

Purdue School of Engineering and Technology
Indiana University-Purdue University Indianapolis (IUPUI)

Department of Biomedical Engineering

IUPUI

**SCHOOL OF ENGINEERING
AND TECHNOLOGY**

A PURDUE UNIVERSITY SCHOOL
Indianapolis

GRADUATE HANDBOOK

**Master of Science Degree in Biomedical Engineering
(MSBME)**

2011 – 2015

(approved by the BME faculty on November 5, 2010)

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1. INTRODUCTION

This manual addresses common questions from applicants and current graduate students concerning the Masters program of study in Biomedical Engineering at IUPUI. Information is provided concerning the application process, establishing a program of study, required scholastic performance and general administrative expectations of the IUPUI Graduate School and the Department of Biomedical Engineering.

2. BIOMEDICAL ENGINEERING FACULTY

As of January, 2011 the core biomedical engineering faculty at IUPUI are:

Karen Alfrey, Ph.D.	Rice University, 2000. Computational biology, neuronal modeling; biological control systems
Edward Berbari, Ph.D.	University of Iowa, 1980. Computer-based medical instrumentation, biomedical signal processing, cardiac electrophysiology and biophysical modeling
Chien-Chi Lin, Ph.D.	Clemson University, 2007. Development of functional hydrogels for tissue regeneration and controlled release applications
Julie Ji, Ph.D.	University of Pennsylvania 2004. Endothelial mechano-biology, cell and nuclear mechanics, and signal transduction in human disease models
Ghassan Kassab, Ph.D.	University of California San Diego, 1990. Vascular biomechanics, coronary artery biology
Sungsoo Na, Ph.D.	Texas A&M University, 2006. Physical and molecular basis of cell migration and regulation in the cardiovascular system by mechanical stimuli
John Schild, Ph.D.	Rice University, 1995. Autonomic control of the cardiovascular system, electrophysiological and computational study of neurocirculatory control
Joseph Wallace, Ph.D.	University of Michigan, 2007. Biological and environmental factors influencing the organization and assembly of bone
Dong Xie, Ph.D.	Ohio State University, 1998. Polymer biomaterials
Ken Yoshida, Ph.D.	University of Utah, 1994. Neural engineering, bioinstrumentation

3. GRADUATE SCHOOL ADMISSION REQUIREMENTS

Students are required to take the Quantitative, Analytical Writing and Verbal GRE exams. Successful applicants typically have scores above the 60th percentile and a minimum undergraduate Biomedical Engineering GPA of 3.0/4.0 from an ABET accredited institution. Applicants with an undergraduate degree in Biomedical Engineering from an educational institution outside of the US are required to take the TOEFL exam. The minimum TOEFL scores required before an application will be considered are the following:

- **Internet-based test (iBT):** The following five (5) minimum scores must be achieved: Writing: 18, Speaking: 18, Listening: 14 and Reading: 19.
- **Paper-based test:** the minimum acceptable score is: **550.**

The British Council's International English Language Testing System (IELTS) is acceptable in lieu of the TOEFL. A minimum overall IELTS band score of 6.5 is required for admission.

4. APPLICATIONS FROM NON-BIOMEDICAL ENGINEERING MAJORS

Preliminary coursework may be required before unconditional admission into the program if, in the opinion of the Biomedical Engineering Graduate Education Committee, an applicant appears capable of graduate level work but would benefit from additional study in select academic areas. The following course listings should be used as a guide for self assessment as the Committee most often identifies needs for additional study in these areas.

