GRADUATE HANDBOOK

Biomedical Engineering Program
Department of Biomedical, Chemical, and Environmental Engineering
College of Engineering and Applied Science
University of Cincinnati

2017/2018

Updated July 2015

1 July 2015

Dear BME Graduate Students,

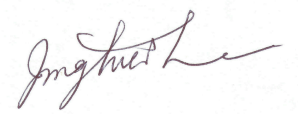
Welcome to the Biomedical Engineering (BME) Graduate Program of the Department of Biomedical, Chemical, and Environmental Engineering (BCEE) at the University of Cincinnati. Our diverse faculty members are internationally recognized researchers with collaborative relationships that span disciplines in engineering and medicine. We have unique strengths in medical devise, medical imaging, and tissue engineering and biomechanics. 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. The size of our graduate program is small enough to enable one-on-one mentoring by your research advisor. The curriculum is focused, yet flexible enough to permit students with pre-existing strengths to concentrate on areas requiring development. The facilities in the College of Engineering and Applied Science are excellent.

The BME graduate program is based on a firm commitment to academic excellence, tempered by kindness and compassion. We are an advocate for the graduate student. However, in order to maintain a reputation for quality, which will enhance your employment opportunities and increase the value of your degree/s, we are also required to set and enforce policies.

This handbook is designed to meet several needs. In sections I and II, we describe the application and admission process as well as registration procedures. Section III highlights the graduate credit requirements and grading policies. The MEng (section IV), Master's (Section V) and Doctoral Degree (Section VI) Programs are also described in detail, including course requirements, minimum academic performance expected, and the Ph.D. Qualifying Exam and thesis and dissertation proposals and defense. In addition, BME also participates in the MD/PhD Medical Scientist Training Program (MSTP) from College of Medicine, which is also described in section VI. The handbook concludes with Special Rules and Provisions. In addition to the Graduate School Handbook, which can be found in the UC web site (http://grad.uc.edu/content/dam/grad/docs/Publications/handbook.pdf), we encourage you to become familiar with the entire document as it provides valuable information as you proceed through your program of study, which is individualized.

We trust that you will be successful in your pursuit of a graduate degree and that you will have valuable experiences while you are at UC. Your progress through the graduate program will provide the necessary foundation for a successful career in academia, industry, or medicine.

Kind regards,



Jing-Huei Lee, Ph.D.
Professor
Director of Graduate Studies

Table of Contents

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PREFACE

All graduate students in BME program should familiarize themselves with the contents of this document and the latest version if applicable. 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. If there are discrepancies, always follow the guidelines of the latest version, which can be found in the BME web site
http://seebme.ceas.uc.edu/Graduate_Students.html

Chapter One
Application and Admission

Application Process

An application to the College of Engineering & Applied Science (CEAS) Graduate Program is a three-step process. These steps can be found in the CEAS website.
(http://www.ceas.uc.edu/Graduate_Studies/ApplyOnline.html)

Step 1) University Online Application
This is the first step in your application. Create an account and complete this step as soon as possible. Here, you will be asked to specify the program you are applying to, your background information and online references. At the end of this step you will be asked to pay the application fee. After completion you will be provided with a link to continue to the CEAS Online Application in Step 2.

Step 2) CEAS Online Application
The CEAS Online application collects the program-specific information required for evaluation of your file. Your grades, statement of purpose, online recommendation letters, etc will be asked at this stage. While you can complete your application at any time before the deadline, it is recommended you complete it as soon as possible. Your files are processed for evaluation only after you complete this application. After you complete the application, your status will be displayed when you login to the CEAS online application website.

Step 3) Transcripts/letter of recommendations and standardized scores
All supporting documents must be mailed to us. You can mail the documents to us any time before the deadline (Dec 31) for admissions. Information on what documents to send as well as the mailing address is provided below.

University of Cincinnati
College of Engineering and Applied Science
2901 Woodside Drive
665 Baldwin Hall
PO Box 210077
Cincinnati, Ohio 45221-0077

Application materials

Materials should be sent in one envelope if possible. Letters of recommendation and transcripts can be sent separately if necessary. Please include your full name, date of birth and program to which you are applying with your documents. Please do not staple any of your documents.

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. Letters of recommendation can be submitted one of two ways:

- Use the online recommendation form (available when completing the online application).
- Submit a letter written by the recommender on letterhead and submit in sealed envelopes.

- Official Standardized Test Scores
  - GRE – This is required by all applicants (for MEng, see below) and must be submitted electronically to UC. A photocopy of your scores may be sent with your application materials for review purposes. The average GRE score (old version) accepted is 1250. The average scores accepted for the new GRE test are about: 155 Quantitative, 155 Verbal and 3.0 Analytical. The University code for GRE is 1833, a department code is not required. For testing information please go to www.gre.org.
  - TOEFL – This is required by all international applicants and must be submitted electronically to UC. A photocopy of your scores may be sent with your application materials for review purposes. This is required of all applicants whose native language is not English – including those with F-1 visas and green cards. The TOEFL requirement may be waived for applicants with degrees (Bachelors or MS) earned in English from accredited universities and colleges in the US, Canada, England, Australia and New Zealand. The minimum TOEFL score accepted, Internet based, is 92. The University code for TOEFL is 1833, a department code is not required. The University of Cincinnati accepts both IELTS (International English Language Testing System) and PTE (PEARSON Test of English) in lieu of TOEFL. For IELTS, an overall band score of 6.5 is required. For PEARSON, a score of 47 is required.

