degree candidates with detailed information concerning the written form of the Dissertation and the mechanics of preparing the final draft and abstract. Regulations on the Electronic Thesis and Dissertation (ETD) can be found at the web site:

<https://grad.uc.edu/student-life/etd.html>

**It is the responsibility of the student to ensure that he/she is in compliance with these regulations.**

## Graduation

There are both applicable College of Engineering and Applied Science graduation requirements and UC Graduate School requirements. Please refer to both to ensure that you meet all requirements.

CEAS graduate student graduation requirements:

<https://ceas.uc.edu/about/info-current-students/grad/graduation-requirements.html>

UC Graduate School graduation requirements:

<https://grad.uc.edu/student-life/graduation.html>

You must meet the following two University deadlines in order to graduate: the deadline for applying for graduation and the Electronic Thesis/Dissertation (ETD) submission deadline. These deadlines are scheduled once per semester. Failure to do so will delay your graduation to the next semester.

To allow sufficient time for review and approval, the final version of the dissertation should be distributed to the Advisor and committee members at least two weeks before the ETD submission deadline for that semester.

Graduation deadlines set by the Graduate School for each semester are listed at the site:  
<https://gradapps.uc.edu/graduationdeadlines/graduation-deadlines.aspx>

## **PhD Student Awards**

The Biomedical Engineering Program annually presents awards to exceptional graduating PhD students. These awards, which include a cash prize and certificate, are decided by the BME Graduate Committee based on letters of nomination from students' advisors and students' accomplishments during their graduate studies, as described in their curriculum vitae.

## **Appendix**

List of BME Primary and Secondary/Graduate Faculty

Annual Review Form (to be completed by the end of May annually)

Qualifying Exam Form ( to be completed at time of qualifying exam)

Independent Study Form (to be used when taking an independent study course)

BME Graduate Curriculum

See below for a list of BME Primary and Secondary/Graduate Faculty. An updated list can be obtained from the Graduate Program Director.

**Primary and Joint Faculty:**

**Medical Imaging and Bioinformatics**

Hans Charles Breiter, M.D.  
Christy K. Holland, Ph.D.  
Jing-Huei Lee, Ph.D.  
T. Douglas Mast, Ph.D.  
Marepalli B. Rao, Ph.D.  
Jing Tang, Ph.D.  
Thomas Talavage, Ph.D.

**Medical Device Innovation and Entrepreneurship**

Angela Zachman Boronyak, Ph.D.  
Aaron Burdette, M.S.  
Leyla Esfandiari, Ph.D.  
Paul Gordon, Ph.D.  
Jason Heikenfeld, Ph.D.  
Orlando Hoilett, Ph.D.  
Mary Beth Privitera, Ph.D.

**Regenerative Medicine and Biomechanics**

Rupak Banerjee, Ph.D.  
Riccardo Barrile, Ph.D.  
Volha Liaudanskaya, Ph.D.  
John Martin, Ph.D.  
Daria Narmoneva, Ph.D.  
Eric Nauman, Ph.D.  
Stacey Schutte, Ph.D.  
Jason Shearn, Ph.D.

**Secondary/Graduate Faculty:**

**Medical Imaging and Bioinformatics**

Ishita Basu, Ph.D.  
Suzanne Boyce, PhD.  
Zackary Cleveland, Ph.D.  
Charles Dumoulin, Ph.D.  
Kevin Haworth, Ph.D.  
Lili He, Ph.D.  
Long Jason Lu, Ph.D.  
Victoria S. McKenna, Ph.D.  
Jarek Meller, Ph.D.  
Xiaoyang Qi, Ph.D.  
Frank Rybicki, M.D.  
Henry Spitz, Ph.D.  
Laura Walkup, Ph.D.

**Medical Device Innovation and Entrepreneurship**

Michael Archdeacon, M.D.  
Chong Ahn, Ph.D.  
Ephraim Gutmark, Ph.D.  
Kelly Cohen, Ph.D.  
Vesa Novak, Ph.D.