Mathematics and Physics Requirements

Graduates of an ABET accredited program other than Biomedical Engineering or graduates from a non-ABET accredited program must provide evidence of proficiency in the following academic areas (IUPUI course equivalents listed):

MATH 16500	Analytic Geometry and Calculus I
MATH 16600	Analytic Geometry and Calculus II
MATH 17100	Multidimensional Mathematics
MATH 26100	Multivariate Calculus
MATH 26600	Ordinary Differential Equations
PHYS 15200	Mechanics
PHYS 25100	Heat Electricity Optics

Engineering and Life Science Requirements

Graduates from a discipline other than Biomedical Engineering will need to demonstrate some depth of academic proficiency consistent with the anticipated area of study (e.g. bioelectricity, biomechanics, biomaterials, biofluids, etc.). At a minimum, the academic areas most often cited by the Committee include (IUPUI course equivalents listed):

BME 32200	Probability and Statistics for BME
BME 33100	Biosignals and Systems
BIOL K324	Cell Biology

The extent to which additional study is required to prepare the applicant for graduate level work in Biomedical Engineering is greatly dependent upon the nature of the undergraduate degree (e.g. B.S. vs. B.A., engineering vs. non-engineering, biology vs. chemistry, etc.) Those areas most often cited by the Committee include (IUPUI course equivalents listed):

BME 22200	Biomeasurements
BME 24100	Biomechanics
BME 33400	Biomedical Computing
BME 38100	Implantable Materials and Biological Response
BME 35200	Tissue Behavior and Properties

Summary

Applicants with an undergraduate engineering degree in a discipline other than Biomedical Engineering who can show evidence of proficiency in these Mathematics, Physics, Engineering and Life Science requirements are given full consideration for admission by the Committee. Applicants with a non-engineering undergraduate degree must show quantitative evidence of proficiency in these areas (e.g. obtaining at least a grade of "B" in any course recommended by the Committee). Demonstrated proficiency with at least one high level computer programming language or a command interpreter such as MATLAB is also required.

5. ADVANCE REGISTRATION AND FINAL REGISTRATION

Each semester a graduate student can pre-register for courses offered in the following semester during the advance registration period of the current semester. Students already in residence are strongly urged to advance register. New students may advance register if they come to campus during the semester before starting graduate work.

If advance registration is not possible, students should register during the final registration period. Final registration follows the same procedure as advance registration and is held during the week preceding the beginning of classes.

6. LATE REGISTRATION

Any student who has not utilized the advanced or final registration periods must schedule under late registration which begins the first day of classes and continues for one week. Penalty fees will apply and the student should consult the Bursar's Office.

Dropping/Adding Courses

Each graduate student is expected to be aware of all procedures, late fees, refund deadlines, etc. associated with dropping/adding of courses. Students may drop/add courses online during the open registration period. However, once the open registration period ends, students must use a Drop/Add form to change a course. Information on procedures and deadlines are available on the IUPUI Registrar's website.

7. ENGLISH LANGUAGE REQUIREMENTS FOR INTERNATIONAL STUDENTS

A student whose first language is not English must take the English for Academic Purposes (EAP) Placement Test. Those students with noted deficiencies are required to take one or more EAP courses. Unless an exception is granted by the Committee, all international students are required to take TCM 460 or an equivalent technical writing course within the first year of graduate study. Language related courses can not count towards the credit requirements for the Masters degree in Biomedical Engineering.

8. FACULTY ADVISOR AND ADVISORY COMMITTEE

Graduate students in both the Thesis and non-Thesis programs of study are expected to have a Faculty Advisor by no later than the end of the first semester of study. If the student is employed as a full time Graduate Research Assistant the Faculty Advisor is most often the faculty member sponsoring the MS thesis research project. If the student is employed part time by the Department or is self supported the student is expected to arrange for an Advisor from among the current Biomedical Engineering faculty. If the student fails to arrange for an Advisor by the end of the first semester of study one will be assigned by the Committee.

The Faculty Advisor and student must establish a Graduate Research Advisory Committee. It is the responsibility of this committee to assist the student in finalizing a formal Plan of Study for fulfillment of the MS degree requirements. This Advisory Committee also conducts all necessary examinations related to the MS thesis research or project for those in a non-Thesis program of study. The Graduate Research Advisory Committee generally consists of three members: the Faculty Advisor, a Professor knowledgeable of the major field of study and a Professor representing a related area of research.