Admission Requirements for BME program

- BS or MS in Engineering, Material Science, Biology, Computer Science, Physics or other Science related majors*.
- GRE score of 155 or higher (on both the verbal and quantitative sections); 3.0 or higher (analytical)**
- 3.0 minimum grade point average (based on 4.0 scale)
- Admissions FAQ can be found in the website (www.ceas.uc.edu/Graduate_Studies/AdmissionsFAQ.html)

**Admission to MEng Program requires a BS in Engineering, Material Science, Computer Science, or Physics.*

***GRE Score is waived for MEng applicants who have an undergraduate engineering degree from an ABET accredited US university and have a GPA of 3.0 or higher. GRE scores are mandatory for applicants from outside the US.*

For international students:

TOEFL – This is required of all international applicants whose native language is not English – including those with F-1 visas and green cards. The TOEFL requirement may be waived for applicants with degrees (Bachelors or MS) earned in English from accredited universities and colleges in the US, Canada, England, Australia and New Zealand. The minimum TOEFL score accepted, Internet based, is 92. **The University of Cincinnati institutional code for TOEFL is 1833**. A department code is not required.

Official electronic scores should be sent to UC, institutional code 1833. If electronic scores are not received, we will not consider your application package complete and will not be able to offer you admission to UC. Photocopies may be sent with the application materials for review purposes.

You may submit your application before taking the necessary standardized tests. Be sure to have official scores of your standardized tests sent directly to UC – institutional code 1833, once you take the exam. It can take up to six weeks for UC to receive the official results and this can delay your total application package being received in time.

The University of Cincinnati accepts both the **IELTS** (International English Language Testing System) and **PTE** (PEARSON Test of English) in lieu of TOEFL. For IELTS an overall band score of 6.5 is required. For PEARSON a score of 47 is required.

TSE (Test of Spoken English) – We do not require TSE, and will not use it as a replacement for TOEFL.

Admission Application Deadlines

The deadline for applications is **December 31st** for applicants that want to be considered for financial aid for Fall admission. The final deadline for Fall admission is March 31st. Applications received between December 31st and March 31st may be considered for financial aid if funding is still available. The current policy of the 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.

Admission

The terms and conditions of financial aid will be stated in your offer letter.

Financial aid

There are five types of financial aid.

- University Graduate Scholarship (UGS)
  This is a scholarship that covers a major portion of tuition costs for the student.

- Research Assistantship (RA)
  This is an assistantship that provides a monthly stipend in the amount of $1,000 - $2,400 per month for a specified period of time to provide research assistance to professors.

- Teaching Assistantship (TA)
  This is an assistantship that provides a monthly stipend in the amount of $1,500 - $2,000 per month for a specified period of time to provide teaching assistance to professors.

- Graduate Assistantships (GA)
  This is an assistantship that provides a monthly stipend in the amount of $1,000 - $2,400 per month for a specified period of time to provide research, teaching or departmental duties.

- BME Outstanding Scholarship (BOS)
  This is a scholarship for outstanding students recruited to the BME program. This highly competitive scholarship will offer a full tuition and additional stipends to cover other fees for the first year. The continuing of BOS after the first year depends on student's performance and his/her advisor's research funding. These outstanding students are expected to submit a F30/F31 training grant to NIH, or an equivalent grant to another agency, by the end of their second year.

Financial aid is not normally terminated during the period for which it has been granted. However, for serious reasons such as poor academic performance (i.e. 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.

Transfer Credits

As a means of assuring that the character and standards embodied in graduate degrees awarded by the University of Cincinnati are preserved, limits are set on the amount of work completed at other institutions which can be included as fulfilling graduate degree requirements. Transferring credits from other universities is subject to the approval of the student's advisor and the Director of BME Graduate Studies. Limits 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 **thirty (30)** graduate credits, the latter half (or 15) of which must be completed while in residence at the University of Cincinnati. The capstone project is four-six (4-6) credits. No thesis is required for this degree. 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 **nine (9)** semester credit hours of relevant course work with grades of 'B' or better.

Master's 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 **thirty (30)** graduate credits, the latter half (or 15) of which must be completed while in residence at the University of Cincinnati. The M.S. thesis is **nine (9)** credits. 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 **six (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, of which the last year must be in residence at the University of Cincinnati or under the University's direction. Eligibility for graduation requires a minimum of 90 graduate credits, the last 30 of which, inclusive of research credits (max. 15), must be completed at the University of Cincinnati. A student who enters the program with a MS degree may be credited with a maximum of 30 credits. In addition, a maximum of 10 research credits can also be transferred.

PhD Degrees in the MSTP program

This degree is offered by BME with the cooperation of the Medical Scientist Training Program (MSTP) from the College of Medicine (http://med.uc.edu/mstp/). 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). Upon successful completion of a PhD thesis, 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.

Chapter Two
Registration and Policies

A graduate student must be registered in the 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.

All full-time students should register for at least 15 credit hours each semester except for summer 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 and have completed all required course work and have the required number of research/thesis/dissertation hours can register for one credit hour each semester. International students have to submit an online request for reduced course load. There are two steps to this process: 1) submit a request for reduced course load to Barbara Carter in the Graduate Studies Office (665 Baldwin); forms are available in that office and, 2) submit an online request for reduced course load on UC International Service's website (http://www.uc.edu/international/services/students/maintaining_status.html). This is an official approval process to ensure that international students remain in status with their visa.

Registration and related issues should be referred to the information posted in the UC web site (http://www.uc.edu/registrar/registration.html).

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 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 at the following link: http://grad.uc.edu/student-life/policies/forms.html. When completed and signed by the Graduate Program Director, the form is submitted to Barbara Carter (665 Baldwin) and will then be forwarded 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 that 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 Committee.

Under normal circumstances it is anticipated that students who request leave on the basis of maternity/paternity considerations 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. Requests for maternity/paternity leave must be made in writing to the Graduate Program Director or Program Chair.

Absenteeism Policy

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.

Chapter Three
Graduate Credits and Grading Practices

Course Load

All graduate 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 do not register for summer semester if not taking summer courses, but still maintain full-time status for summer semester. The recommended course load is fifteen (15) graduate credit hours per semester.

Most International students, under the terms of their visas, must be enrolled as full-time students.

Students who have received a UGS, RA or GA are required to register for fifteen (15) hours during the fall and spring semesters for the duration of the award.

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 (UGS, TA and GA).

Graduate Credit

The CEAS has a five (5) year cooperative undergraduate program. Therefore, courses designated at the 1000 through 5000 levels are strictly undergraduate courses. Graduate courses in the CEAS are numbered at the 6000 level and above. Graduate courses in other Colleges may begin at the 5000 level. 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.