Liran Oren, Ph.D.  
Yoonjee Park, Ph.D.  
Andrew Steckl, Ph.D.  
David Wendell, Ph.D.

**Regenerative Medicine and Biomechanics**

Alister Bates, Ph.D.  
Amit Bhattacharya, Ph.D.  
Gregory Harris, Ph.D.  
Rulang Jiang, Ph.D.  
Winston W-Y Kao, PhD  
Andrei Kogan, Ph.D.  
Chia-Ying James Lin, Ph.D.  
Gui-Rong Liu, Ph.D.  
Yaping Liu, Ph.D.  
Jonathan Nickels, Ph.D.  
Phillip Owens, Ph.D.  
Sarah Pixley, Ph.D.  
Donglu Shi, Ph.D.  
Debora Sinner, Ph.D.  
Patrick Whitlock, M.D., Ph.D.  
Assem Ziady, Ph.D.

Department of Biomedical Engineering, University of Cincinnati

BME Graduate Student Annual Progress Review: General Info

Fill out each applicable field below and the Curriculum Requirements form on the following page, using continuation pages as needed.

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Student Name: \_\_\_\_\_

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Graduate Program:  MEng  MS  PhD      Special Program, if applicable:  ACCEND  MSTP

---

Faculty Advisor: \_\_\_\_\_

---

Committee Members: \_\_\_\_\_

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**Milestone dates (previous or anticipated, noting outcomes as applicable):**

---

First enrollment in graduate program: \_\_\_\_\_

---

Previous annual progress reviews: \_\_\_\_\_

---

Thesis/dissertation committee meetings: \_\_\_\_\_

---

PhD qualifying exam: \_\_\_\_\_

---

PhD candidacy exam (dissertation proposal): \_\_\_\_\_

---

MS thesis or PhD dissertation defense: \_\_\_\_\_

---

Semester of graduation: \_\_\_\_\_

---

---

Number of course credits completed: \_\_\_\_\_ Cumulative QPA: \_\_\_\_\_

---

Course deficiencies (F, N, I, U or Y): list course title, semester, grade \_\_\_\_\_

---

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Is student making satisfactory progress toward degree?    Yes                      No

---

Faculty comments (if any): \_\_\_\_\_

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Student comments (if any): \_\_\_\_\_

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Student Signature: \_\_\_\_\_

---

Faculty Signature: \_\_\_\_\_

---

Date: \_\_\_\_\_

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## BME Graduate Student Annual Progress Review: Curriculum Requirements

Please complete the information below as fully as possible, including past, current, and planned courses.

Applicable Course Requirements:     MS     PhD     PhD (post-MS)     MEng

<b>Core BME Graduate Courses (requirements: 6 cr MS, 9 cr PhD, 3 cr PhD post-MS)</b>			
Course number and name	Semester	Grade	Credit hours

<b>Focus Area Courses (requirements: 6 cr MS, 9 cr PhD, 3 cr PhD post-MS)</b>			
<input type="checkbox"/> <b>Medical Imaging/Bioinformatics</b> <input type="checkbox"/> <b>Medical Device Innovation</b> <input type="checkbox"/> <b>Regenerative Medicine/Biomech.</b>			
Course number and name	Semester	Grade	Credit hours

<b>General Medical Sciences (requirements: 3 cr MS, 6 cr PhD, 3 cr PhD post-MS)</b>			
Course number and name	Semester	Grade	Credit hours

<b>Mathematics (requirements: 3 cr MS, 6 cr PhD, 3 cr PhD post-MS)</b>			
Course number and name	Semester	Grade	Credit hours

<b>Approved Technical Electives (requirements: 3 cr MS, 6 cr PhD, 3 cr PhD post-MS)</b>			
Course number and name	Semester	Grade	Credit hours

