

POLICIES AND PROCEDURES

for

GRADUATE STUDY

in the

Department of

Biological Engineering

Leading to Advanced Degrees

in

Biological Engineering



BIOLOGICAL
ENGINEERING



COLLEGE *of*
ENGINEERING

UtahStateUniversity

Logan, Utah

June, 2016

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INTRODUCTION

Welcome to the Biological Engineering (BE) Department at Utah State University! We hope that your stay with us will be both rewarding and enjoyable. The faculty and staff of the BE Department are committed to assisting you toward a successful completion of your degree at USU.

The USU Graduate Catalog, with which all graduate students should be thoroughly familiar, gives the rules and procedures of the USU School of Graduate Studies that must be followed to obtain your degree. The Graduate Catalog is contained within the USU General Catalog and can be purchased in the USU Bookstore. It can also be viewed online at the following web page: <http://www.usu.edu/ats/generalcatalog/>

This Policies and Procedures manual explains other requirements, rules, and procedures that are specific to the BE Department. This manual is a guide to Departmental academic requirements, expanding upon and clarifying various topics contained in the USU Graduate Catalog.

STUDENT RESPONSIBILITIES

Graduate students are expected to know the requirements and standards of their program and to assume full responsibility for meeting them. Particular attention should be given to deadline dates. Written rules will not be waived, nor an exception made, simply because a student pleads ignorance of the rule or requirement, or asserts that an adviser or the USU School of Graduate Studies did not inform the student. This means that the student should purchase a University Graduate Catalog (or consult on-line information through the USU web site) and read it carefully along with information provided in this BE manual.

GENERAL DEPARTMENT PROCEDURES

The Department of Biological Engineering offers a broad and flexible program to graduate students wishing to study for M.S. (Master of Science), or Ph.D. (Doctor of Philosophy) degrees at USU. The Biological Engineering degree tends to focus in the areas of biomedical and tissue engineering, bioprocess engineering, biofuels, metabolic engineering, synthetic biology, biosensors, food engineering, land-based waste management, bioremediation and other bioenvironmental engineering aspects, and related topics. A student with a non-engineering B.S. degree can qualify for an engineering graduate degree by taking additional undergraduate coursework needed to reach engineering equivalency (see the “Make-up Courses for Non-engineers” section on page 9 of this document) or passing a Fundamentals of Engineering (FE) Exam.

The M.S. degree includes coursework and the preparation of a thesis based upon original and significant research, culminating in the development of one or more draft technical papers that are of sufficient quality to be published in professional peer reviewed journals. The same applies to a Ph.D. degree in the BE Department, except that the coursework requirements are more

extensive, and a dissertation (instead of a thesis) is prepared, also based upon original and significant research. The level of effort needed to develop an acceptable Ph.D. dissertation is higher than that required to prepare an M.S. thesis.

By the end of the first semester (M.S. students), or the end of the second semester (Ph.D. students), the student must formally organize a graduate committee. Three members are needed for a M.S. committee and five members for a Ph.D. The student and major professor, in consultation with the Department Head, recommends the committee to the Dean of the School of Graduate Studies. It is the student's responsibility to contact potential committee members and to obtain their consent to serve on the graduate supervisory committee. Typically, one member of an M.S. graduate committee will be from outside (another Department at USU) the BE Department, or two outside members in the case of a Ph.D. committee. At least one member of a Ph.D. committee must be from outside the BE Department. Adjunct Faculty, including those who are not continuously present on campus, are also available to serve on graduate supervisory committees. Please check with the BE Department to obtain a list of Adjunct Faculty.

It is the responsibility of the student's graduate supervisory committee to approve the final Program of Study (POS), including any proposed transfer credit. The Program of Study must be completed by the start of the third semester for PhD students and by the start of the second semester for MS students. Any variation from the approved POS is done at the student's risk, and the BE Department is under no obligation to accept such work. In the case of a Ph.D. student, deviations from the approved Program of Study may jeopardize qualification for the doctoral tuition waiver policy at USU. Official changes in an agreed-upon POS must have the written approval of both the graduate committee and the USU School of Graduate Studies.

