



THE UNIVERSITY
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Biomedical Engineering Graduate Program *Student Handbook*

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INTRODUCTION

Welcome to the Graduate Program in Biomedical Engineering (BME). The purpose of this handbook is to introduce you to the various requirements that must be met before you are granted the Master of Science (M.S.) Degree or the Doctor of Philosophy (Ph.D.) degree from the Graduate College of The University of Arizona. The strength of the BME Graduate Program derives largely from the flexibility afforded by the interdisciplinary faculty who participate in the Program. This allows each student the freedom to design a unique program of study to meet individual career goals.

However, the flexibility of this Program necessitates careful coordination of your program of study with your mentor, the BME Graduate Studies Committee, the BME Graduate Advisor, and the Graduate College. This handbook should be read upon entering the Program, and used, henceforth, in conjunction with the UA General Catalog (www.catalog.arizona.edu), as a reference regarding the policies and procedures of the BME Graduate Program at The University of Arizona.

The BME Graduate Program is intended to provide the foundation for a career in Biomedical Engineering. To achieve this, the student requires (a) an appropriate base knowledge of life sciences at the molecular, cellular, organ, and systems level, (b) an appropriate base knowledge of an engineering specialty at the graduate level, (c) experience and training in research, culminating in a major research project, and (d) opportunities in teaching, and experience in presenting research findings.

The BME Graduate Program is designed for completion of the M.S. degree in approximately two years and the Ph.D. degree in approximately five years. Obtaining the Ph.D. degree within this time frame depends, in large part, on the motivation and self-discipline of the student. The Program is designed to introduce students to research activities during their first year. By design, the course work requirements are flexible so that the needs of students with diverse areas of specialization can be accommodated. The student, in conjunction with a mentor and the BME Graduate Studies Committee, designs an individualized program of study.

PROGRAM REQUIREMENTS

General

At The University of Arizona, the Graduate College sets the overall framework for the completion of the Master's and Doctoral degree. Within these guidelines, the BME Graduate Program establishes specific requirements and monitors student progress. The overall goals of these requirements are to ensure:

- breadth of knowledge in Biomedical Engineering
- depth of knowledge in the student's area of specialty
- rigorous research training
- training in career skills (writing, speaking, critical evaluation of the literature)
- opportunities for training in teaching skills
- exposure to employment opportunities in academic and industrial environments

In addition, the guidelines and requirements that are described in this handbook have been established to ensure the protection of student interests and successful completion of the Master's or Doctoral degree.

Admission Criteria

A Bachelor's degree in engineering, physical or life sciences, or mathematics will be required for admission to the program. Calculus I and II, ordinary differential equations, and at least one course in life science are normally required for admission. All applicants must submit scores from the Graduate Record Examination (GRE) general test or TOEFL examination for international students.

Students interested in the accelerated Master's program (AMP) may apply after completion of a minimum of 75 eligible undergraduate credit hours, and can enter the program after completion of a minimum of 90 eligible undergraduate credit hours. Applicants must have substantially completed their general education requirements, and expect to complete their undergraduate degree in 4 years. The minimum GPA at the time of admission and entry to the program is a 3.3.

Students applying to the BME AMP go through the regular graduate application process with the following exceptions:

1. "Accelerated Master's" should be indicated on the BME application.
2. In the personal statement, the student should indicate why they are interested in BME graduate education and the accelerated program specifically.
3. The student does not need to submit UA transcripts or to take the GRE.

In addition to regular criteria, the admissions committee will evaluate whether the applicant has demonstrated the maturity necessary for success in an accelerated, highly competitive program. Application deadlines are December 1st for international students and January 6th for domestic students for admission for fall semester.

Graduate College Degree Requirements:

Students are expected to comply with the regulations of the Graduate College with respect to residence, credit hour requirements, and the Qualifying and Comprehensive Examinations (please refer to the Graduate College website <http://grad.arizona.edu>). A high level of performance is expected of students who are enrolled in graduate programs at The University of Arizona. Students must maintain a grade point average of 3.00 (letter grade of B) or better to continue enrollment in the degree-granting program, receive financial support, and to be awarded an M.S. or Ph.D. degree.

The BME Graduate Program considers full-time enrollment for funded students to be 12 graduate units per semester for their first two semesters of enrollment. After that, full-time required enrollment will be 9 graduate units per semester, until all graded coursework is completed. At that point, students must enroll in 6 credit hours per semester until completed.

Graduate College regulations will determine the minimum hours of graded coursework required. See Graduate College for current rules (<http://grad.arizona.edu>).

Faculty and Student Preceptors

A BME faculty member and a student will be assigned as preceptors for each first year student. It is expected that both preceptors be available to guide the first year student through the processes of selecting classes and lab rotations appropriate to the student's research interests, and to answer questions the student may have regarding the program. Preceptors are required to attend the BME Student Orientation, in August, as well as the Welcome Back Event.

It is recommended that the faculty preceptor meet with the student at least once a semester, and that the student preceptor and the first year student communicate during monthly student meetings. E-mail is strongly recommended for additional communication and when face-to-face meetings cannot be organized. Both student and faculty preceptors should read through the BME Student Handbook to ensure that they are up-to-date on policies and procedures.

Ph.D. Program

Doctoral students must complete a minimum of 68 units of graduate credit, and meet the Graduate College's minimum units of courses in which regular grades (A, B) have been earned. Requirements include 15 units of the core BME courses (BME 510, 511, 516, 517, 561, 566, 586); 15 units in the major; a minimum of 9 units in the minor; BME seminar and student forum every semester offered (but only 6 units of which count towards degree requirements); 3 units in a BME approved ethics course; 2 units of laboratory rotations (BME 597G) and 18 units of BME 920 (dissertation). Courses will include graduate engineering, life or physical sciences, or mathematics courses that focus on the student's biomedical engineering research interests according to the student's plan of study. A Plan of Study should be developed by the student and mentor and a copy of the written plan, along with a one-paragraph summary of the proposed dissertation research area and a listing of the proposed Comprehensive Examination and Doctoral defense committee members, shall be sent to the BME Program office for review and approval by the Graduate Studies Committee no later than October 1 of the third semester in the program.

If the student and mentor decide to alter the Plan of Study, an amended plan shall be submitted to the Graduate Studies Committee for approval. Please see the BME Graduate Advisor for details on developing and submitting the Plan of Study.

Ph.D. students entering the program after Fall 2006 are required to take a 3 unit BME approved ethics course. Students prior to Fall 2007 were required to take a total of 6 units of BME forum and seminar. Students prior to Fall 2008 took four core courses (BME 510, 511, 516, 517).

During the course of study, the student must pass the Qualifying Examination (to continue in the Ph. D. program), the Comprehensive Examination, and a Final Examination (dissertation defense).

After completion of the required credits, a student in the Ph.D. program may wish to obtain the M.S. degree. Refer to Master of Science section of this handbook for the M.S. Program.

Transfer Credits

In some cases, certain degree requirements may be waived if equivalent course work has been completed previously. Please see Graduate College policies for transferring credits. Once Graduate College policies have been followed, the BME Graduate Studies Committee will review requests and make decisions about course acceptance. Please contact the BME Graduate Advisor for more information.

Qualifying Examination

Continuation in the Ph.D. program requires that the student pass 5 BME core classes with a grade of B or better. If the student receives a grade below a “B” in a 500 level core course, the Program Committee will develop, with the student and course coordinator, a remedial plan which will be completed prior to continuing the Ph.D. program.

If students have taken any of the core courses at the 400 level the Graduate College no longer accepts 400 level coursework for graduate degrees. The corresponding 500 level course may not be taken to fulfill BME degree units.

In all cases, the Graduate Studies Committee will assess the student’s written and oral communication skills and abilities by examining their Qualifying Examination Worksheet. After reviewing the grades and worksheet, the student may be required to submit additional written work or take other courses before a decision can be made. After evaluating the additional work, then a final decision of continuation will be made. Successful completion of the qualifying examination is required prior to taking the Comprehensive Examination.

Selection of Mentor

Each student should select a mentor no later than the end of the second semester in the program. A mentor is a BME faculty member who will serve as an advisor, supporter, tutor, and role model. A mentor is expected to interact with the student on a regular basis providing guidance, advice, and the intellectual challenge necessary for the student to complete the degree program. Except in the case of self-funded Master’s students, the student is expected to work with the mentor and the BME Program to identify the source of the student’s financial support after the initial year.

The BME major advisor (mentor) cannot serve as the student's advisor for a non-BME minor.

The following suggestions may be of assistance to graduate students in choosing a mentor. There are two broad areas that come into play when choosing a mentor. The first area has a professional basis and the second a personal basis. The choice of a mentor may be the single most important decision made during graduate training. When considering the professional aspects of your selection of a mentor, the following questions may prove helpful:

1. What is this individual's reputation outside the University? Remember, when you have completed your dissertation and you are looking for a position, your mentor's reputation will initially be your reputation.
2. Does your prospective mentor have the funding available to support your research and stipend for at least four years? This area is probably the most problematic for graduate students. The money needed to fund your research project will most likely come from your mentor's laboratory. Therefore, you will need to know not only the amount of money available but also the stability of funding.
3. How does your prospective mentor's lab operate? You should critically evaluate the day-to-day operations of the lab and understand the goals of the lab and where you will "fit in". You should also understand the role of your mentor in those operations. Some principal investigators have lab managers or research assistants who run the laboratory. You should know almost as much about these individuals as about your prospective mentor.
4. What are the professional requirements of the prospective mentor on such issues as work habits, ethics, sharing of ideas, lab meetings, journal clubs, and authorship on papers?

