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DEPARTMENT OF BIOMEDICAL ENGINEERING
(BME)

GRADUATE GUIDELINES

2010/2011

This Guide contains information that supplements the University's Graduate Catalog which is the primary document governing all academic programs. Although every effort has been made to maintain accuracy, the Department of Biomedical Engineering reserves the right to correct errors when found, without further notice to students. The presence of errors will not affect the application of the rules and requirements applicable to all students.

GRADUATE GUIDELINES

Department of Biomedical Engineering
University of Florida
Gainesville, Florida 32611

Department Administration

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TABLE OF CONTENTS

OBJECTIVES AND OVERVIEW OF THE DEPARTMENT

The mission of the Department of Biomedical Engineering (BME) is to educate students with strong engineering and science backgrounds for Master's and/or PhD degrees in Biomedical Engineering so that they can productively apply their training to the solution of engineering problems in the fields of medicine, biology and related fields.

Biomedical Engineering Objectives

1. Provide students with a broad knowledge base of biomedical engineering and specialized knowledge and experience in at least one of the core areas: Biomechanics, Tissue Engineering, Biomedical Imaging and Signal Processing, Cardiac Engineering, Neural Engineering, BioMicro-Electromechanical Systems.

2. Provide students with the ability to apply fundamental engineering principles from several traditional engineering disciplines to identify, analyze, and solve clinical problems and improve health care.

3. Provide students with the ability to design and conduct scientific and engineering experiments, and to analyze and interpret the resulting data.

4. Provide students with experience and understanding of design requirements and constraints in the clinical and biological science environment, including technology transfer.

5. Provide students with the skills needed to communicate effectively, work collaboratively, and understand their professional and ethical responsibilities and the impact of clinically significant engineering solutions in a societal and economic context.

The Department of BME is interdisciplinary and collaborative, with designated departments in the College of Engineering (COE) and College of Medicine (COM) acting as partners in the education of Biomedical Engineers. COE participating departments include: Mechanics & Engineering Science (AeMES), Chemical Engineering (CHE), Computer & Information Science & Engineering (CISE), Electrical & Computer Engineering (ECE), Materials Science & Engineering (MSE), Mechanical & Aerospace Engineering (MAE), and Nuclear & Radiological Engineering (NRE). The participating department within the COM includes Surgery, Anesthesiology, Radiology, and Cardiology.

Biomedical Engineering students are admitted to the Graduate School through the Department of BME. The BME Academic Committee reviews and makes all decisions regarding admission to the Department of BME. Each student's research advisor must hold a Faculty appointment in the Department of BME. Supervisory committees for BME students normally include at least one member of the Faculty from the College of Engineering and one member of the Faculty from the College of Medicine.

GRADUATE FACULTY

Interim Department Chair: B.C. Wheeler. *Graduate Coordinator:* J.H. van Oostrom. *Distinguished Professors:* P.M. Pardalos, J.C. Principe. *Professors:* C.D. Batich, W.E. Bolch, F. Bova, A.B. Brennan, P.R. Carney, R.B. Dickinson, M. Ding, J.R. Fitzsimmons, E.P. Goldberg, J.G. Harris, H. Jiang, T.H. Mareci, J.J. Mecholsky, R.J. Melker, W.M. Phillips, J.D. Stewart, R. Tran-Son-Tay, B.C. Vemuri, B.C. Wheeler. *Associate Professor*s: S.A. Banks, A.S. Edison, Z.H. Fan, J. Forder, B.J. Fregly, D.R. Gilland, L.B. Gower, D.E. Hintenlang, C. Klodell, M. Sarntinoranont, Y. Tseng, J.H. van Oostrom, H. Xie. *Assistant Professor*s: B.G. Keselowsky, P. McFetridge, W.O. Ogle, B.K. Ormerod, B.S. Sorg. *Research Faculty*: T.B. DeMarse , R. Sadleir, S. Talathi.

INTRODUCTION

The Department of Biomedical Engineering (BME) at the University of Florida offers the Master of Engineering (ME), the Master of Science (MS) and the Doctorate of Philosophy (PhD) degrees in Biomedical Engineering. The Graduate Guidelines detail the policies and regulations governing these programs and should be used in conjunction with the University of Florida Graduate Catalog. It is **the responsibility of the student** to be familiar with both publications and to adhere to the stated rules.