OTHER CONSIDERATIONS AND REQUIREMENTS

Academic Standards for Graduate Students

The BE Department strives to maintain high academic standards to assure the competence of its graduates. The grade point average (GPA) is one criterion of measurement and is monitored by the Department and the USU School of Graduate Studies. The courses listed on the "Program of Study" forms for M.S. and Ph.D. graduate degrees constitute the official study program for the student. All students are required to maintain an overall GPA of 3.00 or better for all courses listed on their official study program. Graduate students must also maintain at least an overall 3.00 GPA for ALL courses taken at Utah State University, including any extra courses of personal interest and required make-up courses. Make-up courses must be taken for a grade and cannot be taken for pass/fail (see page 9). If at any time a student's overall GPA for those courses listed on the official program of study falls below a 3.00, he/she will be placed on academic probation by the USU School of Graduate Studies for as long as the GPA is lower than 3.00. In any semester while the student is on probation, if the GPA for that semester falls below 3.00, the student may be suspended as a candidate for an advanced degree. No USU scholarship funding or tuition waiver will be available during suspension. Reinstatement to the degree program or a change from non-degree to degree seeking status will require a petition to the BE Department Head for approval.

Credit Requirements

Graduate degrees in Biological Engineering (BE) require 15 credits of core mandatory graduate BE coursework (see chart below). The balance of graduate courses (electives) are determined by the student, the major professor, and the student's graduate committee. Elective courses must follow the guidelines of the School of Graduate Studies for inclusion on a student's Program of Study and must be approved by the student's committee. Elective graduate courses can be chosen outside the BE department.

Biological Engineering Required Graduate Core Courses (15 credits)		
BENG 6810	Biochemical Engineering	3
BENG 6600	Downstream Processing	3
BENG 6630	Synthetic Biological Engineering	3
BENG 6860/7860	Research Orientation & Planning	2
BENG 6510/7510	Graduate Seminar	1
STAT 5200 OR CEE 6660	Design of Experiments Environmental and Hydrological Data Analysis and Experimentation	3 3
Possible Graduate Elective BE Courses:		
BENG 6910	Biosensors	3
BENG 6890	Tissue Engineering	3
BENG 6620	Metabolic Engineering	3
BENG 6850	Advanced Biomaterials	3
BENG 6930	Biological Engineering Special Topics	3
Other Related Coursework Credit		
Graduate student's committee may choose other related graduate coursework as needed to complete the student's program of study and support their research project.		
Dissertation/Thesis Research Credits per degree program		

Prerequisite Requirements

All BE graduate students must have either a BS in an Engineering field, have passed one of the Fundamentals of Engineering (FE) Exams or take the required make-up courses identified on page 9 of this document. The section of this policy entitled "Make-up Courses for Non-engineers" provides detailed information for these prerequisite requirements.

Information about waving courses

Core courses may be waived only if a class has been taken previously.

If you have previously taken a course or courses similar to one of our core courses at a different institution and wish to waive this course to take another course, the process is:

1. Approval from Major Advisor to waive course.
2. Approval by Instructor of course to waive course.
3. Approval by Department Graduate Committee to allow waiver of course.

The requirements for waiver consideration are:

- Syllabus of class taken provided. This will be reviewed against the syllabus of the core course. The two classes must be similar enough, to the satisfaction of the course instructor.
- Provide final grade from course. Student must have obtained a minimum grade of B for the class to qualify.
- Provide any pertinent supplemental materials.

PhD Comprehensive Exam & Preliminary Research Proposal Defense

In the third semester for PhD students, a Comprehensive Oral Exam & Preliminary Research Proposal Defense will be administered. The **Comprehensive Exam** portion may be waived if the following criteria are met: Satisfactory grades in all core courses – Minimum grade B+ (3.3 GPA).

PhD Preliminary Research Defense Proposal. The student must write a proposal and present it to their committee at least two weeks before the defense. This presentation will be advertised in the department and will be open to the public. After the presentation, the student's Ph.D. supervisory committee will ask questions and make recommendations.

Proposal requirements: Literature review, objectives, research plan, approach, preliminary data (if any). Length: 7-10 pages (not including references), single space, font 12, Arial or Times New Roman.

MS Preliminary Research Proposal

A proposal approved by the major advisor and distributed to the student's committee is required for the MS degree. However, a formal defense of the proposal will be at the discretion of the major advisor.

Extended Study beyond the M.S. Degree

For students who are finishing the M.S. thesis Plan A option and plan to continue their studies for a Ph.D. degree, the following policies apply:

1. Students will not be considered for admission to study for the Ph.D. degree until:
 - a. They have completed all of the coursework required for the M.S. thesis Plan A option degree;
 - b. They have completed and successfully “defended” their thesis; and,

- c. Their graduate supervisory committee has unanimously recommended that they be admitted to study for a Ph.D. degree.
2. Any courses taken beyond those required and approved for an M.S. degree are taken at the risk of being rejected for inclusion in a Ph.D. program of study. If the student is admitted to a Ph.D. program, the graduate committee will be under no obligation to accept any of the extra courses as part of the Ph.D. requirements. Also, only those extra courses (if any) not listed on the M.S. Application for Candidacy form can be considered for inclusion in a Ph.D. program. Exceptions to this policy must be submitted in writing by the Ph.D. committee chair and subsequently approved by the BE Department Head.

