The Pennsylvania State University
Intercollege Graduate Degree
Program in Bioengineering

Graduate Student Handbook

2013
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General Information

The Penn State Intercollege Graduate Degree Program (IGDP) in Bioengineering is a degree granting program that includes faculty members from multiple departments and colleges at Penn State. This list includes faculty with their primary appointment in the Bioengineering Department, Bioengineering Affiliated Faculty who have their primary appointments in other departments and a courtesy appointment in Bioengineering, and Bioengineering Program Faculty who are members of the IGDP in Bioengineering but who do not have an appointment in the Department of Bioengineering. All faculty who advise M.S. and Ph.D. students in Bioengineering must be members of the IGDP in Bioengineering.

Graduate Program Office

The Graduate Program Office for Bioengineering is located in 206 Hallowell Building. The graduate staff assistant, Carol Boring, is available to assist students between the hours of 8:00-4:00 Monday through Friday. If she is unavailable, you may contact Doretta Garvey, Department Head Staff Assistant in 205 Hallowell Building.

The Graduate Program Office can help with the following:

- answer administrative questions, supply forms
- schedule controlled bioengineering classes
- schedule candidacy, comprehensive, and final oral exams
- submit theses and dissertations for printing
- send out Fed Ex packages
- prepare contracts
- prepare letters for leaving the country for international students

Desk, Keys, Supplies, Mail

Desks: Your adviser may have an area with desks and computers near their lab. If not, you may get a desk assignment in the student offices (if available) by asking Doretta Garvey, 205 Hallowell.

Keys: Keys may be obtained by asking your adviser to send an email to Sue Colyer at skc14@engr.psu.edu detailing which lab keys are needed. Keys can then be picked up at her office in 205C Hallowell Building. Once you leave the Bioengineering Department, all keys need to be returned to Sue.

Purchasing Equipment and Supplies: Graduate students may be responsible for purchasing supplies for their lab. Before ordering any supplies or equipment, please see Sue Colyer for the correct procedures for ordering and completing the forms. In addition, be prepared and know what budget numbers to use. Consult your adviser for this information. All supplies are meant for laboratory use, not for your personal use or even class work.

Mail: All graduate students will have a mailbox in 234 Hallowell Building. Inter-university mail and all outgoing mail is picked up at 1:00 Monday–Friday. Students may put personal mail in the outgoing
wire basket as long as it has postage.

**Sending FedEx or UPS Packages:** Either Carol Boring or Doretta Garvey can send out packages. Bring package to 206 or 205 Hallowell along with shipping information, phone number of recipient, budget number to be charged, weight and whether or not the package needs insured.

Packages are delivered in 234 Hallowell daily by Fed EX and UPS. Each student is responsible for checking deliveries of their lab supplies. This room is used by the entire department for many functions, so please be diligent in retrieving your packages.
Tuition Bills and Confirming Registration for ALL Graduate Students

After enrolling in classes, all students will receive an e-mail notification from the PSU Bursar’s Office requiring payment of tuition. Students should follow the instructions outlined in the e-mail to file the tuition bill electronically. Do not ignore this e-mail. Tuition and fees are covered under assistantships/fellowships. Tuition will not be paid until the student completes the appropriate payroll paperwork and the assistantship is processed. After the assistantship has been processed, students should file the tuition bill on eLion (https://elion.psu.edu). Students should locate the “tuition bill” tab, choose the option “make changes or adjustments to my bill”, click the appropriate box for “Assistantship/Fellowship”, change the tuition amount owed to “zero” and submit the bill on-line to confirm registration. By filing the bill online, it confirms your registration and places you into “registered status.”

Full-time Academic Status

Full-time academic status is achieved by taking appropriate course loads as shown in the following pages. Most loan granting agencies and other organizations will consider a 9-credit course load to be full-time status, fulfilling their registration requirements. The U.S. Immigration and Customs Enforcement (ICE) requires that all international students on student visas must achieve “full-time academic status” during the Fall and Spring semesters. For ICE purposes, a course load of nine credits is considered full-time during Fall and Spring semesters, and during the Summer semester, international students do not have to register. All M.S. and pre-comprehensive Ph.D. students should register for BIOE 600 research credits to achieve this 9 credit minimum for full-time status. Any graduate student registered for BIOE 601 is considered to have a full-time academic status (Note: Student must have passed the Ph.D. comprehensive exam in the prior semester or earlier). For full details, see the Graduate Degree Programs Bulletin website at http://bulletins.psu.edu/bulletins/whitebook/index.cfm.

Course Load

Full-time students and students receiving assistantships or fellowships should register for 12 credits per semester. These credits can consist of course credits (400 and 500-level), and research credits (600-level). In addition to course work, students are expected to commit at least half their time to research for greater than six (6) 600-level research credits for a total of at least 12 credits per semester.

Graduate courses carry numbers from 500 to 699 and 800 to 899. Advanced undergraduate courses numbered between 400 and 499 may be used to meet some graduate degree requirements when taken by graduate students. A graduate student may register for or audit courses below the 400 level in order to make up deficiencies or to fill in gaps in previous education but not to meet requirements for an advanced degree.

The Graduate School requires that all students receive a cumulative grade point average of 3.0 or better to graduate.

After passing the comprehensive exam, all Ph.D. students must maintain "continuous registration," which requires them to register for BIOE 601 for the Fall and Spring semesters. If Ph.D. students use
University facilities during Summer Session or plan to take their comprehensive exam during the summer, they must be registered.

BIOENGINEERING (BIOE) Course List: http://www.bioe.psu.edu/students/GRCourses.html

**Student Insurance**

Health insurance is mandatory for all international students (and their dependents) who are supported on assistantships/fellowships or who are self-supported. US students on other health care plans may file a waiver on-line with the Student Insurance Office if they are covered under another health insurance plan. International students may file a declination form on-line but they must present evidence of being covered under another health care plan which is equivalent to the Penn State plan. Students on assistantships/fellowships are automatically enrolled in the medical, dental and vision plans. Insurance premiums are deducted monthly from the assistantship stipend. Penn State will pay 80% of insurance coverage and the student is responsible for 20%. Students who are not on assistantships/fellowships must pre-pay for health care coverage.

The insurance subsidy for eligible dependents is 70% of the annual premium expense. As with the subsidy for your individual insurances, the university will pay 70% of the premium expense directly to the insurance companies and you will pay your 30% of the premium costs through a payroll deduction.

Detailed information on health insurance, including the health insurance booklet, enrollment deadlines and table of monthly payroll deductions is available at:
http://studentaffairs.psu.edu/health/services/insurance/.

It is each student’s responsibility to notify the department, payroll office, and the international office (if applicable) if there is a change of address during your stay at Penn State. Please change the information on eLion and more importantly, on ESSIC (Employee Self-Service Information Center).
https://essic.ohr.psu.edu The ESSIC system is available for students who are on a paid assistantship or fellowship.

**Training in the Responsible Conduct of Research (RCR)**

During the first year of study, all graduate students studying for the M.S. and/or Ph.D. in Bioengineering are required to complete the free online Scholarship and Research Integrity (SARI) training provided by the Collaborative Institutional Training Initiative (CITI).
http://www.research.psu.edu/training/sari/about-sari. Upon completing the training, participants are issued a certificate of completion. Email or photocopy the certificate and submit it to the Program’s Graduate Secretary prior to the end of their second semester of study. All graduate students admitted to candidacy for the Ph.D. degree, shall participate in five hours of discussion based Responsible Conduct of Research (RCR) education. This requirement is considered a prerequisite for scheduling of the comprehensive exam and may be satisfied by enrollment in BIOE 591, Bioengineering Ethics and Professional Development, or IBIOS 591, Ethics in the Life Science (Hershey).
Entering the Bioengineering Graduate Program

University-level requirements for graduate students are spelled out in detail in the Graduate Bulletin and can be found on line at http://bulletins.psu.edu/bulletins/whitebook/degree_requirements.cfm?section=masters.

Specific course requirements for the M.S. and Ph.D. are summarized below. Upon entering the program, a student along with their research adviser will select an academic advisory committee. Working with this committee, the student will select courses appropriate to their research and their professional goals.

Selecting an adviser

New students who are already on Graduate Assistantships have an adviser who has been designated in the offer letter. All others are encouraged to seek out a potential adviser who has a research project of interest to the student. Students should search the web site for members of the Graduate Faculty in Bioengineering who may have a research project of interest and contact the faculty directly. The Graduate Faculty may be found at: http://www.bioe.psu.edu/people.html

Selecting an Academic Advisory Committee

Upon entering the program, a student, along with his/her adviser, will select an academic advisory committee, consisting of three members of the IDGP in Bioengineering Graduate Faculty (including the adviser).

- All students (Masters, IUG and Ph.D.) will assemble an academic advisory committee to help select courses and assess progress on research
  - Committee will meet at least once a year and in time to help student select courses (generally late Spring or August)
  - For every yearly meeting, students will create 1 page document summarizing the hypothesis (or goals) and specific aims of the project, along with a 20 minute PowerPoint presentation.
    - Committee will complete progress report form, attach to aims page and hard copy of presentation slides, and place in student’s academic folder.
  - For IUG and Master’s students, the academic advisory committee will generally serve as their thesis reading committee.
  - For Ph.D. students, the Doctoral Committee will replace the academic advisory committee after completion of the second year of the Ph.D. and before registering for the comprehensive exam.
Master’s Degree Requirements

Below are degree requirements for the M.S. degree in terms of general requirements as delineated by the Graduate School and specific requirements set by the Bioengineering Program. Course expectations are set up so that coursework during the semester will require up to half of the students’ time with research activities taking up the majority of the time. Summers are generally set aside for full-time research. Beyond the specific course requirements listed below, M.S. students are expected to publish at least one first-author paper based on their research. This is not a requirement for graduation, however.