Grading Practices

The BME program uses the grading practices specified in the Graduate Handbook of the Graduate School (http://grad.uc.edu/content/dam/grad/docs/Publications/handbook.pdf). If a student receives a grade of F in a 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.

Chapter Four
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 project in an area of their interest that prepares them for an industry career. The MEng curriculum provides skills and expertise that enhance the individual's ability to contribute to the technical workforce. The degree will 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's of science in a research context, which is focused on discovering new knowledge.

Master of Engineering Curricular Requirements:

Course	***Semester Credit Hours***
BME MEng Program Core Courses	6 – 9
BME Track Courses	12 -15
BME_MEng Approved Technical Electives	6 – 9
BME_MEng Capstone Project	4 – 6
Total Graduate Credit Hours	**30**

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 individual curriculum outline (list of courses) for each focus area can be found in this section and at the end 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 Sheet at the end of this Graduate Handbook as well as Onestop to ensure that the courses are actually being offered for the semester under consideration.)

BME-MEng Core Courses - BME-MEng students are required to take a minimum of 6 credit hours "BME-MEng Core" courses that are common to all MEng students within CEAS. The MEng-Program core provides 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). 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 - In addition, MEng students in the BME track will be required to take a minimum of 12 credit hours of BME coursework. These can be picked from the courses in all BME focus areas, and specifically any BMEXXXX 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 Tables 1 and 2 for further clarification). It is recommended that students pick one or two focus areas (Medical Device Innovation, Tissue/Engineering Biomechanics, or Imaging) to help plan out the course selections for BME-MEng Track courses.

BME-MEng Electives - BME MEng students need to complete a minimum of 2 elective courses (6 Credits) as part of their MEng curriculum (ref. MEng Curriculum section in the Appendix). These electives should permit breadth, depth, or interdisciplinary focus depending on student educational objectives. They should 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 Requirement – BME MEng Students are required to complete a capstone project per CEAS MEng handbook requirements. In BME, it is expected that the capstone project will demonstrate applications of skills and synthesis of knowledge (4-6 credit hours). If additional credit hours are taken above the 6 credit hours maximum, they do not count towards a course requirement. With the College MEng advisor's approval, students can choose: 1) to complete a project, 2) to perform an internship, or 3) to prepare a written paper under the supervision of the capstone advisor.

- **Project** - The capstone project is focused on the application of principles and the practice of engineering and is not meant to be a mini-thesis. The 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 presentation. The report will be read by the College MEng advisor and a representative from the Office of the Associate Dean for Research and Graduate Studies. 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. Students selecting this option will also prepare a report and give a presentation to the College MEng advisor that describes knowledge gained through the work experience and how this furthered their career goals. Internships will be approved for 3 months and can be extended for an additional 3 months with the approval of the capstone advisor. International students can be approved for Curricular Practical Training (CPT) to participate in an internship. Additional documentation is needed for the extension if requested. CPT cannot be done until two semesters of study are done. CPT can only be done prior to or up until a graduation date. CPT terminates upon graduation.

- **Paper** – A written paper can be completed under the supervision of the capstone advisor. The paper will address a topic related to the discipline (focus area) and require 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:** Students should register for their Capstone Project ideally in the following sequence
  - One credit hour in Fall term - to enable planning of your capstone project including the identification of a project topic.
  - Three to five credit hours in Spring term – 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 will receive an "NG" (no grade) grade until it is complete. Upon completion the "NG" will be changed by the capstone advisor to a letter grade.

A detailed summary of MEng Curricular Requirements are provided in Tables 1 and 2 below which also shows how the CEAS MEng curriculum structure can be mapped to the BME curriculum.

Table 1. General MEng Curriculum Requirements

<table>
<tr><th colspan="3">MEng Curriculum Requirements</th></tr>
<tr><th><u>BME MEng Core</u>
These should be picked from the MEng Curriculum Section of this handbook</th><th><u>BME-MEng Track Courses</u>
These should be picked from the MEng Curriculum Section of this handbook</th><th><u>Elective Courses</u>
(Can be picked from any graduate level engineering course that helps student accomplish career goals. See clarification in Table 2)</th></tr>
<tr><td rowspan="3">2-3 courses (6-9 cr hrs)</td><td>4-5 courses (12 – 15 cr hrs)</td><td rowspan="3">2-3 courses (6-9 cr hrs)</td></tr>
<tr><td><u>Capstone</u></td></tr>
<tr><td>4-6 credit hours</td></tr>
</table>

Table 2. A typical plan for a full time BME MEng student.

	Fall Semester	Spring Semester	Comments/Clarification
BME MEng Core Courses	Core Course #1	Core Course #3	These should be picked from the MEng Curriculum Section of this handbook .
	Core Course #2		
BME MEng Track Courses[1]	Track Course #1	Track Course #3	These should be picked from the BME-MEng Curriculum Section of this handbook
	Track Course #2	Track Course #4	
MEng Elective Courses[2]	Elect Course #1	Elect Course #2	These 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 the Graduate Program MEng advisor, and approved accordingly by the advisor.
MEng Capstone Project		Capstone Project	See section above on BME Capstone Requirement
Total Minimum Credit Hours per semester	**15**	**15**	

[1] *Discipline specific course*
[2] *Selected from Engineering Courses based on approval by BME MEng advisor*

Minimum Academic Performance

The Graduate Handbook of the Graduate School (http://grad.uc.edu/content/dam/grad/docs/Publications/handbook.pdf) 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 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 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 master of engineering 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.

Chapter Five
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:

Biomechanics
Medical Imaging
Medical Device Innovation and Entrepreneurship
Tissue Engineering

Master of Science Curricular Requirements:

Course	***Semester Credit Hours***
Core BME Courses	6
Primary BME Focus Area	6
General Medical Sciences	3
Mathematics	3
Approved Technical Electives	3
Thesis Research	9
Total Graduate Credit Hours	**30**

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 (http://grad.uc.edu/content/dam/grad/docs/Publications/handbook.pdf) 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 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 MS 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 requirements.

