

BME GRADUATE STUDENT HANDBOOK

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1. INTRODUCTION

1.1 Biomedical Engineering Graduate Program

The Department of Biomedical Engineering at the University of Utah, is an internationally renowned center of basic and applied interdisciplinary research. The Department offers a Master of Science (M.S.) and Doctor of Philosophy (Ph.D.) programs, as well as multiple dual-degree programs through the Graduate School at the University of Utah. These programs seek to prepare graduate students to function independently, competently and technically in a variety of settings including academic, research, technical, administrative, business management, legal, regulatory and investment career tracks. These goals are accomplished through formal didactic courses, seminars and journal clubs, laboratory research rotations, technical projects and dissertation research. Faculty and staff together seek to assist graduate students to complete these programs in a timely fashion.

1.2 Graduate Program Handbook

This handbook should serve as a guide to help graduate students, graduate advisors, supervisory committee members and other faculty and staff to understand the overall goals and requirements of the Department's graduate program. The Handbook is an important reference and provides information and resources to help students navigate the necessary steps in order to receive the training and experience integral to the degree programs. It also lists the administrative steps required to satisfy student requirements and move smoothly through these programs.

1.3 Biomedical Engineering Graduate Program Faculty and Staff

Department of Biomedical Engineering

Sorenson Molecular Biotechnology Building (SMBB)
36 South Wasatch Drive, Suite 3100, Salt Lake City, Utah 84112 Phone: 801.581.8528
Website: bioen.utah.edu

Dr. David Grainger, Chair, Department of Biomedical Engineering
Office: 3227 SMBB, Email: david.grainger@utah.edu, Phone: 801.587.9263

The Department Chair oversees all research, academic, service and administrative functions of the department. The chair is responsible for setting the strategic direction for the department and ensuring that resources are provided for its different department functions in serving the university mission.

Dr. Chuck Dorval, Director of Graduate Studies
Office: 4535 SMBB, Email: chuck.dorval@utah.edu, Phone: 801.587.7631

The Director of Graduate Studies oversees policies and procedures for all graduate degrees offered through the Department of Biomedical Engineering. The DGS is available to answer general questions about the graduate program and to provide recommendations regarding coursework. They also serve as the default research advisor for new students who have not yet established a research advisor.

Laura Olsen, Graduate Academic Advisor
Office: 3223 SMBB, Email: laura.l.olsen@utah.edu, Phone: 801.581.8559

The Graduate Academic Advisor assists students in all aspects relating to Biomedical Engineering graduate degrees, including applications, admissions, policies and procedures, graduation, tuition benefit and student health insurance. Students are expected to meet with the Graduate Academic Advisor regularly as they progress towards their degree to ensure that procedures and forms are properly completed and submitted.

TBD, B.S./M.S. Program Advisor
Office: TBD, Email: TBD, Phone: TBD

The B.S./M.S. Program Advisor assists undergraduate students in determining progress in the B.S. degree and necessary steps that must be completed in order for students to matriculate into the M.S. program.

Alexis Ulrich, Academic Programs Coordinator
Office: 3225 SMBB, Email: alexis.ulrich@utah.edu,

The Academic Program Coordinator assists the Graduate and Undergraduate Academic Advisors and serves as the Department liaison for the Graduate Student Advisory Committee. They also coordinate events, recruitment, community outreach and social media for the department.

Sheila Olson, Administrative Manager
Office: 3226 SMBB, Email: sheila.olson@utah.edu, Phone: 801.581.8953

The Administrative Manager works with faculty advisors to manage Graduate Student Research Assistant salaries, scholarships, and/or fellowships. All students should correspond regularly with the Administrative Manager and Graduate Academic Advisor concerning compensation, tuition benefits and eligibility.

1.4 Department of Biomedical Engineering Faculty

The University of Utah Department of Biomedical Engineering faculty are dispersed across the University campus in multiple facilities. Faculty have offices and laboratories throughout campus. Primary faculty offices are in SMBB, WEB, MEB and BPRB, while Career and Adjunct faculty may be located across main “lower” campus as well as the Health Sciences “upper” campus and Research Park, including the University Hospital, Huntsman Cancer Institute, Primary Children’s Hospital, Orthopedic Specialty Hospital, UCAIR, the School of Medicine and the College of Pharmacy. For current faculty and staff contact information, please see the faculty directories on our website.

1.5 Graduate Student Advisory Committee

The Biomedical Engineering Graduate Student Activities Committee (GSAC) is run by Biomedical Engineering graduate students to work as a liaison between students and the Department and to organize events to build the Biomedical Engineering community and support our students. The GSAC help to support our Department and the graduate student community by:

- Organizing the annual Utah Biomedical Engineering Conference (UBEC)
- Planning the prospective Biomedical Engineering graduate student weekend
- Planning student social events
- Volunteering for local science and engineering outreach activities

2. DEPARTMENT CHAIR PHILOSOPHY

The Department's M.S. and Ph.D. degree programs are designed and intended to be transient but intensive professional technical training experiences, best pursued and completed as directly and expediently as possible. Efficient student progression through various requirements and diverse opportunities offered by our graduate programs 1) ensures best use of student time and faculty resources, and 2) minimizes the "opportunity cost" of time away from the workplace. As such, our training program is neither a vocation nor a job. Each advanced degree from our department must be earned. Award of our graduate degree comes with new entitlements and privileges resulting from our formal recognition of new technical and workplace skills and Biomedical Engineering capabilities endowed to each of our graduates by virtue of their program accomplishments. Our Department's Graduate Handbook provides the road map to our graduate program requirements, expectations, best practices, and deadlines for student performance and progress. The Chair expects adherence to the prescriptive requirements of the graduate programs as described in the Handbook, and a direct, disciplined and motivated path to the student's future workplace as enabled by the program checkpoints, milestones and expectations.

The Utah graduate school experience is expected to be enriching, enabling and rigorous; our graduate students are expected to be productive, professional, focused and efficient. Financial support provided to our graduate students during graduate training is awarded as a stipend at the discretion of our faculty advisors, with specific technical objectives, deliverables and intellectual products anticipated and expected. Such support is a privilege for study; hence, student research productivity is an expected deliverable in return. It is not a wage since program participation is not formal employment; it is support for completion of the program requirements, a training experience and a productive student-mentor relationship that produces research results and progress: progress both in student capabilities relevant to a career, and in applications of biomedical principles to compelling world problems. This student-advisor relationship is best augmented by fulfilling the formal M.S. or Ph.D. didactic training components, the essential research requirements, and by regular critical review and input of the student's doctoral supervisory committee. Effective communication and technical dissemination are expected learnings. Teaching and mentoring are also a formal expectation of all students: capabilities to assist others in team-based approaches is a real-world asset. Professional service is also an important opportunity: outreach, service learning, and efforts beyond the campus program are essential to our discipline.

As the Department can only improve its performance and impact through the collective work and dedicated group efforts involving our students and faculty, consistent student participation in the wide variety of required and elective department activities is encouraged and expected of all students. Student leadership, initiative and visible contributions to Department progress and growth can take numerous forms. In addition to student research productivity, additional student-based efforts in teaching/curriculum improvement, inter-student and peer networking and morale-building exercises, seminar attendance, research support and grant writing, interfacing with various graduate and student groups, faculty committees and College leaders, and outreach services to our off-campus lay-person and on-campus undergraduate communities are some possible opportunities to assist the Department's continual quest for improved impact, visibility and international recognition.

We hope that this Biomedical Engineering Graduate Handbook provides all resources necessary to efficiently and effectively guide and expedite graduate student progression through our various graduate degree opportunities and expectations. We also hope that program training and milestones produce graduates highly qualified, confident and capable to improve the world around us in their diverse future careers.

David W. Grainger, Ph.D., Department Chair

3. DEPARTMENT MISSION STATEMENT

The mission of the Department of Biomedical Engineering is to advance human understanding, health, and quality of life through:

- 1) Internationally recognized research, discovery, and invention in the area of biomedical engineering
- 2) Education of world-class Ph.D. scientists and engineers for accomplishment in research, academics, medicine, and industry
- 3) Education of nationally recognized graduates for success and leadership in industry, and in preparation for future study in medicine, science and engineering
- 4) Transfer of scientific discoveries and biomedical technology to the private sector nationwide
- 5) Training of students throughout the College of Engineering in bio-based solutions to traditional engineering problems and in the application of their specialty to biological and biomedical science.

4. GRADAUTE PROGRAMS

4.1 Doctor of Philosophy (Ph.D.) Program

Ph.D. Degree Requirements

Ph.D. students must meet all requirements specified by the University of Utah Graduate School. In addition, students must complete the following requirements to be eligible for the Doctor of Philosophy (Ph.D.) in Biomedical Engineering.

Ph.D. Supervisory Committee

Supervisory committees are responsible for approving a graduate student's academic programs, preparing and judging student's qualifying examinations, approving student's dissertation subjects, reading and approving student's dissertations, and administering and judging student's final oral examination and dissertation defense. In addition, supervisory committees are responsible for arbitrating disputes, resolving conflicts, or difficult strategic programming decisions between the student and the advisor, determining student pace or progress in research and graduate programming, and directing the research and writing of student's dissertation, including its quality for submission to the Department Chair and the Graduate School.

Ph.D. supervisory committees are required to be formed within one year after entering the graduate program. In consultation with their research advisor, all students are responsible for contacting prospective committee members about their willingness and availability to serve as a member of their supervisory committee. Best practices include writing a short synopsis of the intended research project and motivation, and rationale for why the contributions of a specific faculty are deemed important to guide the student in such a project. Committee consensus should guide student coursework selection and resulting program of study approvals.

Ph.D. supervisory committees must consist of five faculty members (minimum). The majority of the supervisory committee, including the committee chair, must be tenure-line faculty in the Department of Biomedical Engineering. One member of the supervisory committee must be from another department, normally from another University of Utah department. The process of forming a supervisory committee is completed by student's filing the Request for Supervisory Committee form with the Department for approval by the Director of Graduate Studies.

All students are required to meet with their supervisory committee annually to evaluate and discuss their research progress, strategies, success, coursework advancement, and any issues, technical or otherwise. These meetings are to be documented by the student in the form of meeting minutes distributed to the committee members subsequent to the committee meeting. Additional Ph.D. Supervisory Committee information is available on The Graduate School's webpage.

Ph.D. Research

Ph.D. students must complete independent research and advance the state of knowledge in the field. Completion of the research requirement is demonstrated by writing and defending a PhD dissertation as described in the Dissertation section below.

TA Mentorship Requirement

Starting with the graduate students who entered the PhD program in 2011/12 academic year, every PhD student must fulfill the teaching mentorship requirement by completing 4 credit hours of BME 7880 TA Mentorship course by the end of their fourth year and prior to the expiration of their tuition benefits. The teaching interests and current TA needs in the department are highly variable and TA assignments and opportunities are therefore also highly variable. Mentorship assignments will be determined based on the department needs first, and student track specialization second. Should students not voluntarily select TA duties expediently, they can be assigned based on department need.

To earn TA Mentorship credit a student may do one of the following:

- Complete 2 semesters as Half TA (2 credits each semester) of BME 7880: TA Mentorship with an approved course average time commitment of 10 hours per week for the duration of each semester.

- Complete 1 semester as Full TA (4 credits) of BME 7880: TA Mentorship with approved course average time commitment of 20 hours each week for the duration of the semester.
- In rare cases, courses may require a ¼ TA, which would require registration for 1 credit of TA with an approved average time commitment of 5 hours per week for the semester.
- The TA requirement of 4 credits must be completed by the end of student's 4th year of Ph.D. graduate study or prior to the expiration of tuition benefit, whichever comes first. However, it may be completed prior to this time if a student volunteers or is requested to fill a TA course assignment.

Teaching Assistantship requirements also include:

- TAs are required to strictly abide by the regulations set forth in the Family Educational Rights and Privacy Act or FERPA. This federal law protects the privacy of educational records of students. Information regarding FERPA is available at www.registrar.utah.edu/privacy.php.
- TAs are required to attend a mandatory training provided by the College of Engineering within the first 2 weeks of Fall Semester. The Department will notify prospective TAs of the date, time and location.
- TAs are required to meet with their assigned course instructor(s) prior to the beginning of the semester to initiate organization and to identify the expectations of the TAs role and duties.
- TAs are required to attend all lectures of their assigned course(s) and be sufficiently familiar with the materials covered in both the class and the homework to tutor the content effectively to enrolled students.
- TAs are expected to contribute in a substantive professional way to the pedagogical needs of their assigned course(s). The instructor and the nature of the course determines these needs. For example, TAs should expect to undertake one or more of the following activities: 1) deliver one or more course didactic lectures (with the course instructor present), 2) lead problem-solving or discussion sessions prior to exams, 3) grade exams.
- The Teaching Assistantship requirement is for credit and is not eligible for consideration as a paid TA position until all four 7880 course credit hours have been completed. However, financial support will continue from the student's research advisor during 7880 assignment. Thereafter, additional TA financial support will be determined by the Department.
- TAs are required to be proficient in the English language in order to effectively interact with students in a leadership and pedagogical manner. To be eligible for the Tuition Benefit Program for teaching assistantships, the Graduate School requires all non-native English-speaking graduate students to be cleared by the International Teaching Assistant (ITA) Program prior to any teaching exposure. Therefore, clearance from the ITA Program is a compulsory requirement for all international students. This and additional information is available at www.gradschool.utah.edu/ita/.
- Unsatisfactory student TA performance, either paid or through the 7880 requirement will be subject to review and possible punitive responses including repeating the TA requirement.

TA workshops, as well as online teaching resources are available through the Center for Teaching and Learning Excellence or CTLE at the University of Utah.

Credit Hour Requirements

A Biomedical Engineering Ph.D. Program of Study typically includes 90-120 total credit hours beyond the baccalaureate level. Coursework should include at least 6 credit hours of advanced (7000 level) courses as determined by the student's supervisory committee. Student completion of significant, independent, peer-reviewed, original research is the primary requirement of the Ph.D. program and requires at least 60 credit hours of dedicated research (BME 7970). Students must also complete the graduate Biomedical Engineering core curriculum (17 credit hours of core courses or approved substitutes) and at least 13 credit hours of graduate level science and engineering courses for a minimum of 30 course credit hours beyond the baccalaureate level. These courses are to be selected in consultation with the student's Supervisory Committee, with electives concentrated around the student's anticipated research area.

The student's research advisor and/or supervisory committee may require students to take additional courses depending on the student's performance on the qualifying exam, academic background, knowledge in their area of research, and/or other factors. The minimum allowable grade for any course counted toward the requirements for a student's graduate degree in Biomedical Engineering is a B-. For additional information regarding the use of credit hours previously earned toward a current degree program, please see the "Graduate Program Transfer Credit" section to follow.

Programs of Study

Ph.D. students are required to submit both a Preliminary Program of Study and a Final Program of Study to the department when approved by their Supervisory Committees. The Preliminary Program of Study, used for planning purposes and in preparation for the PhD comprehensive exam, is due by the end of the student's second year and should be developed in consultation with the student's research advisor and supervisory committee as early as possible. The Final Program of Study lists all courses taken during the student's PhD training and is due to the department no later than one semester prior to the semester in which they defend their dissertation.