On the personal side, the answers to the following questions may be extremely helpful:

1. Is the personality of my prospective mentor compatible with my own?
2. Is this individual going to be responsive to my needs and, just as important, am I going to be responsive to his or her needs? When you join a lab, your mentor will have certain expectations of you, and these should be identified when evaluating a prospective mentor. By the same token, what are your expectations of a mentor?
3. What do other students and faculty think about your prospective mentor? The collegial relationship of your prospective mentor with others will influence your interaction with other laboratories.

Do not underestimate the importance of the choice of a mentor, and do not make that choice without a great deal of thought. Talk to other people (including the mentor's current and previous students) about your prospective mentor and ask probing, but not inflammatory, questions. Provide yourself with honest answers to both the professional and personal aspects of your decision. Laboratory rotations are an excellent way to learn more about prospective mentors and labs, and can provide opportunities to answer these questions before choosing a mentor.

Once you have identified a mentor, you and your mentor should inform the BME Graduate Program of this selection in writing. The letter should indicate that the professor has agreed to serve as your advisor for your graduate studies; they will endeavor to ensure that you have financial support during your tenure as a graduate student and that you complete the requirements for the Master's or Doctoral degree in a timely fashion. It should be signed by both the student and faculty member and submitted to the BME Graduate Advisor (See Appendix for sample letter).

Plan of Study

A Plan of Study should be developed after passing the BME core courses. This should be done in conjunction with the Mentor, at the beginning of the second year in the Program. This Plan of Study identifies courses to be transferred (if any) from other institutions, courses completed at the University of Arizona to be applied toward the Ph.D., and any additional courses that may be needed to fulfill the requirements for the Ph.D. degree. In addition, students must submit a one-paragraph summary of the proposed dissertation research area and a listing of the proposed Comprehensive Examination Committee members. The student submits the Plan of Study to the BME Graduate Advisor, and needs approval by the student's advisor/mentor, the BME Graduate Studies Committee, and the Associate Dept. Head for Graduate Affairs in the Department of Biomedical Engineering.

The Comprehensive Examination

The objectives of the Comprehensive Examination are:

- to determine whether the student has attained an adequate breadth of knowledge in Biomedical Engineering,
- to determine whether the student has attained a sufficient depth of knowledge in life sciences appropriate for biomedical engineering,
- to determine whether the student has attained a sufficient depth of knowledge in a special area of engineering appropriate for biomedical engineering,
- to assess the student's ability to think clearly and independently about topics in Biomedical Engineering and to express these thoughts orally and in writing,
- to satisfy graduate college requirements,
- And to test knowledge in subjects covered by core BME courses.

As required by the Graduate Student Academic Services Office, the Comprehensive Examination has two parts, one written and one oral. As a standard of successful performance, the examining committee will determine whether the student has demonstrated the professional level of knowledge expected of a junior academic colleague. The written and oral portions of the Comprehensive Examination are to take place within two successive semesters, not including summer sessions. It is recommended that the written and oral portions be taken within the same semester. Students must pass the written examination and results must be reported to the Graduate Student Academic Services Office before the oral examination is held. In addition, approval of the student's Plan of Study is required by the Graduate College and BME Graduate Program prior to oral examination. The Comprehensive Examination is to be held when essentially all core course (BME core courses) work has been completed. The BME Graduate Program requires that both parts of the Comprehensive Examination must be completed by the end of the fourth semester in the BME Program. However, students are encouraged to take the Comprehensive Examination as early as their third semester. Exceptions may be granted in unusual circumstances by petitioning the BME Graduate Studies Committee in advance of the deadline. A failure to meet this deadline will constitute grounds for withdrawal of financial support from the Program, due to the lack of progress towards the Ph.D. degree.

If a student does not pass the first attempt at the written portion of the examination, the examining committee may recommend that one second examination be allowed. The second examination, if approved, must take place at least three months from the first attempt, and no later than the following semester, not including summer sessions. A second attempt to pass the Oral Comprehensive Examination will be allowed upon the recommendation of the examining committee at a date agreed upon by the committee, Graduate Studies Committee Chair, and student. If a reexamination is recommended, the committee members must be the same as those present at the first examination. If changes are made in the composition of the examination committee, the Dean of the Graduate College and BME Graduate Studies Committee Chair must approve them prior to the examination. The second examination, if approved, must take place no later than the following semester, not including summer sessions.

Comprehensive Examination Committee

It is the responsibility of the student to:

1. Select your Comprehensive Examination committee in consultation with your mentor. The committee must consist of at least five faculty members, three of which must be BME faculty. See current Graduate College requirements for tenure/tenure eligible status requirements for examination committee members. Each member should be able to supply at least one question from a core BME course area to cover the five core courses as well as the student's chosen area of specialty for a total of 6 questions. Each member will grade the question(s) they pose to the student.
2. Submit the names of the proposed Comprehensive Examination Committee members to the Graduate Studies Committee (via the BME Graduate Advisor) for approval, along with the plan of study.
3. Provide your committee with your plan of study, including all of the courses that will be used to fulfill your degree requirements;
4. Meet with committee members and select a committee chair. This chairperson may not be the student's advisor (see following paragraph).
5. Submit the "Comprehensive Exam Committee Appointment" form via the Grad Path system prior to your written comprehensive exam
6. Students are encouraged to meet with the examination committee frequently and to discuss the possible scope of questions with them before the examination.

The student chooses whether to have a face-to-face group meeting with all committee members or an email meeting. If the student feels more comfortable with an actual meeting, or has some faculty that are new to BME comps, then meeting everyone at once may be beneficial. Aim to have as many committee members attend as possible, and submit minutes of this meeting to the BME Graduate Advisor. If the student chooses to have an email meeting, once all details are decided, the student will summarize these, in one email, and send to all committee members, as well as the Graduate Advisor. These will serve as the minutes.

Proposed examination questions and brief outlines of solutions (on separate pages) must be submitted to the BME Graduate Advisor at least 2 weeks prior to the examination. The committee chair is responsible for distributing the questions to the student, and returning copies of the completed examination to the student and the other members of the Examination Committee. During the oral examination, the Chair of the Comprehensive Examination Committee, in consultation with the other members of the Examination Committee, determines the agenda and directs the questioning.

Content and Grading of the Written Portion of the Comprehensive Examination

The written examination will be six hours in length (2 sessions of 3 hours each, on 2 consecutive days) and will be based on materials covered in courses in the student's plan of study, primarily core course work. Six questions will be posed by the examiners; 1 day will consist of 3 life science questions, and the other day 3 engineering questions. Use of a cell phone during the written examination is prohibited. A copy of each question and a brief outline of the solution, each on separate pages, will be submitted to the BME Program Coordinator for review 2 weeks prior to the examination. The student will be required to submit answers to 4 of the 6 questions. The two unanswered questions will be the first questions presented during the Oral Examination. Students are encouraged to meet with the examination committee frequently while preparing for the examination, and to discuss the possible scope of questions with them prior to the examination.

Each of the students' written examination answers will be evaluated by the committee member who wrote the question. The examination committee shall determine whether the student has passed the examination. Each of the questions will be graded on a 100 point scale. A score of less than 60/100 is a "fail". The student cannot fail more than one out of the four answered questions, and the average of all four of the answered questions must be 70 or higher (a sum of 280 points out of 400 total). The student's answers, with written comments, should be returned to the student within 3 business days after the student completes the examination. A copy of the student's answers to all questions should be given to each examination committee member, and a copy kept by the BME Graduate Advisor in the student's file. If a student fails the examination, the examination committee will advise the student on his/her deficiencies, and the written examination must be taken during the following semester for a second and final time. The second written examination attempt must take place at least 3 months after the first attempt. As of 2014, the BME Graduate Program has a new policy for viewing graded written comp exams: the student must be in the presence of the BME Graduate Advisor (BME Office located in Old Engineering, 112C), **OR** can be viewed in the presence of a BME faculty (Mentor or Chair of Comp Committee) – appointment must be made prior to viewing.

Scheduling of Oral Comprehensive Examination

BME does not encourage students to take their oral Comprehensive Examination in the summer. In addition, the Oral Comprehensive Examination can be taken 2 weeks after the Written Comprehensive Examination only if: a) Written Comp Exam answers have all been graded (keep in mind 1 week is held for grading of exam), b) Student has passed written comp exam and Chair has submitted results to Graduate College. The Oral Comprehensive Exam **MUST** be taken no later than three (3) months after the Written Comp exam.

As of spring 2009, the Graduate College is no longer involved in the scheduling of the Oral Comprehensive Examination. The "Application for Oral Comprehensive Examination for Doctoral Candidacy" form will be replaced by the "Announcement of Doctoral Comprehensive Examination" form. The student will be responsible for going online via the Grad Path system and filling out the new form which will be routed to the BME Graduate Advisor and Comp Committee members. Please review the current Graduate College policies in regards to the Oral Comprehensive Examination.