Minimum Requirements:

- 30 credits that must include the following:
  - At least 24 credits at the 500-level or above
  - 20 credits must be earned at a Penn State Campus and recognized by the Graduate School
  - 6 credits of Bioengineering; 6 credits Life Science; and 6 credits Technical/Quantitative/Bioengineering Electives.
  - At least 12 credits must be lecture- or lab-based (not independent study) and at the 500-level (not including the ethics course or the graduate seminar). Additional 6 (or more) credits are at the 400 or 500-level.
  - At least 6 credits of BIOE 600 (Thesis Research)
  - Students must register for BIOE 590 (BIOE Colloquium) each semester in attendance.
  - 1 credit Bioengineering Ethics and Professional Development, BIOE 591

- Completion of online training in Responsible Conduct of Research. See the following website for details: [http://www.research.psu.edu/training/sari/program](http://www.research.psu.edu/training/sari/program).
- Master’s Thesis with oral defense.

Transfer credits

A maximum of 10 graduate credits earned at other accredited institutions may be applied toward the requirements for the master's degree. However, credits cannot have been used for a previous degree. To receive credit for transfer courses, the student must provide a syllabus of the course taken and a completed petition form, available from the bioengineering staff assistant. All courses will be evaluated on a case by case basis.

Bioengineering Colloquium

The Bioengineering Colloquium (BIOE 590) is held every Wednesday at 12:00 noon in 210 Hallowell Building. All Master’s and IUG students must register for BIOE 590 (1 credit) each semester in attendance. Ph.D. students must register for BIOE 590 (1 credit) until they have passed their comprehensive exam. Attendance is mandatory for all graduate students registered in BIOE 590.

Thesis Guide

The Graduate School Office of Thesis and Publications provides a Thesis Guide, which provides formatting instructions, can be located at on the Penn State Graduate School web site at [http://www.gradsch.psu.edu/current/thesis.html](http://www.gradsch.psu.edu/current/thesis.html).
Thesis

A thesis is required of all M.S. students. This thesis must be defended orally in front of the student’s master’s thesis committee, which is composed of the adviser plus two other members. The thesis committee is generally the same as the student’s academic advisory committee, but it does not need to be. The co-chairs of the Bioengineering Program (William Hancock-UP and Christopher Siedlecki-HY) will also be required to review and sign the thesis; two original signature pages are required.

M.S. Thesis Deadlines

The deadline for submitting the final thesis to the Graduate School is generally 3-4 weeks before the end of the semester. Firm dates are established by the Graduate School and are located at http://www.gradsch.psu.edu/calendar/.

To complete the thesis it is necessary to leave sufficient time for the reading committee to read and critique the thesis and for the student to incorporate comments from the reading committee into the final version that is submitted to the Graduate School. Hence, the oral thesis defense must occur at least one week before the Graduate School thesis submission date and the student must provide each committee member with a hard copy and a pdf version of the thesis at least one week before the thesis defense (which is at least two weeks before the Graduate School deadline). Meeting these deadlines is the responsibility of the student and failure to meet deadlines will result in postponement of graduation until the next semester. The thesis draft that is submitted to the committee should be complete, copy edited, spell checked, and thoroughly reviewed by the primary adviser. When submitting the thesis draft to the reading committee, also provide one hard copy for review by the Program Chair. **Remember:** completed theses must be submitted in hard copy and in pdf version to the thesis reading committee and the Program Chair at least one week before the thesis defense and at least two weeks before the Graduate School thesis submission deadline.

Please provide one hard copy to the graduate staff assistant Carol Boring (cxb192@psu.edu) to have bound and placed in the library after all edits have been made.
How to Submit a Master’s Thesis

- Become familiar with the format requirements by reading the Thesis Guide carefully

- Activate the intent to graduate on eLion during the semester in which you plan to graduate. Go to [http://www.gradsch.psu.edu/current/thesis.html](http://www.gradsch.psu.edu/current/thesis.html) for deadline.

- Upload a draft of your thesis for format review (Word or pdf file) to the eTD Web site ([http://www.etd.psu.edu](http://www.etd.psu.edu)) by the specified deadline. Corrections and detailed instructions will be returned to you by e-mail within two weeks.

- Make any changes required by adviser and readers. Receive approval in the form of signatures on the Master’s Approval Page.

- Review the thesis one final time to be sure that no further changes are needed. It will not be possible to make corrections after final approval by the Thesis Office. Convert the file to a pdf for eTD submission. If you cannot do this, contact the Thesis Office for assistance.

- Go to the eTD Web site ([http://www.etd.psu.edu](http://www.etd.psu.edu)) and upload the final eTD. Submit supporting materials to the Thesis Office (Note: It doesn’t matter if you upload first or submit the materials first). Supporting materials are: signed Master’s Approval Page and thesis fee (cash or a check payable to Penn State; please write your student id number on the check. Please be sure to check the website for current fee.)

- Await notification of thesis approval by e-mail. If changes are required, you will be notified. Your eTD will be accessible on the eTD Web site immediately after graduation unless you have restricted access.

Provide one unbound, single sided copy to the department (Carol Boring, Room 206, Hallowell Building; cxb192@psu.edu). Check with your adviser to see if he/she wants a bound copy and if so, you must work out the payment arrangements. Pricing brochures are available in 206 Hallowell or go to the following website for more information. Bring all copies to the Graduate Staff Assistant in 206 Hallowell and she will send them to be bound. ([http://www.multimediaprint.psu.edu](http://www.multimediaprint.psu.edu)).
MASTER’S APPROVAL PAGE

Name of Student__________________________________________ Penn State ID ___________________
Email address(s)_________________________________________________

I hereby certify that I have obtained the necessary permission for copyrighted material included in my thesis and choose that the document be placed in the eTD archives with the following status:

___ 1. OPEN ACCESS — Allows free worldwide access to the entire work beginning immediately after degree conferral. Appropriate for the majority of thesis submissions in immediately fulfilling the requirement for making the work available to the public.

___ 2. RESTRICTED (PENN STATE ONLY)* — Access restricted to individuals having a valid Penn State Access Account, for a period of two years. Allows restricted access of the entire work beginning immediately after degree conferral. At the end of the two-year period, the status will automatically change to Open Access. Intended for use by authors in cases where prior public release of the work may compromise its acceptance for publication

___ 3. RESTRICTED — Restricts the entire work for a period of two years, for patent and/or proprietary purposes. At the end of the two-year period, the status will automatically change to Open Access. Selection of this option requires that an invention disclosure (ID) be filed with the Office of Technology Management (OTM) prior to submission of the final thesis and confirmed by OTM and Office of Theses and Dissertations. Confirmed ______

________________________________________________________
Signature of Student________________________________________ Date________________________

FACULTY APPROVAL
(a minimum of three signatures required, including dept. head or chair of graduate program)

We accept and approve the thesis of the student named above and agree to distribution as indicated.

Signature ____________________________________________ Date________________________
Print name here ______________________________________________________________________

Signature ____________________________________________ Date________________________
Print name here ______________________________________________________________________

Signature ____________________________________________ Date________________________
Print name here ______________________________________________________________________

Signature ____________________________________________ Date________________________
Print name here ______________________________________________________________________

Signature ____________________________________________ Date________________________
Print name here ______________________________________________________________________

Department Head or Chair of Graduate Program

Signature ____________________________________________ Date________________________
Print name here ______________________________________________________________________

*Requests for a two-year extension can be made by contacting the Office of Theses and Dissertations (gradthesis@psu.edu) 30 days prior to the expiration of the restriction.
Ph.D. Degree Requirements

Completing a Ph.D. in Bioengineering consists of satisfying minimum course requirements, passing two formal exams (candidacy exam and comprehensive exam), and completing and defending a dissertation (final exam). The Ph.D. is a research-focused degree and research is expected to be the focus of students’ energies with coursework providing depth of understanding and developing the breadth of knowledge expected of a doctoral candidate. Students are expected to begin their research work upon entering the program, and course requirements are set up with the expectation that during the first two years of study students spend at least half of their time carrying out research with the remainder devoted to coursework. Later years are devoted entirely to research activities. While the number of publications resulting from doctoral research varies, the general expectation is that Ph.D. students should publish at least three first-author publications prior to completing their dissertation. It is permissible to use content from the student’s first-authored papers in the dissertation.

Course Requirements

Upon entering the Ph.D. program, the student, along with his/her research adviser, will select an academic advisory committee, consisting of three members of the IDGP in Bioengineering Graduate Faculty (including the adviser). Working with this committee, the student will select courses appropriate to their research and professional goals. In preparation for selecting proper courses for the first semester, the advisory committee must be selected and meet with the student before the start of classes (normally late August).