Ph.D. Preliminary Program of Study

The Ph.D. preliminary Program of Study lists courses that the student plans to complete as part of their Ph.D. program requirements. The research advisor and supervisory committee should be consulted before selecting specific courses to ensure compliance with required curriculum and relevance to the student's area of research. Students are required to submit their completed and approved Preliminary Program of Study form to the Department one semester prior to taking the written comprehensive exam. The preliminary program of study ensures the both the student and the supervisory committee agree on the student's program completion courses. If a student's preliminary coursework is deficient, their supervisory committee may require the completion of additional courses.

Ph.D. Final Program of Study

The Ph.D. final program of study is a list of all courses students have taken beyond the baccalaureate degree, and must also list all research credits (7970) that will be or are projected to be applied toward the Ph.D. degree. A Ph.D. final program of study typically includes 90-120 total credit hours beyond the baccalaureate level and must contain the following minimum requirements:

- 30 credit hours of coursework including:
 - At least 6 credits of advanced 7000 level courses. This requirement may be reduced at the discretion of the Supervisory Committee
 - At least 17 credits of Core Curriculum (or approved substitutes)
 - At least 13 credit hours of graduate level science and engineering elective courses; typically from the Specialized Graduate Track courses
- 60 credit hours of dedicated research: BME 7970 "Ph.D. Thesis Research"
- 4 credit hours of graded BME 7880 "TA Mentorship"

BME 7990: Continuous Registration does not count toward the fulfillment of the Ph.D. degree requirements and should not be listed on the program of study.

Up to 30 credit hours previously applied toward an M.S. degree in Biomedical Engineering can be included as part of the Ph.D. program of study and listed on the Program of Study Form as "0" credits applied to the Ph.D. itself. These prior courses may be considered by the Supervisory Committee to justify waiver of all or part of the course credit hour requirements described above, subject to specific approval by the Director of Graduate Studies and the student's Supervisory Committee.

Students are required to submit their final Ph.D. Program of Study form to the Department no later than one semester prior to the semester in which they will defend. After the program of study has received all necessary approvals, it is then entered into the student's CIS record and reviewed by the Graduate School.

Specialized Graduate Tracks

Biomedical Engineering is a multidisciplinary field that uses research tools and techniques from virtually all of the physical, life and biomedical sciences. The curriculum within the Department's areas of specialization, or tracks, is designed to accommodate a wide range of approaches. Our goal is to provide an educational framework that will encourage our BME graduate students to excel in their chosen area of specialization. These include:

- bioInnovate
- Biomaterials and Therapeutics
- Biomechanics
- Cardiac Electrophysiology and Biophysics
- Computational Systems and Synthetic Biomedical Engineering
- Imaging
- Neuroengineering

See the "Specialized Graduate Tracks" section of this handbook for more details.

Qualifying Exams

The Ph.D. qualifying exam in Biomedical Engineering consists of two different exams at two different times: 1) a written comprehensive exam in the student's area of specialization, and 2) a two-part original research proposal describing the student's specific Ph.D. research. The written comprehensive exam should be taken no later than the Fall of their third year; the research proposal no later than the end of the third year. Additional information of the Ph.D. qualifying exams can be found in the "Examinations" section of this handbook.

Ph.D. Written Comprehensive Qualifying Exam

The Ph.D. written comprehensive exam is administered by the Dept. of Biomedical Engineering each year within the first two weeks of the fall semester. Students should inform the Director of Graduate Studies of their intent to take the exam and submit a proposed Preliminary Program of Study at least one semester prior to the exam date. The preliminary program of study is a list of all courses that the student plans to complete as part of the requirements for the Ph.D. as approved by their supervisory committee.

The preliminary program of study must be approved by the graduate advisor and the supervisory committee. Students can choose to take the exam in any of the PhD program tracks. Please consult with the Director of Graduate Studies or research supervisory committee to select the most appropriate exam. Exams are prepared and graded by a committee of Biomedical Engineering faculty members with expertise in the exam area.

Students may contact the chairperson of their exam committee to discuss the format of the exam. The format of the exams may vary somewhat from committee to committee, but will generally consist of a set of in-depth questions from the field of specialization and will include comprehensive questions from the Biomedical Engineering core.

The written comprehensive exam will take 8 hours. Books and notes will not be allowed in the exam. The Director of Graduate Studies will inform the students of their exam outcomes. Students who fail will be given a second opportunity to pass the exam. The strengths and weaknesses of students that pass the exam will be noted by their exam committee in a written report that will be placed in the student's file. The student's supervisory committee will review this report before the oral qualifying exam and may direct their questions accordingly.

Ph.D. Research Proposal / Oral Qualifying Exam

The student's oral qualifying exam consists of a formal written and oral presentation of their proposed Ph.D. research. The written portion of the qualifying exam research proposal should follow the NIH R01 format, including all page limits, margins, formatting and with all technical sections as required for the specific research. These technical sections include the Project Summary / Abstract, Specific Aims, Research Plan, Protection of Human Subjects (if required), and Vertebrate Animal Section (if required). Adherence to the PhD time-lines expected: a failure to deliver Oral Qualifying Exam by the end of year 3 may result in a tuition benefit eligibility.

The complete written portion of the exam's research proposal must be provided to the supervisory committee at least two weeks prior to the student's scheduled oral presentation. An announcement and title/abstract of the proposal presentation must be publicly posted at least one week prior to the presentation. The public oral presentation is followed by questions from the audience. The supervisory committee then meets in a closed-door session to examine the student in the absence of their graduate research advisor.

The written proposal and oral proposal presentation are evaluated and voted upon separately. Based on the results of the votes, the committee will choose to a) pass the candidate, b) pass the candidate contingent upon the candidate successfully responding to issues with their proposal (either written, or oral, or both), or c) fail the candidate. Ph.D. candidates have two opportunities to pass the oral qualifying exam in accordance with prevailing policies from the Graduate School.

To pass the exam, the student must demonstrate adequate preparation to begin effective independent research: the student must be well-versed in the fundamentals, have cogent familiarity with the primary literature in the proposed area of research, and demonstrate an ability to design and effectively communicate a competent, sound scientific research plan.

In some cases, the committee may pass the student contingent upon successfully responding to issues raised during the oral qualifying exam. These issues can be focused on both the written and/or oral components of the exam. Contingencies can include proposal revisions, supplemental coursework, supplemental written reporting, new supporting data and/or additional oral presentations. Students are given two opportunities to pass this oral/written research proposal exam. A report of the written research proposal and oral exam outcome must be signed by the supervisory committee and delivered to the Department and then to the Graduate School.

Ph.D. Candidacy

A student becomes a Ph.D. candidate after passing the written comprehensive exam and successfully completing both parts of the research proposal, written and oral.

Seminar Presentation

Ph.D. students must present at least one oral podium presentation or seminar prior to applying for graduation and defending their dissertation.

Publications

The primary requirement of the PhD program is for students to demonstrate competency in independent research and advance the state of knowledge in biomedical engineering. To successfully complete this requirement, the Dissertation typically includes three or more peer reviewed publications written by the candidate that have (or will) appear in supervisory committee-approved journals. The dissertation will also include an introduction that outlines the motivation for research and the challenge in expert terms, with stated objectives and possibly an over-arching hypothesis, and a concluding chapter that provides a technical synopsis of accomplishment as well as an expert's recommendation for specific technical steps for important future work in the area of the dissertation. Supervisory committees should be consulted for their expectations regarding publication of research results.

Dissertation

Dissertations must embody original insights, motivations, and results of the Ph.D. candidate's independent creative scientific conduct and scholarly research. Above all, they must also provide clear evidence of the candidate's scientific maturity, unique expertise, innovation, and ability to perform independent research and contribute new knowledge.

Dissertations must show a mastery of relevant literature and be presented in a style approved by the Department. The Approved Dissertation Style Guide for the Department of Biomedical Engineering is registered with the thesis and dissertation editor, who approves dissertations in accordance with Department and Graduate School policy.

Preparation of the dissertation must adhere to University of Utah Graduate School requirements. If approved by the student's supervisory committee, chapters from student manuscripts "in press" (appropriately documented) or

published may be inserted into the dissertation “as is” (i.e., complete publisher’s galley proof or journal off-print) as a chapter, and with additional amendments and author supplements as desired.

Ph.D. candidates are required to submit copies of their dissertation to their supervisory committee chair and external reviewer (if applicable) at least three weeks prior to the dissertation defense. Additionally, they are required to submit a copy of their dissertation to their supervisory committee members, research advisor, and the Biomedical Engineering graduate academic advisor at least two weeks prior to the dissertation defense. Doctoral dissertations are expected to be made available to other scholars and the general public. Therefore, a copy of the Ph.D. candidate’s dissertation will be made available by the Department for public viewing.

Detailed policies and procedures are contained within “A Handbook for Theses and Dissertations”, published by The Graduate School and available on The Graduate School webpage. Additional information regarding dissertations is available on the Thesis Office webpage.

External Reviewer

The review of the Ph.D. dissertation by an external reviewer is not required, but optional, and can be encouraged by the mentor or supervisory committee. The Ph.D. candidate along with their supervisory committee should consider this option if deemed necessary. The external reviewer must hold an academic appointment at an institution outside the University of Utah and should submit a written evaluation of the dissertation to be read at the time of defense.

Dissertation Defense

The Ph.D. candidate must successfully defend his/her dissertation in a public forum in accordance with the rules of the Department of Biomedical Engineering and the Graduate School. The title, location, date, and time of the student’s defense must be publicly announced at least 2 weeks in advance of the event along with an abstract of the dissertation. The oral presentation is followed by general questions from the public audience in an open session. If relevant, the external review of the dissertation is presented near the end of the public session. If possible, the review should be delivered by the external reviewer or by an oral reading from the thesis advisor if the external reviewer is unable to attend the defense (also by video/teleconference). Following the public defense, the research supervisory committee further examines the candidate in a closed session (the external reviewer can be included in the closed session by supervisory committee invitation).

To successfully defend the dissertation, the candidate must effectively apply the scientific method, demonstrate the significance of his/her contributions to the field relative to the state of the field, and professionally communicate the results in both written and oral form. Following the defense, the supervisory committee and the external reviewer (if any) dismiss the candidate and meet privately to discuss the candidate’s work and defense performance. Votes to pass the candidate on both the dissertation and the oral defense are recorded by the committee alone; the external reviewer does not have a vote. The dissertation and oral defense are evaluated and voted upon separately. Based on the results of the votes, the committee will choose to a) pass the candidate, b) pass the candidate contingent upon the candidate successfully responding to issues with their defense (either written, or oral, or both), or c) fail the candidate. Ph.D. candidates have two opportunities to pass the dissertation defense in accordance with prevailing policies from the Graduate School. Changes and improvements to the dissertation, as recommended or required by the reviewer and/or the committee members, must be incorporated into the student’s oral defense or dissertation document prior to obtaining final dissertation reading approval from the committee, the supervisory chair and final approval from the department chair as necessary for submission to the Graduate School thesis editor.

University Thesis and Dissertation Regulations are available in “A Handbook for Theses and Dissertations” which can be downloaded from the Graduate School Thesis Office website.

4.2 Master of Science (M.S.) Program

M.S. Degree Requirements

To earn an M.S. degree, students must meet the requirements specified by the University of Utah Graduate School. In addition, students must complete the following requirements to be eligible for the Master of Science (M.S.) in Biomedical Engineering.

M.S. Supervisory Committee

Supervisory committees are responsible for approving a graduate student's academic programs, preparing and judging student's qualifying examinations, approving student's thesis subjects, reading and approving student's thesis, and administering and judging student's final oral examination or thesis defense. In addition, supervisory committees are responsible for arbitrating disputes, resolving conflicts, or difficult strategic programming decisions between the student and the advisor, determining student pace or progress in research/project and graduate programming, and directing the research and writing of student's thesis, including its quality for submission to the Department Chair and the Graduate School.

Within the first semester of admission to the M.S. program, students are required to form a supervisory committee consisting of at least three Department of Biomedical Engineering faculty members. The majority of the supervisory committee, including the committee chair, must be tenure-line faculty in the Department of Biomedical Engineering.

The process of forming a supervisory committee is completed by student's filing the Request for Supervisory Committee form with the Department for approval by the Director of Graduate Studies. Students are responsible for contacting prospective committee members about their willingness and availability to serve as a member of their supervisory committee. Best practices include writing a short synopsis of the intended research project and motivation, and rationale for why the contributions of a specific faculty are deemed important to guide the student in such a project. Non-thesis students should first contact their Specialized Graduate Track Advisor to determine an appropriate Committee Chair and members.

Students are required to meet with their supervisory committee annually to evaluate and discuss their research progress, strategies, success, coursework advancement, and any issues, technical or otherwise. These meetings are to be documented by the student in the form of meeting minutes distributed to the committee members subsequent to the committee meeting. Additional M.S. Supervisory Committee information is available on The Graduate School's webpage.

M.S. Credit Hour Requirements

M.S. in Biomedical Engineering students must successfully complete a minimum of 30 semester credit hours at the 5000 level or above. To maintain status in the program, students must register for a minimum of 3 credit hours per semester. However, a minimum of 9 credits is required for Tuition Benefit Program eligibility. A maximum of 9 semester credit hours may be taken as non-matriculated and a maximum of 6 credit hours or 2 courses (not to exceed 6 credit hours) may be transferred from another institution. Up to 6 credit hours may be petitioned undergraduate classes (5000 level or above). The minimum allowable grade for any course counted toward the requirements for an M.S. degree in Biomedical Engineering is a B-. However, a B grade or better is required for transfer or petitioned courses. For additional information regarding the use of credit hours previously earned toward a current degree program, please see the "Graduate Program Transfer Credit" section to follow.

M.S. Thesis, Course and Project Options

Thesis Option M.S.

The Thesis Option M.S. program requires 9 credit hours of thesis research (BME 6970) and submission of a Master of Science Thesis to the Graduate School in the required format. M.S. students will defend their thesis research in a public forum. The public defense is followed by an oral comprehensive examination administered by the supervisory committee.

MS students must effectively apply the scientific method, demonstrate the significance of their contribution to the field, and professionally communicate the results in both written and oral form. The thesis option M.S. candidate must successfully defend his/her thesis in a public forum in accordance with the rules of the Department of Biomedical Engineering and the Graduate School. The thesis title, location, date, and time of the defense must be publicly announced at least 2 weeks in advance of the event. The oral presentation is followed by general questions from the audience, then an oral comprehensive examination administered in closed session by the thesis committee.

To successfully defend the thesis, the candidate must effectively apply the scientific method, demonstrate the significance of his/her contributions to the field, and professionally communicate the results in both written and oral form. Following the defense, the supervisory committee meet in private to discuss the candidate's work and defense. The vote to pass the candidate is taken by the committee alone. Based on the results of the vote, the committee will choose to a) pass the candidate, b) pass the candidate contingent upon the candidate successfully responding to issues with their defense, or c) fail the candidate. M.S. candidates have two opportunities to pass the thesis defense. Changes and improvements to the thesis, recommended or required by the committee members, are incorporated into the document prior to obtaining final reading approval from the committee chair and the department chair for submission to the thesis editor.

University Thesis and Dissertation Regulations are available in "A Handbook for Theses and Dissertations" which can be downloaded from the Graduate School Thesis Office website.

Course Option M.S.

