



**DEPARTMENT OF
BIOMEDICAL ENGINEERING**

SCHOOL OF ENGINEERING AND TECHNOLOGY

Indiana University–Purdue University
Indianapolis

GRADUATE HANDBOOK

Master of Science Degree in Biomedical Engineering
(MSBME)

Fall, 2017

Amendments

1. First version was approved by the BME faculty on November 5th, 2010
2. Amended by the BME faculty on October 3rd, 2011
 - a. Guidelines for selection of approvable electives, page 8
 - b. Expectations for regular attendance of BME Department seminars, page 9. BME graduate students are expected to attend the BME Department seminar series.
3. Amended by the BME faculty on May 4th, 2012
 - a. Capstone requirements for Non-Thesis Master of Science students, page 8, added
4. Amended by the BME faculty on November 3rd, 2014
 - a. Guidelines of selection of elective courses for Plan of Study, pages 8-9
5. Amended by the BME faculty on May 7th, 2015
 - a. Course requirements for Thesis Master of Science students, page 8. The Thesis option minimum credit hours requirement for BME Graduate courses was reduced from 12 credit hours to at least 6 credit hours. If less than 12 credit hours are used the balance of the 12 credit hours must be from graduate level engineering courses.
 - b. Increase in the minimum TOEFL score requirements for admission. Increase the iBT Writing, Speaking, Listening, and Reading requirements as follows: W:18 → 20, S:18 →20, L:14→20, R:19→20, for a total of 79→80. The requested changes are based on the analysis of the iBT TOEFL scores of current and past students found to be lacking in sufficient English skills, and to be consistent with the Paper Test percentile score of 550.
 - c. Credit, grade and index requirements for graduation, page 7. The primary course minimum grade requirement was increased. Students will be expected to maintain a B- or better in each course listed as “primary” on their Plan of Study. If students receive a course less than “B-” in a course listed as primary, they are required to retake the course.
6. Amended by the BME faculty on August 17, 2016
 - a. Guidelines for BME697 included.
 - b. Guidelines for BME 69600 included.
7. Amended by the BME faculty on September 11, 2017
 - a. Revised procedure for course petition submission.
 - b. Updated text on English requirement for international students.
 - c. Removed BME 501/502 course requirement, and replaced with advising consultation.
 - d. Added clarification on whether BME 696 and/or 697 can be counted as Primary courses.

Proposed Changes

TABLE OF CONTENTS

| | Page |
|---|------|
| 1. INTRODUCTION | 4 |
| 2. BIOMEDICAL ENGINEERING FACULTY | 4 |
| 3. GRADUATE SCHOOL ADMISSION REQUIREMENTS | 4 |
| 4. APPLICATIONS FROM NON-BIOMEDICAL ENGINEERING MAJORS | 5 |
| 5. ADVANCE REGISTRATION AND FINAL REGISTRATION | 6 |
| 6. LATE REGISTRATION | 6 |
| 7. ENGLISH LANGUAGE REQUIREMENTS FOR INTERNATIONAL STUDENTS | 6 |
| 8. FACULTY ADVISOR AND ADVISORY COMMITTEE | 6 |
| 9. PLAN OF STUDY | 7 |
| 10. CREDIT, GRADE AND INDEX REQUIREMENTS | 7 |
| 11. COURSE REQUIREMENTS | 8 |
| 12. ACADEMIC STANDING – MINIMUM GRADE REQUIREMENTS | 13 |
| 13. CHANGES IN ACADEMIC PROGRAM | 14 |
| 14. INACTIVE ACADEMIC STATUS | 14 |
| 15. PREPARING THESIS AND FINAL EXAMINATION | 15 |
| 16. FINAL EXAMINATION COMMITTEE | 16 |
| 17. SUMMARY OF THE MAJOR STEPS TOWARD OBTAINING A MASTER OF SCIENCE DEGREE IN BME | 17 |
| APPENDIX A. Sample Plan of Study | 18 |