The minimum credit requirements for a Ph.D. in Bioengineering are as follows:

- Total minimum number of course credits is 29.
- 20 credits must be earned at a Penn State Campus and recognized by the Graduate School.
- 6 credits of Bioengineering; 6 credits Life Science; 6 credits Technical/Quantitative/Bioengineering Electives. 12 of these credits must be lecture or laboratory-based and at the 500 level. The other 6 credits can be 400 or 500-level lecture-based courses and cannot include the ethics course or colloquium.
- 6 additional credits at the 500 level in courses relevant to their research.
- At least 6 credits of BIOE 600 (Thesis Research).
- Ph.D. students must attend colloquium every semester until they have passed their comprehensive exam.
- 1 credit Bioengineering Ethics and Professional Development, BIOE 591
- Completion of online training in Responsible Conduct of Research (RCR) see the following website for details: http://www.research.psu.edu/training/sari/program*
- Any other courses as determined by student’s adviser and/or academic advisory committee.

*All Ph.D. students admitted to candidacy must participate in five hours of discussion-based education on Responsible Conduct of Research, which will be satisfied by attaining a passing grade in BIOE 591 Bioengineering Ethics and Professional Development, in addition to taking the on-line training in RCR (see p. 6).

Students who enter the Ph.D. program with a Master’s degree will work with his/her advisory committee to determine the suitability of substitutions for courses already taken.
Candidacy Exam

The candidacy exam is the first of three formal exams required for a Ph.D. The purpose of the candidacy exam in Bioengineering is to ensure that the student will have all of the qualifications expected of a Ph.D. graduate and can perform as expected upon completion of the degree. The format of the exam is a written proposal on a research topic different from the student’s dissertation project, followed by an oral defense. The candidacy exam should be taken following the second semester in the Ph.D. program (generally in May). The candidacy committee is comprised of a department-appointed committee of four faculty members. The adviser may attend, but cannot participate in exam scoring.

Objective

The overall objective of the Ph.D. candidacy (qualifying) exam is to determine the potential of the candidate to pursue a meaningful and productive career in research, teaching and management of engineering activities in the biological and medical sciences. The focus of the exam is to provide convincing evidence that the candidate has the creativity, maturity and confidence to achieve these ultimate goals. Measures of the candidate's successful performance in the exam shall be based upon:

(1) Demonstration of a mastery of the course work undertaken during prior academic programs at the undergraduate and graduate level;

(2) A well-defined and superior ability to approach the solution of new problems by the methodical and logical application of sound scientific methods based upon fundamental principles of engineering and the physical sciences;

(3) An ability to demonstrate extensive general knowledge of a traditional engineering or physical science discipline in which the candidate possesses a major and readily recognizable strength; and

(4) A minimum grade-point average of 3.00 for work completed at the University prior to candidacy exam.

Proposal Topic

The student is responsible defining the topic of his/her proposal. Advisers and others may be consulted to refine the research topic. The proposal must be on new research (not problems that have already been solved). The topic can be broadly related to the student’s research area, but the proposal must outline research that is distinct from the student’s research project, different from other research being carried out in the lab, and not overlapping with any past grant proposals written by the student’s adviser. The proposal should include a balance of engineering and life science content, and the proposal can describe either design-directed or hypothesis-based research.

Application for Candidacy Exam

The student will submit an application to take the candidacy exam by noon on the last day of classes for the semester. The precise deadline for every semester will be outlined in an email sent by the graduate department.
staff assistant near the start of every semester. The application (see page 18) contains a title and 250 word summary of the proposal. Applications are reviewed by the candidacy exam committee and either approved or returned with suggestions for modifications of the proposal. Upon approval of the subject, which takes one week, the student will be given four weeks to complete the proposal.

**Procedures**

(1) The candidacy exam will consist of the preparation of a written research proposal followed by an oral defense before the candidacy exam committee.

(2) The exam will be taken during the summer following the student’s first year of study (generally in May). In some cases, the exam will be taken at the end of the third semester of study (generally at the end of the Fall semester); exceptions must be approved by the Graduate Curriculum co-Chair, Professors William Hancock and Christopher Seidlecki. Students who switch from the M.S. to the Ph.D. Program will take the candidacy exam at the next time it is offered (end of spring or fall semesters).

(3) A standing candidacy exam committee, made up of at least four Bioengineering IDGP Faculty plus the student’s adviser, will administer the exam.

(4) The student will prepare a research proposal, suitable for Ph.D. level research. The proposal will be in the form of an abbreviated NIH research grant; the maximum number of pages is 11, excluding title page, summary description and references. All figures must fit within the 11 page limit. Points will be docked for proposals over the page limit. The student may include preliminary data they have collected but it is expected that the proposal will be based primarily on data from the literature.

(5) Researching the literature will be the primary tool for developing the proposal. The student may solicit technical advice and consult with experts on campus and in the department as a way to learn about critical techniques, instruments and key experiments. Otherwise, the adviser and other faculty should not be consulted to read and critique rough drafts of the proposal beyond the specific aims. Students are encouraged to solicit critiques on writing and presentation from fellow students.

(6) Students submit a hard copy and pdf file of the completed proposal by the due date to the Graduate Staff Assistant, Carol Boring (cxb192@psu.edu). She will coordinate with the student and committee to select a time for the oral defense of the proposal.

**Written Proposal Format**

The format of the research proposal will consist of the following sections, with recommended page limitations given as follows:

**I. Title Page** (see attached sample)

(a) Provide a succinct title for the proposal and the estimated starting and ending dates of the research.
(b) Name of the student.
(c) Name of dissertation adviser.
II. Summary Description of the Proposal

State the proposal's broad, long-term objectives and specific aims, making reference to the health or biology relatedness of the project. Describe concisely the research design and methods for achieving these goals. Avoid summaries of past accomplishments and the use of the first person. This abstract is meant to serve as a succinct and accurate description of the proposed work when separated from the proposal. Do not exceed the ½ page limit. Make page separate from title page and specific aims.

III. Specific Aims

List the broad long-term objectives and describe concisely and realistically what the specific research described in this proposal is intended to accomplish and any hypotheses that are to be tested. The long term aims may be summarized in a brief paragraph, followed by a list of two to four specific aims, each described in one or two sentences and kept to exactly one page. A figure on the specific aims page is allowed.

IV. Background and Significance

Briefly sketch the background leading to the present proposal, critically evaluate existing knowledge, and specifically identify the gaps which the project is intended to fill. State concisely the importance of the research described in this proposal by relating the specific aims to the broad long-term objectives and to health relevance. Two to three pages are recommended.

V. Preliminary Studies

Provide a summary description of preliminary studies found in the literature that provide the foundation for this proposal. Limit this section to a maximum of two to four pages.

VI. Research Design and Methods

Describe the research design and the procedures to be used to accomplish the specific aims of the project. Include the means by which the data will be collected, analyzed, and interpreted. Describe any new methodology and its advantage over existing methodologies. Discuss the potential difficulties and limitations of the proposed procedures and alternative approaches to achieve the aims. Provide a tentative sequence and time table for the investigation. Limit this section to a maximum of five to seven pages including all figures and tables.

VII. Bibliography

Provide a list of all references cited in the above sections that is in the format of articles written for major journals, such as the American Journal of Physiology or Journal of Biomechanics. Citations within the text may be made by either author (year) or by number. Provide the full citation in the bibliography, i.e. authors, title, journal, volume, page numbers and year. The student is expected to have critically read and understood the publications that provide the foundation of their proposal. Limit the number of references to a maximum of 40. The use of EndNote, Mendeley, or equivalent bibliographic software is strongly recommended.

All text should be typed single space and a minimum font size of 11 points should be used. A minimum 3/4 inch margin should be maintained on the top, bottom and sides of each page. Each page should be
numbered at the bottom.

**Oral Defense and Evaluation**

A two hour oral exam will be scheduled approximately one week following submission of the written proposal. During the oral exam, the student will present a 10 minute (maximum) overview of the proposal which will be followed by a period of questions and answers from the committee. Students should bring a hard copy of the proposal to the exam and are allowed written notes, but PowerPoint slides and overheads are prohibited – this is a “chalk talk.” Student will have use of the blackboard and the committee will have the written proposal, so the student can refer the committee to specific figures in the proposal. The committee will be charged with the task of evaluating the proposal and any questionable areas established by the student’s academic record. Students are expected to be particularly well grounded in technical areas closely related to the proposal.

The committee will grade the written and oral components in five areas using a five point scale with 1.0 being the best and 5.0 being the lowest. The five areas are as follows:

a. Quality of technical content of proposal and presentation  
b. Creativity and innovation in proposed experiments/design  
c. Quality of writing (grammar, clarity, sentence structure)  
d. Quality of oral presentation  
e. Ability to respond to questions and logically reason through problems

Scores from all committee members are averaged and in each category a score of 3.0 or better is defined as passing. To receive a passing grade for the candidacy exam, a student must receive a score of 3.0 or better on at least 4 of these 5 categories. If a student’s performance is unsatisfactory in two areas, they may take the exam once again during the following year and must then pass all five areas. Unsatisfactory performance in three or more areas will constitute failure of the candidacy exam and the student may not continue with the Ph.D. In this case, the student may obtain a Master’s degree upon completion of the requirements for that degree.

Students will be notified of the outcome of their exam within one week of the oral defense. Upon passing the candidacy exam, the student is classified as a Ph.D. Candidate in Bioengineering.

**English Proficiency Exam**

A candidate for the degree of Doctor of Philosophy is required to demonstrate a high level of competence in use of the English language, including reading, writing, and speaking, as part of the language and communication requirements for the Ph.D. (Note: this is separate from teaching assistant testing.)