REQUIREMENTS FOR DEGREES

Unless otherwise specified, for any master's degree, the student must earn a minimum of 30 credits as a graduate student at the University of Florida. No more than 9 of the 30 credits (earned with a grade of A, B+, or B) may be transferred from institutions approved by the University of Florida. A minimum of 90 credits beyond the bachelor's degree is required for the Ph.D. degree. All master's degrees counted in the minimum must have been earned in the last seven years. (Graduate Catalog - Course Requirements).

All coursework within the College of Engineering (COE) and College of Medicine (COM) will count as elective credits toward the degree requirements for the MS, ME and PhD degrees.

A summary of the pertinent degree requirements is shown in the table. The BME specialty areas are: Biomechanics, Cell & Tissue Engineering, Biomedical Imaging and Processing, Cardiac Engineering, Neural Engineering, and BioMicro-Electromechanical Systems.

SCH (Semester Credits Hour) Requirements (minimum number)	Master (Thesis)	Master (Non-thesis)	Doctor of Philosophy
Total SCH	30 [a]	30 [a]	90 [a,b]
BME Core Requirements	21	21	21
BME Electives	3	6	6
Research/Special Project	(var)	(var)	(var)
Supervisory committee members (minimum number)	3	1 [c]	4
Qualifying Exam	None	None	yes [d]
Final Exam	Oral [e]	Written [f]	Oral [g]
Time limit for completing degree	7 years	7 years	5 years [h]

a. Beyond BS
b. May include 30 hours from Master's program
c. Recommend at least 2
d. Two-part exam. Must be taken within 2 calendar years from entry. Record holds will be enforced.
e. On Thesis and course work
f. Exam content determined by the student's supervisory committee
g. On Dissertation and course work
h. 5 years from admission to candidacy.

GENERAL REGULATIONS

Graduate Assistantships and Fellowships

Graduate Assistantships are available through individual academic units. Stipend rates paid are determined by the employing academic unit. Interested students should ask their academic-unit offices about the availability of assistantships and the procedure for making application. Prospective students should write directly to their major academic units.

The full-time registration requirement is reduced for students who are graduate assistants. (See Registration Requirements in the Graduate Catalog for required registration) Graduate assistants are responsible for paying applicable student fees per semester credit hour and will be financially liable for excess credits beyond the required registration. If a student on appointment drops below the required registration at any time in the semester, the student becomes financially liable for the entire registration. (Graduate Catalog – Registration Requirements)

Registration Requirements

Graduate students on appointments as graduate research assistants with an FTE between .25 and .74 are required to register for 9 credits in the Fall/Spring term and 6 in the summer C term (or 3 in summer A and 3 in summer B).

Full-Time Registration - Students may be considered full-time with a registration of 9-12 credits. Students not on appointment may want to enroll full time to finish their degrees in the minimum timeframe or may be required to enroll full time by external funding agencies or their academic units.

To register for each term, a completed Semester Registration Form must be submitted to the GSO by 5:00PM on the published registration deadline. Record holds will be enforced. If the registration includes elective, research or independent study course(s), the signature of the student's advisor must be obtained. The Semester Registration Form can be found on the BME website (www.bme.ufl.edu) under *student forms*. Students have access to their degree audit online at www.isis.ufl.edu. Research credits are graded as S/U.

During the term in which the final examination is given and during the term the degree is awarded, a student must be registered for **at least three credits** in fall or spring and **two credits** in the summer. Thesis students must enroll in 6971 and doctoral students must enroll in 7980. Nonthesis students must enroll in course work that counts toward the graduate degree. The 3-hour minimum final term registration is applicable to all graduate students. The Graduate School will not accept petitions to this policy. (Graduate Catalog – Registration Requirements). Graduate assistants who must register for a certain number of credits as stated in their letter of appointment, must still comply with their required registration.

Students who complete all graduate degree requirements during a given semester, but narrowly miss a deadline specified by the Graduate School due to an unforeseeable event, may receive their degree in the following semester without registering for the minimum three credits (clearing prior). Please see the GSO for clear prior deadlines for the appropriate term.

Add/Drop

Courses may be dropped or added during the drop/add period without penalty. This period lasts five UF calendar days, or three days for summer sessions, beginning with the first day of the semester. Classes that meet for the first time after the drop/add period may be dropped without academic penalty or fee liability by the end of the next business day after the first meeting. This does not apply to laboratory sections. After this period, a course may be dropped and a W will appear on the transcript. **Students become financially liable for any course added or dropped after the deadline, including students with fee waivers.**

Retaking Courses – Graduate students may repeat courses in which they earn failing grades. Grade points from both the initial failed attempt and the first attempt earning a grade of C or better are included in computing the grade point average. The student receives credit for the satisfactory attempt only. (Graduate Catalog – Registration Requirements).