The Graduate Program Director will review graduate student's 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 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. All MS requirements must be completed no later than five years from the date of first registration in the degree program.

Research Projects, Thesis preparation and defense

1. Thesis Research Projects

A student will select a research advisor and a Research Advisory Committee (RAC). The committee should have a minimum of three members 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 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, a thesis will be prepared and defended orally in public.

2. 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 the mechanics of preparing the final draft and abstract. Regulations regarding payment of binding fees, number of thesis copies to be submitted, and other documents required are also available online.

It is the responsibility of the student to see that he/she is in 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.

3. Thesis Defense

Prior to graduation, the thesis student will give an oral defense. In this defense the student will give a 30 to 45 minute 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. Please go to the link and print out PDF forms to submit to the College of Engineering.
http://ceas.uc.edu/Graduate_Studies/CurrentStudents/GraduationRequirements.html
Scroll down the page to CEAS Thesis Defense Form.

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.

Graduation

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

CEAS: http://ceas.uc.edu/Graduate_Studies/CurrentStudents/GraduationRequirements.html
Graduate School: http://grad.uc.edu/student-life/graduation.html

Graduation Deadlines

You must meet the following two University deadlines in order to graduate: the application to graduate deadline and the Electronic Thesis/Dissertation (ETD) submission deadline. 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 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: http://gradapps.uc.edu/graduationdeadlines/graduation-deadlines.aspx

Graduate School Checklist

Please refer to your graduation checklist. http://grad.uc.edu/student-life/graduation.html

Refer to submission information listed above to meet deadlines.

Chapter Six
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.

- 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 Dissertation Committee, together with the student, will prepare the student's program of study and submit it to the Graduate Committee for their information and review. The student and his/her committee will endeavor to draft a program with a central emphasis on some option in Biomedical Engineering with mathematics and some other option in this or another appropriate field of study in a supporting role.

An important function of the Dissertation Committee is to supervise the study program of the student. The student may request a meeting with the Dissertation Committee when there is an important academic matter to discuss.

A 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 *(post MS)*	PhD *(Without MS)*
Course	*Semester Credit Hours*	*Semester Credit Hours*
Core BME Courses	3	9
Primary BME Focus Area	3	9
General Medical Sciences	3	6
Mathematics	3	6
Approved Technical Electives	3	6
Thesis Research	45	54
Total Graduate Credit Hours	**60**	**90**

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. If approved by the BME Graduate Program Director, some courses taken by students who are in the MEng program 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 MD/PhD program may fulfill their credit requirements for General Medical Sciences and Approved Technical Electives from the course credits they earned in the first two years of study in the MSTP program.

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:
Biomechanics
Medical Imaging

Minimum Academic Performance

The Graduate Handbook of the Graduate School
(http://grad.uc.edu/content/dam/grad/docs/Publications/handbook.pdf)
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 requirements.

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.

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 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 four out of five consecutive semesters of study (including summer) or three consecutive summer semesters. 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 or other funding supports.

Qualifying Examination

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

The Ph.D. Qualifying Examination will consist of two parts (i) A written research proposal identifying an important problem and demonstrating knowledge of a broader area of research and (ii) An oral presentation to be given based upon the proposal. The objective and examination grading are based on the student's:

(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.

PHD QUALIFYING EXAM GUIDELINES

1. Written Portion

The written portion of the exam will consist of a 12-page (maximum) research proposal (similar to NIH R21 style – see below) double-spaced and 11 point times roman font with 1 inch margins. It is of the utmost importance that the proposal be the product of only the student.

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. A full discussion on the use of select agents should also be included.

Five to eight pages are recommended.

E. Preliminary Studies (optional).

Use this section to provide an account of the preliminary studies pertinent to the application information that will also help to establish the experience and competence of the investigator to pursue the proposed project. Provide a succinct account of published and unpublished results, indicating feasibility of the project.

One to three 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.

F. Appendix

Here the figures and tables can be included. Again this part DOES NOT count towards the 12-page limit.

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

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 round of qualifying exams (either spring or fall semesters). The advisor/committee chair should provide the student with the committee's comments regarding the written exam.

2. Oral Portion

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 exam. The oral seminar 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. 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 Coordinator to enter into the student's record.

If the student fails the oral exam, the BME Program Coordinator should also be notified and the student must then reschedule and pass the oral exam before the end of fall 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.*

Any Graduate student, whether holding a MS degree or not, who has declared his/her intention to pursue a Ph.D. degree is a Doctoral student and as such is required to pass the Ph.D. Qualifying Examination and is subject to the requirements of this Section.

3. 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 2rd 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 Coordinator. This is notification to the Graduate Committee indicating the student's intent to take the exam, the suggested topic area to be presented, and signatures of all committee members. Advisor and student agree on topic area and references to be reviewed for written proposal. The topic may be related to work performed in the lab.

Phase Two (by Friday of the 6th week of the semester) – Student must submit written proposal to PhD Qualifying committee with a copy to the BME Graduate Coordinator.

Phase Three (by Friday of the 8th week of the semester) – Qualifying Committee will provide their decision (pass or fail) about the written exam to the student and the BME Graduate 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 fall semester.

Phase Four (by the end of semester) – Deadline for student to successfully complete the oral examination related to the written proposal. Decision (pass or fail) must be provided to the student and the Graduate Director/Coordinator by the end of the examination.

4. Qualifying Exam Delay

A student wishing to depart from the time requirements above shall 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 exam.

5. Qualifying Exam Procedures

Prior to taking the Qualifying exam, the following steps must be taken:

i. Identify the problem
ii. Assemble a Qualifying Exam Committee
iii. Approval of proposal by the Qualifying Committee
iv. Submit petition to the BME Graduate Committee

The Qualifying Committee should consist of (at least three members):

- Research Advisor (Primary or Secondary Faculty in BME, and member of UC Graduate Faculty)
- One Primary BME Faculty outside the technical focus area of the research advisor
- One additional faculty member in the research focus area (Primary or Secondary faculty in BME).
- Additional members (optional)

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 date of the written examination. The seminar topic and reference material must be defined by the student and faculty advisor and included on the application.