To fulfill this requirement, the English proficiency of each doctoral student in Bioengineering will be evaluated based upon the written and oral portions of the candidacy exam. Verbal communication skills will be assessed during the oral portion of the candidacy exam. The candidate’s communication skills will be examined by the Candidacy Committee and a judgment of acceptability will be made or a recommendation for remedial course work in English will be made.

Competence in English (see p. 32) must be formally certified by all graduate programs before the
doctoral **comprehensive exam** is scheduled. (International students should note that passage of the minimal TOEFL requirement does not demonstrate the level of competence expected of a Ph.D. from Penn State.) It is the responsibility of the student to meet these requirements by taking whatever remedial steps are necessary to demonstrate an acceptable command of the English language.
Application for PhD Candidacy Examination

Name: ________________________________________________________________

Title of Proposed Research Proposal:
__________________________________________________________

Thesis Adviser: _________________________________________________

Provide a brief (250 words or less) description of the proposed project:

Applicant’s Signature______________________________________________

Research Adviser’s Signature ______________________________Date:__________________
SAMPLE TITLE PAGE FOR CANDIDACY AND COMPREHENSIVE EXAMS

Penn State Bioengineering Program
Ph.D. Candidacy Exam

Research Proposal

A New Method of Determining Molecular Dimensions

Proposed Start Date: September 1, 1904
Proposed Completion Date: April 1, 1905

Submitted by: Albert A. Einstein
Adviser: Professor I. Dunno
Doctoral Committee

In preparation for the comprehensive exam, students, together with their adviser, must form a doctoral committee. The doctoral committee consists of a minimum of four members of the Graduate Faculty including the adviser, who serves as the chair. The adviser must be a member of the Intercollege Graduate Degree Program (IGDP) in Bioengineering. At least three committee members must be members of the IGDP in Bioengineering. The committee must also include an “Outside Field Member” who is not a member of the IGDP in Bioengineering. Finally, at least one member of the doctoral committee must have his/her primary appointment outside the administrative unit in which the adviser’s primary appointment is held. The Graduate School will appoint the committee and notify all persons.

Please note if a committee member changes any time before the final exam is taken, it is the responsibility of the graduate student to notify the graduate staff assistant as new paperwork needs to be completed and processed by the Graduate School.
Comprehensive Exam

The next step toward the Ph.D. degree is the comprehensive exam, which is given when the candidate has completed all required course work. The comprehensive exam is generally given between the end of the second year and the end of the third year of the Ph.D. program and must take place at least one year prior to the PhD dissertation defense (final exam). The exam is intended to evaluate the candidate’s mastery of the major (and if appropriate, minor) field. The Bioengineering Program uses the comprehensive exam as an opportunity to evaluate the Ph.D. student’s dissertation proposal. In preparation for the exam, the student must form a doctoral committee, schedule an exam time, and prepare a detailed Ph.D. dissertation proposal according to departmental guidelines (page 22).

A candidate for the Ph.D. must have satisfied the English competence and the communication requirement before taking the comprehensive exam. This requirement is fulfilled during the oral candidacy exam.

All candidates are required to have a minimum grade-point average of 3.00 for work done at the University at the time the comprehensive exam is given, and may not have deferred or missing grades.

The student must be registered for the semester in which the comprehensive exam is taken. Student can be registered for BIOE 600 to satisfy requirement.

The student must have the committee signatory page signed and approved by the Graduate School before comprehensive exam can be given.

The exam is scheduled and announced officially by the Office of Graduate Enrollment Services upon recommendation of the Bioengineering Program Chair. **Three weeks’ notice is required by the Office of Graduate Enrollment Services for scheduling this exam.** The exam is given and evaluated by the entire doctoral committee. A favorable vote of at least two-thirds of the members of the committee is required for passing. In case of failure, it is the responsibility of the doctoral committee to determine whether the candidate may take another exam. The results are reported to the Office of Graduate Enrollment Services.

The dissertation adviser, as well as the chair of the doctoral committee (can be the same person), along with additional members of the committee to total a minimum of three (3), must by physically present at the comprehensive exam. The graduate student must be physically present at the exam. (Thus for a five-person committee, two could participate via distance.) No more than one member may participate via telephone; a second member could participate via PicTel or other video conferencing modality. The exam request and a request for exceptions must be submitted to the director of Graduate Enrollment Services for approval at least two weeks prior to the date of the exam. Special arrangements, i.e., requirements for meeting participation via distance, should be communicated to the student and the doctoral committee members well in advance of the exam.

When a period of more than six years has elapsed between the passing of the comprehensive exam and the completion of the program, the student is required to pass a second comprehensive exam before the final oral exam will be scheduled.
Format of the Comprehensive Exam

As part of the comprehensive exam, Ph.D. candidates are required to submit a written dissertation proposal to their doctoral committee. Hard copies and pdf versions of the written proposal must be submitted to the Graduate Staff Assistant, Carol Boring and all committee members at least one week prior to the exam. Failure to meet this deadline will result in postponement of the exam. The written version should be read by the primary adviser and revised by the student prior to submitting it to the doctoral committee.

The oral component of the comprehensive exam is a two hour closed-door session in which the candidate prepares a 30 minute PowerPoint presentation (roughly 25 slides) based on their work to date and content of their proposal. The committee will ask questions and evaluate the student’s mastery of coursework, broad knowledge of their field, and specific details of their proposal.

The objective of the dissertation proposal is three-fold. First, the proposal itself serves to outline the course of the student's proposed research program with sufficient detail so that the student's adviser and members of the doctoral committee may provide useful guidance and input into design and execution of the proposed research plan. Secondly, the act of writing the proposal enables the student to map out a clear course of research activities that are logical and methodical. Third, writing the proposal serves as a training exercise that will be of use to the student in the preparation of future applications for research funding.

Format of the Ph.D. Dissertation Proposal

The format of the proposal will be similar in style to that required of established investigators applying for NIH funding, and will consist of the following sections, as outlined below. Examples of NIH proposals can be found online at: http://www.niaid.nih.gov/researchfunding/grant/pages/appsamples.aspx. The proposal should be typed double space on one-sided 8-1/2 x 11 paper, and figures may be either pasted in or printed directly using computer artwork programs. The page limitations given below represent an extreme upper limit. The specific size of each section may vary according to the type of research being conducted and the length of time devoted to preliminary studies prior to submission of the dissertation proposal.

1. **Title Page** (see attached sample)
   a. Provide a succinct title for the proposal and the estimated starting and ending dates of the research.
   b. Name of the student.
   c. Name of dissertation adviser.
   d. Names of dissertation research committee members.

2. **Summary Description of the Proposal** (400 words maximum)
   State the proposal's broad, long-term objectives and specific aims, making reference to the health relatedness of the project. Describe concisely the research design and methods for achieving these goals. Avoid summaries of past accomplishments and the use of the first person. This abstract is meant to serve as a succinct and accurate description of the proposed work when separated from the proposal. Do not exceed the 400 word limit.
3. **Specific Aims.**

List the broad long-term objectives and describe concisely and realistically what the specific research described in this proposal is intended to accomplish and any hypotheses to be tested. A maximum of two pages is recommended.

4. **Background and Significance**

Briefly sketch the background to the present proposal, critically evaluate existing knowledge and specifically identify the gaps that the project is intended to fill. State concisely the importance of the research described in this proposal by relating the specific aims to the broad long-term objectives and to health relevance. Four to six pages are recommended.

5. **Preliminary Studies**

Provide a summary description of preliminary studies performed by the candidate leading to this proposal. For students who have performed M.S. thesis research that has led to this proposal, provide a synopsis of these studies. Describe related research studies that have been done subsequent to the completion of the M.S. degree or following initial entry into the Ph.D. program. Limit this section to a maximum of 12 to 18 pages.

6. **Research Design and Methods**

Describe the research design and the procedures to be used to accomplish the specific aims of the project. Include the means by which the data will be collected, analyzed, and interpreted. Describe any new methodology and its advantage over existing methodologies. Discuss the potential difficulties and limitations of the proposed procedures and alternative approaches to achieve the aims. Provide a tentative sequence or timetable for the investigation. Limit this section to a maximum of 40 pages including all figures and tables.

7. **Bibliography**

Provide a list of all references cited in the above section that is in the format of articles written for major journals, such as the American Journal of Physiology or Journal of Biomechanics. Citations within the text may be made by either author (year) or by number. Provide the full citation in the bibliography, i.e. authors, title, journal, volume, page numbers and year. The number of references should be limited to a maximum of 200. The use of EndNote, Mendeley, or equivalent bibliographic software is strongly recommended.

**Approvals**

The dissertation proposal must be approved by the dissertation adviser and all members of the student’s doctoral committee. In addition, program approval by the Bioengineering Program Chair is also required. The Bioengineering Program Chair will review the proposal to ensure conformity to these guidelines and Graduate School regulations, and to ensure that adequate facilities and Program commitments are available to facilitate completion of the proposed studies.
Final Dissertation Defense

The doctoral candidate who has satisfied all other requirements for the degree will be scheduled by the Office of Graduate Enrollment Services, on the recommendation of the Bioengineering Program Chairs, to take a final exam. Three weeks’ notice is required by the Office of Graduate Enrollment Services for scheduling this exam. According to Bioengineering Program policy, the final oral exam may not be scheduled until at least one year after the comprehensive exam was passed. **It is the responsibility of the doctoral candidate to provide a copy of the dissertation to each member of the doctoral committee and Program Chair at least two weeks before the date of the scheduled exam.** Failure to meet this deadline will necessitate rescheduling of the final exam.