Courses and Credits

Undergraduate courses (1000-4999) may not be used as any part of the graduate degree requirements. Courses numbered 5000 and above are limited to graduate students. Courses numbered 7000 and above are designed primarily for advanced graduate students.

No more than five credits each of 6910 (Supervised Research) and 6940 (Supervised Teaching) may be taken by a graduate student at the University of Florida. Generally graduate courses may not be repeated for credit. However, there is no limit on courses number 6971, 7979, and 7980. Other courses that may be repeated for credit are designated by max: immediately following the semester credit designation. Course numbers 6971 (Masters Research), 7979 (Advanced Research), and 7980 (Doctoral Research) will not count toward the Masters Non-Thesis degree.

Professional Work – Graduate students may receive credit toward their degrees for courses in professional programs (e.g., J.D., D.V.M., or M.D.) when their advisors and graduate coordinators certify that the course work is appropriate for their programs and when the students receive permission from the academic units and colleges offering the courses. A list of such courses for each student must be filed with the Graduate Student Records (106 Grinter) and is limited to a maximum of 9 credits toward the master's degree and 30 credits toward the doctorate. (Graduate Catalog - Courses and Credits).

If a student needs to have any courses that are not considered Graduate Level, i.e., 3000-4000 level, the Graduate Coordinator should make approvals before the student registers for the course. It is crucial that BME students have an overall comprehensive understanding of the curriculum and be able to master it well. If a student lacks in a particular area the Graduate Coordinator should suggest courses to enhance this student(s) education to the benefit of that student and his/her matriculation and experience through the Graduate Program in BME.

Grades

The only passing grades for graduate students are A, A-, B+, B, B-, C+, C, and S. C+ and C grades count towards a graduate degree if an overall GPA of at least 3.0 is maintained. Grade points are not designated for S and U grades; these grades are not used in calculating the grade point average. All letter graded courses taken as a graduate student, except 1000 and 2000 level courses, are used in calculating the cumulative grade point average.

Preparation for Final Semester

It is the student's responsibility to ascertain that all requirements have been met and that every deadline is observed. Deadline dates are set forth in the University Calendar and by the college or academic unit. These dates are included in the front of the Graduate Catalog and online at the Graduate School Website.

During the final term, PhD Students should obtain the Checklist for Doctoral Dissertations and Master's students should obtain the Checklist for Master's Theses from the Graduate School website: http://gradschool.rgp.ufl.edu/editorial/introduction.html. This website also offers formatting guidelines when the dissertation or thesis is ready to be put in final form.

At the beginning of the final term students must also file a degree application online through ISIS and must meet minimum registration requirements. See Cleared Prior in the Graduate Catalog. (Graduate Catalog - Preparation for Final Semester). The GSO also requires a copy of the final thesis or dissertation.

MASTER'S DEGREE

The Department of BME offers both thesis and non-thesis options for the Master's degree. A student seeking the Master's degree with a thesis option is required to pass an oral final exam, and the non-thesis Master's student is required to pass a written comprehensive examination.

Students may choose a thesis or nonthesis option for the Master of Engineering (M.E.) degree. To be eligible for admission to the M.E. program students must have earned a bachelor's degree from an ABET-accredited college or they must complete articulation work for equivalence. Admission requirements of the Graduate School must be met. Students who do not meet the ABET requirement may be admitted to the Master of Science program. The nonthesis M.E. degree is a 30-credit course-work only degree (practice-oriented project or capstone course may be included in the 30 credits). At least 15 credits must be in the student's major at the 5000 level or higher. The Thesis option requires 30 credits of course work which may include up to 6 semester credits of research numbered 6971 in all academic units. At least 12 credits, excluding 6971, must be in the student's major field of study. (Graduate Catalog - Master of Engineering).

Time Limitation - All work, including transferred credit, counted toward the master's degree must be completed during the seven years immediately preceding the date on which the degree is awarded. (Graduate Catalog - General Regulations).

Admission Requirements

The students admitted to the Department of BME for the Master's degree will in general be expected to have an undergraduate upper division grade point average of at least 3.4 on a 4.0 scale, a competitive GRE verbal and quantitative score, where applicable, a TOEFL score of no less than 550 for the paper based, 213 for the computer based test or 80 for the internet based.

Course Requirements

Graduate credit is awarded for courses numbered 5000 and above. The program of course work for a master's degree must be approved by the student's advisor, supervisory committee, or faculty representative of the academic unit. No more than nine credits from a previous mater's degree program may be applied toward a second master's degree. These credits are applied only with the written approval of the Dean of the Graduate School.