Continuous Graduate Registration

All graduate students, once they have begun their study program, must be enrolled in some form of continuous registration until they complete all requirements for the degree, including final submission of the report, thesis, or dissertation*. The following continuous registration alternatives are available:

1. Students may be enrolled and registered for a minimum of three hours of regular courses, seminars, independent study, or thesis research for every fall and spring semester until they complete all requirements for their degree. If the approved study program has been completed, they should register for at least one credit of BENG 6990 or BENG 7990, "Continuous Graduate Advisement." A minimum registration of three semester hours is required for students who are using university facilities and faculty time, including the final semester when the report, thesis, or dissertation is submitted in approved form to Utah State University.
2. Students who are not using campus facilities or are away from campus can pay the "Continuing Registration Fee" to the USU School of Graduate Studies to maintain their graduate status. They cannot be enrolled in any courses, nor make use of faculty time or any university facility. Use of the Continuing Registration Fee alternative requires the approval of the BE Department Head and the School of Graduate Studies. Continuous graduate registration is not required during the summer for students who are away from the University.
3. During the semester in which students defend their report, thesis, or dissertation, they must be registered for at least three credit hours. This requirement may be met by registering for the Continuing Graduate Advisement (BENG 6990 or 7990) or other appropriate courses. The Continuous Registration Fee does not fulfill this requirement. If final completion and clearance of a thesis or dissertation extend into a new semester, the student must register for at least one semester hour.

Notice and Reactivation

Students who do not maintain continuous registration in one of the ways listed above will be so notified by the School of Graduate Studies. If, after receiving this notice, the student still fails to register, the BE Department will be notified and the student's records placed in the "inactive" file. At the discretion of the BE Department, a student's file may be reactivated at a later time (but only before the time limit for the degree has expired). The student will be required to pay a reactivation fee of \$30, in addition to the University's approved registration fees.

The Continuous Graduate Registration requirement becomes effective the first academic semester a student enrolls in the USU School of Graduate Studies and applies to every semester thereafter until the student graduates*. In cases where appropriate graduate admission procedures are not followed, the School of Graduate Studies may retroactively apply the continuous registration requirement. The School of Graduate Studies should be contacted for policy information governing an extended leave of absence.

English Writing Proficiency

The USU School of Graduate Studies requires evidence of writing proficiency at the time the Program of Study forms are submitted. If a student cannot demonstrate proficiency in written English, the student must enroll and pass (with a grade of B or better) ENGL 3040, "Perspectives in Writing and Rhetoric." (3 credits, spring and fall Semesters).

REQUIREMENTS FOR MS AND PhD DEGREES

Requirements for Professional Licensing

It is possible for students who do not hold an accredited B.S. degree in engineering to become registered professional engineers in Utah. A student can do so by obtaining a Master of Science degree in engineering, which includes the undergraduate make-up courses identified previously, and then completing the Fundamentals of Engineering and Professional Engineering Examinations administered by the National Commission of Engineering Examiners. The make-up courses on page 9 are necessary to prepare for the exams.

Make-up Courses for Non-engineers

Students who do not have a formal B.S. degree in an accredited engineering discipline but who want a graduate engineering degree, either M.S. or Ph.D., must take, or must have taken previously, the make-up courses (see page 9), or their equivalents, in addition to the coursework for the BE graduate engineering degree. The make-up courses are intended to build an adequate foundation in basic fundamental and relevant engineering skills. The make-up courses also prepare the student to take the Fundamentals of Engineering (FE) examination. The Candidate for the M.S. or Ph.D. degree in Biological Engineering must have taken the make-up courses or their full equivalent prior to the award of the advanced degree in BE. Equivalent courses taken at other universities or through approved distance education or on-line formats can be substituted, upon approval, for those taught at USU (see page 9).

Undergraduate courses, taken for make-up purposes, cannot be taken using the Pass-Fail option (PF). An average grade of "B" or better is required over all make-up courses taken.

* Continuous graduate registration is not required during the summer.