9. PLAN OF STUDY

Each student is expected to file a Plan of Study during the first semester of graduate study in Biomedical Engineering but no later than 4 – 6 weeks into the second semester of graduate study. Students failing to meet this requirement will not be permitted to register for additional courses or thesis/project credits and may be dismissed from the program.

The Plan of Study form (GS-6) is available on the Forms page of the Office of graduate programs website. A completed Plan of Study form must be signed by the graduate student and each Advisory Committee member. The completed form is then returned to the department and recorded in the student's academic file. Approval by the Head of the Graduate Programs and the Graduate School officially establishes both the Plan of Study and the Advisory Committee. The Graduate Programs Coordinator for the School of Engineering and Technology can offer guidance concerning the logistics associated with filing a Plan of Study.

Change to the Plan of Study

To make changes to an approved Plan of Study the *“Request for Change to the Plan of Study”* form (GS-13) must be completed and filed with the Graduate School. This form is also used to request a change of Faculty Advisor, major professor or other members of the Advisory Committee or for a change between Thesis and non-Thesis MS degree options.

10. CREDIT, GRADE AND INDEX REQUIREMENTS FOR GRADUATION

The number of graduate level credit hours required for a Master of Science degree in Biomedical Engineering is 30. Only grades of "A", "B", or "C" are acceptable in fulfilling the academic expectations set forth in the Plan of Study. The Advisory Committee may require a grade of "B" or better in certain courses. Grades of "Pass/Fail" are not acceptable for any course listed on the student's Plan of Study. Grades of "Incomplete" must be cleared by the twelfth week of the semester immediately following the semester in which the grade of Incomplete was awarded. Failure to do so may result in replacement with a grade of "F" and dismissal from the program. Students are required to maintain a cumulative grade point average of at least 3.0 for all courses listed on the approved Plan of Study. Students in both the Thesis and non-Thesis MS degree programs must have a cumulative grade point average of at least 3.0 for all courses listed on the approved Plan of Study to be eligible for graduation with a MS degree in Biomedical Engineering.

11. COURSE REQUIREMENTS

The number of graduate level credit hours required for a Master of Science degree in Biomedical Engineering is 30. These credits must be distributed according to the following subject areas:

Plan of Study with a Thesis option:

3	credit hours	Approved graduate Mathematics or Statistics courses
12	credit hours	Graduate Biomedical Engineering courses
6	credit hours	Approved graduate life science or engineering elective courses
9	credit hours	Thesis research

Plan of Study with a non-Thesis option:

3 credit hours	Approved graduate Mathematics or Statistics courses
12 credit hours	Graduate Biomedical Engineering courses
0 – 6 credit hours	Approved graduate life science or engineering elective courses
9 – 15 credit hours	Approved graduate engineering electives

With the approval of the Biomedical Engineering Graduate Education Committee students in a non-Thesis program of study may receive a limited number of graduate elective credit hours for successful completion of clinical or industrial internships.

Deviations from these course requirements must be approved in advance by the Biomedical Engineering Graduate Education Committee and the Chair of the Biomedical Engineering Department.

12. ACADEMIC STANDING – MINIMUM GRADE REQUIREMENTS

Good Academic Standing

All graduate students begin their program of study in "good academic standing." In order for a graduate student to remain in "good academic standing" he/she must maintain minimum standards of academic performance that are set by the Biomedical Engineering Department. These expectations **are in addition to** the minimum standards of performance and personal behavior set forth by the IUPUI Graduate School. Failure to remain in "good academic standing" for two consecutive semesters may result in dismissal from the MS degree program.

To be in "good academic standing" a MS graduate student must maintain a semester grade point average of at least 3.00 (4.00 scale) at the end of each semester of study. A graduate student with a semester GPA below 3.00 at the end of any semester is no longer in "good academic standing", is automatically placed on an "*academic checklist*" and is issued a "*warning letter*". Registration is then restricted and students are required to meet with their advisors and complete the form "Request for Temporary Checklist Clearance" in order for the academic checklist to be temporarily released for registration the following semester. Should a student's cumulative GPA remain below 3.00 at the end of the semester immediately following the loss of "*good academic standing*" the student will be placed on "*academic probation*." A student on "*academic probation*" will not be permitted to register for further graduate courses until an academic review has been carried out by the Biomedical Engineering Graduate Education Committee. The outcome of this review will be either dismissal from the MS degree program or a list of expectations the student must achieve in the semester following being placed on "*academic probation*" (e.g. minimum academic performance in specific graduate courses).