1. INTRODUCTION

This handbook addresses common questions from applicants and current graduate students concerning the Master's 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 November, 2017, 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 |
| Steven Higbee, Ph.D. | Rice University, 2013. Biomaterials and tissue engineering, undergraduate research |
| 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 mechanobiology, cell and nuclear mechanics, signal transduction in human diseases |
| Sharon Miller, Ph.D. | University of Michigan, 2008. Biomaterials and tissue engineering |
| Sungsoo Na, Ph.D. | Texas A&M University, 2006. Cellular/molecular mechanics and mechanotransduction of skeletal and vascular systems |
| John Schild, Ph.D. | Rice University, 1995. 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 |
| Hiroki Yokota, Ph.D. | University of Tokyo, 1983. Indiana University, 1993. Biomechanics and systems biology of bone and cartilage |
| 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 met: Writing: 20, Speaking: 20, Listening: 20 and Reading: 20; and Total score: 80.
- **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 Application in 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 | Introduction to Biomechanics |
| BME 33400 | Biomedical Computing |
| BME 38100 | Implantable Materials |
| BME 35200 | Cell and 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.

Once admitted, students with a non-BME undergraduate background are required to meet with their advisor at the start of the program, to discuss if additional courses are needed to prepare them for the BME program. In consultation with an advisor and other faculty in area of interest, students may be asked to take fundamental courses in BME. These classes would not count toward the credit requirements for the Master's Degree in Biomedical Engineering.

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 advance 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. You are exempt from taking the EAP exam if you scored at least: 100+ on TOEFL or 7.5+ on IELTS. Those students with noted deficiencies based on EAP scores are required to take one or more EAP courses or equivalent, if possible, for example TCM 460. Language-related courses cannot count towards the credit requirements for the Master's Degree in Biomedical Engineering.

8. FACULTY ADVISOR AND ADVISORY COMMITTEE

Graduate students in both 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. For Thesis students employed as a full time Graduate Research Assistant, the Faculty Advisor is most often is the faculty member sponsoring the Master of Science Thesis research project. For Non-Thesis students, the Director of the Graduate Program will serve as the Faculty Advisor.

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 Master of Science degree requirements. This Advisory Committee also conducts all necessary examinations related to the Master of Science 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 Form* 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 Director of the Graduate Program and the Graduate School officially establishes both the Plan of Study and the Advisory Committee. The Plan of Study Coordinator for the Biomedical Engineering Department can offer guidance concerning the logistics associated with filing a Plan of Study. A sample Plan of Study for a Thesis Master of Science degree program is provided at the end of this document along with a few helpful instructions.

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 Master of Science 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. All students in the Master of Science degree programs are required to take at least four (4) "Primary" courses for the approved Plan of Study and maintain a grade of "B-" or better for the "Primary" courses. The "Primary" courses with a grade lower than "B-" must be retaken for fulfilling the Plan of Study requirements. Students in both the Thesis and Non-Thesis Master of Science 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 Master of Science 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 |
| 6 - 12 | credit hours | Graduate Biomedical Engineering courses* |
| 0 - 6 | credit hours | Graduate Engineering courses* |
| 6 | credit hours | Approved graduate life science or engineering elective courses |
| 9 | credit hours | Thesis research |

* At least 6 credit hours of Graduate Biomedical Engineering courses must be included in the Plan of Study. If less than 12 credit hours of Graduate Biomedical Engineering courses are included, the balance of the 12 credit hours must be Graduate Engineering courses. These 12 credit hours should comprise the four (4) required Primary (P) courses of the Plan of Study.

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 |

The Non-Thesis option requires at least 3 credit hours devoted to a single capstone project, BME 69600 (Advanced Biomedical Engineering Topics), sponsored by a faculty member. Those graduate students pursuing a Course-Only Non-Thesis Plan of Study may substitute BME 69600 with 69700 (Directed Readings in BME). Prior approval from the BME Graduate Education Committee is required for this substitution. If either BME 69700 or 69600 is sponsored by a faculty outside of the BME Department, a faculty of record within BME will be chosen by the Director of the Graduate Program. Only one, either BME 696 or 697, can be counted as a Primary on a student's Plan of Study. If a student has taken both, BME 696 will count as Primary, and BME 697 will count as a related elective, either science or engineering.