Make-up Courses for Non-engineers

Course Number	Semester Credits	Course Title
MATH 2250a	4	Linear Algebra and Differential Equations
CHEM 1210	4	Principles of Chemistry I
CHEM 1215	1	Principles of Chemistry I Lab
CHEM 2300	3	Principles of Organic Chemistry
CHEM 2315	1	Principles of Organic Chemistry Lab
ENGR 2010	3	Engineering Mechanics: Statics
ENGR 2140	3	Strength of Materials
ENGR 2210	3	Fundamentals of Electronics for Engineers
BENG 3500	3	Biological Fluid Mechanics
STAT 3000	3	Statistics for Scientists
BENG 3000b	3	Bioinstrumentation
BENG 2400	3	Thermodynamics
CEE 2870 or CS 1400 and CS 1405	3 3 + 1	Introduction to Programming Introduction to Programming and lab
BENG 2330	3	Properties of Biological Materials
BENG 3670	3	Transport Phenomena
CHEM 3700	3	Introductory Biochemistry
CHEM 3710	1	Introductory Biochemistry Lab

These make-up courses can be taken any time prior to graduation, but should be taken early in the program of study. Consult with your advisor to determine which courses might be prerequisite to a particular graduate course.

^a The complete mathematics requirement is the equivalent of two years of university calculus, in addition to USU prerequisites that include MATH 1210 (Calculus I) and MATH 1220 (Calculus II).

^b BENG 3000 can be taken for graduate credit by enrolling in BE 6930, Special Problems.

Thesis and Dissertation Format Options

A MS thesis and a PhD dissertation must be formatted according to a selected style guide, such as that published by the USU School of Graduate Studies or a professional journal. Furthermore, theses and dissertations can be either:

1. Traditional chapter format; or,
2. Multiple-paper format.

The traditional format is one in which the dissertation is presented as a series of chapters, often including an Introduction, Statement of Objectives, Literature Review, Experimental Design, Results, Summary and Conclusions, Recommendations, References, and Appendices. The multiple-paper format also has chapters, but the Literature Review, Experimental Design, and Results chapters are replaced by “chapters” which present properly-formatted technical papers which have been submitted (and possibly accepted) for publication to peer-reviewed professional

journals. For an M.S. thesis in multiple-paper format, at least one paper must be presented. For a Ph.D. dissertation format, at least two papers must be presented.

Graduate Program Requirements

Graduate Program	Coursework Credits	Research Credits	Total Credits
Post-MS PhD	24	12	36
Post-BS PhD	30	30	60
MS-A	24	6	30
MS-B	27	3	30

Master of Science Requirements

Concurrent B.S. and M.S.

A student in the BE undergraduate program must apply for a concurrent B.S. and M.S. degree program at the end of their junior year. An overall GPA of 3.2 or greater is required at the time of application. Up to six credit hours of senior-level elective courses can be taken (for the B.S. degree) toward meeting the requirements for the M.S. degree. More information on the concurrent B.S. and M.S. degree program can be obtained from the BE Department website.

Thesis Option

To obtain an M.S. degree in Biological Engineering under the Thesis Option, students must be Bachelor of Science graduates of an ABET (Accreditation Board for Engineering and Technology)-accredited engineering program in the U.S., or its equivalent in another country, or take the make-up coursework as listed above. Engineering make-up coursework will not be counted towards the degree since they are considered to be part of the normal courses required for a Bachelor of Science degree in engineering.

An approved, complete draft of one or more papers that are to be submitted for publication in an appropriate peer-reviewed technical journal, based on the student's research work, must be prepared before the student will be allowed to schedule the defense of the thesis with the graduate committee.

The minimum course requirement for the Master of Science degree is 30 hours of approved graduate credit in addition to any prescribed make-up or review courses. USU School of Graduate Studies policy limits graduate credit to 5000 level and above. However, six hours below the 5000 level can be counted for the M.S. degree if approved by the graduate committee. At least sixteen (16) credit hours of the coursework must be at or above the 6000 level.

Report Option (Plan B)

The Plan B option is designed for individuals interested in employments in a non-research organization. Students wishing to study for the Biological Engineering degree under the Report

Option must not be interested in pursuing a Ph.D. degree or in performing the research necessary for a thesis. The requirements for the degree are similar to those for the research option with the exception of a report instead of the thesis. Note that the same engineering B.S. or equivalent requirements noted under the M.S. thesis option apply. The seven thesis credits (BENG 6970) are substituted by a maximum of three hours of credit for a significant engineering report or design project, and seven or more hours of additional coursework.

The minimum course requirement for the M.S. Report is 30 hours of approved graduate credit. Of these, the BE Department allows a maximum of 3 hours of credit for the technical report, and a minimum of 27 credit hours of approved graduate coursework, in addition to any prescribed supplementary courses. USU School of Graduate Studies policy limits graduate credit to 5000 level and above. However, six hours below the 5000 level can be counted for the M.S. degree if approved by the graduate committee. At least sixteen (16) credits of the coursework must be at or above the 6000 level.