Degree Requirements

Unless otherwise specified, for any master's degree, the student must earn a minimum of 30 credits as a graduate student at the University of Florida. No more than 9 of the 30 credits (earned with a grade of A, B+, or B) may be transferred from institutions approved for this purpose by the Dean of the Graduate School. At least half of the required credits, exclusive of 6971, must be in the field of study designated the major. (Graduate Catalog – General Regulations).

Transfer of Credit

If appropriate, submit a Transfer Petition to the BME Academic Committee, only graduate-level (5000-7999) work, earned with a grade of B or better, is eligible for transfer of credit. A maximum of 15 transfer credits are allowed. These can include no more than 9 credits from institution/s approved by UF, with the balance obtained from postbaccalaureate work at the University of Florida (Graduate Catalog - General Regulations). All courses must have a designation (i.e. engineering requirements, engineering electives, Department requirements, etc.).

Supervisory Committee

The supervisory committee should be appointed as soon as possible after the student has been admitted to the Graduate School but in no case later than the second semester of graduate study. (Graduate Catalog - General Regulations).

Their duties are to advise the student, to check on the student's qualifications and progress, to supervise the preparation of the thesis, and to conduct the final exam. The student is responsible for forming a Supervisory Committee and providing the names of the committee members to the Department of Biomedical Engineering Graduate Student Office. The function of the committee is to guide the student through his/her thesis research and to administer the final examination.

The supervisory committee for a master's degree with a thesis must consist of at least three members selected from the Graduate Faculty. At least two members including the chair must hold an academic appointment in the Department of BME. All BME Graduate Thesis students must have a core BME Faculty Member as a member of their supervisory committee. The chairperson is the student's academic advisor and should advise the student in the selection of other members.

The supervisory committee for a master's degree without a thesis may consist of one member of the BME graduate faculty. The chairperson must be affiliated with the Department of BME and is the one who advises the student.

Thesis

Candidates for the master's degree with thesis must prepare and present thesis (or equivalent in creative work) acceptable to their supervisory committees and the Graduate School. The candidate should consult the Graduate School Editorial Office for instructions concerning the form of the thesis. The University Calendar specifies final dates for submitting the original thesis to the Graduate School. (Graduate Catalog - Master of Arts and Master of Science).

Final Examination Procedures

Within six months prior to graduation, the supervisory committee will give the student an oral examination on the thesis, major and minor subjects, and matters pertaining to his/her field of study.

The student must let the GSO know of their graduation intentions the semester prior to graduation. This will allow time for course requirement checks. It is imperative that copies of the student's thesis be given to the supervisory committee at least one week in advance of the final examination. The Department of BME must receive date, time, title, location, and abstract two weeks prior to the defense date. Graduation may be delayed for those who do not adhere to this rule. All supervisory committee members and the candidate must be present at the final examination. At the time of the examination, all committee members should sign the signature pages and the Final Examination Report.

These may be retained by the supervisory chair until acceptable completion of corrections. This examination may not be scheduled earlier than the semester preceding the term the degree is to be conferred. (Graduate Catalog - General Regulations). On the day of examination, advisor needs to pick up necessary forms at the Department of BME. The Chair of your Supervisory Committee should return the Final Examination Form with your file to the Department of BME.

Non-Thesis

The ME and MS non-thesis master's degrees require 30 hours of course work.

Final Examination Procedures

For the ME degree, an examination is not required, but at the discretion of the department, an oral or written examination may be given. For the MS degree, a comprehensive written or oral examination is required. This examination must be taken within 6 months of the date the degree is to be awarded. Results of the examinations are not final until reviewed by the Supervisory Committee. If the student fails the examination, he/she must retake the examination at the next scheduled time. The exam may be retaken only once. The examination consists of the successful completion of a project designated by the chair of the supervisory committee.

If a Master student applies to the PhD program and is accepted, he/she may choose to take the PhD Written Qualifying Examination and, upon successful completion, satisfy the Master's Non-Thesis and the PhD Written Qualifying Examination simultaneously.

CURRICULUM FOR MASTERS DEGREES

DEPARTMENT OF BIOMEDICAL ENGINEERING

BME Core

The BME Core is required for all MS/ME students

BME Core required		
Number	Course	Credits
BME5407	Molecular Biomedical Engineering	3
BME5401	Physiology	3
BME6010	Clinical Preceptorship	3
BME Core Math requirement (choose 1 of 2)		
BME5703	Computational Methods for BME	3
BME5xxx	Advanced Math for BME	3
BME Core options (choose 3 of 5)		
BME 6360	Neural Engineering	3
BME 6502	Intro to Medical Imaging	3
BME 6330	Cell & Tissue Engineering	3
BME 5052L	Molecular cell biology lab	3
BME 5500	Biomedical Instrumentation	3

BME Electives

All BME elective courses require approval from the student's supervisory committee (chair). Allowable courses are all graduate courses from the COE, and COM, with the exception of independent study, research, and supervised teaching courses.