Content of the Oral Portion of the Comprehensive Examination

The oral examination is intended to assess the student's general knowledge in Biomedical Engineering at the level of the core BME courses, and to examine the student in more detail in those areas pertinent to the

student's Plan of Study. As mentioned in the written examination section, the 2 questions not answered on the written examination will be the first 2 questions presented at the oral examination.

The examination will last not more than 3 hours. Students are encouraged to meet with the examination committee frequently while preparing for the oral examination, and to discuss the possible scope of questions with them prior to the examination. Students in the past have scheduled practice or mock oral exams with peers who have completed exams, to practice the format and style of the oral examination.

Advancement to Candidacy

After successful completion of the written and oral portions of the Comprehensive Examination, the student is eligible for advancement to degree candidacy. The Chair of the comp committee must complete the "Results of the Oral Comprehensive Examination for Doctoral Candidacy form". This form is available in UAccess via the Grad Path system. The form should be submitted electronically where it will be sent to the Graduate College for recording. Please review the current Graduate College policy for details of completing this form.

Dissertation/Prospectus Form

Every student in a doctoral program needs to have an approved dissertation prospectus or proposal file within their department. As soon as the student has an approved prospectus/ proposal on file with the department, the department's Program Coordinator will submit the prospectus/proposal conditional form in Grad Path on behalf of the student.

Selection of the Dissertation Committee

The composition of the Comprehensive Examination Committee and the Dissertation Research Committee can be the same, but is often different. The student must complete the "Doctoral Dissertation Committee Appointment" form via the Grad Path system. The requirements regarding tenure and tenure-eligible status for Dissertation Committee members are the same as those for the Comprehensive Examination Committee. The chairperson for this committee is decided by a vote between members of the committee. The committee must consist of at least four faculty members, two of which must be BME faculty and one which must represent the minor. See current Graduate College policies for additional criteria for composition of the Dissertation committee.

The Student must meet with the dissertation committee at least once per year, beginning within one year of the approval of their Plan of Study, to allow an evaluation of progress and to receive feedback.

External Reviewer

It may be appropriate that an external reviewer be appointed to the dissertation committee. Most often this person is from outside the University of Arizona. However, if circumstances warrant, this person could be from within the University of Arizona. The concept of having an External Reviewer is to add strength and expertise to the Committee that may not exist within the University of Arizona. If an External Reviewer is chosen, it is strongly recommended that this occur early to allow this person to make significant contribution to the student's graduate program. It is expected that the mentor cover any and all costs incurred in the participation by the External Reviewer. This external reviewer is not a voting member of the student's committee (unless the student petitions the Graduate College for an exception as noted above).

Final Oral (Dissertation Defense) Examination

The final examination is your dissertation defense. All dissertation committee members must be present for the dissertation defense, either in person or via teleconference. The “Announcement of Final Oral Examination” form is a required form that must be submitted at least 7 working days prior to the examination (defense) date. This form is available in UAccess via the Grad Path system. . The form should be submitted electronically through Grad Path where it will be routed to the BME Graduate Advisor, the student’s committee members, the Chair of the program and Chair of the minor area of study for their review and approval. Doctoral students are required to attend the weekly BME seminar and present their dissertation research during the last year in the program.

Inclusion of Published Papers in the Thesis/Dissertation

Upon recommendation of the student’s mentor and thesis/dissertation committee, the BME Graduate Program permits dissertations and theses to include published and submitted papers, as described in Appendix A of the Graduate College “Manual for Electronic Theses and Dissertations.” In addition to the requirements contained in the Graduate College Manual, BME students must adhere to the following guidelines:

1. Each paper included in the thesis/dissertation must contain significant effort from the student, and be substantially written by the student. The body of the dissertation must include a description of which parts of each paper include the student’s original, individual work.
2. The thesis/dissertation may include papers that are published in, accepted by, or submitted to refereed journals. Other publications (e.g. conference proceedings, non-refereed journal papers, or book chapters) may be included if approved by the student’s mentor and thesis/dissertation committee.
3. It is the responsibility of the mentor and the thesis/dissertation committee to assure that each paper includes the significant effort of the student.
4. A student’s thesis/dissertation committee must include at least one member who is not an author on the included papers.

Penultimate Draft of Dissertation

Submit copies of the draft of your dissertation document to your committee. Make sure you allow adequate time for your committee to review and for you to prepare the final version. The final version must be submitted to the Graduate Student Academic Services Office at least two weeks prior to the Library deadline. For information regarding the preparation of the dissertation, see the graduate college website for document samples and templates.

Final Copies of Dissertation Document

Please see the Graduate College for current requirements of microfilming and archiving of the final dissertation. Also, be aware of requirements of a letter from the Human/Animal Subjects Committee (IRB or IACUC) if work included in your dissertation project was subject to such a review.

One final printed copy of the final dissertation (preferably bound) is to be delivered to the BME Graduate Advisor in Old Engineering, 112C.

Please check with the Graduate College for appropriate dates and deadlines for submission of dissertation documents and forms for a particular semester.

Minor In Biomedical Engineering (Ph. D. Students Only)

The Graduate College requires all Ph.D. students to complete a "minor" program of study. Ph.D. candidates in other disciplines may select a minor in Biomedical Engineering. Effective Fall 2016, the Doctoral minor is 9 units: 9 units of approved BME core courses (BME 510, 511, 516, 517, 561, 566, 586), and 2 units of either Research methods in Biomedical Engineering (lab rotations) or BME Independent Study.

- Life science majors are not required to take 510/511, but will take 9 units of 516, 517, 561, 566, and 586 plus three units of independent study or rotation units.
- Engineering and Imaging majors will take BME 510 and 511, plus one of 516, 517, 561, 566, 586, plus three units of independent study or rotation units.

Completion of these courses with a "B" average for the required units is necessary for granting of the minor. BME does not require representation at the written Comprehensive Examination, but does require a BME faculty member to be present at the oral examination, and BME-related material must be covered. The student's dissertation (Doctoral final oral examination) committee must contain one BME faculty member. This committee member must be present at the dissertation defense, either in person or by teleconference. The BME Program should receive a copy of the student's Doctoral Plan of Study at the time they declare their minor in BME. The student's non-BME major advisor (mentor) cannot serve as the student's advisor for a BME minor.

A BME Doctoral student may choose to major and minor in Biomedical Engineering, i.e. obtain a "Distributed Minor in Biomedical Engineering". The distributed minor consists of 9 units of formal graded course work in any area of Biomedical Engineering (excluding major course work, seminars, and lab rotations).

Master of Science (MS) Program

All Master's students in the program must take a minimum of 38 units of graduate credit including the following courses: (a) five Biomedical Engineering core courses (BME 510, 511, 516, 517, 561, 566, 586); (b) 3 units of a BME approved ethics course; (c) BME seminar and student forum every semester offered, but only four units will count towards the degree; (d) 1 unit of Research methods in Biomedical Engineering (lab rotations); (e) 9 units in graduate engineering, life or physical sciences, or mathematics courses; and (f) 6 units of BME Thesis; and (g) remaining units which may be chosen by the student to supplement their plan of study. A final thesis defense is required. The units of (e) and (g) will focus on the student's biomedical engineering research interests such that the courses complement and broaden the student's undergraduate degree and provide the student with the skills necessary to complete the research. The courses will be established in consultation with the student's mentor and Thesis committee. The courses chosen should be based on the student's area of specialization (see Appendix for a partial list of courses).

Master's students must register for at least 12 units their first two semesters. In subsequent semesters, Master's students must register at least for the minimum number of units which leads to completion of all degree requirements by the end of the fourth semester, which satisfies Graduate College requirements, and which satisfies requirements of their funding source, if any. Unfunded Master's students on approved part-time status must meet minimum Graduate College requirements.

The student and mentor should develop a "Plan of Study" for the MS degree as soon as possible and no later than March 1 of the first years. This Plan of Study identifies courses to be transferred (if any) from other institutions, courses completed at the University of Arizona to be applied toward the degree, and any additional courses that may be needed to fulfill the requirements for the degree, along with a one-page summary of the proposed thesis (background/significance and aims/objectives), and a listing of the proposed Thesis committee members. The student submits the Plan of Study to the BME Graduate Advisor, and it will then go to the BME Graduate Studies Committee for review and approval. Once approved, the BME Graduate Advisor will notify the student and the student will then submit the approved Plan of Study to the Graduate College Degree Certification Office through UAccess via the Grad Path system. If the student and mentor alter the original goals, an "amended" Plan of Study shall be submitted to the BME Graduate Advisor and onward to the Program Committee for approval. All Master students must complete the "Masters Committee Appointment" form via the Grad Path system whether or not the student has a committee. The MS Thesis committee should be composed of at least four members, two of which must be BME GIDP tenure or tenure eligible faculty. The MS Thesis committee should meet within six months of submission of the Plan of Study, but no later than the beginning of the second year.

The format for the thesis shall follow the instructions specified by the Graduate College. Students shall complete 6 units of BME Thesis and perform original laboratory research. A complete draft of the thesis should be delivered to all members of the student's graduate committee no later than 4 weeks prior to the anticipated MS defense date. All thesis committee members are required to be present at the defense, either in person or via teleconference. After successful defense and final editing of the thesis as per instructions from the student's committee at the defense, the student is required to submit one bound copy of the thesis to the BME program. Please see the Graduate College for requirements of microfilming and archiving of theses.