DOCTOR OF PHILOSOPHY (Ph.D.) REQUIREMENTS

Admission will be based on the student's prior academic records, and if the student is a graduate of USU, the recommendation of their graduate supervisory committee at the time of thesis defense. An approved, complete draft of two or more papers that are to be or have been submitted for publication in an appropriate peer-reviewed technical journal, based on the student's research work, must be prepared before the student will be allowed to schedule the defense of the dissertation with the graduate committee.

In addition to any prescribed review courses, the minimum requirements for a Ph.D. program include 60 credit hours of approved graduate courses beyond the B.S. degree, satisfactory completion of the comprehensive examination and proposal defense, and the preparation of a Ph.D. dissertation based on an original research project. Post-M.S. PhD students require 36 total credit hours, of which 24 credits are coursework and 12 are research credits. As an example of a typical Program of Study, the degree requirements (beyond the B.S. degree) can be met by taking courses in the following areas (please see the list of approved courses on page 12):

Engineering Design, Synthesis, and Systems	15 credits (usual)
Mathematics, Statistics, and or Numerical Analysis	6 credits (usual)
Related-Science Courses	6 credits (usual)
Research Orientation/Planning (BENG 7860)	2 credits (exact)
Graduate Seminar (BENG 7510).....	1 credit (exact)
Dissertation (BENG 7970).....	30 credits (max)
Total.....	60 credits (min)

Note: USU School of Graduate Studies policy limits graduate credit to 5000 level and above.

However, six hours below the 5000 level can be counted for the PhD degree if approved by the graduate committee. At least sixteen (16) credits of the coursework must be at or above the 6000 level.

APPROVED COURSES

The following list of approved courses is not intended to be exclusive. Selection and approval of these courses will be under the direction of the graduate committee. Other courses are offered at USU that may satisfy BE Department graduation requirements and are subject to the review and approval of the student's graduate committee.

Engineering Design, Synthesis, and Systems

The Department courses that satisfy Design, Synthesis, and System requirements are: BENG 6610 Food and Bioprocess Engineering; BENG 6680 Soil-based Waste Management; BENG 6810 Biochemical Engineering; BENG 6830 Management and Utilization of Biological Solids and Wastewater; BENG 6850 Biomaterials Engineering.

Two credits of BENG 6860 Research Orientation and Planning and One credit of BENG 6510/7510 Graduate Seminar are required for the Departmental seminar and count in this category. Graduate students are required to participate in BENG 6510/7510 each year they are enrolled in the graduate program, but will only sign up for the class one semester. Attendance will be monitored and students must attend 2/3 of the seminars to graduate.

Biology:

BIOL 5160 [Methods in Biotechnology: Cell Culture](#),

BIOL 5240 [Virology](#), and

BIOL 5260 [Methods in Biotechnology: Molecular Cloning](#);

Nutrition and Food Science:

NDFS 6020 [Meat Technology and Processing](#) and

NDFS 6030 [Dairy Technology and Processing](#);

Civil and Environmental Engineering:

CEE 6410 [Water Resource Systems Analysis](#),

6430 [Groundwater Engineering](#),

6450 [Hydrologic Modeling](#),

6470 [Sedimentation Engineering](#),

6480 [Groundwater Contamination: Modeling, Monitoring and Management](#),

6500 [Open Channel Hydraulics with an Emphasis on Gradually Varied Flow](#),

6520 [Applied Hydraulics](#), and

6550 [Hydraulics of Closed Conduits](#).

Related-Science Courses

Approved related science courses include those that support the study of biological engineering. Such courses may be found in the disciplines of Soil Science; Biometeorology; Biology; Geography, Range Sciences; Sociology; Economics; Civil and Environmental Engineering; Chemistry; Nutrition and Food Science; Microbiology; Public Health; Plant Science; Watershed Science and Physiology.

Approved Mathematics Courses

Approved mathematics courses include the following: Mathematics: 5000, 6000, or 7000 level mathematics courses; Statistics: 5000, 6000, or 7000 level statistics courses; and, Civil and Environmental Engineering: CEE 6410 [Water Resource Systems Analysis](#), CEE 6510 [Numerical Methods for Civil Engineers](#), CEE 6660 [Environmental and Hydrologic Data Analysis and Experimentation](#), and CEE 7520 [Mathematical Methods for Civil and Environmental Engineers](#).