Elective credit requirement:
MS/ME Thesis: 3 credits
MS/ME NonThesis: 6 credits

BME Research

Research under the supervision of a supervisory committee is conducted by students in the MS/ME Thesis programs. Research will be conducted under the BME6971 course number.

BME Graduate Seminar

Students are required to enroll in BME6936 BME Seminar every Fall and Spring semester after their first year.

Program credit totals

MS/ME: 30 credits

DOCTOR OF PHILOSOPHY DEGREE

Admission Requirements

The students admitted to the Department of BME for the PhD degree will in general be expected to have undergraduate work and graduate work (if taken) equivalent to a 3.4 GPA on a 4.0 scale, a competitive GRE verbal and quantitative score, where applicable, a TOEFL score of no less than 550 for the paper based and 213 for the computer based test. At least three strong letters of recommendation, statement of purpose - This statement should include the field of study that you wish to pursue, your intended area of specialization, and why you have selected the University of Florida and the Department of BME.

Appointment of Supervisory Committee

Upon acceptance into the PhD program, the student has two semesters to identify a professor willing to guide the dissertation research. If no such professor can be found the student can be dismissed from the PhD program. Each student is encouraged to complete this as soon as possible but no later than the second semester.

Supervisory committees are nominated by the department chairperson, approved by the dean of the college concerned, and appointed by the Dean of the Graduate School. The committee should be appointed as soon as possible after the student has begun doctoral work and in general no later than the end of the second semester of equivalent full-time study. The dean of the Graduate School is an ex-officio member of all supervisory committees.

Duties and Responsibilities – Duties of the supervisory committee follow:

1. To inform the student of all regulations governing the degree sought. It should be noted, however, that this does not absolve the student from the responsibility of informing himself/herself concerning these regulations.
2. To meet immediately after appointment to review the qualifications of the student and to discuss and approve a program of study.
3. To meet to discuss and approve the proposed dissertation project and the plans for carrying it out.
4. To give the student a yearly letter of evaluation in addition to the S/U grades awarded for the research courses 7979 and 7980. The Chair should write this letter after consulting with the supervisory committee.
5. To conduct the qualifying examination or, in those cases where the examination is administered by the academic unit, to take part in it. In either event the entire committee must be present with the student for the oral portion of the examination. This examination must be given on campus.
6. To meet when the work on the dissertation is at least one half completed to review procedure, progress, and expected results and to make suggestions for completion.
7. To meet on campus when the dissertation is completed and conduct the final oral examination to assure that the dissertation is a piece of original research and a contribution to knowledge. No fewer than four faculty members, including all members of the supervisory committee shall be present with the candidate for this examination. Only members of the official supervisory committee may sign the

dissertation and they must approve the dissertation unanimously. (pg 35 Graduate Catalog).

Membership - The supervisory committee for a candidate for the doctoral degree shall consist of no fewer than four members selected from the Graduate Faculty. At least two members, including the chair, will be from BME, and at least one member will be drawn from a different educational discipline, unaffiliated with the Department of BME. At least one member should be from the College of Medicine or other health-related college. All BME Graduate PhD students must have a core BME Faculty Member as a member of their supervisory committee. After the committee has been determined, a signed copy of the Supervisory Committee form must be filed with the GSO.

Course Requirements

The course requirements for doctoral degrees vary from field to field and from student to student. A minimum of 90 credits beyond the bachelor's degree is required for the Ph.D. degree in all fields. All master's degrees counted in the minimum must have been earned in the last seven years.

Transfer of Credit

No more than 30 semester credits of a master's degree from another institution will be transferred to a doctoral program. If a student holds a master's degree in a discipline different from the doctoral program, the master's work will not be counted in the program unless the academic unit petitions the Dean of the Graduate School. All courses beyond the master's degree taken at another university to be applied to the Ph.D. degree must be taken at an institution offering the doctoral degree and must be approved for graduate credit by the Graduate School of the University of Florida. All courses to be transferred must be graduate level, letter graded with a grade of B or better and must be demonstrated to relate directly to the degree being sought. All such transfer requests must be made by petition of the supervisory committee no later than the third semester of Ph.D. study. The total number of credits (including 30 for a prior master's degree) that may be transferred cannot exceed 45, and in all cases the student must complete the qualifying examination at the University of Florida. In addition, any prior graduate level credits earned at the University of Florida (e.g., a master's degree in the same or a different discipline) may be transferred into the doctoral program at the discretion of the supervisory committee and by petition to the Graduate School. In such cases, it is essential that the petition demonstrate the relevance of the prior course work to the degree presently being sought. (Graduate Catalog - Course Requirements).

