1. Introduction

The process of receiving a Ph.D. in Bioengineering from the University of Missouri can be divided into several distinct steps. This document will serve as a guide through these steps as they are applied by the Bioengineering Program faculty. The student must also conform to any of the requirements and regulations of the University of Missouri Graduate School and the University of Missouri system. Figure 1, below, shows the overall process.

The remainder of the document will be broken down into the individual items that must be completed. Please note that we are assuming each year has 3 semesters: Fall, Spring, and Summer. All the deadlines mentioned in the following paragraphs will be measured from the first day of classes in the first semester in which a student begins their Ph.D. program of study.

Lastly, in the Department of Bioengineering, students are currently admitted directly to an advisor, rather than to the department as a whole. This advisor will be your faculty mentor, academic advisor, and research mentor throughout your course of study.
Steps to Graduation

Figure 1: Flowchart for Ph.D. Program Requirements
Academic Process for Doctoral Students

Step 1: Complete Qualifying Examination or Process (D1 Form) – Second Semester

To be officially admitted to a PhD program, the student must pass a qualifying examination or process. Any department or area program may limit the number of times this examination or process may be attempted. Exemption may be given if student received a Bachelors degree from Mizzou. Qualifying Examination Results and Doctoral Committee Approval Form (D1)

Step 2: Choose Doctoral Program Committee (D1 Form) – Second Semester

All members of the doctoral program committee participate actively in the activities of the doctoral student at all the stages of the student's career at MU, except the qualifying examination or process. Qualifying Examination Results and Doctoral Committee Approval Form (D1)

Step 3: Submit Plan of Study (D2 Form) – Second Semester

A plan of study is a list of courses and the credit to be earned in each of them. Plan of Study for the Doctoral Degree Form (D2)

Step 4: Take Comprehensive Examination (D3 Form) – Seven Months Before Final Defense

The comprehensive examination consists of written and oral sections. It must be completed at least seven months before the final defense of the dissertation. The two sections of the examination must be completed within one month. Doctoral Comprehensive Examination Results Form (D3)

Step 5: Write dissertation

Step 6: Defend Dissertation (D4 Form) – Last Semester

Report of Dissertation Defense Form (D4)
2. Applying to the Program

2.1. Academic Requirements

1. Earn a bachelor's and master’s degree from an approved course of study with a grade point average (GPA) of at least 3.2 on a four point scale or its equivalent for the last 60 hours of courses. This should be a B.S. and M.S. degree from an accredited university or its equivalent. In rare instances, an exceptional student will be allowed to study for the Ph.D. without first completing an M.S. degree.

2. Take the Graduate Record Exam (GRE) no earlier than five years prior to applying. The minimum quantitative score for acceptance is 162.

3. Take the Test of English as a Foreign Language (TOEFL) if you did not attend high school (or equivalent) where English was the language of instruction. The minimum TOEFL score for acceptance into this program is 79. If the TOEFL score is between 79 and 100, the applicant will be required to take a remedial course.

All applications will be reviewed, however, only students meeting these standards are normally admitted to the Bioengineering graduate program. In exceptional cases (such as strong evidence of prior research experience, teaching experience, or field-related work experience), these eligibility standards may be relaxed at the discretion of the faculty. Financial support is not guaranteed and is offered on a case-by-case basis. Please contact the Director of the Graduate Program directly for more information about whether the eligibility standards might be relaxed.

2.2. Application Deadlines

Applications are accepted at any time during the year. The deadlines are:

- April 1 for Fall Term admittance in the same year
- October 31 for Spring Term admittance the following year

2.3 Application Instructions

1. Assemble all appropriate documents demonstrating the academic criteria are met, including:
   a. Official Transcripts
   b. TOEFL scores
   c. GRE scores

2. Access the online application form and fill it out. This form may be found at: http://gradstudies.missouri.edu/admissions/apply/

3. Application fees are $65 for domestic students and $90 for international students.

Upon receipt of the documents, the Graduate Admissions committee will examine the application materials. Each application will be uploaded to the graduate Apply Yourself System. Once all application materials are received, faculty members will decide if they are willing to serve as a mentor for the student. Students will be informed as to their provisional acceptance to the program usually within two months after submitting a complete application packet. Please note that provisional acceptance will only be given to students with an identified faculty mentor.
Faculty members sponsoring prospective Ph.D. students must be members of the Doctoral Faculty at MU, or must identify another faculty member on the Doctoral Faculty to serve as co-chair on the student’s Doctoral Program Committee.