In lieu of a thesis, the Course Option M.S. program requires the successful completion of at least 9 credit hours of advanced coursework (6000 level or above) within a Biomedical Engineering track specialization. To demonstrate depth of knowledge within the field, the course option M.S. also requires students to pass an oral examination administered by the M.S. supervisory committee or the written portion of the Ph.D. qualifying examination within the student's track specialization.

Project Option M.S.

In lieu of a writing and defending a thesis, the Project Option M.S. program requires the successful completion of at least 9 credit hours of advanced coursework (6000 level or above) within a Biomedical Engineering track specialization. A project is selected by the student to serve as the basis for a scholarly body of work commensurate with their M.S. degree. The basis of the project can be from a class, laboratory or work and should be related to the student's field of study. To demonstrate depth of knowledge within the field, the Project Option M.S. also requires students to present their project to their supervisory committee and pass an oral exam administered by the M.S. supervisory committee. The presentation should demonstrate that the student can integrate the scope and necessary details from their technical training into a cogent, professional presentation. Following the presentation, the MS committee examines the candidate with questions in order to examine the breadth and depth of knowledge. The committee can use the candidate's presentation materials, spoken words and program of study as the basis for the examination questions. No public presentation is required.

M.S. Program of Study

The M.S program of study is a list of all courses taken beyond the baccalaureate degree, and must also list all research credits (6970, if appropriate) to be applied toward the M.S. degree (if applicable).

A Program of Study including courses focused within a well-defined area of specialization must be approved by the research supervisory committee, as well as the Biomedical Engineering Director of Graduate Studies. The student's advisor and supervisory committee should both be consulted before selecting specific courses to ensure compliance with required department curriculum and relevance to the student's area of specialization.

Thesis M.S. Option Programs of Study must contain:

- 21 credit hours of coursework (minimum) including:
 - At least 13 credits of Core Curriculum (or approved substitutes)

- At least 8 credit hours of graduate level science and engineering elective courses; typically from the Specialized Graduate Track courses
- 9 credit hours (minimum) of dedicated research: BME 6970 “M.S. Thesis Research”

Project and Course only M.S. Option Programs of Study must contain:

- 30 credit hours of coursework (minimum) including:
 - At least 9 credits of advanced (6000 level) courses within a track specialization.
 - At least 13 credits of Core Curriculum (or approved substitutes)
 - At least 17 credit hours of graduate level science and engineering elective courses; typically from the Specialized Graduate Track courses

Specialized Graduate Tracks

Biomedical Engineering is a multidisciplinary field that uses research tools and techniques from virtually all of the physical and life sciences. The curriculum within our areas of specialization, or tracks, is designed to accommodate a wide range of approaches. Our goal is to provide an educational framework that will encourage graduate students to excel in their chosen area of specialization.

- bioInnovate
- Biomaterials and Therapeutics
- Biomechanics
- Cardiac Electrophysiology and Biophysics
- Computational Systems and Synthetic Biomedical Engineering
- Imaging
- Neuroengineering

For additional information and course information for areas of specialization, see the "Specialized Graduate Tracks" section of this handbook.

5. DUAL DEGREE PROGRAMS

5.1 M.D./Ph.D. Program

The M.D./Ph.D. Program provides an outstanding education for future physician-scientists. Students develop clinical skills and engage in rigorous scientific training. Through our top medical program and exceptional graduate programs, students become well-prepared for careers as biomedical researchers and clinician scientists.

Admissions Criteria and Application

The M.D./Ph.D. Program admissions criteria are the same as the M.D. Program, but have a greater emphasis on research experience. Please refer to the M.D. Preparing for Medical School website for details about premedical coursework, Grade Point Average (GPA), and Medical College Admission Test (MCAT) score requirements.

Please also refer to the M.D./Ph.D. Program Website for full admission process details and policies. All initial M.D./Ph.D. Program applications must be submitted to the American Medical College Application Services (AMCAS) and are available to US citizens or permanent US residents only. We encourage applications from qualified students nationwide. Applicants will complete 2 additional essays for the M.D./Ph.D. Program application.

- MD-PhD essay
- Significant Research essay

GRE scores are waived in lieu of MCAT scores. Applicants must have MCAT scores of 500 or higher, GPA of 3.0 or higher, community/volunteer service, leadership, research, physician shadowing, patient exposure, etc. A competitive M.D./Ph.D. Program applicant should be well rounded in all of these areas, with a strong focus on research.

If admitted by the School of Medicine, an additional application for admission to the Biomedical Engineering Department PhD program must be submitted through the “Apply Yourself” electronic application system by April 1st of the year in which the Ph.D. is intended to begin. See the Department application process, materials, deadlines, fees, etc. on our website.

Curriculum

For M.D./Ph.D. Program students, the medical school curriculum satisfies the Life Science Fundamental (6 credit hours) and Scientific Presentations (5 credit hours) BME department core requirements as well as an additional 5 credit hours of Elective science courses. Thus, M.D./Ph.D. Program students must fulfill the Bioengineering Core requirement (6 credit hours) and 8 credit hours of Specialized Track courses, resulting in a minimum of 14 minimum credit hours of coursework plus 60 credit hours of PhD Thesis Research (BME 7970) required above the M.D. curriculum. Additionally, the “TA Mentorship” requirement (BME 7880) is optional for M.D./Ph.D. Program students.

The following program timeline is typical for M.D./Ph.D. Program students:

Summer 0	- Lab rotation with Biomedical Engineering faculty (optional but encouraged)
Academic Year 1	- Medical School Year 1
Summer 1	- Lab rotation with Biomedical Engineering faculty
Academic Year 2	- Medical School Year 2 - Select PhD research mentor, lab & project and submit “AY” application to the PhD Dept. - Complete STEP 1 exam and request Leave of Absence from MD program
Summer 2	- Work on PhD research
Academic Year 3	- Start PhD coursework* - Work on PhD research - Establish PhD Supervisory Committee and Submit Preliminary Program of Study**
Summer 3	- Work on PhD research - Prepare for PhD written qualifying exam

Academic Year 4	- Complete PhD qualifying exams: Written Exam (Fall) and Research Proposal (Spring)*** - Work on PhD Research - Finish PhD coursework and submit Final Program of Study
Summer 4	- Work on PhD Research - Present a Seminar or oral conference presentation
Academic Year 5	- Complete PhD research - Defend PhD dissertation (by the end of Spring 5)
Summer 5	- Complete PhD dissertation review/release process w/Thesis Office
Academic Year 6	- Medical School Year 3
Summer 6	- Optional Post-Doc work in mentor's lab
Academic Year 7	- Medical School Year 4 - Graduate with M.D. and Ph.D. degrees

*MD/ PhD students may participate in the Tuition Benefit Program (TBP) if they are paid from qualifying grants and meet the TBP eligibility requirements. The TBP program provides up to 25 credit hour tuition waiver per year: 11 credit hours for Fall and Spring semesters and 3 credit hours for Summer semester (if a qualified/grant funded RA). For more information about TBP see: <https://gradrchoolutah.edu/tbp/guidelines.php>

**By the end of Academic Year 3 each student is expected to form a 5-member PhD Supervisory Committee, with 3 BME tenure-line faculty members, 1 MD/ PhD Operations Committee faculty member and 1 outside faculty member. Additionally, they will select a Biomedical Engineering Specialized Graduate Track

***MD/PhD students may present their Research Proposal prior to taking the PhD Written exam if approved by their Supervisory Committee. However, it must be completed no later than the Spring semester of year 4.

5.2 M.S./M.B.A. Degree Program

This Dual Degree Program enables students to earn both a two-year Biomedical Engineering Master of Science degree, and a two-year Master of Business Administration (M.B.A.) degree in as little as 2.5 years.

In addition, this program combines students' applied interests and training in engineering with a comprehensive business exposure, providing them with professional flexibility in transitioning between the technical and commercial domains. Combining their training and experience, graduates are qualified to direct and/or manage the creation, transition, and improvement of new products, processes, and systems from the laboratory to the boardroom.

M.S./M.B.A. Degree Requirements

- To complete these degrees simultaneously, students are required to apply for, and be accepted to both the Biomedical Engineering M.S. and full-time M.B.A. programs.
- Students are required to successfully complete a minimum of 74 credit hours, 24 credit hours in Biomedical Engineering and 50 credit hours in Business Administration.
 - Biomedical Engineering: minimum of 6 credit hours of Life Science Fundamentals, 6 credit hours of Bioengineering Fundamentals, 1 credit hour of Scientific Presentation and 11 elective/track credit hours
 - Business: 38 "MBA Core" credit hours and 12 Business Elective credit hours (at 6000 level or above)
 - Combined Biomedical Engineering and Business: 6 credit hours of Capstone courses
- The Biomedical Engineering M.S. requirements for this program are the same as the traditional M.S. requirements listed in previous "M.S. Program" with the exception of the 6 credit hours of Capstone courses that are shared with the M.B.A. program and applied to both Programs of Study

M.S./M.B.A. Typical Course Load and Registration Requirement

To complete both programs within 2.5 years typically requires a course load of 16-18 credits hours each semester (Fall and Spring) as follows:

Year One:

Fall Semester = 18 credit hours (14.5 MBA core + .5 BME MS core + 3 Electives)

Spring Semester = 17 credit hours (13.5 MBA core + .5 BME MS core + 3 Electives)

Summer Semester = MBA Internship Strongly Recommended

Year Two:

Fall Semester = 16 credit hours (7 MBA core + 6 BME MS core + 3 Electives)

Spring Semester = 17.5 credit hours (2.5 MBA core + 6 BME MS core + 6 Capstone + 3 Electives)

Summer Semester = MBA Internship Strongly Recommended

Year Three (optional to complete requirements):

Fall Semester = 6 credit hours (6 BME MS Electives)

While the Graduate School enforces a maximum of 16 credit hours for most graduate students, the maximum of 18 credit hours per semester is allowed for M.S./M.B.A. dual degree students. Registration above 18 credit hours would require a petition to the Graduate School.

For additional information, please visit the David Eccles School of Business website.

5.3 B.S./M.S. BME Dual Degree Program

This dual degree program is designed to allow students to begin their M.S. studies while still enrolled as undergraduates; thereby, taking advantage of additional coursework successfully completed as an undergraduate in order to accelerate the completion of the M.S. in Biomedical Engineering degree. A standard M.S. in Biomedical Engineering degree typically requires 2 or more years of study beyond the B.S. degree while the B.S./M.S. program shortens that time, typically to a single year beyond the B.S. degree.

Students must meet the requirements specified by the Department of Biomedical Engineering and the University of Utah Graduate School. In addition, students must successfully complete the following requirements to be eligible for the Bachelor of Science (B.S.) in Biomedical Engineering and the Master of Science (M.S.) in Biomedical Engineering degrees.

B.S./M.S. Program Requirements

Students complete both their BS and MS degrees at the same time and must meet the following requirements.

- A minimum of 122 credit hours that meet the requirements of the Biomedical Engineering BS major
- A minimum of 30 credit hours that meet the requirements of the Biomedical Engineering MS degree
- A maximum of 12 Graduate level credit hours (of the required 30) may be completed while students are still in undergraduate status

Bachelor of Science in Biomedical Engineering Requirements

All requirements for the standard Bachelor of Science in Biomedical Engineering are listed in the Undergraduate Handbook. Students should reference the handbook that correlates with their “catalog year”, i.e., the academic year of their admission to major status.

Master of Science in Biomedical Engineering Requirements

The standard M.S. degree requirements are found in the “M.S. Degree Program” section of this handbook.

B.S./M.S. Application Eligibility and Procedures

To be eligible to apply, students must be U.S. citizens (or Permanent Residents), have full major status in the Biomedical Engineering B.S. program, have completed a minimum of 90 undergraduate credit hours by the end of the semester of application, not yet completed the Senior Thesis I course (BME 4991), and have a minimum 3.0 cumulative GPA.

For eligible students, two separate applications are required. The first is a Department application designed to allow students to join the program beginning their senior year, yet maintain full Undergraduate status and privileges (undergraduate financial aid, tuition rates, etc.). The second is a formal application to the University of Utah Graduate School for admission to “Graduate Status” to complete their MS year in the program.

Department Dual Degree Application Procedure:

Before applying to the B.S./M.S. program, students are encouraged to meet with the Department B.S./M.S. Program Advisor. In addition, for undergraduate students to be eligible to apply to the B.S./M.S. program, they are required to be at major status and enrolled in good standing in their junior year of the Bachelor of Science in Biomedical Engineering at the University of Utah.

The application form and instructions can be found on the Biomedical Engineering Graduate Studies website. The application deadline is April 1 for fall semester admission and November 1 for spring semester admission. The application must be submitted to the Graduate Academic Advisor in the Biomedical Engineering Office. Supporting documents will include a one-page Personal Statement, unofficial Transcript (or DARS), and a professional résumé or CV. Additionally, applicants with a cumulative GPA between 3.000 and 3.499 will be required to provide three letters of recommendation, including at least one from a Biomedical Engineering Core faculty member. Applicants are not required to submit GRE scores for admission to the B.S./M.S. Dual Degree program.

Dual Degree Graduate School application procedure:

Students apply for “Graduate” status after completing 122 semester credit hours of qualified studies, or in the application semester, they complete the maximum of 12 credit hours of 5000+ courses for application to their MS degree requirements. Students must follow regular University of Utah Graduate School application procedures to apply online using the “Apply Yourself” application system.

Students who have advanced to graduate status and who are funded as Graduate Research Assistants in a lab may be eligible for the University of Utah’s Graduate Tuition Benefit Program (TBP). See the Handbook’s Tuition Benefit section.

Once students are enrolled with graduate status, all Graduate School rules apply (e.g., graduate tuition structure, tuition benefit program (TBP), health insurance program, etc.). When deciding on the timing for their change of status from undergraduate to graduate, students should read the TBP guidelines and weigh benefits (e.g., tuition benefit and health insurance) vs. negatives (e.g., no scholarships, more costly tuition).

B.S./M.S. Dual Degree: Petitioning for Graduate credit

Students enrolled in this program may request up to a maximum of 12 credit hours of coursework taken as an undergraduate to be applied to their MS degree. All courses must be at the 5000 level or above and students must submit the “Request for Graduate Credit in the BS/MS Program” to the Registrar’s office during their first semester in

graduate status. The Request for Graduate Credit in BS/MS Program form must be reviewed by the Biomedical Engineering Graduate Academic Advisor before being submitted by the Department to the Office of the Registrar for approval. The Registrar's Office will update the DARS from all B.S./M.S. students, noting that the requested courses have been reserved for graduate credit. When completed, these updates are final and cannot be reversed.

Requested courses that have been approved by the Office of the Registrar be "Reserved" on the student's undergraduate record, and no longer eligible to apply toward the B.S. degree. However, they will be eligible for credit toward the M.S. degree and must be included on the student's MS Program of Study for approval consideration from their supervisory committee.

Criteria:

- The requested course(s) must have a letter grade of B or better
- The requested course(s) may not be used to fulfill requirements toward any other degree (including B.S. core courses). However, up to 6 credit hours can come from the undergraduate elective requirements approved by the Director of Undergraduate Studies.
- Once requested courses have been approved through the Office of the Registrar, students who subsequently withdraw from the B.S./M.S. program will not be allowed to apply those reserved credits toward their B.S. degree, and will be restricted in the extent to which they may apply them toward future M.S. degree requirements (see below).
- B.S./M.S. candidates must maintain two separate enrollment records (undergraduate and graduate) and are responsible to register for the remaining undergraduate courses on their undergraduate enrollment and graduate courses under their graduate enrollment.