Guidelines of Selection of Elective Courses for Plan of Study

BME offers its graduate students considerable flexibility in selecting life science and discipline specific electives. There is, however, an implied expectation that course selections will follow a unified theme in BME that is consistent with the student's research thesis or capstone project. The BME Graduate Committee has reviewed and approved the following courses for inclusion on a Plan of Study for the Master of Science Degree in Biomedical Engineering.

- **Engineering elective courses**

All IUPUI graduate courses at the 500 level and above offered by the ECE and ME departments are acceptable as approved engineering elective courses.

- **Mathematics, Statistics, or Life Science elective courses**

The BME Graduate Committee has reviewed and approved the following courses for inclusion in a Plan of Study for the Master of Science Degree in Biomedical Engineering.

| DEPARTMENT | Course # | Course Title |
|------------|----------|---|
| BIOL | 56100 | Immunology |
| BIOL | 56800 | Regenerative Biology & Medicine |
| BIOL | 55600 | Physiology I |
| BIOL | 50700 | Principles of Molecular Biology |
| CHEM | 53300 | Intro to Biochemistry |
| CHEM | 62100 | Advanced Analytical Chemistry |
| GRAD-G | 661 | Clinical Trials |
| GRAD-G | 819 | Basic Bone Biology |
| MATH | 51000 | Vector Calculus |
| MATH | 51100 | Linear Algebra w/ Applications |
| MATH | 52500 | Intro to Complex Analysis |
| MATH | 53700 | Applied Math Scientists/ENGR I |
| MATH | 55200 | Applied Numerical Methods II |
| MNEU-N | 612 | Neurotransmitter Dynamics & Synaptic Plasticity |
| MNEU-N | 614 | Special Senses & Integrated Neurophysiology |
| MNEU-N | 616 | Developmental Biology of Neurons |
| PHSL-F | 503 | Human Physiology |
| STAT | 51100 | Statistical Methods I |
| STAT | 51200 | Applied Regression Analysis |
| STAT | 51400 | Design of Experiments |
| STAT | 51900 | Introduction to Probability |
| STAT | 52300 | Categorical Data Analysis |
| STAT | 52800 | Intro to Mathematical Statistics |

Courses on this list **do not require prior approval** and can be considered as acceptable for a Plan of Study. This assumes the selection adheres to the credit allocations for the Thesis and Non-Thesis degree options and is thematically consistent with the Master of Science student's research thesis or capstone project.

Furthermore, all graduate courses at the 500 level and above offered by the School of Science and the IU School of Medicine are potential selections for an approved Plan of Study. There may also be suitable graduate offerings in the Schools of Dentistry, Health, Nursing, etc., but, to date, not many have landed on an approved Plan of Study.

Before selecting any course outside of the BME department and NOT on the list of approved courses the student must first review the selection(s) with his/her major professor and then petition the BME Graduate Committee by notifying the Chair of the committee via email and filling out a *Course Request Petition Form*. For new courses, the student must submit a course syllabus and an outline of lecture topics (if available), along with the form, to the BME Graduate Programs Coordinator. The Committee will then determine if

the course has a sufficient life science focus and rigor to be added to an approved Plan of Study for the Master of Science Degree in BME.