Please note that acceptance does not imply that the student will receive financial assistance. If financial assistance is provided, the acceptance letter will include that information.

3. Doctoral Committee

Students, in consultation with their research advisor, will select faculty members to serve as their Doctoral Committee by the end of the second semester of their tenure as a Ph.D. student. These committee members should have expertise in some aspect of the student's projected research. The chair of the Doctoral Committee will be the student's research advisor.

3.1. Committee Composition
The Committee is composed of a Committee Chair, and at least three additional Graduate Faculty Members. The composition of the committee must include:
1. At least three graduate faculty members from the Bioengineering Program,
   (a) At least two must be a Doctoral Faculty Member
   (b) One must be the student's research advisor
2. At least one Graduate Faculty Member from the University of Missouri, but outside of the Bioengineering Program. If the student wishes to include additional University of Missouri Graduate Faculty in their Committee, these members should have specialized expertise critical to the success of the student's projected research. Additional members can only be added via special permission from the Graduate Dean. A list of College of Engineering faculty, along with their research interests, may be found at: http://engineering.missouri.edu/research/researchers-a-z/

3.2. Committee Responsibilities
The members of the Committee will actively participate in the education of the student. This committee is responsible for:
- Evaluating the student's completion of proficiency requirements
- Confirming the Plan of Study
- Conducting the Annual Review
- Conducting the Qualifying Examination
- Conducting the Comprehensive Examination
- Guiding the research activities
- Overseeing the writing and defense of the Ph.D. Dissertation
- Maintaining high standards of scholarship and ethical behavior
- Administering corrective and disciplinary actions when necessary

The student is responsible for:
- Developing a plan of study
- Scheduling all meetings (Annual Reviews, Qualifying Examination, Comprehensive Examination, Dissertation Defense)
- Meeting all requirements at the appropriate time
4. Plan of Study

While a basic goal of the Ph.D. program is to provide students with highly specialized skills in a particular subdivision of Bioengineering, the faculty believes that it is important that our students understand the breadth of the discipline as well. The student, with the advice of their Committee, will prepare and submit a plan of study by the end of the second semester of their tenure as a graduate student. The plan of study includes a list of the formal courses, readings, problems, research hours and seminars that the students will use to fulfill the requirements for the doctoral degree.

4.1 Proficiency Requirements

In addition to the core Bioengineering courses all Ph.D. students are required to take, the student is required to demonstrate proficiency in at least two of the seven proficiency areas listed in Table 1, below, as part of their Plan of Study, before they are allowed to graduate. Therefore, when developing the Plan of Study, the student's first step is to select at least two proficiency areas.

To demonstrate proficiency, the student must do one of the following in each of the two or more proficiency areas:

1. Successfully complete either an appropriate course at the University of Missouri, or an alternate course approved by the Committee, in the proficiency area
2. Demonstrate successful completion of an appropriate course listed in Table 1 as an undergraduate student at the University of Missouri within the five years prior to starting the Bioengineering Ph.D. Program
3. Pass the proficiency exam in the area

Proficiency exams will be offered by the instructors in each area when requested by the Ph.D. student and her / his advisor. These exams will be somewhat like the “final” examinations in each of the classes. Students failing the proficiency exam will have to take an appropriate course to show proficiency in the area prior to undertaking the Comprehensive Examination. Note that problems courses, readings and research hours cannot be used to fulfill proficiency requirements.

Table 1: Courses Covering the Proficiency Areas

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<tr>
<th>Biomaterials</th>
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<tr>
<td>BE 3170 Biomaterials</td>
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<tr>
<td>BE 4170 / 7170 Biomaterials Interfaces of Implantable Devices</td>
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<td>BE 4370 / 7370 Orthopaedic Biomechanics</td>
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<td>BE 8001 Orthopaedic Failure Modes and Defect Analysis</td>
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<td>BE 8370 Materials Characterization Techniques</td>
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<td>BE 8870 Molecular and Cell Mechanics</td>
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<tr>
<th>Bioprocess Engineering</th>
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<tr>
<td>BE 3180 Heat and Mass Transfer in Biological Systems</td>
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<tr>
<td>BE 4315 / 7315 Introduction to Bioprocess Engineering</td>
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<tr>
<td>BE 4316 / 7316 Biomass Refining Operations</td>
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<tr>
<td>BE 4160 / 7160 Food Process Engineering</td>
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<td>BE 8280 Advanced Biological Transport Processes</td>
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<tr>
<th>Bioenvironmental Engineering</th>
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4.2. Class Requirements