PhD degree has the following restrictions:
1. At least 36 hours of 5000, 6000, or 7000 level BME courses are required. Course numbers 5905, 6905, 6910, 6940, 6971, 7979 and 7980 are not considered coursework for the purpose of this 36-credit requirement.

Registration in Research Courses

Advanced Research (7979) is open to doctoral students who have not yet been admitted into candidacy (7 and 8 classifications). Students enrolled in 7979 during the term they qualify for candidacy will stay in this registration unless the academic unit elects to change their enrollment to Research for Doctoral Dissertation (7980). Research for Doctoral Dissertation (7980) is reserved for doctoral students who have been admitted to candidacy (9 classification). (Graduate Catalog - Registration in Research Courses).

Annual Evaluation for PhD Students

The Supervisory Committee Chair, in consultation with the other committee members, will give each PhD student a yearly written evaluation of his/her progress towards his/her degree. The student is given an opportunity to discuss the evaluation with his/her Supervisory Committee Chair. Copies of this evaluation and of student comments are placed in the student's academic file.

Qualifying and Admission to Candidacy Examinations

The Qualifying and Admission to Candidacy Examinations must be taken within two calendar years from entry. Record holds will be enforced. Petitions can be made to the Academic Committee. The current policy for these examinations can be found on the web at: http://www.bme.ufl.edu/academics/graduate.

Final Examination and Doctoral Dissertation

Within six months prior to graduation and after the submission of the dissertation and completion of all other prescribed work for the degree, the doctoral candidate will be given a final examination by his/her supervisory committee. The PhD final examination consists of an oral defense of the research results that are described in the doctoral dissertation.

The Department of BME should be informed of the examination 2 weeks prior to the time that the dissertation is submitted. This will ensure sufficient time to process the Final Examination Report. Copies of the student's dissertation must be given to the supervisory committee members at least one week in advance of the final examination. **Graduation may be delayed for those who do not adhere to this rule.**

At the time of the defense, all committee members should sign the signature pages in the dissertation and sign the Final Examination Report. The final exam report is to be returned to the GSO for forwarding to the College Dean's office and the Graduate School. Students will submit the original copy of their dissertation signed by the supervisory committee and the Dean of the College of Engineering to the Graduate School Editorial Office. The Editorial Office will then check for formatting corrections and return to the student for final corrections. The final dissertation must be submitted on bond paper before the Dean's signature can be affixed to the signature page. The student is required to walk the dissertation along with the signature page to the Editorial Office. The Editorial Office will secure the signature of the Graduate School Dean. The BME and the College of Engineering copy must be corrected to reflect any final changes after the final examination and prior to a faculty vote on graduation.

All work for the PhD degree must be completed within five calendar years after the completion of the PhD qualifying exam

CURRICULUM FOR DOCTOR OF PHILOSOPHY DEGREE

DEPARTMENT OF BIOMEDICAL ENGINEERING

BME Core

The BME Core is required for all PhD students

BME Core required		
Number	Course	Credits
BME5407	Molecular Biomedical Engineering	3
BME5401	Physiology	3
BME6010	Clinical Preceptorship	3
BME Core Math requirement (choose 1 of 2)		
BME5703	Computational Methods for BME	3
BME5xxx	Advanced Math for BME	3
BME Core options (choose 3 of 5)		
BME 6360	Neural Engineering	3
BME 6502	Intro to Medical Imaging	3
BME 6330	Cell & Tissue Engineering	3
BME 5052L	Molecular cell biology lab	3
BME 5500	Biomedical Instrumentation	3

BME Electives

All BME elective courses require approval from the student's supervisory committee (chair). Allowable courses are all graduate courses from the COE and COM, with the exception of independent study, research, and supervised teaching courses.

Elective credit requirement:
PhD: 6 credits

BME Research

Research under the supervision of a supervisory committee is conducted by students in the PhD programs. Students will take BME7979 before passing the candidacy examination, and BME7980 afterwards.

BME Graduate Seminar

Students are required to enroll in BME6936 BME Seminar every Fall and Spring semester after their first year.