Graduation from the B.S./M.S. Program

Following successful completion of all requirements in both degree programs, the B.S. and M.S. degrees are both conferred simultaneously. Therefore, students must apply for graduation in the same semester for both degrees. See the Graduation Office website for application deadlines, etc.: <https://registrar.utah.edu/graduation/index.php>. The M.S. degree will not be awarded to any student who has not successfully completed all of the requirements for the B.S. in Biomedical Engineering program.

Discontinuing the B.S./M.S. Program

Students who request to exit the B.S./M.S., dual-degree program, may do so without penalty if they do so before achieving Graduate status. At that time, qualified coursework will be applied toward the traditional B.S. and M.S. degree requirements, respectively. Graduate Status students who have reserved up to 12 credits of 5000+ coursework can apply only 6 of those credits to a future graduate degree.

6. SPECIALIZED GRADUATE TRACKS

The goal of the graduate program is to provide an educational framework that will encourage students to excel in a chosen area of specialization with relevant technical competence. Each of the specialized graduate tracks has a track advisor. The track advisor's role is to guide the curricular content of the track, establish the specialized track courses, develop track requirements for recruiting prospective graduate students and to advise the student in preparing for the PhD written qualifying exam. Each student works with a graduate track advisor, their research advisor, and their supervisory committee to design a program of study that meets the M.S. or Ph.D. requirements. The program of study should reflect the specific research interests of the student and be designed to develop the highest possible level of expertise.

The Ph.D. written qualifying exam is structured around each student's area of specialization and therefore courses completed as part of the program of study serve as partial preparation for the qualifying exam. The following Specialized Track areas form the basis for Ph.D. writing qualifying exams and M.S. programs of study.

BIOINNOVATE

Dr. Robert Hitchcock, Advisor

- Medical Device Design and Development
- Business Plan Development

The bioInnovate track aims to provide a comprehensive biomedical device design training program through the use of a multidisciplinary, hands-on teaching approach in classroom, clinical, and laboratory settings. The track will focus students on clinical problem identification, medical device innovation, and commercial translation; all within the regulatory framework of the FDA. Students will immerse themselves within clinical environments and learn to observe procedures and medical devices to uncover unmet clinical needs. By refining these needs into feasible medical device products with commercial potential, student teams will further develop these ideas into testable prototypes and develop business. Upon completion of the bioInnovate track, students will be able to 1) observe and identify unmet needs in clinical environments, 2) work effectively in multidisciplinary teams in asynchronous environments, 3) understand and apply FDA QSR in the design and development of medical devices, 4) develop a business plan, attract potential funding sources and start a company in the medical device industry.

Ph.D. Students

Ph.D. Qualifying Exam: Ph.D. students in the bioInnovate track are expected to have general knowledge in the field. General knowledge includes Biomedical Engineering fundamentals, clinical needs identification, concept generation, FDA QSR, medical device design and development, prototyping and testing, business concepts, and business plan development. The purpose of the Ph.D. Qualifying Exam is to encourage students to revisit the fundamental principles in Biomedical Engineering, regulatory compliance, medical device innovation, and business development. Students should take the exam in the second year of study. Although the specific content of the exam changes each year, approximately 25% of the exam covers material from the M.S. level Biomedical Engineering core curriculum and 75% of the exam covers topics specific to the field of medical device development and clinical needs finding. Although specific courses are not required, the following set of courses serve as a basis for the bioInnovate qualifying exam. Additional information on the Ph.D. Qualifying Exam can be found in the "Examinations" section to follow.

For students in the bioInnovate Track, the Program of Study in Biomedical Engineering should include a hierarchy of courses selected to develop expertise in a focus area. Although there are no specific requirements, knowledge in fundamental areas noted above will be required to pass the Qualifying Exam. Additional expertise in a focus area will be required to perform well on the research proposal.

Additional courses must be completed to meet the minimum course credit hour requirements for the Ph.D. A typical plan of study would include approximately 5 specialized courses in addition to the bioInnovate track core courses to reach the course credit requirement. A limited set of example courses are given below. The specific set of courses, over and above the bioInnovate track core courses, should be selected on an individual basis to maximize expertise in the area most closely related to the student's area of research.

bioInnovate Courses

Core Courses

- BME 6081: Biomedical Device Innovation I
- BME 6082: Biomedical Device Innovation II

Competitive Admission Track Courses

- BME 6181: Clinical Problem Solving Through Strategic Analysis I
- BME 6182: Clinical Problem Solving Through Strategic Analysis II

bioInnovate Advanced Courses

Business

ACCTG 5620	Business Valuation and Analysis	3 Credits
ENTP 5770	Business Discovery and Creation	3 Credits
ENTP 5774	Funding the Social Enterprise	3 Credits
ENTP 6810	Venture Foundations	1.5 – 3 Credits
ENTP 6820	Venture Trends	1.5 – 3 Credits
ENTP 6830	Applied Venture Skills	1.5 – 3 Credits
ENTP 6840	Venture Planning	1.5 – 3 Credits
ENTP 6860	Lassonde Venture	1.5 – 3 Credits
FINAN 5300	New Venture Finance	3 Credits
FINAN 5881	Managing the Venture Process	1.5 – 3 Credits
FINAN 6300	Venture Capital	1.5 Credits
FINAN 6881	Venture Planning	1.5 – 3 Credits
MBA 6860	Technology Commercialization	3 Credits
MHA 6550	Marketing for Health Professionals	3 Credits
MHA 6553	Health Care Financial Management	1.5 – 3 Credits
MKTG 6551	The Environment of Healthcare I: Management and Administration	1.5 Credits
MKTG 6552	The Environment of Healthcare II: Management and Administration	
MKTG 6715	Entrepreneurial Marketing	1.5 Credits
MKTG 6860	Marketing Research	1.5 – 3 Credits
MST 6020	Effective Leadership and Management for Scientists	1 Credit
MST 6021	Strategic Planning and Marketing for Scientists	1 Credit
MST 6022	Production and Operations Management for Scientists	1 Credit
MST 6600	Applied Statistical Techniques	3 Credits
STRAT 5750	Profiles of Leadership	1 – 3 Credits
STRAT 6710	Strategy and Technology	1.5 – 3 Credits

Law

LAW 7051	Business Planning	3 Credits
LAW 7056	Corporate Finance: Mergers and Acquisitions	3 Credits
LAW 7065	Intellectual Property	3 – 4 Credits
LAW 7360	Health Law	3 Credits
LAW 7630	New Ventures Clinic	1 – 5 Credits
LAW 7760	Patent Law	3 Credits
LAW 7773	Intellectual Property Licensing	3 Credits
LAW 7788	New Ventures	2 Credits
LAW 7847	Bioethics and the Law	3 Credits
LAW 7889	Colloquium in Contemporary Issues in Law and the Health Sciences	1 Credit

Biomedical Engineering and Mechanical Engineering

BME 6421	Fundamentals of Micromachining	3 Credits
BME 6701	Microfluidic Chip Design and Fabrication	3 Credits
ME EN 6010	Principles of Manufacturing Processes	3 Credits
ME EN 6030	Reliability Engineering	3 Credits
ME EN 6040	Quality Assurance Engineering	3 Credits
ME EN 6050	Fundamentals of Micromachining Processes	3 Credits
ME EN 6100	Ergonomics	3 Credits
ME EN 6120	Human Factors in Engineering Design	3 Credits
ME EN 6250	Object-Oriented Programming for Interactive Systems	3 Credits
ME EN 6620	Fundamentals of Microscale Engineering	3 Credits

BIOMATERIALS AND THERAPEUTICS

Dr. Russell Stewart, Advisor

- Biomedical Polymers
- Biomolecular Engineering
- Synthetic Biology
- Tissue Engineering
- Drug Delivery and Nanomedicine

The Biomaterials and Therapeutics track covers an interdisciplinary field focused on the physical and biological study of biomaterials and drug delivery systems and their applications to modern biomedical problems. It encompasses synthetic materials, macromolecules, bioconjugates, modern drug delivery systems, genetically programmed materials and networks, composites and hybrid materials, cell-material combinations and self-assembling systems, as well as their interactions with biological environments and physiological systems. Students in the Biomaterials and Therapeutics track should understand the relationships between the

structure and designs of biomaterials, synthetic biology, and drug delivery systems and their interactions with complex biological systems.

Biomaterials and Therapeutics Elective Courses

BME 6140	Fundamentals of Tissue Engineering	2 Credits
BME 6405	Nanomedicine	3 Credits
BME 7160	Physics Nature of Surfaces	3 Credits
PHCEU 7011	Fundamentals of Pharmacokinetics	3 Credits
PHCEU 7030	Macromolecular Therapeutics and Drug Delivery	4 Credits
PHCEU 7040	Biotechnology	4 Credits

BIOMECHANICS

Dr. Jeffrey Weiss, Advisor

Example Sub-fields:

- Molecular, Cell, Tissue, Organ and System Level Biomechanics
- Biosolids, Biofluids, and Biofluid-solid Interactions
- Biophysics
- Computational Biomechanics
- Mechanobiology

Biomechanics is a broad field directed at applying the principles of engineering mechanics, across multiple length scales, to the study of biology and medicine. Topics in biomechanics range from understanding the role of stress in cytoskeleton dynamics as related to cell growth, migration, and adhesion to establishing patient-specific modeling techniques to predict in vivo biomechanical loading environments. The University of Utah has faculty conducting biomechanics research in areas such as: molecular biomechanics, cellular biophysics, cell mechanotransduction, computational biomechanics, hemodynamics, mechanobiology, medical device design, soft tissue mechanics (arteries, cartilage, ligaments), ocular biomechanics, orthopedic biomechanics, cardiovascular biomechanics, tissue engineering, and traumatic brain injury. Given the broad range of biomechanics research at the University of Utah, with faculty spanning numerous departments there exist ample collaborative opportunities and interdisciplinary projects with faculty in the College of Engineering, College of Science, Huntsman Cancer Institute, School of Medicine, and the Scientific Computing and Imaging (SCI) Institute. The Biomechanics track aims to provide students with a strong quantitative foundation in engineering mechanics, physiology, and medicine that will serve them equally well for careers in both academia or industry.

Masters Students

M.S. students within the biomechanics track must successfully complete the Biomechanics Track Core Courses and at least one additional course from the list of Biomechanics Track Elective Courses (shown below). Please note that some of the courses are offered every other year and plan accordingly.

Ph.D. Students

Ph.D. Qualifying Exam

The purpose of the Ph.D. Qualifying Exam is to ensure students are competent in the theoretical and conceptual fundamentals of biomechanics before undertaking intensive research in their selected field of study. Ph.D. Students in the Biomechanics track are expected to be proficient in the following topics: index and direct notation, finite deformation kinematics, concepts of stress and strain, linear elasticity, material behavior of biological materials, hyperelasticity, mixture theory, and fluid mechanics. These topics are covered in Biomechanics I and II courses, so much of the Qualifying Exam material will come from these courses. Additional information on the Ph.D. Qualifying Exam can be obtained by contacting the track advisor. Students should take Ph.D. Qualifying Exam following completion of the second year of study.

Program of Study

The Program of Study is a list created by the student and the supervisory committee of all courses to be completed by the student as part of the requirements for the Ph.D. The Program of Study requires formal approval by the student's advisor, Dissertation Supervisory Committee, and Director of Graduate Studies. In addition to the Biomedical Engineering graduate core curriculum, the Program of Study for students in the Biomechanics track includes the Biomechanics Core Courses and Elective Courses that support the student's area of research.

Biomechanics Track Core Courses*

Completion of these core courses and proficiency in the course content are required to pass the written Ph.D. Qualifying exam and the Ph.D. proposal, which includes an oral qualifying exam.

BME 5250	Biomechanics II	3 Credits
BME 6480	Biomechanics Research (3x)	1 Credit
BME 7210	Computational Biomechanics	3 Credits

**If students are not already familiar with the material covered in Biomechanics I from their undergraduate studies, they will be required to audit BME 4250 (Biomechanics I) prior to enrolling in BME 5250 (Biomechanics II)*

Biomechanics Track Elective Courses

The course selection that will be appropriate for each student in the Biomechanics track will depend on the specific research project in which the student participates. It will be especially important to choose courses that provide both the scientific background and the technical skills required to carry out this research. A typical set of elective courses would include approximately six specialized courses in addition to the Biomechanics Core Courses. Some example courses that have been included in the Programs of Study of PhD students in the Biomechanics Track are provided below, organized by the parent department. The specific set of courses, over and above the Biomechanics Core Courses, should be selected on an individual basis to maximize expertise in the area most closely related to the student's area of research.

Department of Biomedical Engineering

BME 6002	Molecular Biophysics	
BME 6303	Cell and Tissue Engineering: Stem Cells in Tissue Engineering	
BME 6304	Introduction to Polymers and Biopolymers	
BME 6305	Cell and Tissue Engineering:	

BME 6401	Medical Imaging Systems	
BME 6500	Mathematics of Imaging	
BME 6702	Introduction to Image-based Modeling	
BME 6760	Modeling and Analysis of Biological Networks	

School of Computing

CS 6210	Advanced Scientific Computing I	
CS 6962	Programming for Engineers	

Department of Mathematics

MATH 5610	Introduction to Numerical Analysis I	
MATH 5620	Introduction to Numerical Analysis II	
MATH 6420	Partial Differential Equations	
MATH 6610	Analysis of Numerical Methods I	
MATH 6620	Analysis of Numerical Methods II	
MATH 6830	Mathematical Biology I	

Department of Mechanical Engineering

ME EN 6510	Introduction to Finite Elements	
ME EN 6520	Introduction to Continuum Mechanics	
ME EN 6700	Intermediate Fluid Dynamics	
ME EN 6720	Computational Fluid Dynamics	
ME EN 7540	Advanced Finite Elements	
ME EN 7525	Inelasticity	

CARDIAC ELECTROPHYSIOLOGY AND BIOPHYSICS

Dr. Rob MacLeod, Advisor

- Membrane Ion Transport and Ionic Channels
- Cell Action Potentials and Ion Currents, Ion Regulation, and Contraction
- Cell to Cell Coupling and Spread of Excitation
- Electrocardiography and Volume Conductors
- Experimental and Simulation Techniques

Cardiac electrophysiology and biophysics is a discipline that encompasses all the electrical activity of the heart, includes both basic science and clinical components, and spans a spectrum from the molecular to the complete body. Research in this area addresses some of the most basic questions of how cells, organs, and the body function and also seeks to develop methods, interventions, and devices that could have profound impact on diseases of the heart and vasculature. Despite dramatic improvements in clinical detection and care, cardiovascular diseases remain the leading

causes of death in developed countries. Research in cardiac electrophysiology makes use of the most advanced technologies in areas such as bioinstrumentation, multichannel signal acquisition and processing, molecular biology, imaging across many modalities, mathematical simulation and modeling, and all aspects of computer technology.

As a result of this diversity of biomedical and technical opportunities, students with graduate training in cardiac electrophysiology and biophysics receive a very broad education in both physiology and biomedical technology and will be extremely well-equipped for careers in academia and industry. The program makes use of background courses from several departments as well as specialized training in the discipline through both courses and extensive laboratory experiences. Because of the outstanding research emphasis on cardiac electrophysiology and biophysics at Utah, rich opportunities exist for student interactions with a wide range of experts in the field as well as involvement in interdisciplinary projects within teams of related researchers and students.