Guidelines for BME 69700 Directed Readings

BME 69700 is a reading course designed for students to gain background and up-to-date knowledge about a specific BME topic. The course is offered by individual faculty with expertise in the selected topic. Description of the individual sections of BME 69700 will be posted through usual communication venues and students interested in the course should discuss with his/her Faculty Advisor prior to signing up for the course. The following guidelines are established to ensure the rigor of the course:

- The course instructor should submit a list of reading materials (research articles, review articles, book chapters, books, etc.) to the GEC no later than the first week after the semester starts.
- Course will be advertised on the BME Programs site. The announcement should include the topic of the reading course, schedule of meetings, and any expectation from the faculty instructor. Instructor permission is mandatory for students who are interested in registering for the course.
- Students should not register for more than 3 credit hours (1, 2, or 3) for the course.
- Unless approved by the Graduate Education Committee, BME 69700 **cannot** be used as a Graduate Biomedical Engineering Course (Primary course) on the Plan of Study.
- At the end of the semester, the students are required to submit a written report to the GEC summarizing the materials covered in the course. The level of expectation varies depending on the credit hours registered.
 - **1 cr:** Submit a written report that summarizes the reading materials. The student should demonstrate **Knowledge** and **Comprehension** of the reading materials.
 - **2 cr:** Submit a written report that summarizes the reading materials and a section of critical evaluation. The student should develop critical thinking on the reading assignments. The written report should start with a summary of the reading materials and finish with a section of critical evaluation on selected reading assignments. In addition to **Knowledge** and **Comprehension**, the student should demonstrate **Application** (the ability to apply knowledge) and **Analysis** (break down ideas into simple thoughts). Some examples of critical evaluation include commenting on the strengths and weaknesses of ideas proposed in the reading, or comparing and contrasting two or more methodologies.
 - **3 cr:** Submit a written report that summarizes the reading materials. In addition to critical evaluation of the reading materials, the students should also develop/identify a scientific/engineering problem within the realm of the topic. With assistance from the faculty instructor, the student should also offer potential engineering, analytical, or technical solutions to the problem. The written report should include all components described above. The student should demonstrate the **Synthesis** and **Evaluation** levels of comprehension as defined by Bloom's Taxonomy.
- The instructor of record for the BME 69700 section will be a regular faculty member. In cases where the directed readings sponsor (main instructor) is an adjunct faculty, non-BME faculty, or external sponsor, a regular faculty member will serve as the instructor of record for the directed readings to help guide the external main instructor adhere to the aim and spirit of the course and help in the assessment and assignment of the student's course grade.

Guidelines for BME 69700 Evaluations:

- **Report language:** The summary report should be written in scientific language with appropriate citations. The students are encouraged to seek professional assistance on the structure and writing of the report.
- **Report length:** The length of the report should be appropriate to the level (i.e., cr. hr) of the effort.
- **Critical evaluation:** With the assistance from the instructor, the students will be trained to develop original critical evaluation.
- **Problem solving:** The students are not required to propose original ideas and solutions for the scientific/engineering problems. However, based on the reading materials, they should provide logical evolution and correlation between the scientific/engineering problem and the potential solutions.
- **Grade recommendation:** The course grade for the student will be assigned by the instructor based upon the participation of the student in the regular meetings with the instructor and the quality of the report based upon the guidelines above. Reports will be submitted to the BME Graduate Committee at the end of the semester. The Graduate Committee will scan the report for plagiarism as well as assess the quality of the report and course grade assigned by the instructor against the course expectations and above guidelines. Feedback will be given to the instructor of record to ensure consistency of scoring and quality across BME 69700 sections. Feedback, in particular to adjunct faculty, external sponsors, and junior faculty (< 3 years in the department) will play an important role in establishing consistency in the scoring of BME 69700 across sections.

Grades should be assessed in terms of degree of meeting expectations laid out per the number of course credit hours, above. The degree of meeting expectation, evidenced by the report, should be assessed against the following descriptors: A = Excellent, B = Very Good, C = Fair, D = Poor, F = Failure. Please note that graduate students are expected to maintain a cumulative B grade on courses on their Plan of Study to graduate from the program.