<b>BME MEng (requirements: 4-8 cr MEng core, 10-15 cr BME, 6-9 cr electives, 3-6 cr capstone, 30 cr total)</b>			
Course number and name	Semester	Grade	Credit hours
<b>MEng Core: Project/Task Management Development (1 course required)</b>			
<b>MEng Core: Interpersonal Skill Development (1 course required)</b>			
<b>BME MEng Track Courses (4 BME-listed graduate courses required)</b>			
<b>BME MEng Electives (graduate courses listed in BME curriculum or approved by BME MEng Advisor)</b>			
<b>BME MEng Capstone (3-6 credit hours)</b>			
Description (e.g. planned capstone project, supervisor, location)		Semester	Credit hours

**Qualifying Exam Committee:**

**BME Student Name:** \_\_\_\_\_ ID # M \_\_\_\_\_

**Exam Topic/Title:** \_\_\_\_\_

The following faculty agree to serve on the Qualifying Exam Committee for the above named student. Note there must be one faculty member from outside the student's focus area.

**1. Research Advisor:** \_\_\_\_\_  
Print Name

\_\_\_\_\_  
Signature Date

**2. Primary BME Faculty:** \_\_\_\_\_  
Print Name

\_\_\_\_\_  
Signature Date

**3. Faculty in Focus Area:** \_\_\_\_\_  
Print Name

\_\_\_\_\_  
Signature Date

**4. Additional Faculty (optional):** \_\_\_\_\_  
Print Name

\_\_\_\_\_  
Signature Date

**INDEPENDENT STUDY FORM**

Student Name \_\_\_\_\_ ID# M \_\_\_\_\_

Calendar Year \_\_\_\_\_ Semester (circle one) F S U

**Course # and Section # and Course Title**

BME \_\_\_\_\_-\_\_\_\_\_ Independent Study in \_\_\_\_\_

Credit hours \_\_\_\_\_ Hours per week \_\_\_\_\_

**Goals/Learning Objectives:** \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Grading Criteria:**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

*By signing this form, I agree to supervise the student and assign a grade based on the above criteria.*

Instructor signature \_\_\_\_\_ Date \_\_\_\_\_

Student signature \_\_\_\_\_ Date \_\_\_\_\_

## BME Graduate Curriculum (MS and PhD)

### Common Curriculum for all Focus Areas

#### Core BME Graduate Courses

Course Title	# Cr Hrs	Semester
BME Survey (BME 7001)	3	F
BME Seminar and Career Building Blocks (BME 7003)	1*	F
BME Research Design (BME 7005)	3	S
BME Seminar (BME 7007)	1*	S
BME Research Impact (BME 7008)	1	F
<b>Total Core Required (MS, PhD post-MS, PhD alone)</b>	<b>6, 3, 9</b>	