In certain circumstances a mentor may suggest a Master's report. In this case, please see the BME Graduate Advisor or BME Graduate Studies Committee Chair to discuss.

Transfer from MS to PhD

Any BME graduate student wishing to transfer from their current MS program into the PhD program must complete the following:

1. Students must submit an official graduate application through the Graduate College <http://grad.arizona.edu>
2. A signed Change of Program form submitted to the BME Graduate Advisor and to Graduate Admissions asking for a direct program transfer (without receiving an M.S.) to the PhD program.
3. Letter of support from mentor (PI) stating that the candidate:
 - a. Is in good academic standing (GPA 3.0 or higher) (Satisfactory Progress – from Graduate college website – <http://grad.arizona.edu/academics/policies/academic-policies/satisfactory-academic-progress>).
 - b. Will have continued mentor support (funding) while matriculating in the program (or until graduation).

Transfer Credits

In some cases, certain degree requirements may be waived if equivalent course work has been completed previously. Please see Graduate College policies for transferring credits. Once Graduate College policies have been followed, the BME Graduate Studies Committee will review requests and make decisions about course acceptance. Please contact the BME Graduate Advisor for more information.

Matriculation of MD-PhD students in BME PhD program

Review Program Overview from the MD-PhD website <http://mdphd.medicine.arizona.edu/admissions>

1. 2 rotations (2 credit hours) will be completed prior to entering the BME PhD program (typically completed in the summers following Year 1 & 2).
2. The MD-PhD student will receive a minor in medicine (9 credit hours) for completion per guidelines
3. Applicable core courses may be waived if taken previously at a lower level and with approval by course instructor. *Students will need to take same total number of credits for graduate degree.
4. BME 517 is a required course and must be taken by students in spring semester.
5. An additional 12 credit hours in coursework acceptable for the BME MUST BE COMPLETED. (Not to include seminar/forum or dissertation). It is advised that these courses provide the proper foundation for the Comprehensive Exam and dissertation (research) work.
6. The Comprehensive Exam will be taken at the end of Year 1 in the BME program.

Accelerated Master's Program (AMP)

Students take 12 units of BME courses in their senior year (BME 510: Biology, BME 511: Physiology, BME 517: Bioinstrumentation, plus one of the following: BME 516: Bioimaging, BME 566: Biomechanics, BME 561: Biomaterials). These courses apply towards both the Bachelor's and Master's degrees. A Graduate "Plan of Study" must be submitted to the BME Graduate Program office no later than May 1st of the senior year (October 1st for students admitted for Spring). The student submits the Plan of Study to the BME Graduate Advisor, who will send it to the BME Graduate Studies Committee for review and approval. Once approved, the BME Graduate Advisor will notify the student and the student will then submit the approved Plan of Study to the Graduate College Degree Certification Office through UAccess via the Grad Path system. The form will then be routed to the BME Graduate Advisor, the student's committee members, the Chair of the program and Chair of the minor area of study for their final review and approval. After completion of all Bachelor requirements, awarding of a "B" or better in the BME courses, and completion of the GRE, students will be recommended for graduate status and enter the Master's program.

During the second year of the program, students will take the following courses: (a) one Biomedical Engineering core course (BME 510, 511, 516, 517, 561, 566, 586); (b) 3 units of a BME approved ethics course; (c) 1 unit each of BME seminar and student forum; (d) 1 unit of Research methods in Biomedical Engineering (lab rotations); (e) 9 units in graduate engineering, life or physical sciences, or mathematics courses; and (f) 6 units of BME Thesis; and (g) remaining units which may be chosen by the student to supplement their plan of study. A final thesis defense or Master's report is required. The units of (e) and (g) will focus on the student's biomedical engineering research interests such that the courses complement and broaden the student's undergraduate degree and provide the student with the skills necessary to complete the research. The courses will be established in consultation with the student's mentor and thesis committee. The courses chosen should be based on the student's area of specialization (see Appendix for a partial list of courses).

The AMP is intended to be a terminal degree. It is not intended for students who wish to eventually obtain a PhD. If a student is subsequently admitted to the PhD program, only units taken during the graduate year will be eligible for consideration of transfer into the PhD program.

PROGRAM TIMELINE:

The following is the general time frame in which students are expected to progress through the program in Biomedical Engineering. Typical grids of course work are included at the end of this handbook. Receipt of program funds is contingent upon satisfactory progress along and adherence to the timeline; requests for time extensions may be submitted to the BME Graduate Studies Committee.

YEAR 1

Complete BME 510, 511, 517, two of three bio-emphasis courses (BME 566 – Biomechanics; BME 516 Bioimaging; or BME 561 or 586 – both Biomaterials), and SLHS 649 (Ethics) with a grade of "B" or better and demonstrate satisfactory mastery of written and oral communication skills, to pass the Ph.D. qualifying examination.

Begin laboratory rotations BME 597G with the goal of choosing a faculty mentor and research project by the end of this year.

Attend mid-year meeting with program chair.

By the end of your first (M.S. students) or second (Ph.D. students) semester, you should have chosen a mentor from the Biomedical Engineering faculty. To formalize your selection, you and your mentor must submit a letter, indicating your choice and your mentor's acceptance of you into the laboratory, to the BME Graduate Advisor. See additional information under "Mentor Selection".

Masters students must prepare, in conjunction with their faculty mentor, and submit to the BME Graduate Studies Committee, a proposed Plan of Study by March of their first year.

The BME Graduate Studies Committee will evaluate student progress, annually, using input from both the student and mentor. All students must submit an Annual Report each year.

YEAR 2

At the beginning of the second year, Doctoral students should prepare, in conjunction with their faculty mentor, and submit, to the BME Graduate Advisor, a proposed Plan of Study, no later than their third semester. You and your mentor should work on this together. This Plan of Study should be revised and re-submitted as changes occur throughout your graduate studies. You should have established your major and minor fields of study and have determined the necessary course sequences. You should also be in the process of formulating a Doctoral dissertation research project, and conducting preliminary experiments.

M.S. students should complete all required coursework including 6 credits of BME 910 thesis or 3 units of BME 909 Master's report (see Program Office for clarification). A thesis or report should be submitted and defended to obtain the M.S. degree.

Doctoral students should have formed, and be meeting with, their Comprehensive Examination Committee, and complete their Comprehensive Examination in the second year, no later than the fourth semester. The Comprehensive Examination consists of written and oral portions (see above). It is suggested that you schedule several meetings to discuss the possible scope of questions with your committee.

*Note that to remain eligible for Program funding, you must complete the Comprehensive Examination by the end of the fifth semester. Coordinate the examination and schedule with the BME Graduate Program Office.

Doctoral students must also submit, with their annual Progress Report, a 1 to 3 page research proposal with their suggested research aims (which can be an expansion, if necessary, to what is submitted with their Plan of Study).

[The remainder of the TIME LINE applies to students working toward the Ph.D.]

YEAR 3

At the end of your third year, you should have completed the lecture courses required for a major in Biomedical Engineering.

No later than your fifth semester in residence, finalize a Dissertation Committee. The earlier you meet with the committee members, the better. Inform your committee of your Plan of Study and your research project. Solicit input from the committee members during the writing of your Research Proposal. Note that students are required to have at least one meeting per year with the dissertation committee, during years 3-5. More frequent meetings are recommended. Written minutes of these meetings must be sent to all committee members, and a copy sent to the BME Graduate Advisor.

At the end of year three, with their annual Progress Report, students must submit a formal research proposal, 3 to 5 pages in length, approved by their dissertation committee. A pre-doctoral proposal submitted to an outside agency would meet this requirement.

YEARS 3 – 5

Complete the presentation of the required full-length seminar. This seminar is one of two that you are required to give (the second may be a part of your final defense). It is your responsibility to contact the chairperson of the seminar series to be included in the list of scheduled speakers.

YEARS 4 and beyond

Each year, update the previous year's research proposal, and submit with the Annual Report.

FINAL SEMESTER

Present your dissertation research at one of the weekly BME seminars during the last Fall in residence.

Obtain the "Manual for Theses and Dissertations" on the Degree Certification website at <http://grad.arizona.edu/gsas/dissertations-theses>. This manual contains the directions for formatting your dissertation; however, you and your mentor should determine the overall organization of the dissertation. It is the responsibility of your Mentor to proof your dissertation.

The original form, the "Announcement of Oral Defense Examination" must be submitted to the Graduate College Degree Certification Office through the Grad Path System at least two weeks before the date of your final examination. Once you submit the form electronically, it will be routed for approval by the BME Graduate Advisor, your committee members, your mentor and the BME Graduate Studies Committee Chair.

Penultimate copies of your completed dissertation manuscript must be distributed to your committee members at least three weeks before your final examination.

After passing your final examination, a final copy of your dissertation must be submitted to the BME Graduate Program Office and to UMI/Proquest for archiving purposes. Please visit <http://grad.arizona.edu/gsas/dissertations-theses/submitting-your-dissertations>.

Questions regarding submitting forms, Graduate Representatives, and/or deadlines should be directed to the BME Graduate Program Office.