Guidelines for BME 69600 Advanced Biomedical Engineering Project

BME 69600 is a project-oriented course designed for students to gain hands-on experience in solving a specific BME problem, as well as to learn techniques in data processing, interpretation, and presentation. The course is offered by individual faculty with expertise in the selected BME topic. Description of the individual sections of BME 69600 will be posted through usual communication venues, and students interested in the course should discuss with his/her Faculty Advisor prior to signing up for the course. If appropriate, before undertaking any BME 69600 Directed Project the student should complete a comparable number of BME 69700 Directed Readings credits with the same Project Mentor. Doing so will ensure the student has sufficient knowledge of the Mentor's research area to accomplish the project objectives as well as understand the technical significance of the work.

The following guidelines set expectations concerning course rigor and reporting:

- The course instructor should submit a summary of the project to the GEC **at least one week before the semester starts.**
- Instructor permission is mandatory for students who are interested in registering for the course.

- Students should not register for more than 3 credit hours (1, 2, or 3) for the course.
- Unless approved by the GEC, BME 69600 **cannot** be used as a Graduate Biomedical Engineering Course (Primary course) on the Plan of Study.
- At the end of the semester, the students are required to make a 15-minute presentation to the GEC summarizing the work conducted in the project and submit a written report to the GEC summarizing the progress of the project. The level of expectation varies depending on the credit hours registered. If the project involves multiple researchers (e.g., undergraduate and graduate students, postdocs, research technicians, etc.), the student should clearly and specifically describe his/her contribution to the project.
 - **1 cr:** Submit a written report that summarizes the work assigned work performed. The student should demonstrate the background of the problem, the research techniques/tools used for the project, and the results obtained from the work along with a minimum of statistical analysis.
 - **2 cr:** In addition to the instructions above, the student should demonstrate his/her contributions to problem solving or trouble-shooting difficulties in the project (e.g., demonstration of prototyping and redesign as a result of testing and analysis).
 - **3 cr:** In addition to the instructions above, the students should also demonstrate the ability to design aspects of the experiments and/or protocols for the projects including statistical design of all testing protocols. The written report should also include recommendation for future directions.
- The instructor of record for the BME 69600 section will be a regular faculty member. In cases where the directed readings sponsor (main instructor) is an adjunct faculty, non-BME faculty, or external sponsor, a regular faculty member will serve as the instructor of record for the directed readings to help guide the external main instructor adhere to the aim and spirit of the course and help in the assessment and assignment of the student's course grade.

Guidelines for BME 69600 Evaluations:

- **Report language:** The summary report should be written in scientific language with appropriate citations. The students are encouraged to seek professional assistance on the structure and writing of the report.
- **Report length:** The length of the report should be appropriate to the level (i.e., credit hours) of the effort.
- **Critical evaluation:** With the assistance from the instructor, the students will be trained to develop original critical evaluation.
- **Problem solving:** The students are not required to propose original ideas and solutions for the scientific/engineering problems. However, they should provide logical evolution and correlation between the scientific/engineering problem and the potential solutions.
- **Grade recommendation:** The course grade for the student will be assigned by the instructor based upon the participation of the student in the project and the quality of the report based upon the guidelines above. Reports will be submitted to the BME Graduate Committee at the end of the semester. The Graduate Committee will scan the report for plagiarism, and assess the quality of the report and course grade assigned by the

instructor against the course expectations and the above guidelines. Feedback will be given to the instructor of record to ensure consistency of scoring and quality across BME 69600 sections. Feedback, in particular to adjunct faculty, external sponsors, and junior faculty (< 3 years in the department) will play an important role in establishing consistency in the scoring of BME 696 across sections.

Grades should be assessed in terms of degree of meeting expectations laid out per the number of course credit hours, above. The degree of meeting expectation, evidenced by the report should be assessed against the following descriptors: A = Excellent, B = Very Good, C = Fair, D = Poor, F = Failure. Please note that Graduate students are expected to maintain a cumulative B grade on courses on their Plan of Study to graduate from the program.

Guidelines: Miscellanea

For the math course requirement there is again considerable flexibility in terms of acceptability, but here a much closer look is given to the level of analytical rigor in the course material and thematic consistency with the topic of the Master of Science student's research thesis or project.