The candidate must be continuously registered and maintain their student status until passing the final oral exam and their dissertation is accepted by their doctoral committee. This may be satisfied by registering (fall and spring semesters) for course work; BIOE 601 and BIOE 610 are for Ph.D. dissertation preparation and are full-time, non-credit courses.

Both the dissertation adviser and the student are responsible for ensuring the completion of a draft of the dissertation and for adequate consultation with members of the doctoral committee well in advance of the oral exam. Major revisions to the dissertation should be completed before this exam. The dissertation should be in its final draft, with appropriate notes, bibliography, tables, etc., at the time of the oral exam; both the content and style should be correct and polished by the time the final draft of the dissertation is in the hands of the committee.

The final exam of the doctoral candidate is an oral exam administered and evaluated by the entire doctoral committee. It consists of an oral presentation of the dissertation by the candidate and a period of questions and responses. These will relate in large part to the dissertation, but may cover the candidate's entire program of study, because a major purpose of the exam is also to assess the general scholarly achievements of the candidate. The portion of the exam in which the dissertation is presented is open to the public. This public session is followed by a closed-door session of the candidate and the committee in which more detailed questions and specific concerns of committee members are addressed. Following this discussion, the candidate is excused from the room, the committee decides on pass or fail, and the candidate is then notified of their status.

The dissertation adviser, as well as the chair of the doctoral committee (can be the same person), along with additional members of the committee to total a minimum of three (3), must by physically present at the comprehensive exam. The graduate student must be physically present at the exam. No more than one member may participate via telephone; a second member could participate via PicTel or equivalent video conferencing modality. The exam request and a request for exceptions must be submitted to the director of Graduate Enrollment Services for approval at least two weeks prior to the date of the exam. Special arrangements, i.e., requirements for meeting participation via distance, should be communicated to the student and the doctoral committee members well in advance of the exam.

A favorable vote of at least two-thirds of the members of the committee is required for passing. The results of the exam are reported to the Office of Graduate Enrollment Services. If a candidate fails, it is the responsibility of the doctoral committee to determine whether another exam may be taken.

If a member of the committee needs to be changed, a new signatory pages needs to be signed and submitted to the Graduate School for approval. Please see graduate staff assistant for assistance.
Doctoral Dissertation Information

How to Submit a Doctoral Dissertation

- Become familiar with the format requirements by reading the Dissertation Guide carefully (http://www.gradsch.psu.edu/current/thesis.html).

- Activate the intent to graduate on eLion during the semester in which you plan to graduate. Go to http://www.gradsch.psu.edu/current/thesis.html for deadlines.

- Upload a draft of your dissertation for format review to the eTD Web site (http://www.etd.psu.edu) by the format review deadline. Corrections and detailed instructions will be returned to you by email within two weeks. (Note: the format review can be done either before or after the oral defense, as long as the deadline is met.)

- Make any changes required by your committee and Office of Theses and Dissertations. Receive approval from the committee in the form of signatures on the doctoral approval page.

- Review the dissertation one last time to be sure that no further changes are needed. It will not be possible to make corrections after final approval by the Office of Theses and Dissertations. Upload the final dissertation, as a pdf file, to the eTD Web site by the deadline.

- Submit the supporting materials to the Office of Theses and Dissertations (this may be done either before or after you upload your file). Supporting materials are: signed doctoral approval page, ProQuest/UMI Agreement, Survey of Earned Doctorates, and $95 fee (cash or check). All forms can be found at http://www.gradsch.psu.edu/current/thesis.html.

- Await notification of approval (if further changes are required, you will be notified).

- Provide one unbound copy to the department. Check with your adviser to see if he/she wants a bound copy and if so, you must work out the payment arrangements. If you would like personal copies, you can submit copies for binding with a check to cover the cost of binding and shipping to the bioengineering staff assistant in Room 206 Hallowell or you can take your copies to the Multimedia & Print Center on campus. (http://www.multimediaprint.psu.edu)
DOCTORAL APPROVAL PAGE

Name of Student _________________________________________  Penn State ID ________________
Email address(s)_________________________________________________________________________

I hereby certify that I have obtained the necessary permission for copyrighted material included in my dissertation and choose that the document be placed in the eTD archives with the following status:

___ 1. OPEN ACCESS — Allows free worldwide access to the entire work beginning immediately after degree conferral. Appropriate for the majority of dissertation submissions in immediately fulfilling the requirement for making the work available to the public.

___ 2. RESTRICTED (PENN STATE ONLY)* — Access restricted to individuals having a valid Penn State Access Account, for a period of two years. Allows restricted access of the entire work beginning immediately after degree conferral. At the end of the two-year period, the status will automatically change to Open Access. Intended for use by authors in cases where prior public release of the work may compromise its acceptance for publication.

___ 3. RESTRICTED FOR PATENT DEVELOPMENT — Restricts the entire work for a period of two years, for patent and/or proprietary purposes. At the end of the two-year period, the status will automatically change to Open Access. Selection of this option requires that an invention disclosure (ID) be filed with the Office of Technology Management (OTM) prior to submission of the final dissertation and confirmed by OTM and Office of Theses and Dissertations.

Confirmed____________________________

Signature of Student ___________________________  Date____________________

FACULTY APPROVAL

We accept and approve the dissertation of the student named above and agree to distribution as indicated.

Signature ___________________________  Date____________________
Print name here ____________________________________________________________________

Signature ___________________________  Date____________________
Print name here ____________________________________________________________________

Signature ___________________________  Date____________________
Print name here ____________________________________________________________________

Signature ___________________________  Date____________________
Print name here ____________________________________________________________________

Signature ___________________________  Date____________________
Print name here ____________________________________________________________________

Department Head or Chair of Graduate Program

Signature ___________________________  Date____________________
Print name here ____________________________________________________________________

*Requests for a two-year extension can be made by contacting the Office of Theses and Dissertations (gradthesis@psu.edu) 30 days prior to the expiration of the restriction.
Thesis Deadlines and Format Review

Every thesis and dissertation at Penn State must be reviewed and approved by the Thesis Office (a division of Graduate Enrollment Services). There are no exceptions.

Thesis deadlines (calendar) for each semester can be found on the Graduate School’s Website at: http://www.gradsch.psu.edu/calendar/gradcal.html.

It is the responsibility of the thesis author to be aware of and to meet deadlines for submission. Failure to meet the specified deadlines will result in the removal of your name from the graduation list. It is not necessary to submit the thesis for format review a second time if graduation is postponed to a later semester.

The length of time required for review of the thesis or dissertation by the Thesis Office varies according to the number of documents awaiting review at any given time. If you submit early in the semester, you will most likely get it back in less than a week. If you wait until the final deadline, it may take longer. In either case, you will be notified by e-mail when the review is completed.

Intent to Graduate

You must activate the intent to graduate on eLion during the semester in which you plan to graduate. This will put your name on the graduation list so that a diploma is printed for you. If you fail to meet the other deadlines (e.g., submission of the thesis for format review), your intent to graduate will be removed. It does not carry over to the next semester.

Final Submission, Approval, and Letter of Certification

When the final thesis is uploaded, it is examined once more to make certain that the required revisions have been made and all the pages are present. If everything is in order, the document will be approved and the author will be notified of the approval. The eTD will be available online immediately after the degree conferral date (unless restriction is requested). Without exception, changes cannot be made to the thesis or dissertation after approval by the Thesis Office, so it is important to carefully proofread the thesis before final submission.

If you require documentation stating that you have met the requirements for the degree before graduation, you may apply to Graduate Enrollment Services in 114 Kern Building (814-865-1795) for a Letter of Certification. You should apply for this letter at least two weeks before you need it. The letter will be provided only after approval of your final dissertation.
Example Timeline for Bioengineering M.S. and Ph.D. Degrees

Semester 1
- In August, set up academic advisory committee and define course plan for year 1
- Take two 3-credit courses
- Take 1 credit BIOE 591 (Bioengineering Ethics and Professional Development) and 1 credit BIOE 590 Colloquium
- Register for BIOE 600 research credits up to at least 12 total credits
- Take online Training in the Responsible Conduct of Research

Semester 2
- Take two 3-credit courses
- Take 1 credit BIOE 590 Colloquium
- Register for BIOE 600 research credits up to 12 total credits

End of Semester 2
- Present yearly update to advisory committee and plan courses for Year 2
- (Ph.D. Students) Take candidacy exam
- Carry out research during summer

Semester 3
- Take two 3-credit courses
- Take 1 credit BIOE 590 Colloquium
- Register for BIOE 600 research credits up to 12 total credits

Semester 4
- (Ph.D. Students) Take two 3-credit courses
- Take 1 credit BIOE 590 Colloquium
- Register for BIOE 600 research credits up to 12 total credits
- (Master’s Students) Write and defend Master’s thesis (can push to summer)

End of Semester 4
- Present yearly update to advisory committee
- (Ph.D. Students) Plan courses for year 3 with advisory committee
- Carry out research during summer

Year 3 (Ph.D. Students)
- Take any classes suggested by advisory committee
- Take 1 credit BIOE 590 Colloquium until passing comprehensive exam
- Form doctoral committee
- Take comprehensive exam
- Register for BIOE 600 research credits up to 12 total credits until passing comprehensive exam and register for BIOE 601 after.

Years 4 and 5 (Ph.D. Students)
- Carry out full-time research
- Meet with doctoral committee at least once per year
- Complete and defend dissertation
Bioengineering Upper Division and Graduate Courses:

The following courses are currently offered by the Bioengineering Program.