Program credit totals

PhD: 90 credits

BME COURSES AND ELECTIVES

Program Core Courses:

BME 5401 - Physiology (3) The course covers the physiology of cells, bones and circulatory system from a Biomaterials, Biomechanics, Cellular & Tissue Engineering perspective.
BME 5407 – Molecular Biomedical Engineering (3) An introductory course in the fundamentals of Molecular Biology for Biomedical Engineers. This course is designed for first year biomedical engineering students where they will learn the nomenclature, and current state of knowledge of the eukaryotic cell and its related structures. Topics covered in this course: Protein structure and function, Enzymes, the structure and nature of DNA, cellular structure and function of various cellular organelles. In addition they will learn energy and the function of mitochondria and chloroplast, cellular communication, and the function of the extracellular matrix.
BME 6010 - Clinical Preceptorship for Engineers (3) Instructor's approval required. The Clinical Faculty have unique insights into the restraints on current medical practice imposed by conditions, which may be changed by application of engineering principles. Students shadow a clinical faculty member in a clinic and work with an engineering faculty member to examine some of these practices and restraints with a goal to propose and evaluate possible improvements.
BME 6936 - Biomedical Engineering Seminar (1) The seminar provides state of the art reports on engineering research and clinical experience. It is designed to inform students and faculty of current developments, opportunities, and needs in the field. Faculty are encouraged to attend.

BME Core Math Requirement:

BME 5703 - Computational Methods for BME (3) This course covers computational methods needed for biomedical engineering research. Students will be acquainted with a variety of techniques for analyzing and modeling experimental data arising in molecular, cellular, physiological, and pathological systems encountered in typical laboratory and clinical settings.
BME 5XXX – Advanced Math for BME (3) This course covers advanced mathematics from a biomedical engineering perspective. Linear and nonlinear systems, partial differential equations, optimization and inverse problems will be discussed. Advanced mathematical techniques are increasingly needed in today's biomedical engineering. For example, one needs a nonlinear system to describe a model or problem in neural engineering. Finite element has been a powerful numerical method to deal with many problems in biomechanics and biomaterials where partial differential equations are involved. Inverse problems are common almost everywhere in the field of biomedical imaging. This course is geared towards the applications of the advanced mathematical techniques to various biomedical engineering problems.

BME Core Options:

BME 6360 – Neural Engineering (3) Neural Engineering represents the application of Engineering to neuroscience including such diverse areas as neural tissue engineering, models of neural function, and neural interface technology. This course will focus on these areas primarily in the context of neural interfaces/prosthetics beginning with basic neural physiology and models of neural mechanisms to the advanced neural interfaces currently being developed and or produced commercially by the field.
BME 6502 – Intro to Medical Imaging (3) This course covers modern medical imaging technologies from a biomedical engineering perspective. The physics, mathematics, instrumentation and clinical applications of all common medical imaging modalities including x-ray radiography, computed tomography (CT), ultrasound imaging, positron emission tomography (PET), and magnetic resonance imaging (MRI) will be discussed. Emerging imaging modalities including diffuse optical tomography (DOT), optical coherence tomography (OCT) and photoacoustic tomography (PAT) will also be introduced.
BME 6330 - Cellular & Tissue Engineering (3) Application of engineering principles toward understanding property-function relationships in cells and tissues. Manipulation of cell and tissue properties or the design of bioartificial substitutes to alter, restore, or improve cell and tissue function.
BME 5500 - Biomedical Instrumentation (3) Prereq: Basic knowledge of physics and calculus is required. This course will present all the major methods for measuring physiological signals from the human body. Whenever possible, actual physiological monitors will be used for the students to try out.

BME Electives:

Students may count any College of Engineering or College of Medicine Graduate Course (5000 level and above) towards their BME elective. Students may count up to 6 undergraduate credits towards their degree program as long as it is outside of their major, must be approved by the Chair of the students Supervisory Committee and Graduate Coordinator.

BME/EML 5595—Mechanics of the Human Locomotor System (3) Prereq: EGM 3401, 3520. Analysis of human musculoskeletal system as sensors, levers, and actuators. Joint articulations and their mechanical equivalents. Kinematic and kinetic analysis of human motion. Introduction to modeling human body segments for analysis of human activities.
BME 6905 - Individual Study (1-6; max: 8)
BME 6936 – Biomedical Engineering Seminar (1) This seminar will provide state-of-the-art reports on engineering research and clinical experience. It is designed to inform students and faculty of current developments, opportunities, and needs in the field. This course is WebCT enhanced. You will need access to a computer and the web for this course. Reports must be submitted via the web page, and the approved listing of seminars is only at the WebCT course page.