A written seminar announcement must be distributed to all members of the faculty, stating the time and place of the presentation, at least two weeks before the scheduled date.

All faculty members of the student's major area of study, with a minimum of three, are expected to be present at the oral examination; however, all members of the faculty are welcome.

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

6. Special requirement for International students

International students subject to TOEFL requirements are strongly urged to pass the Oral English Proficiency Exam before taking the PhD Qualifying Examination because of the inherent language skills required for the oral portions of the exam.

7. Change of focus area

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

Ph.D. Dissertation Proposal

1. Dissertation Advisor and Committee

   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 (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.

2. PhD. Candidacy

   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 ***Graduate Handbook:***
   http://grad.uc.edu/content/dam/grad/docs/Publications/handbook.pdf

   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.

3. Time Requirements

   At least seven months prior to graduation, the student must have a Dissertation Proposal presented to and accepted by his/her Dissertation Committee. A completion form must be submitted to the Director at that time. Forms are available in the Graduate Office. (Note: The Graduate School no longer tracks 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

4. Petition Requirements

   A student wishing to depart from the time requirements of Section A 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.

5. The Ph.D. 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 Dissertation Proposal must be distributed by the student to the members of his/her Dissertation Committee at least one week prior to the oral presentation.

   After the oral presentation, the Dissertation Committee shall evaluate the Dissertation Proposal and 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:
http://ceas.uc.edu/Graduate_Studies/CurrentStudents/AdmissionToCandidacy.html

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

6. Dissertation Proposal Guidelines

The dissertation proposal should take place within 2 years of passing the qualifying exam. The **written portion** should be a 14 (maximum) page dissertation prospectus including the following items plus bibliography (the bibliography DOES NOT count toward the 14-page limit).

- Introduction (1 page abstract)
- short review of the literature
- preliminary results
- an outline of the proposed thesis
- a list of potential titles of papers that would come out of the dissertation work and the journals to which they would be submitted

The proposal should be presented orally to your dissertation committee in a power-point format.

Candidacy and Time Limitations

As stated in the Graduate Handbook of the Graduate School (http://grad.uc.edu/content/dam/grad/docs/Publications/handbook.pdf) 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

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:
http://ceas.uc.edu/Graduate_Studies/CurrentStudents/AdmissionToCandidacy.html
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 begin term up to and including graduation).

Candidacy for the doctorate automatically terminates after nine years. 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 the fall semester of 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 Coordinator no later than two weeks prior to the final defense.

1. 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 date of this presentation will be arranged by the Dissertation Advisor and presentation of copies for binding (in accordance with the rules of the CEAS) constitutes the final requirements for the doctoral degree.

2. Publication of Dissertation

If you plan on including papers you have published in your dissertation, you should obtain permission from the publishers to reprint the articles in their entirety. 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.

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: http://grad.uc.edu/student-life/etd.html

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

Graduate 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.

Graduation

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

CEAS: http://ceas.uc.edu/Graduate_Studies/CurrentStudents/GraduationRequirements.html
Graduate School: http://grad.uc.edu/student-life/graduation.html

Graduation Deadlines

You must meet the following two University deadlines in order to graduate: the application to graduate deadline and the Electronic Thesis/Dissertation (ETD) submission deadline. 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: http://gradapps.uc.edu/student-life/graduation.html

Graduate School Checklist

Please refer to your graduation checklist. http://grad.uc.edu/student-life/graduation.html

Refer to submission information listed above to meet deadlines.

Appendix

List of BME Primary and Secondary/Graduate Faculty

Advisor Form (to be completed at the end of the first year)

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

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

Curricula for focus areas

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

Primary Faculty:

Bioinformatics
Marepalli Rao, Ph.D.

Medical Imaging
Christy K. Holland, Ph.D.
Jing-Huei Lee, Ph.D.
T. Douglas Mast, Ph.D.

Medical Device
Mary Beth Privitera, M.Des.
Angela Zachman, Ph.D.

Tissue Engineering
Chia-Ying Lin, Ph.D.
Daria Narmoneva, Ph.D.
Jason Shearn, Ph.D.

Secondary/Graduate Faculty:

Bioinformatics
Jason Lu, Ph.D.
Jarek Meller, Ph.D.

Medical Imaging
Zackary Cleveland, Ph.D.
Charles Dumoulin, Ph.D.
Kevin Haworth, Ph.D.
Yoonjee Park, Ph.D.
Xiaoyang Qi, Ph.D.
George Shaw, M.D., Ph.D.

Medical Device and others
Michael Archdeacon, M.D.
Leyla Esfandiari, Ph.D.
Jason Heikenfeld, Ph.D.
Liran Oren, Ph.D
David Wendell, Ph.D.

Tissue Engineering/Biomechanics
Rupak Banerjee, Ph.D.
Amit Bhattacharya, Ph.D.
Steve Boyce, Ph.D.
Donita Bylski-Austrow, Ph.D..
Winston W-Y Kao, PhD
Andrei Kogan, Ph.D.
Anant Kukreti, Ph.D.
Phillip Owens, Ph.D.
Sarah Pixley, Ph.D.
Patrick Whitlock, M.D., Ph.D.

Biomedical Engineering Program
PhD Dissertation Advisor Form

Name _____

ID # _____

Focus Area _____ Date _____

This is to certify that I will be doing my PhD dissertation under the direction of

_____
(Advisor Name)

Signature _____
(Student)

This is to acknowledge that I agree to serve as the advisor for the above-mentioned student. By serving as advisor I also agree to provide financial support for this student including the stipend and tuition as requested.

Advisor Signature _____

Please submit form to Graduate Program Director and to the Graduate Studies Office (665 Baldwin) Director by May 30.

