

Graduate Student Handbook

2009-2010

Department of
Biomedical Engineering



UNIVERSITY OF MINNESOTA

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Location and Contact Information

Department's Main Mailing Address:

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Graduate Student Mailboxes:

Located in the Department Reception Area, 7th floor NHH

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After-Hours Building Access

Students who have an adviser with lab space in Nils-Hasselmo Hall (NHH) or Shepherd Laboratories will be authorized for after-hours access to the relevant building. After hours-access to NHH and its labs is granted through use of the U-Card, your University of Minnesota identification card. After-hours access to Shepherd Labs requires the U-Card and a key. Key request forms are available from the Undergraduate or Graduate Program Coordinators in room 7-105 NHH, or on the department website at <http://www1.umn.edu/bme/PDFFiles/pdf/Key%20Request.pdf>. A key deposit (\$5.00, \$10.00, or \$20.00 per key, depending on the room type) must be submitted along with the key request form.

Lab Safety Training

New graduate students in the BMEGP *must* complete the online lab safety training, or they will not be granted lab access. The online training can be accessed using the X.500 user ID and password. ALL of the following training modules must be completed:

- Intro to Research Safety <https://www.dehs.umn.edu/training/labsafety/introduction>
- Chemical Safety <https://www.dehs.umn.edu/training/labsafety/chemicals>
- Chemical Waste Management <https://www.dehs.umn.edu/training/labsafety/waste>
- Radiation Safety <https://www.dehs.umn.edu/training/rpd/orientation/homepg.php>
- Preventing Employee Exposure to Bloodborne and Other Pathogens
http://www.dehs.umn.edu/bio_pracprin_blood_bpt.htm

Council of Graduate Students (COGS)

The Council of Graduate Students, (COGS) is the official governing body representing graduate students at the University. COGS provides opportunities for graduate students to participate actively in University and Graduate School administrative and policy decisions. Students may contact COGS at the University of Minnesota, 405 Johnston Hall, 101 Pleasant St. S.E., Minneapolis, MN 55455 (612) 626-1612; e-mail cogs@umn.edu; www.cogs.umn.edu.

E-Mail and Wireless Accounts

E-mail is the University's official means of communication with students. Students are responsible for all information sent via their University e-mail account. Students who forward their University e-mail account are still responsible for all the information, including attachments, sent to the account.

The Office of Student Finance (OSF) uses e-mail as the means of sending tuition bills to all University of Minnesota Twin Cities students. Students who primarily use a different e-mail account (e.g., hotmail, gmail, etc.) must regularly check their University-assigned e-mails for University communications such as tuition bills. Students have the option of forwarding their University-assigned e-mails to another preferred account (go to <http://www.umn.edu/dirtools>).

Students who choose to use their personal computers on campus must register their computer with U-Network at <http://www1.umn.edu/wireless/gettingstarted.html> in order to access the University's wireless network.

Responsible Conduct of Research

The Graduate School mandates that all graduate students receive the equivalent of eight hours of instruction in Responsible Conduct of Research. All graduate students in BME are required to attend Responsible Conduct of Research instruction as follows:

- Complete four hours of Research Ethics Training (part of BME Department Orientation)
- Attend one Center for Bioethics Seminar each semester in which you take BMEn 8601/8602: Biomedical Engineering Seminar

Contact the Graduate Program Coordinator with any questions about the Responsible Conduct of Research requirements.

Advising Information

General Advising

At the start of graduate study in the Biomedical Engineering Graduate Program (BMEGP), students will be able to consult as necessary with the Director of Graduate Studies (DGS) or with the Graduate Program Coordinator.

The DGS serves as the initial adviser for all incoming graduate students and can assist with course planning, adviser selection, etc.

The Graduate Program Coordinator can assist students with most administrative matters, such as Graduate School paperwork, departmental policies, or course permission numbers. Graduate School forms are

available at http://www.grad.umn.edu/current_students/forms/doctoral.html (PhD students), http://www.grad.umn.edu/current_students/forms/masters.html (MS students), or from the literature rack at the Graduate School (3rd floor Johnston Hall). Department-specific forms are available at <http://www1.umn.edu/bme/html/students.html>, or from the Graduate Program Coordinator in 7-105 NHH.

Students are responsible for keeping their *BME Graduate Program Handbook* until they have graduated from the program, since the handbook contains the particular degree requirements that pertain to each entering class. Students are also responsible for knowing and adhering to the relevant rules and procedures described in the *Graduate School Catalog* (<http://www.catalogs.umn.edu/grad/index.html>), and the relevant rules and procedures on One Stop (<http://onestop.umn.edu/onestop/registration.html>).

Choosing Your Adviser

All students must eventually identify a permanent adviser, who will guide advisees in choosing their remaining coursework, thesis/project research, and examination committees.

Part-Time and/or Unsupported Students

Because the time to degree completion for part-time students varies so greatly, there is no set procedure or timeline for them to find a permanent adviser. Part-time students should, however, have an adviser assigned by no later than one semester prior to taking the thesis/project credits. Until that time, the DGS will continue to serve as the adviser.