The University of Missouri requires that a minimum of 72 hours of course credit be completed to earn a Ph.D. These hours may include:

1. 30 hours of graduate credit earned at the University of Missouri system or transferred from another university, if approved by the student’s Committee
2. 28 hours of research credits (BE 9990)

These hours must include:

1. 44 hours (minimum) of graduate level courses, including the required courses and elective courses.
2. Required courses:
   (a) BE 8087 (Seminar - 1 hour)
   (b) BE 8402 (Research Methods - 2 hours)
   (d) STAT or STAT or STAT (Statistics - 3 hours)
   (e) BE (Numerical Methods – 3 hours)
   (f) 2 additional 8000 level Bioengineering courses (which may also be used to fulfill proficiency requirements)
3. Elective courses, including 7000 and 8000 level courses from Bioengineering or other departments at the University of Missouri, which may also be used to fulfill proficiency requirements
4. Excluding research, problems or independent study courses
Elective courses should be chosen to strengthen the student's ability to do research in their specific area or to fulfill proficiency areas. Please note that these are minimum requirements. In general, the University of Missouri Graduate School does not accept correspondence or extension course credit earned at any other campus. However, a student may take up to eight hours of correspondence courses that are authorized for graduate credit and offered through the UM Center for Distance and Independent Study. Correspondence courses to be taken for graduate credit must be approved by the Graduate Dean, and the enrollment form has a place designated for the Graduate Dean's signature. See: http://online.missouri.edu/ for more information on distance education opportunities. A student will take more than 28 hours of research credits (BE 9990) in order to complete their projected research and successfully defend their dissertation, but only 28 hours are allowed to count towards the 72 hour minimum to earn a Ph.D.

4.3. Changes to the Plan of Study
In some unusual circumstances, it may become necessary to change a Plan of Study after it has been developed by the student and their Committee. Any substitutions, deletions or modifications of a student's Plan of Study must be approved by the Committee. The student's research advisor should inform Stacy Osterthun, 254 Agricultural Engineering Building, in writing, of any necessary changes as soon as possible to assure that the proper paperwork is filed with the Graduate Dean.

4.4. Completing the Plan of Study
The student must successfully complete all the classes, except the research, problems, or readings courses, listed in their Plan of Study before being allowed to take the Comprehensive Examination. Successful academic progress on the plan of study includes an acceptable Grade Point Average (GPA). For graduate work, the Bioengineering Program faculty and the MU Graduate School require all students to maintain at least a cumulative 3.0 GPA (on a 4 point scale). A student receiving a cumulative or semester GPA of less than 2.0 is subject to immediate dismissal from the Bioengineering Program and MU. Students falling below a 3.0 cumulative GPA in any semester will be put on academic probation for the following semester. If at the end of the first probationary semester the student's cumulative GPA is greater than or equal to 3.0, the probationary status is removed. If the cumulative GPA has not reached 3.0, the student is allowed one more probationary semester. Failure to achieve a cumulative 3.0 GPA in two successive probationary semesters will result in the immediate dismissal of the student from the Bioengineering Master's Program. Unsatisfactory academic performance may also result in a student being dismissed from the University.

The Graduate School has a comprehensive policy covering the requirements and procedures to be followed when it becomes necessary to dismiss a student. They also have developed procedures for appealing any decision by the Bioengineering Program. Students should consult the University of Missouri Graduate Catalog for further details. A copy of the catalog is available at: http://gradstudies.missouri.edu/policies/

4.5. Reasonable Rate of Progress
Every Ph.D. student will be evaluated annually for satisfactory progress by their research advisor as required by the Graduate School (see Graduate School Catalog, Dismissal Policy and Appeals
Process for Graduate Students. Satisfactory progress includes adherence to a suitable timeline for completing the doctoral degree as described in this document, and adequate academic performance. It is the student’s responsibility to schedule this meeting before September 1 each year. Satisfactory progress includes adherence to a suitable timeline for completing the Ph.D. as described in this document, and adequate academic performance as described in the Plan of Study section. The student's academic advisor will inform the Director of Graduate Studies as to the outcome of the evaluation on or before September 1 of each year.

It is important to note that a reasonable rate of progress towards the doctoral degree is required. The doctoral degree must be completed within five years after passing the Comprehensive Examination. In unusual circumstances, it may be necessary to extend the time required to finish the degree. In these cases, the student requiring additional time must submit a request for extension prior to the expiration of the applicable period. On petition of the student, together with their research advisor, the Director of Graduate Studies in the Bioengineering Program may endorse an extension of time. A request for an extension of time must be submitted to the Graduate School for approval. Students who take more than five years to complete the Ph.D. after passing the Comprehensive Examination may be required by the Bioengineering faculty to retake some or all of their course work.