401 INTRODUCTION TO BIOENGINEERING RESEARCH AND DESIGN (3 cr.) Challenges and constraints of bioengineering research and design. Emphasis on immunoresponse, tissue mechanics, biological transport phenomena, and biomaterials.

402 BIOMEDICAL INSTRUMENTATION AND MEASUREMENTS (3 cr.) Biomedical measurements, including consideration of techniques, equipment, and safety. Prerequisite: MATH 250; 3 credits in electrical circuits.

403 BIOMEDICAL INSTRUMENTATION LABORATORY (1 cr.) Biomedical measurements laboratory, including measurement of biopotentials, experiments in medical imaging techniques, and use of cardiovascular and pulmonary system instrumentation. Prerequisite: BIOE 402.

409 BIOFLUID MECHANICS (3 cr.) The fundamental relations in fluid mechanics and their application to biofluids including steady/unsteady flows, diseased states, devices and biorheology.

410 BIOMEDICAL APPLICATIONS OF MICROFLUIDICS (3 cr.) Study of fluid mechanics at small length scales. Low Reynolds number flow, electrokinetic flows, bioseparations in microfluidic devices.

413 BIOENGINEERING TRANSPORT PHENOMENA (3 cr.) An integrated study of the fundamentals of mass transport processes with emphasis on the analysis of physiological systems.

443 (MATSE 403) BIOMEDICAL MATERIALS (3 cr.) Describe properties of materials and composites and their in vivo interactions.

444 (MATSE 404) SURFACES AND THE BIOLOGICAL RESPONSE TO MATERIALS (3 cr.) Focus is on special properties of surface as an important causative and mediating agent in the biological response to materials.

445 TISSUE ENGINEERING: CONCEPTS, CALCULATIONS AND APPLICATIONS (3 cr.) Introduction to interdisciplinary tissue engineering concepts, associated biochemical and biomechanical engineering calculations and cardiovascular, musculoskeletal and other tissue application examples.

497D POLYMERS IN BIOENGINEERING (3 cr.) A foundational course in biomedical polymer design, synthesis, characterization, and processing with applications such as devices, therapeutics, and regenerative medicine.

501 BIOENGINEERING TRANSPORT PHENOMENA (3 cr.) Application of the equations of mass, energy, and momentum conservation to physiological phenomena and to the design of artificial organs.

503 FLUID MECHANICS OF BIOENGINEERING SYSTEMS (3 cr.) Cardiovascular system and blood flow, non-Newtonian fluid description, vessel flows, unsteady flows and wave motion, wind-kessel theory, transmission line theory.

505 BIOENGINEERING MECHANICS (3 cr.) Application of the principles of continuum mechanics to characterization of the passive and active mechanical properties of soft and hard tissues and their constituent cells. Fundamentals of the description of stress and strain and advanced topics in visco-elasticity are considered to describe the normal and diseased state at the tissue, cellular and molecular level. Prerequisites: EMCH 210, ME 033 or equivalent.
506 **MEDICAL IMAGING** (3 cr.) Medical diagnostic imaging techniques, including generation and detection of ultrasound, X-ray, and nuclear radiation; instrumentation and biological effects. Prerequisite: PHYS 202.

508 (MATSE 508) **BIOMEDICAL MATERIALS** (3 cr.) Properties and methods of producing metallic, ceramic, and polymeric materials used for biomedical applications. Prerequisites: None

509 **MECHANOBIOLOGY** (3 cr) Explore the molecular bases of cell mechanics and the role of mechanics in cell biology.

510 **BIOMEMS** (3 cr.) Build basic foundations for understanding electrical, mechanical and chemical transducers in biomedical applications through learning BioMEMS fabrication, design and analysis.

512 **CELL AND BIOMOLECULAR ENGINEERING** (3 cr.) Graduate level cell and molecular biology course for engineers emphasizing molecular mechanisms.

513 **BIOENGINEERING LABORATORY TECHNIQUES** (3 cr.) Laboratory techniques in cell molecular biology, protein biochemistry and cell culture with an emphasis on engineering analysis and quantification.

514 **QUANTITATIVE MICROSCOPY** (3 cr.) Application of advanced microscopy to quantification of cellular and molecular function.

515 **CELL MECHANICS AND BIOPHYSICS** (3 cr.) Advanced topics and recent developments in cellular engineering; applications of engineering science to cell biology. Prerequisite: BIOE 505

517 (MATSE 517) **BIOMATERIALS SURFACE SCIENCE** (3 cr.) Special properties of surfaces as an important causative and mediating agent in the biological response to materials. Prerequisite: None.

519 **ARTIFICIAL ORGAN DESIGN** (3 cr.) Basic techniques and principles of a multidiscipline approach to artificial organs design. Prerequisites: None.

552 (EMCH 552, IE 552) **MECHANICS OF THE MUSCULOSKELETAL SYSTEM** (3 cr.) Structure and Biomechanics of bone, cartilage, and skeletal muscle; dynamics and control of musculoskeletal system models. Prerequisite: consent of program. Prerequisite or concurrent: BIOL 472

553 **ENG 553** **ENGINEERING OF HUMAN WORK** (3 cr.) Physics and physiology of humans at work; models of muscle strength; dynamic movements; neural control; physical work capacity; rest allocation. Prerequisite: BIOL 041 or 472.

576 **BIOENGINEERING OF THE CARDIOVASCULAR SYSTEM** (3 cr.) Experimental and analytical studies of network branching patterns, regional blood flow, rheology and mechanics of blood cells and vessels as they affect physiological function. Prerequisite: BIOL 472.

590 **BIOENGINEERING COLLOQUIUM** (1 cr.) Weekly series of seminars by speakers from outside and within Penn State University on new and developing research areas in Bioengineering, and presentations by registered students on their thesis research. All students are required to attend; M.S. degree students must register for four semesters and Ph.D. students must register every semester until comprehensive exam is passed.

591 **BIOENGINEERING ETHICS AND PROFESSIONAL DEVELOPMENT** (1 cr) Discussions focused on issues related to medical device development and marketing, responsible conduct of research, and meeting oversight requirements by Institutional Review Boards for human studies and IACUC oversight of animal experiments.
596 **INDIVIDUAL STUDIES** (1-9 cr.) Opportunity for advanced graduate students to study independently in consultation with a faculty adviser.

597 **SPECIAL TOPICS** (1-9cr) This designation is assigned to new or developing graduate courses covering specialized areas of interest in Bioengineering. Past offerings have focused on topics such as advanced studies of cardiovascular function, advanced topics in artificial organ design and cellular biomechanics.

597F **APPLICATIONS OF SOFT LITHOGRAPHY IN BIONANOTECHNOLOGY** (3 cr.) Soft lithography techniques and application in biological sciences with an emphasis on studies of mechanobiology, tissue engineering, and biochemical pathways.

597G **NANOBIO MATERIALS** (3 cr.) Foundational course in synthesis, fabrication and characterization of nanobiomaterials and their applications in biomedical engineering.
PENN STATE AMERICAN ENGLISH ORAL COMMUNICATIVE PROFICIENCY TESTING FOR PROSPECTIVE INTERNATIONAL TEACHING ASSISTANTS

International students who plan to be teaching assistants must take the Penn State American English Oral Communicative Proficiency Test. A copy of the various courses can be found at: http://aplng.la.psu.edu/academicPrograms/ita_whatIsAEOCPT.shtml

Students must register for the test by going to the above website or by calling the Linguistics and Applied Language Studies office at 814-865-7365, or go to Room 305 Sparks Building. A $60 fee is charged. Your department will need to send the budget information before you can take the test. Students can also find a sample copy of the test and a description of test results at the above link. Students with a temporary ID card or no ID card should bring their passport with the official admission letter from the Graduate School to the test.

For results of your test scores, please see the graduate staff assistant in your department.
GRADUATE PETITION

A student wishing to file a substitution request to the program requirements must complete Part A of this form in consultation with your adviser. Adviser signs part B. Then give the form to the Graduate Staff Assistant for Graduate Officer and Program Chair signatures.

A. Name:_________________________  PSU ID____________________
   Email_________________________  Major ____________________
   Class you want to substitute: __________________________________________
   What class do you plan to replace it with___________________________________
   ATTACH A COPY OF THE COURSE SYLLABUS.
   Why do you think this is a viable substitution? ________________________________
   ________________________________________________________________________

B. I approve of this substitution.
   Adviser Name: ________________________ Date: _______________________
   Adviser Signature: _________________________________________________

C. Graduate Officer:____________________ Date: _______________________
   Graduate Officer Signature: ___________________________________________
   I approve of this substitution ___________ I DO NOT approve the substitution____________
   Comments:

D. Program Chair Name: ________________________ Date: _______________________
   Please check the appropriate box below and sign.
   I approve of this substitution____________ I DO NOT approve the substitution ___________
   Comments:

   Program Chair Signature: ________________________ Date: _______________________

BIOENGINEERING FACULTY AND THEIR RESEARCH

Mohammad Abidian,* Ph.D., assistant professor of bioengineering. Neural engineering and biomaterials.

James Adair, Ph.D., professor of material science and engineering, and bioengineering. Nanoscale materials and phenomena for biological, electronic, optical, and structural applications; property manipulation for designer particles and materials; colloid and interfacial chemistry; material synthesis and chemistry; powder and material characterization; and powder processing.