Cardiac Electrophysiology and Biophysics Courses

BME 6000	Systems Physiology I: Cardiovascular, Respiratory and Renal Systems	4 Credits
BME 6003	Cellular Electrophysiology and Biophysics	3 Credits
BME 6460	Electrophysiology and Bioelectricity of Tissues	3 Credits

Biomedical Engineering

BME 6330	Principles of Magnetic Resonance Imaging (MRI)	3 Credits
BME 6500	Mathematical Foundations of Imaging	3 Credits
BME 6640	Introduction to Digital Image Processing	3 Credits
BME 7310	Advanced Topics in Magnetic Resonance Imaging (MRI)	3 Credits
BME 7320	3D Reconstruction Techniques in Medical Imaging	3 Credits

Biology

BIOL 5110	Molecular Biology and Genetic Engineering	3 Credits
BIOL 5210	Cell Structure and Function	3 Credits
BIOL 5910	Mathematical Models in Biology	3 Credits
BIOL 6500	Advanced Statistical Modeling for Biologists	3 Credits

Computer Science (scientific computing and software)

CS 6100	Theory of Computation	3 Credits
CS 6210	Advanced Scientific Computing I	3 Credits
CS 6220	Advanced Scientific Computing II	3 Credits
ECE 7820	Parallel Computer Architecture	3 Credits

Electrical Engineering (signal processing, electromagnetics)

ECE 5510	Random Processes	3 Credits
ECE 5530	Digital Signal Processing	3 Credits

ECE 6340	Numerical Techniques in Electromagnetics	3 Credits
ECE 6533	Advanced Digital Signal Processing I	3 Credits
ECE 6534	Advanced Digital Signal Processing II	3 Credits
ECE 6540	Estimation Theory	3 Credits
ECE 6560	Multivariable Systems	3 Credits

Mathematics

MATH 5040	Stochastic Processes and Simulation I	3 Credits
MATH 5050	Stochastic Processes and Simulation II	3 Credits
MATH 5110	Mathematical Biology I	3 Credits
MATH 5120	Mathematical Biology II	3 Credits
MATH 5410	Introduction to Ordinary Differential Equations	4 Credits
MATH 5440	Introduction to Partial Differential Equations	3 Credits
MATH 5600	Survey of Numerical Analysis	4 Credits
MATH 5610	Introduction to Numerical Analysis I	4 Credits
MATH 5740	Mathematical Modeling	3 Credits
MATH 6630	Numerical Solutions of Partial Differential Equations	3 Credits
MATH 6740	Bifurcation Theory	3 Credits
MATH 6770	Mathematical Biology I	3 Credits
MATH 6780	Mathematical Biology II	3 Credits

Physics

PHYS 6720	Introduction to Computing in Physics	4 Credits
PHYS 6730	Computational Physics II	4 Credits

COMPUTATIONAL SYSTEMS AND SYNTHETIC BIOMEDICAL ENGINEERING

Dr. Orly Alter and Dr. Tara Deans, Advisors

- Cellular Systems Biomedical Engineering
- Cellular Synthetic Biomedical Engineering
- Computational Data Science, and Mathematical and Statistical Modeling
- High-Throughput Molecular Biotechnologies

Systems and Synthetic Biomedical Engineering are complementary emergent fields that combine experimental, computational and theoretical methods to solve challenging biomedical problems. Systems Biomedical Engineering is based on a holistic approach of integrating large amounts of molecular information to elucidate the relationships between genotype and phenotype. This multi-scale understanding of biological systems will help answer important questions about physiological systems, human disease, and therapeutic strategies. Synthetic Biomedical Engineering

is the design and construction of biological systems from molecular biological components for useful purposes. Such systems have applications in a wide range of complex biomedical problems.

Among the greatest challenges in these fields are how to obtain, manipulate, and interpret massive datasets. Research in this area also requires a multi-scale understanding of the system of interest, from molecules to cells, to organisms to ecosystems. Computational systems and synthetic Biomedical Engineering draw from a wide range of specialties including mathematical modeling, scientific computing, signal processing, molecular biology, and high-throughput technologies to provide a unique approach to solving biomedical problems.

This track draws from the rich set of resources currently available at the University of Utah to provide students with valuable interdisciplinary academic and research experiences. Students receive training in desirable skills including large-scale data analysis and genomic technologies, making them well-suited for careers in academia, industry and government.

Because computational systems and synthetic Biomedical Engineering are inherently interdisciplinary, the program supplements a strong Biomedical Engineering core with courses from a variety of departments. Below are summaries of the proposed course and research requirements for the track.

Computational Systems and Synthetic Biomedical Engineering Courses

Biomedical Engineering

BME 6000	Systems Physiology I: Cardiovascular, Respiratory and Renal Systems	4 Credits
BME 6010	Systemic Physiology II	3 Credits
BME 6002	Molecular Biophysics	3 Credits
BME 6003	Cellular Biophysics and Electrophysiology	3 Credits

Biology

BIOL 5110	Molecular Biology and Genetic Engineering	3 Credits
BIOL 5140	Genome Biology	3 Credits
BIOL 6500	Advanced Statistical Modeling for Biologists	3 Credits

Biological Chemistry

BLCHM 6400	Genetic Engineering	2 Credits
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Biomedical Informatics

BMI 6030	Foundations of Bioinformatics	2 Credits
BMI 6420	Advanced Biomedical Computing	2 Credits
BMI 6530	Bioinformatics Data Integration and Analysis	3 Credits

Computer Science

CS 6140	Data Mining	3 Credits
CS 6150	Advanced Algorithms	3 Credits
CS 6220	Advanced Scientific Computing II	3 Credits

CS 6350	Machine Learning	3 Credits
CS 6530	Database Systems	3 Credits
CS 7120	Information-Based Complexity	

Electrical and Computer Engineering

ECE 6520	Information Theory	3 Credits
ECE 6530	Digital Signal Processing	3 Credits
ECE 6540	Estimation Theory	3 Credits
ECE 6550	Adaptive Filters	3 Credits
ECE 6570	Adaptive Control	3 Credits

Family and Preventive Medicine

PBHLT 6107	Survival Analysis	3 Credits
PBHLT 7120	Linear and Logistic Regression Models	3 Credits

Human Genetics

BIOL 5920	Advanced Eukaryotic Genetics	3 Credits
H GEN 6500	Human Genetics	3 Credits
H GEN 6503	Clinical Cancer Genetics	3 Credits

Mathematics

MATH 6770	Mathematical Biology I/II	3 Credits
MATH 6780		
MATH 6810	Stochastic Processes and Simulation I/II	3 Credits
MATH 6815		
MATH 6845	Ordinary Differential Equations and Dynamical Systems	3 Credits
MATH 6855	Survey of Numerical Methods	4 Credits
MATH 6860	Introduction to Numerical Analysis I/II	4 Credits
MATH 6865		

Molecular Biology

MBIOL 6420	G3: Genetics, Genomes and Gene Expression	3 Credits
BIOL 5120	Gene Expression	3 Credits

Medicine Clinical Research Center

MDCRC 6150	Foundations in Personalized Healthcare	2 Credits
MDCRC 6420	Genetics of Complex Diseases	1.5 Credits

IMAGING

Dr. Edward Hsu, Advisor

- Medical Imaging
- Optical Systems, Imaging Methods and Hardware

Visualization of anatomical and physiological processes of the body plays an indispensable role in today's clinical healthcare as well as basic science research. This is the interdisciplinary field of imaging, which encompasses hardware instrumentation, acquisition methodology, contrast agent development, post-processing analysis, and the application of any combination of the above in biomedical research. The Imaging track curriculum is designed to cover both the breadth and depth in the training, and to prepare students for research in the development or application of biomedical imaging technologies.

Imaging Courses

BME 5480	Principles of Ultrasound	3 Credits
BME 6330	Principles of Magnetic Resonance Imaging (MRI)	3 Credits
BME 6500	Mathematical Foundations of Imaging	3 Credits
BME 6640	Introduction to Digital Image Processing	3 Credits
BME 7310	Advanced Topics in Magnetic Resonance Imaging (MRI)	3 Credits
BME 7320	3D Reconstruction Techniques in Medical Imaging	3 Credits
PHCEU 7110	Molecular Imaging	2 Credits

NEUROENGINEERING (formerly Neural Interfaces)

Dr. Gregory Clark, Advisor

- Electrophysiology
- Biomaterials
- Computational / Modeling

The Neuroengineering Track trains students in the fields of basic and applied neuroscience and neuroengineering. Its goals include the application of engineering approaches to the treatment of neural dysfunction, and conversely, the discovery of effective strategies utilized by biological nervous systems and their application to traditional engineering problems. Research areas of Biomedical Engineering faculty in Neuroengineering area include electrical neural interfaces and neuroprostheses; cell and chemical delivery systems for neural tissue; engineering of neural self-repair; neural plasticity; neural coding in sensory and motor systems; neural imaging; and non-traditional modes of stimulating neural tissue (e.g., focused ultrasound and magnetic stimulation)

Students in the Neuroengineering Track are expected to have general knowledge in the fields of basic and applied neuroscience.

Ph.D. students in the Neuroengineering Track typically are required to complete successfully the required Neuroengineering core courses below. The core courses are intended to provide knowledge in the major areas of the field. They also will provide considerable assistance in preparing for the written portion of the Neuroengineering qualifying exam. A student's Supervisory Committee may grant exemptions to these course requirements on a case-by-case basis if the exemptions are sufficiently justified. Students may take either or both of the two computational courses: BME 6050 (offered in Spring Semester of odd years) or BME 60xx (pending and under development; expected to be offered in Spring Semester of even years). Either course will suffice to help prepare for the qualifying exam, although they will have somewhat different emphases. In practice, the Qualifying Exam may combine topics

across courses; e.g., questions regarding cellular or systems neuroscience may be asked from a quantitative perspective.

Course readings also serve as way for students to prepare for the qualifying exam, although not all core courses have assigned textbooks. The first portion of Kandel et al., Principles of Neural Science, provides an excellent text for the study of cellular neurosciences; the latter portion of this text is used for BME 6430 Systems Neuroscience.

Masters students in the Neuroengineering Track typically are required to complete successfully the same required core courses as do PhD students, with the exception that NEUSC 6040 Cellular and Molecular Neuroscience is not required for Masters students. Understanding of cellular/molecular neuroscience is nonetheless still required for exams for Masters students.

Two of the Neuroengineering Track core courses (BME 6430 Systems Neuroscience and BME 6440 Neural Engineering) may also count as two of the required Biomedical Engineering core courses.

Neuroengineering Track students are also expected to enroll and participate routinely in BME 6470 Neural Engineering Research Group (NERG).

The purpose of the written portion of the Neuroengineering Qualifying Exam is to encourage students to approach their graduate education as an experience that transcends the boundaries of individual courses; to revisit the fundamental principles in basic and applied neuroscience; and to consolidate, synthesize, and integrate this material. Specific topics that may be covered on the qualifying exam are covered in the Neuroengineering Track core courses.

Neuroengineering Core Courses

BME 6005 or BME 60xx	Computational Neuroscience or Computational Neuroscience, Systems/Quantitative Neuroscience (pending; under development)	3 Credits
BME 6430	Systems Neuroscience	4 Credits
BME 6440	Neural Engineering	3 Credits
BME 6470	Neural Engineering Research Group (NERG) (2 semesters)	0.5 Credits
NEUSC 6040	Cellular and Molecular Neuroscience (not required for Masters students)	4 Credits

Additional Generally Useful Courses

BME 6010	Systemic Physiology II	3 Credits
BME 6140	Fundamentals of Tissue Engineering	2 Credits
BME 6230	Functional Anatomy for Engineers	3 Credits
BME 6433	Biological Statistical Signal Processing	3 Credits
BME 6460	Electrophysiology and Bioelectricity	3 Credits
BME 7120	Biocompatibility	2 Credits
ECE 6520	Information Theory	3 Credits
ECE 6540	Estimation Theory	3 Credits
MATH 6770	Mathematical Biology I	3 Credits
MATH 6780	Mathematical Biology II	3 Credits
MATH 6790	Case Studies in Computational Engineering and Science	3 Credits

MDCRC 6450	Grant Writing	3 Credits
NEUSC 6060	Neuroanatomy	1.5 Credits
NEUSC 6010	Frontiers in Neuroscience (seminar)	1 Credit

Additional Advanced Courses in Neuroengineering

Electrophysiology

BME 6003	Cellular Biophysics	
BME 6421	Fundamentals of Micromachining	3 Credits
BME 6433	Biological Statistical Signal Processing	3 Credits
ECE 6550	Adaptive Filters	3 Credits
ECE 6533	Advanced Digital Signal Processing I	3 Credits
ECE 6534	Advanced Digital Signal Processing II	3 Credits
ECE 6710	Digital VLSI Design	4 Credits
NEUSC 7750	Developmental Neurobiology	3 Credits
NEUSC 6245	Cellular and Molecular Neurophysiology Laboratory	2 Credits
ONCSC 6150	Biostatistics	
RHSCI 7200	Neuromuscular Performance & Adaptation	3 Credits

Biomaterials

BME 6140	Fundamentals of Tissue Engineering	2 Credits
BME 6302	Biomaterials	3 Credits
BME 7120	Biocompatibility	2 Credits
BME 7160	Physical Nature of Surfaces	3 Credits

Computational/ Modeling

CS 6210	Advanced Scientific Computing I	3 Credits
CS 6355	Structured Prediction (machine learning)	3 Credits
CS 6955	Deep Learning (advanced neural networks and applications)	
CS 7960	Neuromorphic Architectures (neural networks)	
MATH 6070	Mathematical Statistics	3 Credits
MATH 6440	Advanced Dynamical Systems	3 Credits
MATH 6630	Numerical Solutions of Partial Differential Equations	3 Credits
MATH 6740	Bifurcation Theory	3 Credits
ME EN 7200	Nonlinear Controls	3 Credits
ME EN 7210	Optimal Controls	3 Credits

7. DEPARTMENT COURSE REQUIREMENTS

Department Core Course Requirements

Our Biomedical Engineering core curriculum builds upon course material introduced to students in undergraduate biology, chemistry, mathematics, and physics. Students must complete the graduate core curriculum (or committee-approved substitutes) as part of the required 30 course credit hours minimum beyond the baccalaureate level.

Coursework should align with student's educational goals and areas of specialization, and be an approved part of their Program of Study. Student's supervisory committees may require students to take additional courses depending on the student's performance on the qualifying exam, academic background, or other factors.