4.6. Document Submission
Once the Plan of Study has been developed, the student should submit the Program of Study for the Doctoral Degree form (D-2), available at:
http://gradstudies.missouri.edu/forms-downloads/
to the Graduate Coordinator. The Coordinator will submit the completed form to the Director of Graduate Studies and the Graduate Dean.

5. Qualifying Examination
Ph.D. students in the Bioengineering Program are expected to have a general knowledge of Bioengineering and to be able to communicate in English. In addition, students are expected to show the ability to think clearly and critically and to express themselves adequately in both written and spoken English. The student will take a formal Qualifying Examination by the end of the second semester of their tenure as a Ph.D. student. This exam is designed to test the academic and communication abilities of the student.

5.1 Qualifying Examination Format
Expect the Qualifying Examination to be the most difficult exam you will ever take. Using the format faculty deem appropriate, this exam will determine whether or not the student is qualified to pursue the Ph.D. For example, a typical exam may consist of:

1. A written and oral section. In this case, after completion of the written exam, the student, in consultation with their research advisor and Committee, should schedule the oral exam. The oral exam is designed to determine whether the student can think quickly and clearly and express themselves in English. The oral exam may take two to three hours. The student will be expected to defend their answers on the written portion of the Qualifying Exam.
2. A set of grade requirements for the Bioengineering courses taken in the first two terms.

5.2. Document Submission
If the student has passed the Qualifying Examination, the student should submit a completed: Qualifying Examination Results and Doctoral Committee Approval form (form D-1), available at: [http://gradstudies.missouri.edu/forms-downloads/](http://gradstudies.missouri.edu/forms-downloads/) to the Graduate Coordinator. The Coordinator will submit the completed form to the Director of Graduate Studies and the Graduate Dean.

6. Comprehensive Examination
Ph.D. students in the Bioengineering Program are expected to have general knowledge of their research field, and to demonstrate the skills necessary to successfully complete their projected research. The student will take a formal Comprehensive Examination by the end of the sixth semester of their tenure as a Ph.D. student. This exam is designed to test the research and communication abilities of the student. The student is allowed 2 attempts to successfully complete the Comprehensive Examination.

6.1 Comprehensive Examination Format
Students must carry out the initial work of their projected research, and demonstrate that they will sincerely complete the Ph.D. requirements. Using the format faculty deem appropriate, this exam will determine whether or not the student is qualified to become a Ph.D. Candidate.
A typical format, which includes both a written and oral portion, may ask the student to prepare:

1. 10 page review, to be submitted to their Doctoral Committee, in standard format, of their research project and progress to date. Students should approach this like they would approach writing a paper for submission, except with more detail on their plans, research experiments and results. This review should include all pertinent data the student has already obtained, as well as a clear discussion of their results. This type of preliminary data is essential if the student wishes to demonstrate their work ethic and sincerity.
2. 5 page research proposal, to be submitted to their Doctoral Committee, in a standard format similar to those required by the NIH, NSF, or USDA, which should propose an in-field project that is not already being undertaken in their research group. The student should be prepared to orally defend his/her 5-page research proposal.
3. 30 minute presentation on their research project to date, to be given to their Doctoral Committee, in conference format. The student should be prepared to orally defend his / her work to date.

The student will submit a copy of the Comprehensive Exam materials to each member of the Doctoral Program Committee at least two weeks prior to the date of the exam. Students must be enrolled in MU at the time of the comprehensive exam. In addition, MU must be officially in session (fall, spring or summer semesters) when the comprehensive exam is administered. The comprehensive exam must be completed at least seven months before the final defense of the dissertation (step 13).

At the end of the Comprehensive Examination, the Doctoral Committee will determine if the student has performed adequately to become a Ph.D. Candidate in the Bioengineering program. For the comprehensive examination to be successfully completed, the Doctoral Committee must vote to pass the student on the entire examination, both written and oral sections, with no more than one dissenting or abstaining vote. Two or more dissenting or abstaining votes will result in a determination that the student has failed the comprehensive examination. A report of this decision
must be sent to the Graduate School and the student no later than two weeks after the Comprehensive Exam is completed. If any part of the Comprehensive Examination materials is unacceptable to the committee, the student will be informed of the deficiencies within two weeks after the Comprehensive Examination date. The materials will be revised and resubmitted until the Doctoral Committee is satisfied. Failure to successfully revise the materials will result in dismissal from the Ph.D. program.