Qualifying Exam Committee:

BME Student Name: _____ ID # _____

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 student 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# _____ - ____ - _____

Calendar Year _____ Semester (circle one) F S Su

Course # and Section # 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 _____

Medical Device Innovation and Entrepreneurship Curriculum

Course Title	# Cr. Hrs.	Semester
"Core" BME Graduate Courses:		
BME Survey (BME 7001)	3	F
Bioinstrumentation (BME 7002)	3	F
BME Research Design (BME 7005)	3	S
Total "Core" Required (MS, PhD post MS, PhD alone):	**6, 3, 9**	
Primary BME Focus Area (Medical Device Innovation and Entrepreneurship) Courses:		
Biomedical Signal and Image Processing (BME 6012)	3	F
Functional Tissue Engineering (BME 6030)	3	S
Tissue Biomechanics (BME 7021)	3	F
Entrepreneurship: New Venture Creation (ENTR 7005)	3	F
Leadership and Organizations (MGMT 7014)	2	F
Biomedical Microsystems (EECE 6007)	3	F
Biomicrofluidic Systems (EECE 6078C)	4	S
Total Focus Area Required (MS, PhD post MS, PhD alone):	**6, 3, 9**	
General Medical Sciences Courses:		
Human Gross Anatomy (ANAT 8071C)	4-10	U
Scientific Integrity & Research Ethics (BE 7067)	1	U
Biology of Cancer (CB 8080)	3	S
Molecular and Cellular Biology (GNTD 7001)	3	F
Biochemistry and Cellular Signaling (GNTD 7002)	3	F
Human Physiology (MCP 7000)	4	F
Diagnostic Radiological Imaging Physics (MP 9050)	3	F
Brain and Behavior I (NS 8041)	4-10	S
Brain and Behavior II (NS 8061)	4-10	F
Advanced Physiology and Pathophysiology (NURS 8022)	4	F
Ethics in Research (GNTD 7003)	1	S
Total Focus Area Required (MS, PhD post MS, PhD alone):	**3, 3, 6**	
Mathematics Courses		
Biostatistics in Research (BME 7061)	3	F,S
Advanced Statistical Methods in Biomedical Res. (BME 8064)	3	S
Introduction to Biostatistics (BE 7022)	3	F
Computational Fluid Dynamics (EGFD 6037C)	4	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
Mathematical Programming (MATH 6015)	3	S
Applied Ordinary Differential Equations (MATH 6051)	3	S
Scientific Computation (MATH 8011)	3	S
Mathematical Physics (PHYS 7001)	4	F
Advanced Numerical Analysis (MATH 8010)	3	S
Applied Math Methods (MATH 8012)	3	F
Total Math Required (MS, PhD post MS, PhD alone):	**3, 3, 6**	

Approved Technical Electives

Biomedical Ultrasound (BME 6010)	3	S
Magnetic Resonance Imaging and Spectroscopy (BME 6011)	3	S
Joint Biomechanics and Measurement Methods (BME 6024)	3	S
Biostatistics in research (BME 7061)	3	S
Global Entrepreneurship: (ENTR 70025)	3	U
Management of Innovation (MGMT 7035)	3	S
Biosensors and Bioelectronics (EECE 7032)	3	F
Biochips and Lab-On-Chips (EECE 7026)	3	S
Nondestructive Testing (AEEM 7027)	3	F
Biochemical Engineering (CHE 6023)	3	S
Bioseparations (CHE 6050)	3	S
Biomedical Microsystems (EECE 6007)	3	F
Biomicrofluidic Systems (EECE 6078C)	4	S
Viscous Flow and Heat Transfer (EGFD 7041)	3	F
Turbulent Flows (EGFD 7042)	3	
Introduction to Nuclear Eng. and Health Physics (MECH 6003)	3	F
Bio-Fluid Mechanics (MECH 6046)	3	
Applied Fast Fourier Transforms (MECH 6060)	3	F
Acoustics (MECH 6066)	3	F
Fundamentals of Biomechanics (MECH 6085)	3	(N/O)
Advanced Biomechanics (MECH 6086)	3	(N/O)
Solid Mechanics of Biological Materials (MECH 7056)	3	(N/O)
Bio-Heat Transfer (MECH 7095) [Offered alternate years]	3	F

Total Tech. El. Required (MS, PhD post MS, PhD alone): 3, 3, 6

N/O: not offered at this time

Medical Imaging Curriculum

Course Title	# Cr. Hrs.	Semester
"Core" BME Graduate Courses:		
BME Survey (BME 7001)	3	F
Bioinstrumentation (BME 7002)	3	F
BME Research Design (BME 7005)	3	S
Total "Core" Required (MS, PhD post MS, PhD alone):	**6, 3, 9**	
Primary BME Focus Area (Medical Imaging) Courses:		
MR Imaging and Spectroscopy (BME 6011)	3	F
Biomedical Signal and Image Processing (BME 6012)	3	F
Biomedical Ultrasound (BME 6050)	3	S
Advanced Topics in Magnetic Resonance Imaging (BME 7012)	3	S
Independent Study in Medical Imaging (BME 8010)	3	F,S,U
Diagnostic Radiological Imaging Physics (MP 9050)	3	F
Total Focus Area Required (MS, PhD post MS, PhD alone):	**6, 3, 9**	
General Medical Sciences Courses:		
Human Gross Anatomy (ANAT 8071C)	4-10	U
Scientific Integrity & Research Ethics (BE 7067)	1	U
Biology of Cancer (CB 8080)	3	S
Molecular and Cellular Biology (GNTD 7001)	3	F
Biochemistry and Cellular Signaling (GNTD 7002)	3	F
Human Physiology (MCP 7000)	4	F
Brain and Behavior I (NS 8041)	4-10	S
Brain and Behavior II (NS 8061)	4-10	F
Advanced Physiology and Pathophysiology (NURS 8022)	4	F
Ethics in Research (GNTD 7003)	1	S
Total Focus Area Required (MS, PhD post MS, PhD alone):	**3, 3, 6**	
Mathematics Courses		
Biostatistics in Research (BME 7061)	3	F,S
Advanced Statistical Methods in Biomedical Res. (BME 8064)	3	S
Introduction to Biostatistics (BE 7022)	3	F
Computational Fluid Dynamics (EGFD 6037C)	4	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
Mathematical Programming (MATH 6015)	3	S
Applied Ordinary Differential Equations (MATH 6051)	3	S
Scientific Computation (MATH 8011)	3	S
Mathematical Physics (PHYS 7001)	4	F
Advanced Numerical Analysis (MATH 8010)	3	S
Applied Math Methods (MATH 8012)	3	F
Total Math Required (MS, PhD post MS, PhD alone):	**3, 3, 6**	
Approved Technical Electives		
Nondestructive Testing (AEEM 7027)	3	F