Reka Albert, Ph.D., professor of physics and biology. Computational systems biology, modeling of signal transduction networks

Harry R. Alcock, Ph.D., Evan Pugh Professor of chemistry. Application of chemical synthesis to polymer chemistry, materials science, and biomedicine; and the chemical synthesis of new materials to generate useful combinations of properties.

James G. Brasseur, Ph.D., professor of mechanical engineering and bioengineering. Biofluid mechanics, neuromuscular mechanics, turbulent flows, graphical imaging.


Paul Brown, Ph.D., professor of ceramic science and engineering. Low temperature formation of advanced ceramics and composites.

Peter J. Butler,* Ph.D., associate professor of bioengineering. Membrane biophysics, cell mechanotransduction, vascular physiology; use of quantitative light microscopy to investigate the molecular bases of vascular function.

Wen-Wu Cao, Ph.D., professor of mathematics and materials science. Computer modeling and design of composite transducers for medical ultrasonic imaging.

Brent A. Craven, Ph.D., research associate, Applied Research Laboratory. Computational fluid dynamics, fluid-structure interaction, multi-physics modeling, numerical methods, digital image processing, three-dimensional anatomical reconstruction.

Wayne R. Curtis, Ph.D., professor of chemical engineering and biotechnology. Biotechnology, plant biology pharmaceutical production using plants.

Melik C. Demirel, Ph.D., associate professor of engineering science & mechanics. Synthesis and fabrication of functional materials, Bioinspired Engineering, Biointerfaces, Multi-scale computing for biological systems.

Henry J. Donahue, Ph.D., professor of orthopaedics, rehabilitation, cellular and molecular physiology and bioengineering. Bone and cartilage cell biology, mechanotransduction, fluid flow, gap junctions, Ca²⁺ imaging, orthopedic biomaterials and cancer.

Cheng Dong,* Ph.D., distinguished professor of bioengineering, and engineering science and mechanics; department head and chair of the Intercollege Graduate Program in Bioengineering. Biomechanics, cellular mechanics, cell motility, cell deformation and cell adhesion in the microcirculation, computer modeling.

Patrick Drew, Ph.D., assistant professor of engineering science & mechanics and neurosurgery. Neurovascular coupling, vascular development, neurophysiology, neural engineering.

Qi Deng, Ph.D., Verne M. Willaman Professor of Mathematics. Applied mathematics, scientific computing, geometric meshing, modeling and simulations of materials interfaces, membranes and cell mechanics.


Mary I. Frecker, Ph.D., professor of mechanical engineering and bioengineering. Mechanical design, compliant mechanisms, design optimization, medical devices.

Andris Freivalds, Ph.D., professor of industrial engineering. Industrial ergonomics, cumulative trauma disorders, biomechanics, work physiology.

Bruce J. Gluckman, Ph.D., associate professor of engineering science & mechanics, neurosurgery and bioengineering. Dynamical and pattern forming systems.

Esther W. Gomez, Ph.D., assistant professor of chemical engineering and bioengineering. Biomechanics, fibrosis and caner, tissue engineering, biosensors.


William E. Higgins, Ph.D., distinguished professor of electrical engineering and bioengineering. 3-D/4-D medical imaging analysis and visualization and virtual endoscopy.

Kane M. High, M.D., associate professor of anesthesiology. Anesthesia management and respiratory assist devices.

Tony Jun Huang, Ph.D., associate professor of engineering science and mechanics. BioMems, biomanochemistry, microfluidics.

Christine Dolan Keating, Ph.D., professor of chemistry. Biological interfaces, experimental models for intracellular organization, biomolecular-nanoparticle conjugates, multiplexed biosensors.

Michael Krane, Ph.D., research associate, Applied Research Laboratory. Experimental studies in unsteady fluid mechanics: fluid-structure interaction, acoustics, speech sound production, sleep apnea, snoring, multiphase flows.

Robert Kunz, Ph.D., senior scientist and professor of aerospace engineering.

Applied Research Laboratory and professor of aerospace engineering. CFD algorithm/code development, biomedical engineering and biological system simulation, turbulence modeling and turbulence dispersion.

Gregory Lewis, Ph.D., assistant professor of Orthopaedics and Rehabilitation. Development and Testing of a Novel Simulation Technology for Fracture Treatment Education.

Herbert H. Lipowsky,* Ph.D., professor of bioengineering and science and mechanics. Pressure and flow relationships in the microcirculation, in vivo rheology of blood flow in sickle-cell disease and other hematological disorders.

Sheereen Majd,* Ph.D., assistant professor of bioengineering. Role of molecular processes within and across normal and diseased cellular functions.

Keefe Manning,* Ph.D., associate professor of bioengineering. Hemodynamics, pediatric heart defects, blood rheology and cardiovascular prosthetics.

Costas D. Maranas, Ph.D., Donald B. Broughton Professor of Chemical Engineering. Reconstruction, analysis and redesign of metabolic networks, computational protein design.

Richard S. Meyer, Ph.D., research associate. Applied Research Laboratory.

Thomas Neuberger, Ph.D., research associate in the Huck Institutes of the Life Sciences and assistant professor in bioengineering. Imaging techniques of MRI.

Joseph L. Rose, Ph.D., Paul Morrow Professor in engineering design and manufacturing. Development of ultrasound imaging and guided...
wave devices.

**Gerson Rosenberg**, Ph.D., Jane A. Fetter professor of surgery and bioengineering. Mechanical circulatory assistance, the electric artificial heart, artificial organs.

**Jeffrey Schiano**, Ph.D., associate professor of electrical engineering. Control systems and nuclear resonance sensors.

**Steven J. Schiff**, Ph.D., Brush chair professor of engineering; professor of neurosurgery and engineering science and mechanics. Understanding the physics of dynamical disease of the nervous system and developing smart prosthetics

**Neil A. Sharkey**, Ph.D., professor of kinesiology, orthopaedics and rehabilitation. Human biomechanics.

**Christopher A. Siedlecki**, Ph.D., professor of surgery and bioengineering. Cardiovascular biomaterials, structure/function, relationships of proteins and surfaces, protein and cellular interactions and implanted biomaterials, surface modification and characterization, scanning probe microscopy.

**Margaret Slattery**, Ph.D., assistant professor of bioengineering.

**Srinivas Tadigadapa**, Ph.D., professor of electrical engineering and bioengineering. Design, fabrication and characterization of microelectromechanical systems, integration of smart materials into MEMS devices, biological MEMS, inertial MEMS and RF MEMS devices.

**Akif Undar**, Ph.D., professor of pediatrics, surgery and bioengineering.

**Erwin A. Vogler**, Ph.D., professor of materials science and engineering and bioengineering. Surfaces and the biological response to materials, the mediating role of water, mechanisms of water wetting, and thin-film phenomena.

**Yong Wang**, Ph.D., associate professor of bioengineering. Using synthetic oligonucleotides and polymers to develop antibody-like nanomaterials, programmable protein delivery systems, and tissue-like nanostructured biomaterials.

**William Weiss**, Ph.D., professor of surgery and bioengineering. Implantable circulatory support devices, electromechanics, transcutaneous energy transmission.

**Qing X. Yang**, Ph.D., professor of radiology and bioengineering. Ultra-fast imaging, pulse sequence and k-space sampling method developments; fMRI; high field MRI/NMR (susceptibility effects, dielectric effects); RF coil design.


**John Yen**, Ph.D., professor of information, science and technology. Intelligent agents, artificial intelligence, soft computing.


**Sulin Zhang**, Ph.D., associate professor of engineering science & mechanics and bioengineering. Mechanics of nanostructured materials, small-scale contacts and nano-bio interfaces, cellular mechanics, biomechanics and multi-scale methods across different length and time scales.

**Nanyin Zhang**, Ph.D., associate professor of bioengineering. Medical Imaging

**Siyang Zheng**, Ph.D., assistant professor of bioengineering. Micro/nano technologies for biological and medical applications.

*Bioengineering Primary Faculty*
ELECTIVE COURSES

Coursework is divided into three categories: Bioengineering Courses, Life Science Electives, and Technical Electives. For technical electives, students can choose courses in engineering, math, physics, chemistry, or other departments. Bioengineering courses can also be used as technical electives. Life science electives are courses that focus on biology and physiology at the molecular, cellular, organ or organism level. Generally, Biology 472 (Human Physiology) is recommended for every student. Courses such as bioinformatics, analytical techniques, and similar technical courses that focus on analytical tools and do not focus on the biology do not count as Life Science Electives. Below is a list of courses that count as Life Science Electives. Students should explore course offerings in other departments and consult with other students and faculty to learn about the most up-to-date course offerings across campus. Each student’s advisory committee will be responsible for determining whether specific courses count toward life science or technical elective distributional requirements; the Graduate Curriculum Chair, Dr. Will Hancock will make final decisions on distributional requirements.

**BIOL 404 Cellular Mechanisms in Vertebrate Physiology** (3) This course considers cellular mechanisms governing physiological aspects of vertebrate cell signaling and their adaptation to particular organismal functions.

**BIOL 409 Biology of Aging** (3) Mechanisms of the aging process, with special reference to man. Unfavorable progressive changes in molecules, cells, systems, and organisms. Effective: Summer 1984 Prerequisite: 6 credits in biology

**BIOL 411 Medical Embryology** (3) Develops an understanding of human reproductive physiology, embryological processes, their time frames, and the development of major human body systems. The course emphasizes clinical correlations and the medical consequences of developmental abnormalities.