Life Science Fundamentals:

Minimum of 6 credit hours required for all students from the following courses

BME 6000	Systems Physiology for Engineers	4 Credits
BME 6303	Cell and Tissue Engineering I	3 Credits
BME 6430	Systems Neuroscience	4 Credits
BME 6440	Neural Engineering	3 Credits

Biomedical Engineering Fundamentals:

Minimum of 6 credit hours required for all students from the following courses

BME 6401	Medical Imaging Systems	3 Credits
BME 6002	Molecular Biophysics	3 Credits
BME 6250	Biomechanics II	3 Credits
BME 6302	Biomaterials	3 Credits

Scientific Presentations:

Minimum of 1 credit hour required for all students from the following

BME 6090	Department Seminar <i>To be taken the first semester in the program</i>	0.5 Credits
BME 6090	Department Seminar <i>To be taken the second semester in the program</i>	0.5 Credits

Minimum of 4 credit hour required for Ph.D. students (only) from the following

BME 7070	Proposal Writing and Presentations I <i>To be taken Spring Semester of 2nd year</i>	2 Credits
BME 7071	Proposal Writing and Presentations II <i>To be taken Fall Semester of 3rd year</i>	2 Credits

Department Core Curriculum Substitution Guidelines

Students may have documented evidence of equivalent previous experiences and knowledge in the "Fundamental" curriculum areas, based on previous degree curriculum and research experience. When this is the case, students may consider selecting alternative courses related to the Fundamental areas of study which would better meet their needs and interests.

However, students with limited experience or knowledge in the core curriculum may be required by their Research advisor or Supervisory Committee to complete additional coursework within a “Fundamental” area.

Any core curriculum substitutions are to be requested in the form of a memorandum and must be approved by the supervisory committee prior to approval by the Director of Graduate Studies. Approvals will be based on the student’s demonstrated proficiency in the subject matter and previous degree fields as follows:

Students with B.S. Degrees in the Formal Sciences, the Physical Sciences, or Traditional Engineering

Students who enter the graduate program with a B.S. degree in the formal sciences (i.e. mathematics or statistics), the physical sciences (i.e. physics or chemistry), or traditional engineering (i.e. chemical, computer, electrical, materials, or mechanical) may have little training in the life sciences.

Students in this category may be required to complete independent self-study and/or prerequisite coursework prior to enrolling in life science fundamentals courses. Students in this category are strongly encouraged to take 3 courses (a minimum of 9 credits) in the life science fundamentals core instead of the required 2 courses (a minimum of 6 credits).

It is rare for Life Science Fundamental core curriculum substitutions to be approved for students in this category.

Students with B.S. Degrees in the Life Sciences

Students who enter the graduate program with a B.S. degree in the life sciences (i.e. biology, microbiology, physiology, or biochemistry) may have little training in engineering, mathematics, and/or physics.

Students in this category may be required to complete independent self-study and/or prerequisite coursework prior to enrolling in Biomedical Engineering fundamentals courses. Students in this category are strongly encouraged to take 3 courses (a minimum of 9 credits) in the Biomedical Engineering fundamentals core instead of the required 2 courses (a minimum of 6 credits).

It is rare for Biomedical Engineering Fundamental core curriculum substitutions to be approved for students in this category.

Students with B.S. Degrees in Biomedical Engineering or Biomedical Engineering

Typically, students who enter the graduate program with a B.S. degree in Biomedical Engineering or Biomedical Engineering have completed introductory courses similar to the Life Science and Biomedical Engineering fundamental core courses.

Students in this category are permitted to choose alternate Life Science and Biomedical Engineering courses to fulfill the core curriculum requirements. Students are given considerable flexibility when requesting Life Science and Biomedical Engineering Fundamental course substitutions, based on their individual backgrounds and research interests.

Course Substitution Procedure

Students intending to request relevant course substitutions for the department core course requirements must submit a written proposal outlining their request to their supervisory committee and the Director of Graduate Studies. Substitution proposals should indicate the following:

- The student’s experience/background in the core area including a list of specific courses and when taken.
- The reason(s) the proposed course(s) meets the aim/scope of a "Fundamental" requirement in that area.
- The student’s research focus and why the proposed course(s) would be in their best interest.

Proposals will be submitted with the student’s Program of Study form (or Preliminary Program of Study form) for their Supervisory Committee’s approval. An additional approval of the Director of Graduate Studies will also be required.

Department Seminar

During the academic semesters, the Department hosts topical seminar speakers on a weekly basis. These speakers are leaders in their fields from both the University of Utah as well as outside institutions. All graduate students are expected to attend whether or not they are registered for the BME 6090 course. This is an important part of our Biomedical Engineering community and many good ideas come from listening to seminar speakers who are speaking in areas outside of the student's dissertation research area. Although attendance is not taken at these seminars, it is clear to the faculty, committee members and the Department administration who attends the seminars and how regularly they attend. All Biomedical Engineering graduate students are expected to attend these seminars without exception.

8. GRADUATE SCHOOL REGISTRATION REQUIREMENTS

Credit Hour Policies

For graduate students, 9 credit hours is considered full-time enrollment until the “Enrollment Residency” Requirement is completed (see below). After that point, 3 credit hours of Thesis Research registration (BME 6970 and BME 7970 only) will qualify a student in good standing for full-time student status (and at in-state tuition rates). Students are not allowed to register for more than 16 credit hours without approval from the Dean of the Graduate School. Students are required to enroll in at least 3 credit hours in the semester they complete their final exam or defend their thesis/dissertation. BME 7990 “Continuing Registration” is only available to Ph.D. students who have been admitted to candidacy and are not using University resources other than the library (i.e., not performing any research on campus, not occupying university space beyond the library, not using faculty or staff time, etc.). BME 7990 registration is limited to 4 semesters and does not qualify a student for full or part-time enrollment status for loan deferments or insurance eligibility, etc. Students who are not U.S. citizens should refer to the University of Utah International Student Scholar Services office for additional registration requirements.

“Enrollment Residency” Requirement

- Ph.D. students are required to complete at least one year (two consecutive semesters) of the Ph.D. program in full-time academic work at the University of Utah campus.
- M.S. students are required to complete at least 24 credits of resident study at the University of Utah campus.

These requirements do not refer to or fulfill the other “Utah Residency for Tuition Purposes” Requirements for graduate students from the Graduate School. Per policy, domestic, out-of-state students must apply for Utah State residency upon completion of 40 graduate level semester credit hours at the University of Utah. Details on qualifying and applying for Utah residency reclassification are available on the Admissions office website. For additional information on the Enrollment Residency Requirement, please see Degree Requirements on the Graduate School’s website.

Continuous Registration

The Graduate School requires graduate students to be registered for at least one course from the time of formal admission through completion of all requirements for the degree they are seeking, unless granted an official leave of absence. Further, the Biomedical Engineering department requires a minimum registration of 3 credit hours per semester for all graduate students through their final exam/defense semester. Summer semesters are excluded from the registration requirement unless the student will complete their final exam/defense during the summer semester. Non-compliance with this policy will result in discontinuation from graduate study and the student will be required to re-apply for admission to the program.

Leaves of Absence

Requests for leaves of absence may be granted for up to one year for circumstances related to:

- a serious health condition of the student or family member
- parental leave to care for a newborn or newly adopted child
- a call to serve in military service
- other compelling reasons that the student’s department believes is in the best interests of both the student and the University.

The form requesting a leave of absence for a current semester must be completed and received in The Office of the Registrar by the last day of classes of that semester. Leaves of absence are not granted retroactively. Students must officially withdraw from classes in any semester for which a leave is granted; failure to formally withdraw results in the reporting of E or EU grades for all classes.

The period during which a leave of absence is granted does not count toward the period allowed to complete the degree. Leaves are granted for a maximum of one year at a time, and may be renewed by submitting a new form to The Office of the Registrar. The leave of absence is void if a student registers for classes in a semester for which a leave was granted. Please refer to the Graduate School website for additional information on Leaves of Absence.

Leaves of Absence for International Students

In response to guidance from U.S. immigration authorities, the University is required to make a change to the vacation semester policy for F-1 visa holders. Beginning Fall 2017, vacation semesters will automatically be granted to all international students during the Summer semesters. Students will no longer be eligible for a vacation semester during the Fall or Spring semesters.

Please NOTE the following important changes to the Vacation Semester Policy:

- Students will no longer need to submit vacation requests to ISSS, but will instead be automatically granted vacation in the summer
- Students may still choose to take full time courses in the summer if they wish
- Students may no longer request to be below full time for the purpose of a vacation in the Spring or Fall semester
- Students may still choose to take courses at another university during their summer semester as long as they request a letter to attend another school from ISSS
- Students will NOT be allowed to participate in Full-time CPT or on campus work during Spring or Fall semesters (unless during official university breaks such as Spring break or Fall break). Students MAY participate in Full-time CPT or on campus work during their summer vacation semester

International Student Registration Guidelines

International graduate students must be registered for a minimum of 9 credit hours until they have completed the “Enrollment Residency” requirement and/or while they are participating in the Tuition Benefit program. After which, they may register for 3 credit hours Thesis Research (6970 or 7970 only) per semester to maintain full-time student status. F-1 students must take the minimum credits each semester except during vacation semester (i.e., Summer) through the semester in which they take their final exam or defend their thesis/dissertation. Please consult the International Student Scholar Services (ISSS) website for and personnel for complete international student policies, laws and regulations. <http://internationalcenter.utah.edu/students/immigration-status/maintaining-status.php>

9. GRADUATE PROGRAM TRANSFER CREDITS

Transfer of Credit from Another Institution

Students who received credit for graduate courses from regionally-accredited institutions, may petition for those courses to be transferred to the University of Utah as part of the fulfillment of their Biomedical Engineering degree requirements. Restrictions:

- No more than 6 graduate semester hours or 2 courses (not to exceed 6 credits) may be transferred.
- Transfer credits may be applied to one degree only and cannot have been used to earn a previous degree.
- Must be graduate level courses equivalent to the UofU 5000 level or above
- The student must have earned a letter grade of B or higher for the requested transfer course
- Credit only grades are not acceptable
- Must be relevant and applicable to the students Biomedical Engineering degree program and approved by student's supervisory committees
- Requested transfer credits must have been taken within 4 years of M.S. student's semester of admission and within 7 years of Ph.D. student's semester of admission

Non-Matriculated Course Credit

Students who completed courses as a non-matriculated student at the University of Utah may request those courses to be applied toward the fulfillment of their degree requirements. Restrictions:

- A maximum of 9 graduate semester hours
- Must be graduate courses at 5000 level or above
- Non-matriculated credits may be applied to one degree only.
- Must be relevant and applicable to the students Biomedical Engineering degree program and approved by student's supervisory committees
- Requested non-matriculated credits must have been taken within 3 years of the student's semester of admission to any graduate program

Undergraduate Petition for Graduate Credit

Students who received credit for graduate courses from the University of Utah during their undergraduate program, may petition for those courses to be applied to their graduate degree as part of the fulfillment of their Biomedical Engineering degree requirements. Restrictions:

- No more than 6 graduate semester hours or 2 courses may be transferred (whichever comes first)
- Credits used to earn an undergraduate degree cannot be applied toward a graduate degree also.
- Must be graduate courses at 5000 level or above
- The student must have earned a letter grade of B or higher for the requested course
- "Credit" only grades are not acceptable
- Must be relevant and applicable to the students Biomedical Engineering degree program and approved by student's supervisory committees
- Requested credits must have been taken within 3 years of the student's semester of admission to any graduate program

Request for Graduate Credit in BS/MS Program

BS/MS Dual Degree program students (only) who earn credit for graduate level courses from the University of Utah before matriculating to graduate status, may petition for those courses to be applied to their graduate degree as part of the fulfillment of their Biomedical Engineering MS degree requirements once graduate status is achieved. Restrictions:

- No more than 12 graduate credit hours may be “reserved” for the MS degree
- Credits to be used to earn an undergraduate degree cannot be applied toward a graduate degree also.
- Must be graduate courses at 5000 level or above
- The student must have earned a letter grade of B or higher for the requested course(s)
- “Credit” only (CR) grades are not acceptable
- Must be relevant and applicable to the students Biomedical Engineering degree program and approved by the student’s supervisory committees
- Credits must be “reserved” for the MS degree during the first semester as graduate status
- If discontinuing the BS/MS program, the “reserved” graduate credits cannot be applied toward an undergraduate degree.

10. TIMELINE FOR PROGRAM COMPLETION

The timelines for each degree program differ and are summarized below.

PhD completion timeline:

Students typically graduate within 5 years of entering the BME Ph.D. program. However, the nature of some projects and methods require longer time commitments for full completion of dissertation work.

The official time limit for completing the Biomedical Engineering Ph.D. degree is 8 years. If a student in good standing has not completed the Ph.D. program within 8 years, a time limit extension may be requested with a letter of support from the student's Supervisory Committee Chair to the Department Chair and Graduate School, justifying reasons for the extension and including a forecast for student completion. Time limit extensions must be approved by the Department Director of Graduate Studies as well as the Dean of the Graduate School.

The following timeline is based on a five-year plan for students entering the Ph.D. program with Bachelor's degree. Please note that students entering with their master's degree will typically follow a more accelerated three- or four-year plan depending on their M.S. degree institution. (see the Tuition Benefit section)

First Year

- Begin the Core Curriculum courses
- Identify a Research Advisor (and typically Committee Chair) by the end of the first semester
- Begin dedicated Ph.D. research (BME 7970)
- Select an Area of Specialization/Track
- Establish full Ph.D. Supervisory Committee before the end of the second semester and convene first committee meeting to discuss research aims, expectations, timeline, course plan, etc.

Second Year

- Meet with Supervisory Committee to report progress, planned coursework, research aims, set goals, etc.
- Take advanced courses and specialized research track courses to fulfill course requirements
- Begin TA Mentorship requirement
- Begin Proposal Writing and Presentations Series (Spring)
- Submit Preliminary Program of Study by the end of the fourth semester
- Prepare for the Ph.D. Qualifying Examinations

Third Year

- Meet with Supervisory Committee to report progress and prepare for Research Proposal
- Take written Ph.D. Qualifying Exam (Fall)
- Complete Proposal Writing and Presentations Series (Fall)
- Fulfill TA Mentorship requirement
- Complete written Research Proposal
- Complete and present oral Ph.D. Qualifying Exam (Research Proposal)
- Report research at public seminar

Note: Failure to take the written Ph.D. Qualifying Exam in the fall semester and take the oral qualifying exam by the end of Year 3 may result in a loss of tuition benefit eligibility.

Fourth Year

- Meet with Supervisory Committee to report progress
- Complete any remaining course requirements, including TA Mentorship if needed
- Report research (podium presentation) at scientific meeting or seminar
- Identify External Reviewer (if applicable)
- Submit Final Program of Study for the Ph.D. degree to the Department

Fifth Year

- Meet with Supervisory Committee to report progress
- Apply for graduation
- Write and Defend Ph.D. Dissertation
- Submit Ph.D. Dissertation manuscript to the Thesis Office. See the Thesis Office website for policies

M.S. completion timeline:

Students typically graduate within 2 years of entering the BME M.S. program. However, the nature of some projects and methods requires longer time commitments for full completion of thesis work, etc.

The time limit for completing the Biomedical Engineering M.S. degree is 4 years. If a student in good standing has not completed the M.S. program within 4 years, a time limit extension may be requested with a letter of support from the student's Supervisory Committee Chair to the Graduate School, justifying reasons for the extension and including a forecast for student completion timeline. Time limit extensions must be approved by the Department Director of Graduate Studies as well as the Dean of the Graduate School.