TEACHING

The Biomedical Engineering faculty believes that teaching experience is an integral part of the graduate training program. Accordingly, all students are encouraged to participate in teaching activities throughout their tenure in the Program. Students are not expected to present formal lectures in the first semester, but generally assist the faculty by tutoring or teaching small groups of students in laboratory settings.

PROGRAM ADMINISTRATION

1. The BME Graduate Program is administered by a BME Graduate Studies Committee (GSC) which is chaired by the Associate Head for Graduate Affairs in the Department of Biomedical Engineering. The GSC reports to the Head of the Department of Biomedical Engineering and is responsible for curriculum and course development, evaluation of graduate student progress, maintenance of the Graduate Handbook (which states the policies and procedures for graduate education), mediation of the concerns and grievances of graduate students and development of the financial plan for the graduate Program.
2. A Graduate Recruitment and Admissions Committee (GRAC) is responsible for publicizing the graduate program, recruiting applicants, evaluating applicants, and recommending admission of qualified candidates.

FINANCIAL STRUCTURE

The funds utilized by the BME Graduate Program to support graduate-student stipends are derived from Research Grants, Training Grants, Graduate College Fellowships, and faculty contributions. In general, these funds dictate the number of students supported by the Program. Since the NIH training grant stipends and some of the teaching assistantships are lower than the levels approved by the BME Graduate Program, these stipends may be supplemented by the faculty mentor of the Program.

For the semester of their expected graduation, and each successive semester afterward, students will receive support on a per-semester basis, pro-rated if necessary from the fiscal year rate. A student at any level whose stipend is pro-rated will still receive the full amount of their registration fees.

It is the intent of the BME Graduate Program to provide financial support utilizing a combination of Program funds and mentor contributions with the stipulation that adequate progress is being made towards the degree.

Students are eligible to increase to the Graduate Associate stipend rate the beginning of the next spring or fall semester after they successfully pass the written and oral components of the Comprehensive Examination.

Pre-doctoral Fellowships

The Program encourages individual students to seek supplementary funding. The advantages of seeking pre-doctoral fellowships are that it provides you with an opportunity to develop grant-writing skills, it brings prestige to the Program, enables the Program to recruit more students, and permits you to supplement (increase) your stipend. The BME Graduate Studies Committee can provide guidance in this endeavor by identifying potential funding agencies. The student is expected to write the proposal in consultation with the mentor and/or with the advice of the BME Graduate Studies Committee.

Conferences

The Program believes that participation in scientific meetings and conferences is an important experience for graduate students and encourages all students to submit work for presentation at national meetings. To aid in this activity, BME graduate students can apply to the Program for travel support after their first year. The intent of the Program is that BME graduate students are able to attend one national meeting per year. Students applying for travel funds are expected to have submitted an abstract/paper to the meeting/conference as the presenting author. Students are also expected to be in good standing with the Program and progressing towards their degree along the appropriate timeline. Travel Request Application Forms are available in the Appendix. The program encourages all students to also apply for travel awards from sources outside the Program. One such possibility is the Graduate and Professional Student Travel Grant Fund (GPSC) - Contact the Graduate College at 621-9091 to receive copies of the application forms and attachments.

Outside Activities

The Program believes graduate studies and research are a full-time effort. BME graduate students are expected to work diligently towards timely completion of their degree, and to avoid outside activities which could have a significant negative impact on their research and education. Graduate studies can require a time commitment that is extensive and/or outside of standard working hours.

Students considering, or currently engaged in, activities which could potentially create a conflict of interest, or a conflict of commitment, should discuss these activities with the BME Graduate Studies Committee Chair and their mentor, if applicable. According to the UA Office for the Responsible Conduct of Research, "Conflicts of Interest exist when an individual's personal financial relationships could influence the execution of his/her University responsibilities. Conflicts of Commitment exist when an individual's outside activities could interfere with the execution of his/her University responsibilities. Conflicts are not unethical or evidence of misconduct; rather, conflicts are situations that must be identified and managed to prevent damage to the individual, the research, and the institution." Examples of activities which could create potential conflicts include, but are not limited to: employment (paid or unpaid) outside the Program, taking courses (at UA or elsewhere) not on the

approved plan of study, service or volunteer work which requires a significant time commitment and/or restricts hours available to graduate studies, and ownership or involvement in a company. Paid employment outside the Program may be prohibited by the stipulations of a student's funding source. If in doubt about a possible conflict, discuss the situation with the BME Graduate Studies Committee Chair and/or mentor.

Intellectual Property

Under most circumstances, intellectual property (IP) developed at the University of Arizona is the property of the University, regardless of the employment status of the student. Students with IP concerns or questions are encouraged to discuss them with their mentor, the BME Graduate Studies Committee Chair, and the UA Office of Technology Transfer.

Mentors and lab directors should make clear to the student what, if any, intellectual property of the laboratory should not be discussed publicly. The student's papers, reports, and posters should be approved by the lab director/mentor (as well as any other authors) prior to each publication or presentation.

Deadlines

Any student that misses a stated deadline, for items related to the BME Graduate Studies Committee, will be required to submit a letter to the BME Graduate Studies Committee stating why the deadline was missed, and also have their mentor sign the letter before submission. The BME Graduate Studies Committee will consider the request, but does not guarantee the matter will be considered before the next scheduled BME Graduate Studies Committee meeting. If the student chooses to not write a justification letter to the BME Graduate Studies Committee, the item will be on the agenda of the next scheduled BME Graduate Studies Committee meeting. Visit the Graduate College at <http://grad.arizona.edu> for additional information regarding graduate deadlines.

Appendix I
BME 597G- Laboratory Rotation

Student: _____

Rotation Advisor: _____

Please indicate rotation period (each rotation is 6-8 week period):

_____ Rotation 1 _____ Rotation 2

Average number of hours per week: _____

Upon completion of the rotation, the student will prepare a summary of the accomplished research and the training experience. The Rotation Advisor will review and approve the final rotation report. Research activities may change during the rotation, yet beginning with an initial research plan can provide a beneficial rotation experience for the student.

Research activities to be performed:

***Student & Rotation Advisor's signature required. All forms must be turned into BME Graduate Program Office (Trisha Stanley) in Old Engineering 112C prior to start of rotation.**

Signatures

Student Name

Date

Rotation Advisor's Name

Date

Appendix III

Partial Listing of Courses Available for Graduate Credit

The following list is not meant to be complete or exhaustive, but represents course offerings students in the Biomedical Engineering Program have taken in the past. These courses may or may not currently be offered by the respective departments. Please consult the current University Schedule of Classes for class offerings and availability. Additional graduate level courses in these and other departments may also be taken for graduate credit at the discretion of the student and their mentor.

| Department/ <u>Course number</u> | <u>Title</u> |
|---|---|
| <u>Aerospace and Mechanical Engineering (AME)</u> | |
| 563 | Finite Element Methods |
| 566 | Biomechanical Engineering |
| 583 | Micro Biomechanics |
| 588 | Micro and Nano transducer Physics and Design |
| 662 | Micromechanics |
| <u>Agricultural & Biosystems Engineering (ABE)</u> | |
| 508 | Environmental Simulation |
| 581 | Engineering of Biological Processes |
| 516 | Simulation of Biological Systems |
| 519 | Engineering Properties of Biol. Materials |
| 523 | Biosystems Analysis and Design |
| 547 | Sensors and Controls |
| 581b | Cell and Tissue Engineering |
| 584 | Advanced Biosystems Transport Phenomena |
| 586 | Biomaterial Tissue Interactions |
| 588 | Microand Nano Transducer Physics and Design |
| <u>Animal Sciences (AN S)</u> | |
| 535 | Biotechnology in Animal Science |
| 585 | Domestic Animal Endocrinology |
| <u>Biochemistry (BIOC)</u> | |
| 564 | Neurophysiology: Sensorimotor Perspective |
| 565 | Enzymes |
| 567 | Computational Biophysics |
| 572 | Cell Regulation |
| 585 | Biological Structure 1 |
| <u>Cell Biology & Anatomy (CBA)</u> | |
| 565a | Fundamentals of Light Microscopy & Electronic Imaging |
| 575 | Special Topics in Biological Imaging |
| <u>Cancer Biology (CBIO)</u> | |
| 555 | Cancer Therapeutics |

| Department/ Course number | <u>Title</u> |
|--|---|
| (CBIO continued) | |
| 589 | Cancer Genetics |
| Chemical & Environmental Engineering (CHEE) | |
| 554 | Law for Engineers and Scientists |
| 570 | Fundamentals of Polymeric Materials |
| 573 | Biodegradation of Hazardous Waste Compounds |
| 577 | Physiological Basis of Microbial Treatment Processes |
| 580 | Bioseparation Techniques for Engineers |
| 581 | Bioreactor Engineering |
| 585 | Biomedical Transportation Phenomena |
| 586 | Advanced Biomedical Engineering |
| Chemistry (CHEM) | |
| 534b | Practical Nuclear Magnetic Resonance Spectroscopy Lecture |
| 584 | Nuclear Magnetic Resonance Spectroscopy |
| Computer Science (C SC) | |
| 570 | Foundations of Artificial Intelligence |
| Ecology & Evolutionary Biology (ECOL) | |
| 568 | Comparative Physiology |
| 579 | Art of Scientific Discovery |
| Electrical & Computer Engineering (ECE) | |
| 525 | Reverse Engineering |
| 531 | Image Processing Laboratory for Remote Sensing |
| 532 | Computer Vision |
| 533 | Digital Image Processing |
| 541 | Synthesis of Control Systems |
| 548 | Adaptive Control Systems |
| 559 | Fundamentals of Optics for Electrical Engineers |
| 579 | Principles of Artificial Intelligence |
| Materials Science & Engineering (MSE) | |
| 503 | Applied Surface Chemistry |
| 504 | Optical Spectroscopy of Materials |
| 509 | Transport Phenomena |
| 510 | Thermodynamic Characterization of Materials |
| 512 | Physical Chemistry of Materials |
| 520 | Optical Materials for Solid-State Laser Systems |
| 523 | Electrochemistry in Materials Science |
| 532 | Solid-Fluid Reactions |
| 533 | Imperfections in Solids |
| 534 | Advanced Topics in Electronic Materials |
| 535 | Corrosion and Degradation |
| 540 | Thermodynamics of Condensed Phases |