Ultrasonic NDE (AEEM 7028)	3	S
Joint Biomechanics and Measurement Methods (BME 6024)	3	S
Functional Tissue Engineering (BME 6030)	3	S
Tissue Biomechanics (BME 7021)	3	F
Biochemical Engineering (CHE 6023)	3	S
Bioseparations (CHE 6050)	3	S
Biomedical Microsystems (EECE 6007)	3	F
Digital Image Processing (EECE 6042)	3	F
Biomicrofluidic Systems (EECE 6078C)	4	S
BioSensors and Bioelectronics (EECE 7032)	3	F
Viscous Flow and Heat Transfer (EGFD 7041)	3	F
Turbulent Flows (EGFD 7042)	3	
Finite Element Techniques (EGFD 7052)	3	S
Advanced Finite Element Method (EGFD 7055)	3	
Preparing Future Faculty in Engineering (ENGR 9051-9053)	1-3	F,S
Introduction to Nuclear Eng. and Health Physics (MECH 6003)	3	F
Bio-Fluid Mechanics (MECH 6046)	3	F
Applied Fast Fourier Transforms (MECH 6060)	3	F
Acoustics (MECH 6066)	3	F
Fundamentals of Biomechanics (MECH 6085)	3	(N/O)
Advanced Biomechanics (MECH 6086)	3	(N/O)
Solid Mechanics of Biological Materials (MECH 7056)	3	(N/O)
Bio-Heat Transfer (MECH 7095) [Offered alternate years]	3	F
Diagnostic Radiological Imaging Physics II (MP 9051)	3	S

Total Tech. El. Required (MS, PhD post MS, PhD alone): 3, 3, 6

Tissue Engineering/Biomechanics Curriculum

Course Title	# Cr. Hrs.	Semester
"Core" BME Graduate Courses:		
BME Survey (BME 7001)	3	F
Bioinstrumentation (BME 7002)	3	F
BME Research Design (BME 7005)	3	S
Total "Core" Required (MS, PhD post MS, PhD alone):	**6, 3, 9**	
Primary BME Focus Area (Tissue Engineering and Biomechanics) Courses:		
Joint Biomechanics and Measurement Methods (BME 6024)	3	S
Functional Tissue Engineering (BME 6030)	3	S
Tissue Biomechanics (BME 7021)	3	F
Independent Study in Biomechanics (BME 8020)	3	F,S,U
Independent Study in Tissue Engineering (BME 8030)	3	F,S,U
Molecular and Cellular Biology (GNTD 7001)	3	F
Biomechanical and Physiological Aspects of Muscular Activity (OSE 7044C)	2	F
Total Focus Area Required (MS, PhD post MS, PhD alone):	**6, 3, 9**	
General Medical Sciences Courses:		
Human Gross Anatomy (ANAT 8071C)	4-10	U
Scientific Integrity & Research Ethics (BE 7067)	1	U
Biochemistry and Cellular Signaling (GNTD 7002)	3	F
Medical Biochemistry & Human Genetics (GNTD 7041)	3	F
Medical Biochemistry & Human Genetics II (GNTD 7042)	3	S
Human Physiology (MCP 7000)	4	F
Fundamentals of Molecular Genetics (MG 6001)	3	F
Principles of Biochemistry I (MG 6010)	3	F
Principles of Biochemistry II (MG 6011)	3	S
Methods in Biomedical Research (PMM 8082)	3	F
Advanced Physiology and Pathophysiology (NURS 8022)	4	F
Ethics in Research (GNTD 7003)	1	S
Total Med. Sci. Required (MS, PhD post MS, PhD alone):	**3, 3, 6**	
Mathematics Courses		
Biostatistics in Research (BME 7061)	3	F,S
Advanced Statistical Methods in Biomedical Res. (BME 8064)	3	S
Introduction to Biostatistics (BE 7022)	3	F
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
Mathematical Programming (MATH 6015)	3	S
Applied Ordinary Differential Equations (MATH 6051)	3	S
Scientific Computation (MATH 8011)	3	S
Advanced Numerical Analysis (MATH 8010)	3	S
Applied Math Methods (MATH 8012)	3	F
Total Math Required (MS, PhD post MS, PhD alone):	**3, 3, 6**	

Approved Technical Electives

Biomedical Ultrasound (BME 6010)	3	S
MR Imaging and Spectroscopy (BME 6011)	3	S
Biomedical Signal and Image Processing (BME 6012)	3	F
Advanced Cell Biology (BIOL 6030)	3	F
Human Physiology & Biomechanics (BIOL 6093C)	4	S
Advanced Strength of Materials (AEEM 6001)	3	F
Elasticity I (AEEM 7001)	3	F
Elasticity II (AEEM 7002)	3	S
Nondestructive Testing (AEEM 7027)	3	F
Ultrasonic NDE (AEEM 7028)	3	S
Biochemical Engineering (CHE 6023)	3	S
Bioseparations (CHE 6050)	3	S
Molecular Engineering of Functional Nanomaterials (CHE 6098)	3	F
Biomedical Microsystems (EECE 6007)	3	F
Digital Image Processing (EECE 6042)	3	F
Biomicrofluidic Systems (EECE 6078C)	4	S
BioSensors and Bioelectronics (EECE 7032)	3	F
Viscous Flow and Heat Transfer (EGFD 7041)	3	F
Finite Element Techniques (EGFD 7052)	3	S
Advanced Finite Element Method (EGFD 7055)	3	
Nanostructured Materials Engineering (EME 6012C)	3	S
Preparing Future Faculty in Engineering (ENGR 9051-9053)	1-3	F,S
Bio-Fluid Mechanics (MECH 6046)	3	F
Solid Mechanics of Biological Materials (MECH 7056)	3	(N/O)
Bio-Heat Transfer (MECH 7095) [Offered alternate years]	3	F
Polymer and Biopolymer Engineering (METL 8001C)	3	F,S
Advanced Medical Device Design 1 (BME 7020C)	3	S