With the prior approval of the BME 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 BME Graduate Education Committee and the Chair of the BME 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 Master of Science degree program.

To be in Good Academic Standing, a Master of Science 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 Faculty Advisor 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 Master of Science 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 Master of Science 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.

Finally, the BME Department sponsors many opportunities for academic, scientific research, and professional career enrichment. The BME faculty strongly encourage our graduate students to make the most of these opportunities to ensure their training experience is grounded in a broader understanding of the Biomedical Engineering field and its role in advancing medical science. While voluntary for all students, there is one exception. **Master of Science BME graduate students in Good Academic Standing are expected to regularly attend BME Departmental Seminars.** This is the most efficient way to ensure Master of Science graduate students are exposed to the wide range of medical science-related research that is Biomedical Engineering.

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, *Request for Change to the Plan of Study*, is completed and filed with the Graduate School (see Section 9, above). However, the following rules must be observed:

- A course cannot 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 Master of Science 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 Master of Science 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 Master of Science 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 Master of Science 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 Plan of Study Coordinator in the Department of Biomedical Engineering ***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 Oral 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 Plan of Study Coordinator in the Department of Biomedical Engineering.

- 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 Master of Science degree can be conferred.

- Students must 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.
- Students must check with their research advisors to determine whether their Thesis needs to be kept confidential. If confidentiality is required for your Thesis, form GS-15, *Request for Confidentiality* must be filed with the Plan of Study Coordinator in the Department of Biomedical Engineering upon completion of the Final 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 Master of Science degree cannot 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 members 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. A similar, but less formal committee review and oral presentation of the capstone project (BME 69600, Advanced Biomedical Engineering Topics) is required for those students enrolled in a project-based, Non-Thesis Plan Of Study. Those graduate students pursuing a course-only, Non-Thesis Plan Of Study may choose to make an oral presentation to BME Faculty summarizing their final report from BME 69700 (Directed Readings in BME).

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

The following is an abbreviated list of the various steps which must be taken along the path toward a Master of Science 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. A sample Plan of Study for a Thesis Master of Science degree program is provided at the end of this document along with a few helpful instructions.
- 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.

Appendix A. Sample Plan of Study (GS-6) for a Master of Science in BME, Thesis option

The sample document is attached to the end of this document.
A few helpful suggestions include:

1. Mark **(X)** Thesis Option on the plan.
2. List a total of 7 courses and arrange the courses into two separate groups. Group courses in the Primary area first followed by the group of courses in the Related area. Consult with your advisor on the primary and the related area courses. For each of the courses listed designate “**P**” for Primary and “**R**” for Related under the column for Area on the far left column. Do not include Master of Science Research Thesis credits.
3. For the column labeled “**Date Completed or To be Completed**”, only the month and year is required. There is no need to include a specific date of completion.
4. For the column labeled “**Regular Registration**”, a check indicates that this particular course was or will be completed after official admission to graduate program, i.e. courses taken following admission to the IUPUI Graduate School AND the graduate program in BME.
5. For the column labeled “**Non-degree Regis**”, a check indicates that this particular IUPUI course was completed as a non-degree graduate student BEFORE being admitted into the BME program.
6. The column labeled “**Other or Transfer From**” refers to those courses taken at another institution that are to be transferred to the Plan of Study. The name of the institution (i.e. one other than IUPUI) which offered the courses must be recorded. This is required for Purdue graduate courses taken at a campus other than IUPUI as well as all online course offerings from Purdue (e.g., via the Engineering Professional Education online program) and requires prior approval from the student's Advisory Committee. However, had the student started his/her Master of Science degree program in a department at IUPUI other than BME (e.g., Biology) and decided to switch to BME, the course(s) completed in the Biology department would also be considered transfer courses and must be indicated as such in the “**Other or Transfer From**” column.

With respect to item #6: **It is a rule for all Master of Science degree programs in the Purdue system that no more than 12 credit hours can be transferred onto a plan of study** from an outside institution or some other IUPUI graduate degree program (i.e. the Biology example above).