Without exception, the MS degree in Biomedical Engineering will not be awarded to a graduate student with a cumulative grade point index below 3.00 (4.00 scale). The cumulative grade point index is calculated using the courses that are on the Plan of Study. If a course is taken more than once while the student is enrolled as a graduate student, only **the most recent grade received** in the course will be used in computing the grade point index. Transfer courses are not included in the computation of the cumulative grade point index. Any course on the Plan of Study that carries a grade of "D" or "F" must be repeated.

13. CHANGES IN ACADEMIC PROGRAM

As a student progress through their course work and research there may arise conditions that make it necessary to make changes to their approved Plan of Study and/or changes to their research objectives. Such changes, when based on appropriate academic reasons, are generally acceptable and require that form GS-13 is completed and filed with the Graduate School (see Section 9, above). However, the following rules must be observed:

- A course can not be removed from an approved Plan of Study once the course has been taken and a grade of "D" or lower has been received. This course must be repeated and the student must receive at least of grade of "C" before the course can be removed from an approved Plan of Study. This is a Purdue Graduate School rule.
- Any change to a Plan of Study and subsequent filing of form GS-13 requires approval of the student's Graduate Research Advisory Committee and the Chair of the Biomedical Engineering Graduate Education Committee.

14. INACTIVE ACADEMIC STATUS

Students who do not enroll in classes for three (3) consecutive academic sessions, including summer sessions, will be automatically assigned an "**inactive academic status**" and are no longer considered to be in *good academic standing* by the Biomedical Engineering Graduate Education Committee. While under an *inactive academic status* no progress can be made toward completion of the MS degree requirements. In order to be removed from an *inactive academic status* and returned to an active academic status the student must complete a new application with the Graduate School requesting re-admission. While all other supporting application materials (e.g. GRE, transcripts, etc.) are *not required* for re-admission to the Graduate School these and other materials may be required for re-admission into the Biomedical Engineering Department and return to *good academic standing* in the MS degree program. Students should consult with the Chair of the Biomedical Engineering Graduate Education Committee to clarify and confirm Committee expectations in order to return to *good academic standing* in the MS degree program.

Students must wait for their applications for re-admission to be officially approved by the Purdue University Graduate School before enrolling for classes. Registration activities that take place while under *inactive academic status* and before a new application for re-admission has been officially approved by the Graduate School are considered invalid and will not count toward graduate credit.

15. PREPARING THESIS AND FINAL EXAMINATION

- All students preparing a thesis document and a final oral examination *must attend* a "thesis/defense preparation briefing." These sessions are regularly offered by the Office of Graduate Programs in the School of Engineering and Technology with dates, times and locations reposted each semester. Each MS student is expected to complete this briefing prior to composing the first draft of the thesis. Generally, the student and major professor begin working through drafts of the thesis at least 2 – 3 months before the anticipated date of the final oral examination. Therefore, it would be prudent to complete a "thesis/defense preparation briefing" the semester before the anticipated date of the final oral examination.

- All requirements and deadlines must be met for successful completion of final oral examination and thesis deposit for graduation.
- Students must complete and submit form GS-8 “*Request for Appointment of Examining Committee*” to the Graduate Programs Coordinator **at least four weeks prior** to the anticipated final oral examination date. The Purdue Graduate School requires that the date, time and location of the final examination be registered at least three weeks in advance of the oral examination.

Students must have in their possession form GS-7 “*Report of Master's Examining Committee*” and form GS-9 “*Purdue University Graduate School Thesis Acceptance*” for completion immediately following their oral examination. These forms are available from the Graduate Programs Coordinator of the School of Engineering and Technology.