The following timeline is based on a two-year plan for traditional full-time M.S. students. Please note that students in a dual degree program or part-time M.S. may need to adjust their timeline accordingly

First Year

- Begin the Core Curriculum courses
- Select a Specialized Graduate Track
- Form a Supervisory Committee and submit Supervisory Request form by the end of the first semester
- Meet with Supervisory Committee at the beginning of the second semester to report planned coursework, timeline for completion, expectations, etc.
- Thesis students may begin dedicated M.S. research (BME 6970)
- Begin Specialized Graduate Track courses

Second Year

- Meet with Supervisory Committee at the beginning of the second year to report progress, finalized/approve Program of Study and plan for Final Exam or Thesis Defense
- Take advanced Specialized Track courses (6000+) and complete course requirements and Thesis Research credits (if applicable)
- Submit approved Program of Study form
- Apply for graduation
- Non-thesis students complete a final oral exam by the last day of Finals and submit "Report Final Exam" form
- Thesis students complete a thesis defense/exam and submit "Report Final Exam" form
- Thesis Students must also submit their written manuscript to the Thesis Office for publication. See the Thesis Office website for policies and deadlines.

11. ACADEMIC PERFORMANCE, STANDARDS AND STANDING

All graduate students are required to maintain good academic standing by meeting the minimum academic standards as defined by the Graduate School and the Department. The Graduate School academic standards can be found on the University of Utah Graduate School website. Many privileges associated with graduate standing require this minimal academic performance. Students who fall below minimum academic performance requirements are placed immediately on academic probation for one semester.

If these students fail to correct their record after one semester with subsequent sufficient improvements in academic performance so to maintain minimal standards as defined by the Graduate School, then they will lose benefits, including fellowships, tuition support, and stipend. This may require that they leave the program, either voluntarily or involuntarily. As per the Graduate Student Handbook for the Graduate School at the University of Utah, "Candidates for graduate degrees are required to maintain a 3.0 or higher GPA in course work counted toward the degree (i.e. courses on the program of study)."

The Graduate School's policy to remain in good academic standing is to maintain a 3.0 GPA or higher in coursework counted towards the fulfillment of degree requirements. The Biomedical Engineering students must remain in good academic standing with the Graduate School (i.e., GPA > or equal to 3.0) or risk probation and/or dismissal. If the student is on probation from the Graduate School, one semester is allowed to increase the student's GPA to meet the minimum GPA requirements before termination of the Tuition Benefit Plan and dismissal from the Graduate program. In addition, students must pass each of the core Biomedical Engineering courses and electives with a B- or better grade. If a student does not achieve a B- minus grade or better in all Biomedical Engineering core courses, one additional opportunity is allowed for remediation prior to dismissal from the Biomedical Engineering program. The student will be informed that there is a student academic deficiency as delineated in the Department Policies and Procedures and the Code of Student Rights and Responsibilities. The student, supervisory committee chair, Director of Graduate Studies, and Department Chair will be notified in writing. If the situation is not remedied, the Director of Graduate Studies will provide a letter of notification that the student has not remedied the deficiency, resulting in his/her termination.

Below is a list of common conditions that cause a student to be academically deficient within the Ph.D. program. If a student satisfies any of the conditions below, then the student is academically deficient unless a previous formalized arrangement is signed off with the Director of Graduate Studies for approved deviation from the corresponding academic requirement(s). Problem areas for dismissal concerns include:

- Failure to identify and research advisor by the end the first semester of graduate study
- Failure to establish a graduate supervisory committee and meet together by the end of the first year of graduate study
- Failure to have annual evaluations between the student and supervisory committee
- Failure to take the written comprehensive exam by the fall semester of the third year of graduate study
- Failure to pass the written comprehensive exam on the second attempt
- Failure to present the oral portion of the Ph.D. qualifying exam by the end of the spring semester of their third year
- Failure to pass either the written or oral portions of the Ph.D. qualifying exam by the date specified by the department chair, director of graduate studies, or the student's supervisory committee
- Failure to maintain a 3.0 grade point average as required by the Graduate School
- Failure to meet satisfactory progress as determined by the supervisory committee chair, Director of Graduate Studies or Department Chair
- Failure to meet any individualized requirements specified by student's supervisory committees and/or the Director of Graduate Studies as stipulated in writing
- Failure to graduate by the date specified in student's most recent letter of support, or within the 8-year time limit from matriculation into the Ph.D. program

Students who are remiss in satisfying any of these categories, or who fail to meet other requirements specified for their program, can be dismissed from the graduate program. In these cases, students must promptly appeal to the Director of Graduate Studies and Department Chair if they wish to continue in the program (these deficiencies may be pointed out to the student earlier). Dismissal from the Biomedical Engineering graduate program shall result in termination of graduate student support, stipends or funding.

Academic, Behavioral, and Professional Misconduct Policies

All Biomedical Engineering graduate students, as well as any students taking a Biomedical Engineering course or course cross-listed with Biomedical Engineering are required to read and understand the Department of Biomedical Engineering policy statement on academic misconduct and to sign and file the associated student acknowledgement form with the Department. See the department's misconduct policy on BME "Graduate Studies" webpage.

Academic misconduct includes, but is not limited to, cheating, misrepresenting one's work, inappropriately collaborating, plagiarism, and fabrication or falsification of information. It also includes facilitating academic misconduct by intentionally helping or attempting to help another to commit an act of academic misconduct.

The University's complete "Student Code" policy, Policy 6-400: Code of Student Rights and Responsibilities from the Regulations Library, includes the 7 sections listed below.

- Section I: General Provisions and Definitions – ACADEMIC SANCTION
- Section II: Student Bill of Rights
- Section III: Student Behavior – STANDARDS OF BEHAVIOR
- Section IV: Student Academic Performance
- Section V: Student Academic Conduct
- Section VI: Student Professional and Ethical Conduct
- Section VII: Student Records

"Students at the University of Utah are members of an academic community committed to basic and broadly shared ethical principles and concepts of civility. Integrity, autonomy, justice, respect and responsibility represent the basis for the rights and responsibilities that follow. Participation in the University of Utah community obligates each member to follow a code of civilized behavior."

"The purposes of the Code of Student Rights and Responsibilities are to set forth the specific authority and responsibility of the University to maintain social discipline, to establish guidelines that facilitate a just and civil campus community, and to outline the educational process for determining student and student organization responsibility for alleged violations of University regulations. University policies have been designed to protect individuals and the campus community and create an environment conducive to achieving the academic mission of the institution. The University encourages informal resolution of problems, and students are urged to discuss their concerns with the involved faculty member, department chair, dean of the college or dean of students. Informal resolution of problems by mutual consent of all parties is highly desired and is appropriate at any time."

"Section VI. A. Standards of Professional Conduct – To ensure that the highest standards of professional and ethical conduct are promoted and supported at the University, students must adhere to the prescribed professional and ethical standards of the profession or discipline for which the student is preparing, as adopted or recognized as authoritative by the relevant academic program." "Section VI. B. Professional Misconduct – A student who engages in academic misconduct may be subject to academic sanctions including, but not limited to, a grade reduction, failing grade, probation, suspension or dismissal from the program or the University, or revocation of the student's degree or certificate. Sanctions may also include community service, a written reprimand, and/or a written statement of misconduct that can be put into an appropriate record maintained for purposes of the profession or discipline for which the student is preparing."

Program Suspension and Dismissal Policies

Matriculated graduate students in the program who fail to comply with performance expectations in either their graduate research and/or didactic coursework, and/or with codified university policies for graduate conduct (including plagiarism) can be dismissed from either the Department's academic program or from the Graduate School, or both.

Student's progress, academic and research performance is evaluated annually in meetings held with students and their Supervisory Committees. These meetings are considered formal reviews of student progress in the program and are the student's responsibility to initiate and complete. Failure to produce this annual review and reporting is considered a major student programmatic deficiency. Should any issues regarding continuation in the program arise, these issues will be discussed at the Committee level and documented with the student, first in a formal letter emanating from the Director of Graduate Studies (with input from the faculty advisor after faculty meeting discussions) followed by discussion with the faculty advisor.

However, individual faculty members can coordinate with the Director of Graduate studies to initiate the dismissal process of a student from the Biomedical Engineering graduate program and/or the Graduate School at any time for failure to meet the academic requirements of the program and for academic or professional misconduct. An ad hoc committee of faculty may be called to arbitrate if necessary. Final decision is provided to the student by the Department Chair.

12. LABORATORY PERFORMANCE AND EXPECTATIONS

Research creativity, consistent productivity, evident progress, independence and motivation are the hallmarks of successful graduate student performance. Those students who perform in their academics and research generally succeed and proceed expediently through the graduate program. Unfortunately, unsatisfactory student performance and progress in their graduate research program can result in their dismissal from the program and loss of stipend support. University policy 6-309 Section D Orderly Dismissal) provides a basis for this evaluation and dismissal process.

Section III.D.1 states:

“Performance Evaluation. Any person appointed according to the provisions of this section may be dismissed for cause. The individual’s designated supervisor shall provide timely informal evaluations of the individual’s job performance and make conscientious efforts to assist the individual to correct any unsatisfactory aspects of job performance. If unsatisfactory aspects of job performance persist, the supervisor must provide the individual with a written statement of difficulties and a reasonable time in which to correct them.”

The Department faculty supervising the student reserves the right to dismiss students who, after notice of their sub-optimal performance and deficiencies, fail to either perform to expected standards or to exhibit an acceptable trajectory of substantial improvement, effort and motivation. Department policy mandates that the student will be provided written notification of the advisor’s dissatisfaction and evidence for failure to progress or insufficient research performance.

Upon meeting with the research advisor, the student shall sign this written notice, acknowledging the meeting’s occurrence (whether they agree with the assertions or not) and this document will be placed in their graduate file.

The student can lodge a protest with their supervisory committee first, then the Chair, and if also use the University’s appeal process desired to counter these assertions. Following this meeting, the student will be given a 6-week probationary period to change their performance as prescribed and produce tangible evidence of improvement and productivity. A second student-advisor meeting at this 6-week time-point will produce a second written evaluation of the student’s performance and evidence asserting either improvements, further concerns or non-improvements as evidence of failure to progress. Another second 6–week period will be the final evaluation period.

At termination of 12 weeks, the student is provided a written permission from the advisor to continue in their specific research program or for dismissal from that advisor/mentor’s group based on specific cited criteria for poor productivity, poor performance, sub-optimal motivation or failure to progress.

The student can remain in the department’s graduate program, but without support/stipend, as long as they remain in good academic standing, but must find another willing faculty mentor to produce a qualified research project that satisfies department graduate program requirements in order to finish their degree. This policy does not supersede current student rights accorded by the University’s Policy and Procedures Manual (PPM), and its references to student participation in formal Family Leave or Medical leave policies and procedures.

Responsible Conduct of Research

The National Science Foundation (NSF) and the National Institutes of Health (NIH) require appropriate training in the Responsible Conduct of Research (RCR) for certain types of grants. RCR instruction must be undertaken at least once during each career stage, and at a frequency of no less than once every four years.

The NSF requirements apply to all postdoctoral scholars, graduate and undergraduate students participating on a funded project. The NIH policy requires inclusion of a plan to receive RCR instruction in applications of most types of training grants including fellowships, career development awards, research education grants, and dissertation research grants.

13. FINANCIAL SUPPORT AND TUITION

Biomedical Engineering graduate students at the University of Utah are often supported by Graduate Research Fellowships through the College of Engineering, Research Assistantships, Teaching Assistantships or Extramural Fellowships. Financial support is a privilege and intended to support direct, efficient progression of the student through their graduate experience.

Admission to the Ph.D. program generally includes a research-based Research Assistantship and stipend or salary provided by the research advisor. Note: this salary is not guaranteed. It is based on the availability of research funding from various sources (grants and contracts). A subsidy may be provided for individual health insurance at the research advisor's discretion, but is not required or expected.

Financial support for the period in which the student is conducting dissertation research is the responsibility of the student's faculty mentor and is normally derived from faculty research grants. No Departmental funds are available for this purpose; no guarantees for graduate student financial support come from the Department, although it attempts to mediate extenuating circumstances and unusual hardships as resources allow.

Hence, the award of a Research Assistantship is considered a privileged position for each student, one to be respected, and should be considered the primary means of support for the primary focus of the student in the program: expedient and efficient pursuit of the graduate degree.

Financial support may also be rescinded by supervising faculty for documented student failure to progress both in research and in performing to minimal academic standards. Although this can be a unilateral advisor decision, faculty-student relationships would best enroll the advice of the student's supervisory committee before withdrawing stipend support. Additionally, the University Policies and Procedures Manual provides specific recommendations and process for addressing "failure to progress" and other student performance deficiencies with documentation, warnings, and written responses.

Differential Tuition

Per current College policy, all students, regardless of class standing, will be charged an additional College of Engineering differential fee per credit hour for graduate level courses in the College of Engineering. This differential tuition is not included as part of the Graduate School's tuition benefit program and must be paid by the student. Please see the Income Accounting Tuition website detailed tuition and fee rates.

Other Fees and University Expenses

- **Special Course Fees.** For those courses requiring them, special fees are shown in a column of the course listings. These fees, which must be paid with tuition, are in addition to regular tuition and mandatory fee charges.
- **Mandatory Fees.** The mandatory fees include the following fees: ASUU Activity, Athletic, Building, Collegiate Reader Program, Computing, Fine Arts, Utilities, Health, Library, Publication Council, Recreation, Study Abroad, Sustainability, Money Management and Transportation. The amounts for these fees are included in the Tuition and Fee schedule listed above.
- **Health Insurance.** All BME graduate students are required to have documented health insurance.
 - Subsidized insurance is available to TAs and RAs who are receiving a full 100% tuition benefit. They may hold both a TA and an RA position (with the total adding up to 100% tuition benefit) to qualify. The insurance is the same Student Health Insurance policy offered to all U of U students. Coverage for dependents is not subsidized. Qualifying students are billed for 20% of the premium through Income Accounting and the Graduate School pays the remaining 80% at the start of the semester.
 - If not qualified for the TBP-subsidized insurance Program, students are responsible to purchase their own health insurance. Policy and premium information is available from University Student Health Services.

See the "Student Health Insurance" section to follow.

14. FELLOWSHIPS AND ASSISTANTSHIPS

Fellowships

Students are encouraged to continually seek out and apply for university, state, national and international fellowships to supplement or replace their stipend support. Although faculty advisors determine support levels, fellowship support is a distinction, and therefore, all fellowship support should remain the property of the student receiving this honorary award, with stipend support adjusted at the faculty advisor's discretion. Stipend and fellowship support levels are determined by the faculty advisor although it is recognized that fellowship support is a distinction, and therefore, all fellowship support should remain the property of the student receiving this honorary award, with stipend support adjusted per advisor discretion. Additionally, students are encouraged to continually seek and submit their own fellowship applications from numerous university, national and international agencies that sponsor these awards.

Extramural Fellowships

A current listing of Extramural Fellowships is available online through the Graduate School.

Research Fellowships

Several outstanding Biomedical Engineering students receive support each year from fellowship administered through the College of Engineering. The Department Scholarship Committee nominates these students based on the application information provided and the Department Chair must support their nomination in writing. Additional information regarding the College of Engineering fellowships can be found on the College of Engineering website.

Research Assistantships (RA)

Individual faculty members from the Department of Biomedical Engineering offer Research Assistant or RA positions, supported by research grants and contracts, to a vast majority of graduate students. The Department recommends that stipends offered to students align with NIH pre-doctoral level of support for Ph.D. students. In addition, students receive tuition waivers through the Graduate School's Tuition Benefit Program (TBP).