Failure on either the written or oral section of the exam constitutes failure of the entire Comprehensive Examination. If a failure is reported, the committee must also include in the report an outline of the general weaknesses or deficiencies observed in the student's work. The student and committee members are encouraged to work together to identify steps the student might take to become fully prepared for the next examination. If, at any time, the student believes that the advice given by the committee is inadequate, the student may send a written request for clarification to the committee. A copy of this request should be sent to the Graduate School as well. The committee must respond to this request in writing within two weeks and have a copy of the response filed with the Graduate School. A student who fails the Comprehensive Examination may take a second exam, no sooner than twelve weeks after the first exam. Failure to pass the second comprehensive examination will automatically prevent a student from becoming a Ph.D. candidate. This will result in dismissal from the Bioengineering Ph.D. program.

6.2. Document Submission
Once the Comprehensive Examination process is completed, the student or the major advisor should prepare the form D-3, Doctoral Comprehensive Examination Results. This form is available at:

http://gradstudies.missouri.edu/forms-downloads/

The D-3 form should be submitted to the Graduate Coordinator, even if the student fails the comprehensive exam. The Coordinator will submit the completed form to the Director of Graduate Studies and the Graduate Dean.

7. Research Project

All Ph.D. students are required to develop and execute a research project. Most students will begin their research project shortly after beginning their Program of Study. The research project is a collaborative effort between the student, the major advisor and the Doctoral Program Committee. A successful project will involve original research and scholarship that will significantly contribute to an increased understanding of Bioengineering. The project must be a reflection of the student's own work and must demonstrate a capacity for research and independent thought. Students are expected to maintain the highest standards of ethical behavior while engaged in research at MU. Plagiarism or falsification of data will result in a student being immediately dismissed from the program and MU.

7.2 Manuscripts
The research project must result in at least two manuscripts (not including review articles), judged acceptable by their research advisor and at least one additional member of the student’s Doctoral Committee. These manuscripts must be submitted to refereed journal, prior to submitting “Report of the Dissertation Defense” form (Form D-4) to the Graduate Coordinator. Most students will
begin their research project shortly after beginning their Program of Study. The research project is a collaborative effort between the student, the research advisor and the Thesis Committee. A successful project will involve research and scholarship that will significantly contribute to an increased understanding of Bioengineering. The project must demonstrate the student’s capacity for managing and interpreting research.

7.2. Dissertation
A dissertation based on the original research completed by the students must be reviewed by the student’s Committee. The dissertation must be submitted to the Graduate Coordinator and Committee at least two weeks prior to the dissertation defense. Specific regulations regarding completing and filing the dissertation are outlined in “Guidelines for Preparing Theses and Dissertations.” Every Ph.D. candidate should obtain this document, which is available at: http://gradstudies.missouri.edu/academics/thesis-dissertation/diss-thesis-guideline/

The style of the dissertation is left up to the discretion of the research advisor and the student, as long as the minimum requirements of the Graduate School are met.

7.3. Dissertation Defense
After the dissertation has been completed and submitted, a dissertation defense will be conducted by the Doctoral Committee. The candidate should be prepared to defend the dissertation and discuss any related areas. The Dissertation Defense must take place when MU is officially in session, must be announced at least two weeks prior to the scheduled date, and must be attended by all members of the Doctoral Committee. Lastly, the candidate must be enrolled at MU for that term. The Dissertation Defense will consist of two parts: an open session, which may be attended by the general public, and a closed session, which may be attended by MU Graduate Faculty. For the open session, the student will prepare and present a 50 minute seminar on their research project to the general university audience. For the closed session, the student will defend their work to the members of the MU Graduate Faculty in attendance. Moreover, the student will address any issues with their submitted dissertation.

7.4. Document Submission
A report of the examination, carrying the signatures of all members of the committee, must be sent to the Graduate School before the deadline preceding the anticipated date of graduation. For the dissertation to be considered successfully defended, the student's Doctoral Committee must vote to pass the student on the defense with no more than one dissenting or abstaining vote. A final copy of the dissertation, including any changes the Doctoral Committee asked the student to perform, must be submitted to the Graduate School in an electronic format with supplemental paper documents.

Finally, the student should submit the form D-4, Report of the Dissertation Defense to the Graduate Coordinator as soon as possible. The Coordinator will submit the completed form to the Director of Graduate Studies and the Graduate Dean. The form is available at: http://gradstudies.missouri.edu/forms-downloads/