- Students must adhere to the standards set forth in the “*Manual for the Preparation of Graduate Theses*” published by the Purdue Graduate School and available from the Graduate Programs Coordinator of the School of Engineering and Technology.

It is incumbent upon the student to adhere to the requirements and guidelines stated in this manual. The Purdue Graduate School will not accept a thesis that has improper or inappropriate formatting. In such cases the thesis will be returned to the student for revision before the MS degree can be conferred.

- Purchase one set of Purdue thesis black binders and 100% white cotton paper (20 lb weight). In addition to submitting one bound thesis for the department's archive, students must submit an electronic thesis deposit (ETD) to the Purdue University Graduate School as well as an ETD submission to the IUPUI Libraries.
- Check with your research advisor to determine whether your thesis needs to be kept confidential. If confidentiality is required for your thesis form GS-15 “*Request for Confidentiality*” must be filed with the Graduate Programs Coordinator of the School of Engineering and Technology upon completion of the oral examination.
- The student must personally meet with the Graduate Programs Coordinator for verification of thesis document format.
- The final, approved thesis document for the Purdue Graduate School must be deposited at the IUPUI Graduate Office by the published semester deadline. Contact the IUPUI Graduate Office to make an appointment at least **one week in advance** of this deadline to arrange for deposit of the thesis.
- Students should plan for needing at least 2 days to complete all of the final revisions for thesis formatting and administrative paperwork related to the thesis deposit process. While all of this takes place after successful completion of the oral examination, a MS degree can not be conferred until the thesis has been officially recorded with the Purdue University Graduate School.

16. FINAL EXAMINATION COMMITTEE

The Final Examination Committee consists of at least three members. One member must be the Graduate Faculty Advisor. The others are appointed by the Faculty Advisor and most often consist of the Graduate Research Advisory Committee. The Final Examination Committee evaluates the thesis and conducts the final oral examination. As a hedge against unanticipated problems with the thesis research each member of the Committee should have a copy of the thesis document **at least one month prior** to the final oral examination.

17. SUMMARY OF THE MAJOR STEPS TOWARD OBTAINING A MS DEGREE IN BME

The following is an abbreviated list of the various steps which must be taken along the path toward a MS degree in Biomedical Engineering.

- A. Before registering for classes each semester report to your Faculty Advisor. If a Faculty Advisor has yet to be established the student should report to the Chairman of the Biomedical Engineering Graduate Education Committee.
- B. Before registering for the first semester of classes ensure what steps must be taken to fulfill any English language proficiency requirements (if necessary).
- C. Before the end of the first semester establish a Faculty Advisor and inform the Chair of the BME Graduate Education Committee. As soon as is practically possible, the student and Faculty Advisor should form a Graduate Research Advisory Committee.
- D. No later than 4 – 6 weeks into the second semester of study the student, working in conjunction with the Faculty Advisor and Research Advisory Committee, should file a Plan of Study with the Biomedical Engineering Department and the Purdue University Graduate School. Forms can be obtained from the website for the Office of Graduate Programs, School of Engineering and Technology.
- E. Ideally, steps C and D should be completed BEFORE the start of the second semester. Failure to do so means the second semester consists of course work that has not been reviewed and approved by the student's Graduate Research Advisory Committee.
- F. If possible, all English language proficiency requirements should be completed by the end of the first semester of study. All English language proficiency requirements must be successfully completed no later than the end of the second semester of study. The Graduate School will not approve the Plan of Study nor the formal appointment of the Graduate Research Advisory Committee until all English language proficiency requirements have been fulfilled.
- G. Submit any request for a change of Plan of Study to the Graduate School before classes begin in the semester you plan to graduate. The Plan of Study must be in its final form and received by the Graduate School before the first day of the last semester in order to be eligible for graduation.
- H. Follow the steps outlined in Sections 15 and 16 for administrative processing of the thesis document and preparing for the final oral examination.