BME 6938 - Special Topics in Biomedical Engineering (1-4; max 6)
BME 6938 - Finite Element Modeling for Biomedical Applications (3) This course will deal with the implementation of finite element and related methods, drawing examples from Biomedical Engineering. Therefore the course will also cover method of incorporating freeform biological shapes in computational models such as shape importation and image segmentation. The course will cover the basics of Finite Element methods, such as shape functions and sparse matrix methods, giving students enough background to allow them to intelligently operate complex commercial software or to construct their own models. Students will also be exposed to methods such as finite difference, boundary element and time domain modeling, adaptive meshing and other large scale modeling techniques. A substantial portion of the course will involve students developing and solving their own models.
BME 6938 – Genetic & Protein Engineering (3) An introduction to the principles and concepts of protein design and modification. The course will also cover aspects of gene regulation and methodologies for regulating the expression of modified proteins.
BME 6938 – Stem Cell Engineering (3) Introduction to Stem Cell Biology for Biomedical Engineers. Lectures will be given by Dr. Ormerod and students enrolled in the class. Topics will include an historical review of stem cell research and policies surrounding it, current stem cell sources, strategies and reviews of current stem cell research. This information is essential for Biomedical Engineers to understand in their attempts to repair/rebuild the human body after injury or disease.
BME 6938 - Design and Practical Implications with Engineered Cardiovascular Tissues (3) The basic class will cover aspects of cardiovascular tissue engineering with a focus on blood vessel development, heart tissues including cardiac muscle and valves. Other special topics will include mechanisms of vascularization and project based class assignments.
BME 6938 – Special Neurobiology Topics for Biomedical Engineers (3) Introduction to Neurobiology for Biomedical Engineers. Lectures will be given by Dr. Ormerod and students enrolled in the class. Topics will include an introduction to the central nervous system (CNS), its cytoarchitectonic and functional organization, and behaviors that different brain regions control. Finally diseases that affect the CNS and their molecular bases will be described. This information is essential for Biomedical Engineers to understand in their attempts to repair/rebuild the central nervous system.
BME 6938 – Biomaterial Immunomodulation (3) his course will examine current biomaterial platforms relevant to the field of immunology and fundamental interactions of immune cells with implanted materials. The course format for this course consists of a combination of lectures and journal club-style student presentations.
BME 6938 – Cancer Biology, Diagnosis, and Therapy for Engineers (3) Introduction to the biology, diagnosis, and therapy of cancer. Examples of topics to be covered include tumor initiation and progression to the malignant state, metastatic cascade, tumor hypoxia and molecular oxygen sensing, tumor angiogenesis and aberrant microvasculature, cancer screening and imaging, screening test evaluation including 2x2 tables and receiver-operator characteristic curves, radiation therapy, chemotherapy, hyperthermia, photodynamic therapy. Quantitative mathematical modeling and analysis will be used as appropriate.
BME 6938 – Multivariate Signal Processing (3) This course will deal with the statistical analysis of biomedical signals from a multivariate time series analysis perspective. Starting from the probabilistic foundation of time series we introduce analysis concepts and

methods both in the time domain and in the spectral domain. Whenever possible actual recordings from biomedical applications will be used to demonstrate the methods.
BME 6938 - Light & Laser Tissue Interactions (3) Comprehensive introduction to the theory and modeling of light and laser-tissue interactions. Tissue optical properties, radiative transport theory, and Monte Carlo modeling of photon propagation in tissue; tissue thermal properties, bioheat transfer equation, and finite difference modeling of heat transfer in tissue; tissue thermal damage and Arrhenius damage integral.
BME 6938 - Math Modeling (3) This course will deal with the mathematical modeling of biological and physiological phenomena. Starting from the basic theory of linear systems we introduce qualitative analysis of nonlinear ordinary differential equations and maps. Examples from biomedical applications will be used to demonstrate the concepts and methods.

BME Research:

BME 6910 - Supervised Research (1-5; max: 5) S/U
BME 6940 - Supervised Teaching (1-5; max: 5) S/U
BME 6971 - Research for Master's Thesis (1-15) S/U
BME 7979 - Advanced Research (1-12) Research for doctoral students before admission to candidacy. Designed for students with a Master's degree in the field of study or for students who have been accepted for a doctoral program. Not open to students who have been admitted to candidacy. S/U.
BME 7980 - Research for Doctoral Dissertation (1-15) S/U