| Department/ <u>Course number</u> | <u>Title</u> |
|---|--|
| (MSE continued) | |
| 551 | Atomistic Computational Techniques in Materials Science |
| 552 | Nondestructive Evaluation of Materials |
| 557 | Integrated Circuit Laboratory |
| 560 | Materials Science of Polymers |
| 561 | Biological and Synthetic Materials |
| 562 | Structure and Properties of Polymers |
| 565 | Microelectronic Packaging Materials |
| 570 | Technology of Polymers and Ceramics |
| 571 | The Formation and Structure of Glass |
| 572 | Kinetic Processes in Materials Science |
| 588 | Scanning Electron Microscopy |
| Mathematics (MATH) | |
| 509 | Statistics for Research |
| Microbiology & Immunology (MBIM) | |
| 695b | Immunopathology |
| Molecular & Cellular Biology (MCB) | |
| 511 | Topics of Molecular Biology |
| 512 | Biological Electron Microscopy |
| 516 | Bioinformatics and Genomic Analysis |
| 577 | Principles of Cell Biology |
| 695e | Science, Society and Ethics |
| Neuroscience (NRSC) | |
| 502 | Principles of Neuroanatomy |
| 582 | Topics in Neural Development |
| 584 | Cellular Neurobiology |
| 586 | Intracellular Messengers |
| 588 | Prin. Of Cellular & Molecular Neurobiology |
| 589 | Principles of Systems Neurobiology |
| Optical Sciences (OPTI) | |
| 508 | Probability and Statistics in Optics |
| 538 | Medical Optics |
| 630 | Biomedical Optics and Biophotonics |
| 638 | Advanced Medical Imaging |
| Pathology (PATH) | |
| 515 | Basic Human Pathology |
| Pharmaceutical Sciences (PHSC) | |
| 507 | Pharmacokinetics |
| 610 | Pharmaceutical Solids, Nanotechnology & Solid-State Particle Engineering Design in Drug Delivery |

| Department/ <u>Course number</u> | <u>Title</u> |
|--|---|
| 508a | Pharmacokinetics Discussion |
| 609a,b | Pharmacokinetics |
| Pharmacology/Toxicology (PCOL) | |
| 550 | Drug, Disposition and Metabolism |
| 551 | Molecular Biology of Pharmacological Agents |
| 620 | Principles of Pharmacology |
| 653 | Neuropharmacology |
| Physics (PHYS) | |
| 502 | Medical Physics |
| 530 | Introduction to Biophysics |
| Physiological Sciences (PS) | |
| 503 | Cellular and Molecular Physiology |
| 595 | Colloquium |
| 601 | Systems Physiology |
| 602 | Readings in Systems Physiology |
| 610 | Research Methods in Physiology |
| 620 | Intro to Systems Neurophysiology |
| 625 | Human Neuroscience |
| 696 | Seminar/Forum |
| 697 | Workshop (tutorials) |
| Public Health (CPH) | |
| 576a | Biostatistics for Public Health |
| 576b | Biostatistics for Research |
| Speech, Language & Hearing Sciences (SPH) | |
| 649 | Survival Skills for Students |
| Surgery (SURG) | |
| 800 | Intro to Surgical Research |
| 815L | Orthopedic Biomechanics/Biomaterials |
| 815F | Orthopedic Surgical Research |
| 815H | Lymphovascular Sys. Health & Disability |
| Systems & Industrial Engineering (SIE) | |
| 510 | Behavioral Judgment and Decision Making |
| 511 | Human Factors and Ergonomic Design II |
| 530 | Engineering Statistics |
| 551 | Modeling Physiological Systems |
| 577 | Introduction to Biomedical Informatics |
| 578 | Artificial Intelligence for Health & Medicine |
| 585 | Robotics and Automation |
| 685 | Advanced Topics in Robotics and Automation |
| Veterinary Sciences (V SC) | |
| 543 | Research Animal Methods |

Appendix IV

CODE OF RESEARCH ETHICS

Subscribed to and Adopted by the University of Arizona Faculty Senate
on December 7, 1998 for University of Arizona Faculty and Research Personnel

We the members of the University of Arizona (U of A) faculty and U of A researchers (hereafter: research community) are engaged in the quest for knowledge, in scholarly and artistic pursuits (hereafter: research) with the ultimate goal of benefiting humankind. Our quest is founded on the fundamental principles of honesty and trust.

I. In fulfilling our obligation to the public as a whole, we expect that all individuals within the U of A research Community shall:

- promote and follow research and professional practices that enhance the public interest and well-being;
- use public and private funds responsibly in the pursuit of research endeavors;
- adhere to government and institutional regulations for research such as those ensuring the welfare of human subjects, the welfare of fellow researchers, the comfort and humane treatment of animal subjects and the protection of the public and the environment; and
- report research findings resulting from public and private funding in a full, open, and timely fashion to the relevant research community;

II. In fulfilling our obligations to our colleagues, we expect that all individuals within the U of A research Community shall:

- have actually carried out experiments, projects and other scholarly activity in the manner reported;
- represent their best understanding of the work in their descriptions and analyses of it;
- accurately describe experimental methods utilized in sufficient detail to help insure their repeatability by others;
- share unique propagative materials developed through publicly-funded research with others in the field in a reasonable fashion;
- not report the work of others as if it were their own; strive to insure that due recognition is given where credit is due to collaborators including students and trainees;
- adequately summarize previous relevant work and ideas with proper attribution to those who pioneered the work;
- when acting as reviewers or editors, treat submitted manuscripts and grant applications confidentially and refrain from inappropriate use;
- and disclose financial and other interests that might present a conflict-of-interest, and make every effort to avoid such conflicts perceived or real.

III. In fulfilling obligations to students and trainees, we expect that all individuals within the U of A research Community shall:

- provide training and experience to advance the students' and trainees' scholarly skills and their understanding of the importance of ethical practice and behavior;
- provide appropriate support in advancing the careers of students and trainees;
- recognize publicly and appropriately the scholarly contributions of the trainees;
- encourage and support the publication of results of trainees' research in a timely fashion without undisclosed limitations; and
- work together to create and maintain a working environment that is safe and that encourages individual integrity, plurality, open communications, and fairness without regard to gender, race or belief.

Appendix V

Biomedical Engineering Ph.D. Course Requirement Worksheet (Include in Plan of Study)

Name _____ Date _____ Previous Degree _____

Ph.D.

| Required (Hrs) | Semester |
|---|----------|
| BME 510 (3) | |
| BME 511 (3) | |
| BME 517 (3) | |
| Choose at least two different focus areas (6 units) of: BME 516 (3) – Bio-imaging BME 561 (3) – Bio-materials BME 566 (3) – Bio-mechanics BME 586 (3) – Bio-materials | |
| SLHS 649 Survival Skills & Ethics (3units) | |
| BME 696A Seminar/696C Forum Required each semester (6 units) | |
| | |
| BME 597G Rotation (2 units) | |
| | |
| Units in the Major (15) List: | |
| | |
| | |
| | |
| | |
| Units in the Minor (min. 9)+ | |
| | |
| | |
| | |
| | |
| | |
| | |
| Dissertation Units (min. 18) BME 920 | |

TOTAL = 68 minimum

TOTAL = _____

***Students entering the program with a M.S. degree may petition to apply previous graduate coursework to the Ph.D. degree requirements. The Graduate College requires that at least 30 units of graduate credit must be completed at The University of Arizona. +Students choosing a BME Distributed minor need 9 units in the minor. No more than 3 units of non-traditional classroom experience (rotations, independent study, and internships) may be counted toward the unit total.**

Appendix V

Biomedical Engineering M.S. Course Requirement Worksheet (Include in Plan of Study)

Name _____ Date _____ Previous Degree _____

Master of Science

| Required (Hrs) | Semester |
|---|----------|
| BME 510 (3) | |
| BME 511 (3) | |
| BME 517 (3) | |
| Choose at least two different focus areas (6 units) of: BME 516 (3) – Bio-imaging BME 561 (3) – Bio-materials BME 566 (3) – Bio-mechanics BME 586 (3) – Bio-materials | |
| SLHS 649 Survival Skills & Ethics (3) | |
| BME 696A Seminar/696C Forum Required each semester (4 units) | |
| | |
| BME 597G Rotation (1 units) | |
| | |
| | |
| | |
| Advanced Coursework (9 units) – List: | |
| | |
| | |
| | |
| BME 910 Thesis (6 units) or BME 909 Master’s Report (3 units) and additional coursework (3 units) | |
| | |
| | |
| | |
| | |
| | |

TOTAL = 38 minimum

TOTAL = _____

***No more than 3 units of non-traditional classroom experience (rotations, independent study, and internship) may be counted toward the unit total.**

Appendix VI

BIOMEDICAL ENGINEERING GRADUATE STUDENT ANNUAL REPORT

Semester/Year of First Enrollment: _____

Name: _____ Mentor: _____

Laboratory Rotations/Experiences: (For first year students, list your lab rotations and include a description of efforts made to identify a Mentor. For students who have identified a lab, describe overall laboratory experiences. (Use back of page if necessary).