**BIOL 413 Cell Signaling and Regulation** (3) Introduction to the themes of cellular signaling and regulation through critical review of primary literature.

**BIOL 416 Biology of Cancer** (3) This course intends to illustrate biological basis of cancer development, and discusses aspects on prevention, detection, and treatment of cancer.

**BIOL 422 Advanced Genetics** (3) Chromosomal mechanism of heredity; cytoplasmic and polygenic inheritance, chemical genetics, genomics, and experimental evolution.

**BIOL 426 Developmental Neurobiology** (3) Overview of basic developmental processes as they apply to the central nervous system.

**BIOL 430 (B M B 430, ENT 430) Developmental Biology** (3) Molecular and genetic analyses of mechanisms involved in differentiation and determination in biological systems.

**BIOL 432 Developmental Genetics** (3) An advanced course in developmental biology, focusing on the use of genetics techniques to study fundamental questions of animal development.

**BIOL 443 Evo-devo: Evolution of Developmental Mechanisms** (3) How evolution of animals and plants can be traced to changes in the regulation and/or interactions of genes controlling development.

**BIOL 460 (ANTH 460) Human Genetics** (3) The human genome, its variation, origins, and relation to disease and other traits.

**BIOL 465 General Cytology** (3) Structure and function of organelles of plant and animal cells, mitosis, meiosis, cytological techniques.
**BIOL 469 (BB H 469) Neurobiology** (3) Comprehensive examination of neuroanatomy and physiology designed to integrate the principles of neurochemistry, neuroendocrinology, and molecular biology.

**BIOL 470 (BB H 470) Functional and Integrative Neurosciences** (3) Neurobiological function in motivated behaviors, motor and sensory functions, learning and memory development, sexual differentiation, and pathology.

**BIOL 471 Molecular Neurobiology/Cell Biology Laboratory** (3) Introduction to modern molecular and cellular methodologies. The course is designed to integrate the principles of molecular cell biology with neurochemistry and neuroendocrinology.

**BIOL 472 Mammalian Physiology** (3) Mechanisms concerned with normal animal function, with special emphasis on humans.

**BIOL 479 (AN SC 479) General Endocrinology** (3) Endocrine mechanisms regulating the morphogenesis, homeostasis, and functional integration of animals.

**BIOL 497A Biology of RNA** (3) This course will explore the biological functions that RNA plays in diverse organisms, including transcription, translation, virology, and RNA- interference.

**B M B 400 Molecular Biology of the Gene** (2-3) Biochemistry of genetic phenomena, including the structure, replication and dynamics of genes and chromosomes, their expression and regulation.

**B M B 401 General Biochemistry** (3) Principles of the structure and function of biological molecules, including carbohydrates, lipids, membranes, proteins, and enzymes. Students may not receive credit for both CHEM 476 and B M B 401.

**B M B 402 General Biochemistry** (3) Comprehensive survey of the pathways and regulation of intermediary metabolism.

**B M B 406 Molecular Biology** (3) A discussion of current aspects of cell molecular biology with a laboratory emphasizing current biotechnology techniques.

**B M B 432 (MICRB 432, VB SC 432) Advanced Immunology: Signaling in the Immune System** (3) The study of signaling pathways that regulate the immune response.

**MICRB 410 Principles of Immunology** (3) Theories of immunity; focuses on the basis for the acquired immune response at the organ, cell, and molecular levels.

**B M B 442 Laboratory in Proteins, Nucleic Acids, and Molecular Cloning** (3) Laboratory in enzyme purifications and assay techniques; nucleic acid isolation and characterization, including plasmid preparation.

**B M B 443W Laboratory in Protein Purification and Enzymology** (3) Laboratory in protein isolation methodology, enzyme kinetics, and physico-chemical properties of proteins.

**B M B 460 (MICRB 460) Cell Growth and Differentiation** (3) Mechanisms and regulation of protein trafficking, organelle biosynthesis, cell development, signaling and cell cycle control. Emphasizes experimental design and analysis.

**B M B 464 Molecular Medicine** (3) An exploration of the impact of advances in molecular biology on understanding disease mechanisms, medical diagnosis, and therapeutics.

**B M B 465 Protein Structure and Function** (3) A study of the relationship between structure and function of proteins; internet analysis to predict structure and function is included.
**B M B 474** Analytical Biochemistry (3) Physical/chemical theory and techniques that emphasize purification and characterization of biological macromolecules, including proteins, lipids and nucleic acids.

**B M B 480** (MICRB 480) Tumor Viruses and Oncogenes (3) Oncogenes, DNA and RNA tumor viruses, and relevant experimental techniques with emphasis on molecular basis of carcinogenesis and gene regulation.

**BIOTC 489** (V SC 489) Animal Cell Culture Methods (3) An overview of animal cell culture methodology and its practical application in bioprocess technology.

**VB SC 420** General Animal Pathology (3) Nature and mechanisms of the disease process including degenerations, growth disturbances, inflammation, host-parasite relationships and neoplasia.

**VB SC 448W** Current Topics in Immunology (3) Study of current approaches and questions driving research in immunology and infectious diseases.

**Graduate Level Courses**

**BMMB 501** Core Concepts in Biomolecular Science (5) Introduction to broaden one's understanding of biochemical and biophysical principles and the basic aspects of eukaryotic and prokaryotic cell biology.

**BMMB 541** Molecular Biology of Animal Development (3) The course emphasizes comparative molecular genetic analyses of developmental gene networks using vertebrate and Drosophila model systems.

**BMMB 551** (IBIOS 551) Genomics (3) Structure and function of genomes including use of some current web-based tools and resources for studies and research in genomics.

**BIOL 571** (PHSIO 571) Animal Physiology (3) Mammalian cardiovascular, respiratory, renal, and gastrointestinal systems.

**BIOL 572** (PHSIO 572) Animal Physiology (3) Mammalian nervous, endocrine, metabolic, and reproductive systems.

**VB SC 520** Pathobiology (3) The course deals with the mechanism of disease. Topics are: homeostasis, vascular injury, inflammation, neoplasia, genetic disorders, and biochemical toxicology.

**VB SC 534** Current Topics in Cancer Research (3) A discussion of current cancer research literature with the focus on primary research literature.

Note: Other Life Science courses not listed here can be used with approval of Dr. William Hancock, Chair of the Graduate Curriculum Committee.
Code of Conduct

The Penn State Intercollege Graduate Degree Program (IGDP) in Bioengineering has adopted the same Code of Conduct as The Graduate School. Please refer to the links below regarding the code policies.

http://www.gradsch.psu.edu/policies/student.html
**Graduate Advisory Committee Meeting Form**

Students fill out this form before committee meeting and hand out to members of advisory committee along with a one page research description (first year students exempt). Advisory committee meeting includes 10 minute presentation by student covering their educational and research background, their current research progress, the courses they have taken to date, and their proposed courses. Following the meeting, the student is responsible for finalizing this form based on the discussion and obtaining signatures from committee members, signifying their approval. Within one week of meeting, student must submit this completed form (both soft and hard copy) to Carol Boring along with an updated C.V., one page research description, and hard copy of powerpoint slides from meeting.

Name:  
ID#:  
Date of Meeting:  

Adviser:  
Degree (MS/PhD):  

Topic/Title of Thesis or Dissertation:  

Members of student advisory committee:

BIOE Entry Yr  
BS Major Yr  
MS Major Yr  

Relevant undergraduate courses taken (course title or content):  
(List upper level technical courses relevant to graduate work)

Relevant graduate courses taken at other institutions (course title or content):

Career Goals:  Industry  Academia  Both  

Current Field:

Define areas of foundational engineering/scientific knowledge that are important in your field, for your career goals and relate these areas to past and future coursework.

A. Knowledge areas well covered by courses you have taken to date

B. Knowledge areas that need to be strengthened through coursework

C. Knowledge areas that need to be strengthened by avenues other than coursework

Title of papers published, accepted, submitted, or in preparation to date:
Courses taken toward your degree to date:

Credit numbers are minimum requirements. Of the 18 credits of Bioengineering, Life Sciences and Technical Electives, at least 12 credits must be at 500-level, the other 6 Technical Elective credits for PhD must be at 500-level. Life Science courses are in biological science departments such as Bio, BMB and IBIOS; engineering, chemistry and related courses do not count for Life Science electives. Technical electives are engineering, math, chemistry, physics, etc.; Life Science courses do not count toward technical electives.

Bioengineering Courses (6 credits minimum):

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<th>Course Number</th>
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<th>Credits</th>
<th>Semester</th>
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Life Science Courses (6 credits minimum):

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<th>Course Title</th>
<th>Credits</th>
<th>Semester</th>
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Technical Elective Courses (6 credits for MS, 12 credits for PhD minimum):

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<th>Course Number</th>
<th>Course Title</th>
<th>Credits</th>
<th>Semester</th>
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</table>

Bioe 590 (take every semester until graduation for MS and until Comp passed for PhD):

Enter each semester taken:

Bioe 591 Ethics. Enter semester taken:

Proposed courses for next two semesters (Give course number, title, # of credits and category.)

Semester:

(List course number, title, # of credits and category.)

Semester:

Candidacy Exam date taken or proposed:

Comprehensive Exam date taken or proposed:

Other issue discussed at advisory committee meeting:
Signatures of Advisory Committee members:

____________________________________________________

____________________________________________________

____________________________________________________

Signature of Student:

____________________________________________________

Attachment: One page research description (first year students exempted).