\*Can be repeated

#### BME General Medical Sciences Courses

Course Title	# Cr Hrs	Semester
Scientific Integrity and Research Ethics (BE 7067)	1-2	U
Cancer Biology and Therapeutics (CB 8080)	4	S
Advanced Speech and Hearing Science (CSD 9092C)	2	S
Introduction to Developmental Biology (DB 9085C)	3	F
Fundamentals of Integrative Medicine (GNTD 6087)	3	F,S
Science and Practice of Mind-Body Medicine (GNTD 6088)	3	F,S
Principles of Molecular and Cellular Biology (GNTD 7001)	1-4	F
Biochemistry and Cellular Metabolism (GNTD 7002 or MG 7002)	3	S
Ethics in Research (GNTD 7003)	1	S
Intro to Biomedical Research Techniques (GNTD 7010L)	6	F
Communicating Your Science (GNTD 8004)	2	S
The Healthcare and Public Health Landscape (HI 7001)	3	F, U, S
Health Informatics, Information Systems and Technology	3	F, U, S
Human Physiology (MCP 7000)	4	F, S
Neurobiology of Disease (MCP 7001)	3	S
Fundamentals of Systems Biology (MCP 7055)	3	S
Introductory Microbiology (MG 7003)	2-3	F
Fundamentals of Molecular Genetics (MG 7021)	3	F
Human Medical Genetics (MG 7022)	3	S
Immunology (MG 7023)	2	S
Mechanisms of Signal Transduction (MG 7024)	2	S
Principles of Biochemistry I (MG 7027)	3	F
Fundamentals of Neuroscience I (NS 7078)	4	F
Fundamentals of Neuroscience II (NS 7079C)	5	S
Advanced Physiology and Pathophysiology (NURS 8022)	4	F
Racism as a Public Health Concern (PH 7003)	3	F
Global Reg. and Devel. Strategies Drugs and Medical Devices (PHDD 8010)	3	F
Discovery of Drugs and Therapeutic Biologicals (PHDD 8020)	3	F
Health Psychology I/II (PSYC 9050/9051)	3	S
Neuropsychology I/II (PSYC 9060/9061)	3	S
<b>Total Focus Area Required (MS, PhD post-MS, PhD alone)</b>	<b>3, 3, 6</b>	

The General Medical Sciences coursework requirement can also be met by other UC graduate courses. This requires a request and justification for the intended course, which must be submitted to and approved by the BME Graduate Program Director.

### BME Mathematics Courses

Course Title	# Cr Hrs	Semester
Biostatistics in Research (BME 7061)	3	S
Introduction to Data Science (BME 7082)	3	F
Introduction to Biostatistics (BE 7022)	3	F, S, U
Advanced Biostatistics (BE 7023)	3	F
Advanced Topics in Mining Spatial and Temporal Data (CS 7051)	3	S
Data Science for Biomedical Research (CS 7054)	3	S
Computational Fluid Dynamics (EGFD 6037C)	3	S
Numerical Analysis (MATH 6006)	3	F
Partial Differential Equations and Fourier Analysis (MATH 6007)	3	S
Applied Probability and Stochastic Processes (MATH 6008)	3	F
Applied Linear Algebra (MATH 6012)	3	S
Mathematical Programming (MATH 6015)	3	S
Nonlinear Optimization (MATH 6019)	3	F, S
Applied Ordinary Differential Equations (MATH 6051)	3	F
Advanced Mathematical Modeling (MATH 7011)	3	S
Advanced Numerical Analysis (MATH 8010)	3	S
Scientific Computation (MATH 8011)	3	S
Applied Math Methods (MATH 8012)	3	F
Mathematical Statistics I/II (STAT 6021/6022)	3	F/S
Applied Regression Analysis (STAT 6031)	3	F
Design and Analysis of Experiments (STAT 6032)	3	S
<b>Total Math Required (MS, PhD post-MS, PhD alone)</b>	<b>3, 3, 6</b>	

The Mathematics coursework requirement can also be met by other UC graduate courses. This requires a request and justification for the intended course, which must be submitted to and approved by the BME Graduate Program Director.

### BME Approved Technical Electives

Course Title	# Cr Hrs	Semester
Advanced Strength of Materials (AEEM 6001)	3	F
Entrepreneurship and Technology Law (AEEM 6067)	3	S
Nondestructive Testing (AEEM 7027)	3	F
Ultrasonic NDE (AEEM 7028)	3	S
Finite Element Method (AEEM 7052)	3	S
Aeroacoustics I (AEEM 7065)	3	S
Human Physiology and Biomechanics (BIOL 6093C)	4	S
Biochemical Engineering (CHE 6023)	3	S
Electroanalytic Chemistry (CHEM 8022)	3	
Machine Learning (CS 6037)	4	F
Introduction to Functional Genomics (CS 7097C)	3	F
Intro to Medical Informatics (CS 7053)	3	F
Introduction to Bioinformatics (CS 7099)	3	S
Biochips and Lab-on-Chips (EECE 7026)	3	S
Viscous Flow and Heat Transfer (EGFD 7041)	3	F
Applied Biology for Engineers (ENVE 6000)	3	F
Applied Biology for Engineers Laboratory (ENVE 6001L)	2	F
Introduction to Nuclear Engineering and Health Physics (MECH 6003)	3	F
Bio-Fluid Mechanics (MECH 6046)	3	S
Applied Fast Fourier Transforms (MECH 6060)	3	F
Acoustics (MECH 6066)	3	F
Design for Manufacturability and Assembly (MECH 6069)	3	
Polymer and Biopolymer Engineering (METL 8001C)	3	F,S