Total Tech. El. Required (MS, PhD post MS, PhD alone): 3, 3, 6

MEng Curriculum Courses (For BME MEng Students Only)[1]

Course Title	# Cr. Hrs.	Semester
BME MEng Core Courses (one course from each category – need minimum of 6 Cr Total)		
Project / Task Management Development Courses (1 required)**		
Advanced Medical Device Design (BME 7020)	3	F
Medical Device Life Cycle Engineering (BME 7010)	3	S
Engineering Economic Analysis (ENGR 6030)	3	S (***On Line)***
Quality Control (MECH 6074)	3	F (***On Line)***
Eng Project Management (ENGR 6014)	3	S
Technology Law (EGFD 6067)	3	S
Interpersonal Skill Development Courses (1 required)**		
Management of Professionals (ENGR 6002)	3	S
Fundamentals of Leadership (ENGR 6050)	3	F
Effectiveness in Technical Organizations (ENGR 6010)	3	F,S (***On Line)***
Advanced Technical Skill Development* (1 required)*		
Biosensors and Bioelectronics (EECE 7032)	3	A
Biochips and Lab-On-Chips (EECE 7026)	3	S
Nondestructive Testing (AEEM 7027)	3	F
Biochemical Engineering (CHE 6023)	3	
Bioseparations (CHE 6050)	3	
Biomedical Microsystems (EECE 6007)	3	F
Biomicrofluidic Systems (EECE 6078C)	4	S
Viscous Flow and Heat Transfer (EGFD 7041)	3	F
Turbulent Flows (EGFD 7042)	3	
Introduction to Nuclear Eng. and Health Physics (MECH 6003)	3	F
Bio-Fluid Mechanics (MECH 6046)	3	
Applied Fast Fourier Transforms (MECH 6060)	3	F
Acoustics (MECH 6066)	3	F
Fundamentals of Biomechanics (MECH 6085)	3	
Advanced Biomechanics (MECH 6086)	3	
Solid Mechanics of Biological Materials (MECH 7056)	3	
Bio-Heat Transfer (MECH 7095)	3	

****This requirement can be satisfied with other discipline-specific courses.***
*****In these course categories, the student can petition for other courses to be included, but will require approval of the MEng Advisor***

BME MEng Track Courses (Need at least 12 cr total)

Medical Device Innovation & Entrepreneurship (MDIEP) Track Courses		
Biomechanical Design of Implantable Devices (BME 7011)	3	F
Advanced Medical Device Design (BME 7020)	3	F
Medical Device Life Cycle Engineering (BME 7010)	3	S

Note: *MDIEP Track can be combined with any of the other tracks (T/E Biomech, or Imaging)*

[1] Note: Not all courses are taught every year. Students should use this curriculum sheet as a guide, and check Onestop prior to enrollment every semester to ensure that the course being considered is actually offered in that semester. This requires careful planning and students should start early to develop their program of study with the MEng program advisor.

Tissue Engineering and Biomechanics Track Courses:

Joint Biomechanics and Measurement Methods (BME 6024)	3	S
Functional Tissue Engineering (BME 6030)	3	S
Tissue Biomechanics (BME 7021)	3	F
Independent Study in Biomechanics (BME 8020)	3	F,S,U
Independent Study in Tissue Engineering (BME 8030)	3	F,S,U
Molecular and Cellular Biology (GNTD 7001)	3	F
Biomechanical and Physiological Aspects of Muscular Activity (OSE 7044C)	2	F

Medical Imaging Track Courses:

MR Imaging and Spectroscopy (BME 6011)	3	F
Biomedical Signal and Image Processing (BME 6012)	3	F
Biomedical Ultrasound (BME 6050)	3	S
Advanced Topics in Magnetic Resonance Imaging (BME 7012)	3	
Independent Study in Medical Imaging (20 BME 8010)	3	F,S,U
Diagnostic Radiological Imaging Physics (MP 9050)	3	F

BME MEng Electives (Need at least 6 cr total from the following)

General Medical Sciences Courses:

Human Gross Anatomy (ANAT 8071C)	4-10	U
Scientific Integrity & Research Ethics (BE 7067)	1	U
Biology of Cancer (CB 8080)	3	S
Molecular and Cellular Biology (GNTD 7001)	3	F
Biochemistry and Cellular Signaling (GNTD 7002)	3	F
Human Physiology (MCP 7000)	4	F
Brain and Behavior I (NS 8041)	4-10	S
Brain and Behavior II (NS 8061)	4-10	F

Mathematics Courses

Biostatistics in Research (BME 7061)	3	F,S
Advanced Statistical Methods in Biomedical Res. (BME 8064)	3	S
Introduction to Biostatistics (BE 7022)	3	F
Computational Fluid Dynamics (EGFD 6037C)	4	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
Mathematical Programming (MATH 6015)	3	S
Applied Ordinary Differential Equations (MATH 6051)	3	S
Scientific Computation (MATH 8011) 3	S	
Mathematical Physics (PHYS 7001)	4	F
Advanced Numerical Analysis (MATH 8010)	3	S
Applied Math Methods (MATH 8012)	3	F

In addition to the above courses, these 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 the Graduate Program MEng advisor, and approved accordingly by the advisor. E.g if Medical Device Innovation is chosen as the Track area combined with T/E Biomech, then electives can be selected from the Imaging Courses. All elective choices need approval of the MEng Program Director.