Meetings with Committee: (All students are required to meet at least annually with their research/dissertation committee, beginning within the year after approval of their plan of study. Comp exams do not fulfill this requirement. List all dates since formation of committee.

Other BME Program Activities: (committee participation, participation in recruiting, poster, or seminar presentations, social activities, etc.) List title/description and date(s)

Membership in Professional Societies and/or Community Service:

Teaching Activities:

Professional Meetings: (Name of Meeting, Location. Give title, if you presented)

Publications: (Refereed articles, abstracts. Full bibliographic citation)

Honors & Awards Received:

Student signature Date _____

Mentor/Advisor signature Date _____

Mentorship Evaluation Form – Biomedical Engineering Program Student Annual Report

To be completed by trainee for primary mentor; additional forms for secondary mentor(s) can be provided if desired. All evaluations will remain confidential to the BME Graduate Studies Committee.

This evaluation is for (circle one): Primary Mentor Secondary Mentor

Name of mentor _____

Circle one: 1= Disagree strongly 2= Disagree 3= Agree 4= Agree strongly

| Topics | Rating | Comments (Additional comments may be written on back of this form) |
|--|---------------|--|
| Intellectual Growth and Development: Helps me become increasingly independent in identifying research questions and conducting and publishing my research | 1 2 3 4 | |
| Helps me develop my capacity for theoretical reasoning and data interpretation | 1 2 3 4 | |
| Provides thoughtful advice on my research progress and results | 1 2 3 4 | |
| <u>Professional Career Development:</u> Provides opportunities for me to meet with visiting scientists, faculty and peers | 1 2 3 4 | |
| Maintains balance between supporting his/her own research and developing my own career | 1 2 3 4 | |
| Provides training in the skills needed to mentor others | 1 2 3 4 | |
| Academic Guidance: Provides advice on my coursework and academic goals | 1 2 3 4 | |
| Ensures that I am firmly grounded in rules regarding good laboratory practice, ethical behavior and scientific responsibility | 1 2 3 4 | |
| Skill Development: Helps me to work effectively with other individuals | 1 2 3 4 | |
| Provides constructive feedback on my presentation and writing skills | 1 2 3 4 | |
| Personal Communication: Listens carefully to my concerns | 1 2 3 4 | |
| Takes into account gender, ethnic and cultural issues in interacting with me | 1 2 3 4 | |
| Is appropriately accessible to me | 1 2 3 4 | |
| Serves as Role Model: Conveys high ethical standards and concern for research subjects | 1 2 3 4 | |
| Illustrates active teamwork and collaboration | 1 2 3 4 | |
| Illustrates good work habits | 1 2 3 4 | |
| Illustrates good mentoring skills | 1 2 3 4 | |

Appendix VI

Sample Format for Mentor Acceptance Letter

(Substitute actual information for examples *in italics*;
both the faculty advisor and the student sign.
The letter should be submitted on UA BME letterhead)

Today's Date

Allen B. Peterson, Ph.D., Chair
Biomedical Engineering Graduate Program
University of Arizona
PO Box 210020
Tucson AZ 85721

Dear Dr. *Peterson*:

This is to confirm that I will officially serve as *Jeremiah Bullfrog's* advisor and mentor during *his* Doctoral studies in Biomedical Engineering at the University of Arizona. I look forward to a productive and engaging collaboration with *Jeremiah. Mr. Bullfrog* and I have worked together on an initial project involving *mechanical tissue printing*, and are now developing *a machine that will fabricate entire artificial organs utilizing cornstarch and flies as the raw material*. I will endeavor to ensure that *Jeremiah* has financial support during *his* tenure as a graduate student, and that *he* completes the requirements for the Doctoral degree in a timely fashion.

Thank for you for the opportunity to participate in the Biomedical Engineering here at the University of Arizona, and work with such an outstanding student.

Sincerely,

Albert "Big Al" Einstein, Ph.D.
Professor
Math/Physics/Biomedical Engineering

Jeremiah Bullfrog, B.S.
Graduate Student
Biomedical Engineering

Biomedical Engineering
Travel Assistance Request

Name

Date

Name of Conference

Dates of Conference

Location of Conference

Estimated Cost of Request

To receive travel assistance, you must be the primary author on an abstract that has been accepted for presentation at the conference, and you must be a Ph.D. or an M.S. student in good standing within the BME Graduate program. In addition to the above, the BME Graduate Studies Committee requires that you attend at least three (3) of the activities listed below (within the last 12 months) in order to be considered for travel assistance.

Your signature below indicates that you are in compliance with these terms. Your mentor's signature indicates that he or she is also in agreement with these terms.

Student Signature

Mentor Signature

When completed, submit this form, a copy of your abstract, notification that your abstract has been accepted for presentation, and an itemized list of projected travel costs to Trisha Stanley, stanley@email.arizona.edu. The BME Graduate Studies Committee will review the request and notify you of a decision.

CONFERENCE REPORT

If you receive travel assistance, you must submit a brief report about your experiences at the conference to Trisha Stanley, stanley@email.arizona.edu, within one month of the end date of the conference. The report should include:

- A) the title, dates, and location of the conference
- B) the title and all authors of your presentation
- C) a brief summary of your research that comprised your presentation (1 paragraph)
- D) a brief summary of ≥ 3 other oral presentations and/or poster presentations at the conference that pertained to your research and/or were most compelling for your research interests (1-2 paragraphs)
- E) a brief summary of other conference activities in which you participated (educational sessions, workshops, vendor booths, other networking opportunities; 1-2 paragraphs).

A photo from the conference would be a great addition to your report.

With your permission, items A-C may be included in the BME newsletter and other marketing materials for the BME Graduate Program. Items D and E are needed to ensure that the Travel Assistance Program is meeting its goal of career development for BME graduate students.

BME GIDP ACTIVITIES ATTENDED (check those that apply)

- | | | | | | |
|------------------------------|--------------------------|------------|-----------------------|--------------------------|------------|
| "Welcome Back Party" | <input type="checkbox"/> | date _____ | BME Recruitment Event | <input type="checkbox"/> | date _____ |
| New Student Orientation | <input type="checkbox"/> | date _____ | Ice Cream Social | <input type="checkbox"/> | date _____ |
| GIDP Student Showcase | <input type="checkbox"/> | date _____ | Picnic in the Park | <input type="checkbox"/> | date _____ |
| Builder's Day Poster Session | <input type="checkbox"/> | date _____ | | | |

Appendix IX

Biomedical Engineering Absence Request Form

Must be submitted to the BME Graduate Advisor for all absences longer than 2 business days
Must be submitted at least one week prior to departure

Date: _____

Name: _____

- Vacation
- Conference (list name of conference and dates)
- Sick (may be completed upon return, if unplanned)
- Personal illness
- Family illness
- Funeral
- Jury duty
- Other _____

First day away from work: _____

Date of return to work: _____

During my absence, I can be reached as follows:

Employee signature

Mentor/Supervisor signature

Appendix X

Guidelines for Mentors Biomedical Engineering Graduate Program Version Draft II July 12, 2006

Introduction: The purpose of these guidelines is to inform mentors of important aspects of the Biomedical Engineering Graduate Program. This handbook is not an all-inclusive document; official BME policy can be found in the BME Graduate Handbook, available on the BME website: (www.bme.arizona.edu).

BME mentors advise, challenge, and guide their students. They assure that the student is making appropriate progress to degree and identify sources of support for the student. The following describes the specific and sometimes unique role of a BME mentor.

Mentor eligibility: Any tenure-track (or approved as equivalent) faculty who is a member of the BME may mentor a BME student. To apply for membership in the BME Department, contact the BME graduate coordinator at 626-9134. Non tenure-eligible faculty may serve as a day-to-day mentor for students, but the faculty and student must identify an eligible faculty to serve in the official capacity of mentor. The official mentor is expected also to abide by these BME mentor guidelines.

Rotations: BME students perform laboratory rotations during their first two semesters, and select a mentor by the end of the second semester. The primary purpose of rotations is to facilitate the process of students finding a mentor, and potential mentors identifying students. In some cases, students who already have a mentor may wish to perform rotations in order to obtain training not available in their own laboratory. The purpose of the rotation should be made clear by the student. A rotation should last for approximately 45-60 hours. Longer time periods can be agreed upon by the student and faculty, for additional rotation units. The student should write up a short description of the rotation activities and objectives, to be agreed upon by the faculty. A one-page report is required from the student at the end of the rotation, to be signed by the mentor, and submitted to the BME Graduate Advisor.