Course Title	# Cr Hrs	Semester
<b>Total Tech Electives Required (MS, PhD post-MS, PhD alone)</b>	<b>3, 3, 6</b>	

Also approved as technical electives for BME MS and PhD students are all courses listed in this handbook as BME Core, Focus Area, Mathematics, General Medical Sciences, or MEng Core courses, if not needed to fulfill the student's minimum requirements in the respective categories.

In addition, technical electives can come from any graduate level engineering, science, medicine, business, or law course that is relevant to the student's career goals as determined via discussion with and approved accordingly by the student's research advisor. All technical elective choices for BME MS and PhD students, if not listed above, also need approval of the BME Graduate Program Director.

### **BME Curriculum: Focus Area Courses**

#### **Primary BME Focus Area Courses – Medical Device Innovation and Entrepreneurship**

Course Title	# Cr Hrs	Semester
Advanced Medical Device Design I (BME 7020C)	3	F
Biomedical Microsystems (BME 6007)	3	F
Optics for Engineers (BME 6048C)	3	F
Bioinstrumentation (BME 7002C)	3	F
Bio-Heat Transfer (BME 7095)	3	S
Biomedical Instrumentation (EECE 6006C)	3	S
Fundamentals of MEMS (EECE 6008)	3	F
The Microfabrication of Semiconductor Devices (EECE 6018)	3	F
Biomicrofluidic Systems (EECE 6078C)	4	S
Biosensors and Bioelectronics (EECE 7032)	3	S
Electrical Engineering of the Human Body (EECE 8025)	3	S
Humans, Machines, Robots and their Interactions (EECE 8115C)	3	S
Engineering Project Management (ENGR 6014)	3	S
Entrepreneurship: New Venture Creation (ENTR 7005)	3	F,S
Leadership and Organizations (MGMT 7014)	2	S
Management of Innovation (MGMT 7035)	2	S
Lean Six Sigma (ENGR 6025)	3	S
Product & Process Quality (ENGR 7025)	3	F
<b>Total Focus Area Required (MS, PhD post-MS, PhD alone)</b>	<b>6, 3, 9</b>	



### Primary BME Focus Area Courses – Medical Imaging and Bioinformatics

Course Title	# Cr Hrs	Semester
Biomedical Ultrasound (BME 6010)	3	S
Magnetic Resonance Imaging and Spectroscopy (BME 6011)	3	F
Biomedical Signal and Image Processing (BME 6013C)	4	F
Intro. to Medical Imaging and Diagnostic Technology (BME 6014)	3	F
Optics for Engineers (BME 6048)	3	F
Bioinstrumentation (BME 7002C)	3	F
Bio-Heat Transfer (BME 7095)	3	S
Independent Study in Medical Imaging* (BME 8010)	3	F,S,U
Biomedical Instrumentation (EECE 6006C)	3	S
Introduction to Digital Signal Processing (EECE 6024)	3	F
Digital Image Processing (EECE 6042)	3	F,S
Deep Learning Applications in Image Processing (EECE 8042)	3	S
<b>Total Focus Area Required (MS, PhD post-MS, PhD alone)</b>	<b>6, 3, 9</b>	