The Graduate Admissions Committee can assist students with identifying potential faculty sponsors, but ultimately, it is student's responsibility to secure an RA position, stipend and benefits.

During on-campus admissions interviews and after acceptance to the Biomedical Engineering Graduate Program, students are strongly encouraged to arrange interviews with potential faculty advisors to sponsor an RA position.

Continuation of tuition waivers, stipend and increases are contingent upon continuous enrollment, rules of The Graduate School, and satisfactory progress in the BME graduate program.

Teaching Assistantships (TA)

Teaching Assistantships provide Ph.D. students with valuable pedagogical leadership experiences and mentoring opportunities. The Department determines which Biomedical Engineering undergraduate and graduate courses will utilize TAs. Duties may include lecturing, holding discussion or problem sessions, conducting laboratory sections, grading, tutoring and holding office hours.

Ph.D. students must first fulfill the 4 required credit hours of TA Mentorship (BME 7880) prior to accepting a paid Teaching Assistantship. See the PhD Program requirements section for more details

Teaching Assistantship Time Commitment:

- A "Half TA" assignment requires a time commitment of 10 hours per week for the duration of each semester. PhD students may earn 2 credits of BME 7880: TA Mentorship by fulfilling a Half TA assignment.
- A "Full TA" assignment requires a time commitment of 20 hours per week for the duration of the semester. PhD students may earn 4 credits of BME 7880: TA Mentorship by fulfilling a Full TA assignment.
- In rare cases, courses may need a "Quarter TA", which would require a time commitment of 5 hours per week for the duration of each semester. PhD students may earn 1 credit of BME 7880: TA Mentorship by fulfilling a Quarter TA assignment.

Teaching Assistantship requirements also include:

- TAs are required to strictly abide by the regulations set forth in the Family Educational Rights and Privacy Act or FERPA. This federal law protects the privacy of educational records of students.
- TAs are required to attend a mandatory training provided by the College of Engineering within the first 2 weeks of Fall Semester. The Department will notify TAs of the date, time and location.
- TAs are required to meet with their assigned course instructor(s) prior to the beginning of the semester to initiate organization and to identify the expectations of the TAs role and duties.
- TAs are required to attend all lectures of their assigned course(s) and be sufficiently familiar with the materials covered in both the class and the homework to tutor the content.
- TAs are expected to contribute in a substantive way to the pedagogical needs of their assigned course(s). The instructor and the nature of the course determines these needs. For example, TAs should expect to undertake one or more of the following activities: 1) deliver one or more course lectures, 2) lead problem-solving or discussion sessions prior to exams, or 3) grade exams.
- The TA requirement of 4 credits must be completed by the end of student's 4th year of Ph.D. graduate study, and prior to the end of their TBP, but may be completed prior to this time if a student volunteers or is asked for a TA course assignment.
- The Teaching Assistantship requirement is for credit and is not eligible for consideration of a paid position until the four 7880 credit hours have been completed. However, financial stipend support will continue from the student's research advisor. Thereafter, additional financial support will be determined by the Department.
- TAs are required to be proficient in the English language in order to effectively interact with students in a leadership and pedagogical manner. To be eligible for the Tuition Benefit Program for teaching assistantships, the Graduate School requires all non-native English speaking graduate students to be cleared by the International Teaching Assistant or ITA Program prior to any teaching exposure. Therefore, clearance from the ITA Program is a compulsory requirement for all international students.
- TA workshops, as well as online teaching resources are available through the Center for Teaching and Learning Excellence (CTLE).
- Student TAs are not allowed to provide formal didactic lectures without a department faculty or faculty or record in the classroom; or prior review and approval of the lecture presentation.
- For all other students, TA and Grader positions will be made available at the discretion of the Department Chair.

15. OUTSIDE EMPLOYMENT

The Department of Biomedical Engineering considers a full-time research stipend for graduate support to be a full-time traineeship, with the privilege of support, and expectation of long and irregular hours required for successful degree completion. Responsibilities of such conditions of graduate study preclude the pursuit of other gainful employment without interference with doctoral program progress.

Therefore, students are strongly discouraged from engaging in employment outside of the Department. Such arrangements must be approved in writing and in advance of the situation, from both the faculty advisor and supervisory committee. If a student is employed outside the Department, the student's supervisory committee and department faculty will monitor whether such employment interferes with the expectations of the program (i.e. the student's progress in course and research work, research or other program requirements). Outside employment includes employment, internships or other "out of lab" training that occurs at the University of Utah (e. g. Lassonde internship, Center for Medical Innovation internship, Bench to Bedside competition, etc.) or outside the University of Utah (e. g. employment at a private / public corporation).

If the supervisory committee or department faculty determines that outside employment is unduly interfering with the student's doctoral progress, the student may be asked to reduce their outside employment commitments or to leave the program.

16. TUITION BENEFIT PROGRAM

Administered by the Graduate School, the Tuition Benefit Program (TBP) provides payment of general graduate tuition and mandatory fees for eligible graduate students who are compensated through the University of Utah. Students receiving this benefit are responsible to pay all differential tuition and non-mandatory fee charges.

Categories of Supported Graduate Students

The four eligible classifications qualifying a student for TBP participation are:

- Graduate Research Assistant (RA) with Exempt job code 9314: Students assigned directly to an externally funded research grant (5000 fund) and performing research for that project.
- Graduate Assistant (GA) with Exempt job code 9330: Students assigned work related to their degree program and not covered in the previous category. A GA must be funded from within their payroll department and not supported by external grant funding.
- Graduate Teaching Assistant (TA) with Exempt job code 9416: Students with instructional responsibilities as the instructor of record, assistant to the instructor of record, or tutor. International students must be cleared through the International Teaching Assistant Program before being assigned a TA position.
- Graduate Fellow (GF): Students on a fellowship, whose tuition is not paid by their award. If tuition is included in a student's fellowship award, the student may not also use the tuition benefit. The University must administer the award and a service expectation may or may not accompany it.

Graduate School Requirements for TBP

- Students must be matriculated and in good standing.
- Students must maintain the Graduate School's minimum cumulative GPA of 3.0.
- Students must be registered for a minimum of 9 credit hours (full-time for graduate students) for the duration of both fall and spring semesters.
- Students must meet minimum financial support levels indicated on the TBP website. These levels vary by semester/year. Financial support must be paid through the University of Utah.
- Non-resident, non-international graduate students receiving the tuition benefit must apply for Utah residency upon completion of 40 semester credit hours at the University of Utah per Graduate School policy. This is to avoid billing the university for out-of-state student tuition at unnecessary out of state rates. Additional information regarding the Residency for Tuition Purposes policy is available on the Office of Admissions website, as well as the Residency Reclassification Application.
- Both, students and the Department are responsible for maintaining an accurate count of the semesters students receive TBP support. If students receive TBP support for more semesters than they are eligible, they may be retroactively billed and liable for tuition (in-state or out-of-state if not UT resident) for ineligible semesters.
- Students covered by TBP support who withdraw mid-semester or fail to comply with TBP requirements mid-semester (or summer) may be required to re-pay TB support (in-state or out-of-state if not UT resident).

Tuition Benefit Coverage Guidelines

- For GAs, TAs, and GFs, the tuition benefit covers 9-12 credit hours in fall and spring semesters (only).
- For RAs, the tuition benefit covers 9-11 credit hours in fall and spring semesters, and 3 credit hours in summer semester.
 - For summer semesters, the tuition benefit is only available to RAs who were classified on TBP and paid as 100% RA in the preceding fall and/or spring semesters, and who will continue to be classified and paid as an RA in summer semester.
 - Summer TBP covers only 3 credit hours and students must register for 3 credits to be eligible.
 - Summer semesters do not count against the total number of semesters students are eligible for the tuition benefit.

- The TBP covers student's non-resident tuition in full, with the exception of RAs who exceed 84 cumulative credit hours. In the semester an RA exceeds 84 cumulative credit hours, the tuition benefit will cover only resident tuition amounts. To avoid being charged non-resident tuition, non-resident RAs who have completed their required coursework should only register for 9 credit hours of BME 7970: Ph.D. Thesis Research.

Restrictions

- The recommended Full-Time Equivalent (FTE) maximum is 0.50 (20 hrs/week) and cannot exceed 0.74 FTE. Other paid positions on campus (internships, tutoring, etc.) are counted toward the student's FTE.
- Courses designated as undergraduate (below 5000 level), contract, audit, repeat, and credit/non-credit will count toward the required minimum of 9 credit hours, but do not qualify and will not be paid for by the tuition benefit.
- The tuition benefit program will not pay for any withdrawn credit hours, and if a student's registration falls below 9 credit hours at any time during the semester, they will become ineligible for tuition benefit support and will be billed full tuition for that semester.
- Students may register for the maximum of 16 credit hours, but will be responsible to pay all tuition and fee amounts above 12 credit hours (or 11 for RAs).
- Non-matriculated students, part-time students, and students on academic probation are not eligible to participate in the tuition benefit program.

Semester Limits

Students are limited in the number of semesters, which are not required to be sequential, that they may participate in the tuition benefit program.

- Students enrolled in the M.S. program are limited to 4 semesters (2 years) of tuition benefit support.
- Students who enter the Ph.D. program with a bachelor's degree are limited to 10 semesters (5 years) of tuition benefit support.
- Students enrolled in the Ph.D. program who receive(d) a master's degree from the University of Utah are limited to 10 semesters (5 years) total of tuition benefit support, 4 semesters (2 years) for a master's degree and 6 semesters (3 years) for a doctorate degree. The 4 semesters of TBP designated to the master's degree do not carry over to the doctoral degree if not used. Therefore, students who earn a master's degree from the University of Utah are eligible for a maximum of 6 semesters (3 years) of TBP for their PhD program
- Students who enter the Ph.D. program with a master's degree from another university are eligible for 8 semesters (4 years) of tuition benefit support.

Additional information regarding the Tuition Benefit Program and its policies is available on the Graduate School's website under Fellowships and Benefits.

17. STUDENT HEALTH INSURANCE

Subsidized Graduate Student Health Insurance

Subsidized student health insurance is available to TAs and RA's who receive 100% tuition benefit. Students who qualify will be enrolled in the insurance plans by the Tuition Benefit office during the open enrollment period for the semester. The Tuition Benefit office will pay 80% of the insurance premium and the students will be billed the remaining 20% on their tuition account after the open enrollment period closes.

Insurance coverage is not subsidized for spouses or dependents. However, students may purchase dependent insurance plans at their own expense, directly through United Healthcare for standard health insurance and EMI Health for vision and dental insurance.

Additional information regarding Subsidized Graduate Student Health Insurance is available on the Tuition Benefit Office website.

Non-Subsidized Graduate Student Health Insurance

Students who do not qualify for subsidized student health insurance may purchase their own insurance through the University Student Health Center. Students must be registered for a minimum of 3 credit hours to qualify to purchase the University of Utah contracted student health insurance plans. These plans are the same as the subsidized student health insurance plans.

International Student Health Insurance

The University requires all new, transfer or readmitted international students to be automatically enrolled in the University of Utah Student Health Insurance Plan administered by United Healthcare Student Resources. For more information about student insurance, including cost please visit www.uhcsr.com/utah. International Student who qualify for and request the Subsidized insurance coverage through the Tuition Benefit Program will be refunded the automatic charge; however, the 20% student portion will still be charged as indicated above.

If you have an existing insurance plan, you may be eligible to apply for a waiver from the insurance requirement. Your existing plan must have coverage that equivalent to or better than the plan offered by the University. Travel insurance plans do not qualify. For information regarding the waiver process contact the International Student Scholar Services (ISSS) office: <https://iss.utah.edu/students/orientation-arrival/health-insurance.php>

18. PARENTAL LEAVE POLICY

Parental Leave for Employees

Parental leave is available to full-time graduate students who are employed part-time in a research lab and in good standing following the birth or adoption of a child who will serve as the primary caregiver to their own or their partner's newborn or newly adopted child during the requested leave time.

Students who become new parents are entitled to six weeks of parental leave with full pay, and an additional six weeks of parental leave without pay, during which students will retain their benefits. Students will also receive their normal financial compensation for the duration of the leave, provided that they 1) use their vacation allowance during that year as part of the parental leave, and 2) the research advisor and/or Department can provide this funding commensurate with University policies and procedures for funded projects.

To request parental leave, students must submit the Parental Leave of Absence request in writing to the Department prior to the expected arrival of the child. Under normal circumstances, students should arrange the parental leave time with their advisor and the Department at least 30 days in advance. The parental leave should be complete within six months of the arrival of the new child, and may only be taken for purposes relating to childcare.

Upon approval, the parental leave will begin on the date requested, and students will be released from professional duties and not be expected to maintain scholarly productivity for the duration of the approved parental leave.

No extensions of this leave will be granted. If additional time is required due to medical and/or other reasons, an unpaid, formal Leave of Absence from the program should be requested through the Office of the Registrar.

The Director of Graduate Studies must approve exceptions to these and other eligibility criteria.

Students who experience a medical condition associated with their pregnancy and need accommodations recommended by their medical provider should review the Pregnancy and Pregnancy-Related Accommodations online, where the Pregnancy Accommodation Request form is available and which is a service provided by the Office of Equal Opportunity, Affirmative Action, and Title IX.

Leave of Absence from Academic Program

Please see the "Graduate School Registration Requirements" section above for information regarding leave of absence policies for domestic and international students. Please also refer to the leave of absence policy information on the Graduate School webpage. A leave of absence from the student's academic program for up to one year must be approved by the student's supervisory committee and the director of graduate studies or department chair. If additional time is required, an additional request must be approved and submitted to the Registrar's Office. Access the Leave of Absence request forms on the Registrar's website.

Disability Access and Accommodation

For information regarding disability access and accommodation, and the Americans with Disabilities Act (ADA), please visit the Office of Equal Opportunity, Affirmative Action, and Title IX.

Students requesting accommodations should contact the Center for Disability and Access to schedule an appointment. Students may also access the Process for Students Requesting ADA Accommodations, the Center for Disability and Access Student Handbook, and the Documentation Guidelines through the How to Qualify for Services website.

19. SAFETY AND WELLNESS

Your safety is our top priority. In an emergency, dial 911 or seek a nearby emergency phone (throughout campus). Report any crimes or suspicious people to 801-585-COPS (2677); this number will get you to a dispatch officer at the University of Utah Department of Public Safety (DPS; dps.utah.edu). If at any time, you would like to be escorted by a security officer to or from areas on campus, call DPS for assistance.

The University of Utah seeks to provide a safe and healthy experience for students, employees, and others who make use of campus facilities. In support of this goal, the University has established confidential resources and support services to assist students who may have been affected by harassment, abusive relationships, or sexual misconduct. A detailed listing of University Resources for campus safety can be found in the University of Utah Student Handbook found on the Registrars' Office website at: <https://registrar.utah.edu/handbook/campussafety.php>

20. DISCLAIMER

Although some content herein is recommended for best practices as a graduate student in the Department, other university and department policies described in this handbook are intended to be read, understood and followed by all department graduate students. Violations of university and department policies are grounds for immediate dismissal from the program. Policy exceptions may be made in well justified cases that are petitioned in writing by the student and supported by the student's committee. No policies or recommendations in this Handbook are intended, interpreted or construed to conflict with or violate standing College or University policies except where allowed. Given such a university conflict without allowance, this Handbook defers to standing universities policies and expectations.