The rotation is an opportunity for the potential mentor and the student to determine if they are compatible from a research qualifications/interest and a personality standpoint. BME students are expected to ask, and potential mentors are urged to honestly answer, questions about future research projects, student/project funding availability, and laboratory expectations.

Selection of mentor: Upon agreement to serve as a mentor, a letter needs to be sent to the BME Chairperson (sample letters are available in the appendix of the BME Student Handbook), The letter should state that the mentor has agreed to serve as the student's advisor, will endeavor to ensure that the student has financial support during his/her tenure as a graduate student, and will assure that the student completes the requirements for the degree in a timely fashion. The letter must be signed by both the student and mentor.

Student timeline: The mentor should assure that the student adheres to the timeline set out in the BME Graduate Handbook. A copy of this timeline is attached. A summary of important deadlines (for Ph.D. students) is as follows:

- Submission of Annual Report: every year near the end of Spring
- Submission of Plan of Study: end of third semester
- Formation of Comprehensive Examination Committee: end of third semester
Completion of Comprehensive Examination: end of fourth semester
Formation of Dissertation Committee: end of fifth semester

- Dissertation committee meetings: end of sixth semester, subsequently at least annually
Final Defense: expected to be by the end of the fifth year

Failure of the student to progress will make the student ineligible for BME travel funds, promotions, or raises. Assistance by the mentor in assuring that students follow this timeline is critical for student success. Additional information on each of these milestones is provided below.

Annual report: The student submits a report each year describing progress in coursework, research, BME activities, publications, and related activities. In later years, a description of the research plan is attached. The student should prepare the annual report, and the mentor and student jointly review it. The annual report is reviewed by the BME Graduate Studies Committee to evaluate student progress and compliance with the milestones. However, it is also intended to be an opportunity for the student and mentor to reflect on the year's achievements and develop plans for the subsequent year.

Plan of study: The plan of study should be submitted to the BME Graduate program office by the end of the third semester. The plan of study identifies the body of coursework to be taken, to fulfill the requirements of the BME Program, and should be jointly agreed upon by the student and mentor. A worksheet is available in the appendix of the BME Student Handbook to assist in assuring all BME requirements are met. In addition to the course listing, students must submit a one-paragraph summary of the proposed dissertation research area and a listing of the proposed Comprehensive Examination Committee members.

The mentor, BME Graduate Studies Committee, must all approve the plan of study, prior to submission to the Graduate College. A plan is unlikely to be approved if it contains less than two courses, each, that provide significant depth of knowledge in an area of life sciences and engineering (in addition to the core courses). However, the main criteria for acceptance are adequate preparation for the student's research activities. It is expected that the plan of study may change during the student's tenure; modified plans are approved by the same process as the original. The student may not meet with the comprehensive exam committee prior to approval of the plan of study.

Comprehensive Examinations: The details of the Comprehensive Examination process are provided in the BME handbook. The student is encouraged to take both the written and oral portions of the examination as early as practical, but not later than the fifth semester. Students should meet with their committee members individually, and as a group, to discuss the possible scope of questions with them, well in advance of the examination.

Dissertation committee: The student must meet with the dissertation committee by the end of the sixth semester, and subsequently no less than once per year. The purpose of the committee meetings is to define an acceptable scope of work for the dissertation, obtain feedback on research results, and gather suggestions for future research efforts.

Defense: The BME Ph.D. is designed to be a 5 year program. Significant extension beyond this time should be discussed with the dissertation committee and a plan for completion developed.

Student difficulties: The mentor is requested to notify the BME Graduate program office if he/she notices that the student is experiencing difficulties that are impacting research or academic progress. The BME Graduate Advisor, BME Graduate Studies Committee Chair, are available to assist in resolving student and/or student/mentor conflicts.

Questions? Please contact: BME Graduate Advisor, Trisha Stanley, Stanley@email.arizona.edu 626-9134 BME Graduate Studies Committee Chair, Ted Trouard, trouard@email.arizona.edu 626-2177

Appendix XI

List of Past BME Comprehensive Examination Committee Members
(This list is not comprehensive; students are not limited to faculty listed herein.)

| Life Sciences | Engineering |
|--------------------------|--------------------|
| Scott Boitano | Jennifer Barton |
| Heddwen Brooks | Art Gmitro |
| Brett Colson | Chuck Higgins |
| Erika Eggers | Minkyu Kim |
| Andy Fuglevand | Jeffrey Rodriguez |
| Katalin Gothard | Marek Romanowski |
| John Konhilas | Manoj Saranathan |
| Ron Lynch | Jim Schweigerling |
| Jane Mohler | Tim Secomb |
| Tim Secomb | Vignesh Subbian |
| John Szivek | Ted Trouard |
| Martin Slepian | Urs Utzinger |
| India Indik | Jeong-Yeol Yoon |
| Harrison Barrett | Xiaoyi Wu |
| Fiona Bailey | Wolfgang Fink |
| Henk Granzier | Yitshak Zohar |
| Zain Khalpey | |
| Terry Matsunaga | |
| Julio Cardenas Rodriguez | |
| Jil Tardiff | |
| Donna Zhang | |

Appendix XII

Checklist for MS Students

Coursework:

- BME 510 (Cell Biology)
- BME 511 (Physiology)
- BME 517 (Bioinstrumentation)
- 2 of 3 of the Following:
 - BME 516 (Bioimaging)
 - BME 566 (Biomechanics)
 - BME 561 or BME 586 (Biomaterials)
- SLHS 649 Survival Skills & Ethics
- Rotation 1 (signed rotation report submitted)
- Rotation 2 (signed rotation report submitted)
- 3 BME related courses
- 6 unites of BME Thesis or 3 units of BME Master's Report and 3 units of Additional Coursework
- 38+ units completed

Program Requirements:

- Choose a BME Faculty Member (finish before second semester in residence)
- Mentor submitted letter indicating acceptance of student
- Attend Mid-Year meeting with Program Chair during First Year
- Submitted Plan of Study (approved by Program Committee before March of 1st year)
 - Submitted Course Requirement Worksheet (Appendix IV) to Program Coordinator
 - Submitted Graduate College Plan of Study Form to Grad College Degree Cert. Office
 - Submitted Proposed Thesis Committee Members to Program Coordinator
 - Submitted Research Paragraph to Program Coordinator
- Assembled Thesis Committee (meet with committee at least once a year)
- Submitted Completed Thesis to Members of Committee (submit at least 4 weeks before deadline)
- Successfully defended Thesis of presented Master's Report
- Finish final editing of Thesis or Master's Report and submit to Committee Chair
- Submit soft copy of Thesis or Master's Report to BME Program Office

**Check the BME timeline and other relevant sections for details related to each item above.*

Appendix XIII Checklist for PhD Students

Coursework:

BME 510 (Cell Biology)
BME 511 (Physiology)
BME 517 (Bioinstrumentation)
2 of 3 of the Following:

- BME 516 (Bioimaging)
- BME 566 (Biomechanics)
- BME 561 or BME 586 (Biomaterials)

SLHS 649 Survival Skills & Ethics
Rotations Completed

- Rotation 1 (signed rotation report submitted to Program Coordinator)
- Rotation 2 (signed rotation report submitted to Program Coordinator)
- 5 BME Related Courses

9+ units completed for Minor
18 units of BME 920 (Dissertation)
68+ units completed

Program Requirements:

Chose a BME Faculty Member (finish before third semester)
Mentor Submitted letter indicating Acceptance of Student
Attended Mid-Year meeting with Program Chair during First Year
Submitted Plan of Study Packet (approved by Program Committee before March of 1st yr)

- Submitted Course Requirement worksheet (Appendix IV) to Program Coordinator
- Submitted Graduate College Plan of Study to Graduate College Degree Cert. Office
- Submitted Proposed Dissertation Committee Members to Program Coordinator
- Submitted Research Paragraph to Program Coordinator

Comprehensive Examination Completed (Finish before fifth semester)

- Assembled Examination Committee
- Met with Examination Committee
- Submitted Comprehensive Exam Committee Appointment Form
- Passed Written Examination
- Passed Oral Examination

Finished Dissertation Research

- Assembled Dissertation Committee (meet with committee at least once a year)
- Presented Research in Full-length Seminar
- Submitted Verification of Prospectus/Proposal Approval Form
- Submitted Doctoral Dissertation Committee Appointment Form
- Submitted Announcement of Final Defense Form
- Successfully defended Dissertation Research
- Finished Final editing of Dissertation and submitted to Committee Chair
- Submitted electronic copy to Program Office and to Graduate College

*Check the BME timeline and other relevant sections for details related to each item above.

**Biomedical Engineering Graduate Program
Dissertation Prospectus/Proposal Approval Form**

Prior to Advancing to Candidacy, this internal form must be filled out, signed and returned to BME Graduate Program Office.

Student Name: _____ Date submitted: _____

Proposal Title: _____

Date Approved by Dissertation Committee: _____

Required Signatures (Please print name after signature)

Dissertation Director: _____

Faculty (Major) _____

Faculty (Major) _____

Faculty (Minor) _____

Faculty (Minor) _____

Additional Committee Member/Outside Reviewer if applicable
(Provide title and location if outside UA)