### Primary BME Focus Area Courses – Regenerative Medicine and Biomechanics

Course Title	# Cr Hrs	Semester
Continuum Models in Biomedical Engineering (BME 6017)	3	F
Joint Biomechanics and Measurement Methods (BME 6024)	3	S
Functional Tissue Engineering (BME 6030)	3	S
Biomechanics of the Musculoskeletal System (BME 6060)	3	F
Bioengineering for Regenerative Medicine (BME 6061)	3	F
Bioinstrumentation (BME 7002C)	3	F
Tissue Biomechanics (BME 7021)	3	F
Mechanobiology (BME 7040)	3	S
Bio-Heat Transfer (BME 7095)	3	S
Independent Study in Biomechanics* (BME 8020)	3	F,S,U
Independent Study in Tissue Engineering* (BME 8030)	3	F,S,U
Biomedical Instrumentation (EECE 6006C)	3	S
Molecular and Cellular Biology (GNTD 7001)	3	F
Biomech. And Physiol. Aspects of Muscular Activity (OSE 7044C)	2	F
<b>Total Focus Area Required (MS, PhD post-MS, PhD alone)</b>	<b>6, 3, 9</b>	

Courses considered to be highly relevant to the above focus areas, but not listed above, can be considered for addition to these lists by petition to the Graduate Program Director and approval by the BME Graduate Committee.

\*Independent Study courses can be arranged by the student with a member of the BME graduate faculty. The student and faculty define a mutually agreeable curriculum, learning goals/objectives, and grading criteria for the course, which are summarized on the Independent Study Form included in the Appendix of this handbook and must be approved by the BME Graduate Program Director. A course listing, with the faculty member as Instructor, may then need to be added to the UC Registrar's system for the term, which can be done by the BME Executive Staff Assistant on request.

## BME MEng Curriculum

### BME MEng Core Courses (one course from each category)

#### Project/Task Management Development Courses (1 required)

Course Title	# Cr Hrs	Semester
Entrepreneurship and Technology Law (AEEM 6067)	3	S
Systems Engineering Analysis (AEEM 6099)	3	F
Engineering Data Management & Analysis (CVE 6079)	3	F
Engineering Project Management (ENGR 6014)	3	F,S
Lean Six Sigma (ENGR 6025)	3	Varies
Engineering Supply Chain Cost Modeling (ENGR 6031)	3	F
Industry 4.0 Domains of Knowledge (ENGR 6032)	3	F
Interdisciplinary Innovation for Eng (ENGR 6045)	3	F
Product & Process Design Control and Quality (ENGR 7025)	3	F
Occupational Safety Engineering (MECH 6050)	3	F
Quality Control (MECH 6074)	3	F,S (online)

#### Interpersonal Skill Development Courses (1 required)

Course Title	# Cr Hrs	Semester
Organizational Behavior for Technical Professionals (ENGR 6003)	3	F,S
Effectiveness in Technical Organizations (ENGR 6010)	3	F,S
Innovation and Design Thinking (ENGR 6012)	3	F,S
Applied Leadership of Project Teams (ENGR 6016)	3	F
Fundamentals of Leadership (ENGR 6050)	3	F
Special Topics in Entrepreneurship (ENTR 7082)	1-6	F,S,U
Individual Behavior in the Workplace (OLHR 8029)	2-3	F

### BME MEng Track Courses (Need at least 4 courses, 10-15 credit hours total)

Courses fulfilling the BME MEng Track requirement may be taken from any BME-listed graduate courses (BME 60XX, 70XX, or 80XX), including those listed above as Core BME graduate courses and Focus Area courses.

### BME MEng Electives (6 credit hours required)

Courses fulfilling the BME MEng elective requirement may be taken from any available course listed in the BME graduate curriculum above. The requirement can also be fulfilled by graduate-level courses from any discipline, as long as they meet the students' career goals and are approved by the BME MEng Program Advisor.