Full-Time Supported Students: Lab Rotations

Full-time supported students must identify a permanent adviser during the fall semester of the first year. In addition to providing academic and research advice, the adviser will also provide financial support for advisees from his/her research grants.

In order to facilitate the adviser selection process, the department requires that all students complete three-week lab rotations with three different faculty members. The rotation/selection schedule for Fall 2009 is as follows:

Fri 8/28	BME Orientation: students are provided with list of possible rotations; faculty presentations begin
Mon 8/31	Students turn in first rotation preferences after faculty presentations
Tue 9/1	First rotation is assigned and announced to faculty and students
Wed 9/2-Fri 9/18	Rotation 1
Mon 9/14	Students turn in second rotation preferences
Thu 9/17	Second rotation is assigned and announced to faculty and students
Mon 9/21-Fri 10/9	Rotation 2
Mon 10/5	Students turn in third rotation preferences
Thu 10/8	Third rotation is assigned and announced to faculty and students
Mon 10/12-Fri 10/30	Rotation 3
Fri 10/30	Students rank adviser preferences of their three rotations. Students may also list alternative advisers with whom they did not rotate, but those must be ranked separately.
Fri 11/6	<i>Student-Adviser pairings are announced</i>

New students who have at least two years of full support (fellowships or traineeships) are still required to do rotations but may submit their choices for adviser anytime before May 15 of the first year. Students with traineeships should check with the stipulations of the training grant regarding the timing of adviser selection.

Graduate Assistantships and Financial Support

Please note that this section applies only to students who were guaranteed financial support in their offer letters.

All graduate assistants at the University of Minnesota should be familiar with the policies governing graduate student employment as outlined by the Office of Human Resources (200 Donhowe Building) at <http://www1.umn.edu/ohr/gae/index.html>. Any questions about payroll, health benefits, or tuition benefits should be directed to the BME Administrative Professional.

Financial support for graduate assistants in Biomedical Engineering is broken down into three categories: Fellowships, Research Assistantships, and Teaching Assistantships

Fellowships

Until the date student-adviser pairings are announced, full-time students without their own external or internal fellowships will be paid with fellowship funds provided by the department. These are service-free fellowships that come with no obligation other than to be registered for a full course load (13-14 credits, as advised by the DGS) and to submit adviser choices by the deadlines outlined above. Failure to complete at least 13 credits during the fall semester of the first year, *unless pre-approved by the DGS*, constitutes failure to make satisfactory progress and may result in the termination of support.

Research Assistantships

Once students are paired with an adviser, they will be paid almost entirely from the adviser's research grant(s) as a Research Assistant (RA). This is a service-based assistantship requiring students to perform research related to the adviser's grant-funded projects while also completing coursework for the degree.

Teaching Assistantships

At least once every four semesters (but no more than once every three semesters), supported full-time students are required to serve as Teaching Assistants (TA's). Depending on the TA assignment, students will be expected to spend an average of 10-20 hours per week on instruction-related duties. Normally, students do not serve as a TA until their second year of graduate work (it is rare but possible to be assigned a TA-ship during the spring of the first year). At the beginning of summer, students are asked to indicate the course(s) for which they would like to TA during the next academic year. Final TA appointments are assigned by the Department Head. Students on external fellowships that do not permit teaching assistantships should discuss their individual cases with the Director of Graduate Studies.

New TA Orientation

All students will be required to attend the New TA Orientation offered by the University's Center for Teaching and Learning at the start of the fall semester preceding their first TA assignment, as directed by the DGS. Students typically complete this orientation at the beginning of their second year in the program.

SPEAK Test (International Students)

University policy states that all nonnative English speakers acting as TA's must pass the SPEAK test with a score of 55-60 (campus rating of 1 or 2). For more information about the SPEAK test, contact the Center for Teaching and Learning at University Office Plaza, Suite 400 (612-625-3041; teachlrn@umn.edu; <http://www1.umn.edu/ohr/teachlearn/nonnative/index.html>). Students who do not pass the SPEAK test with a score of 1 or 2 will be required to enroll in supplemental English language skills coursework until they pass the test. Those who do not fulfill the departmental requirement to serve as a TA jeopardize their graduate appointment, so passing the SPEAK test is imperative. Students who receive a 2 may be required to enroll in GRAD 5105 (Practicum in University Teaching for Nonnative English Speakers) at their expense.

Compensation

Paychecks are issued every other Wednesday. The first paycheck of the fall semester will be issued September 23, 2009. The pay period and pay day schedule is available online at <http://www1.umn.edu/ohr/compensation/paytaxes/paydays/index.html>. Students should complete a *Direct Deposit Authorization Form* (available in the orientation packet or from the Department Administrator) to have their pay deposited directly into a bank account. Those who opt for direct deposit can view their pay statements on line at <http://hrss.umn.edu/>.

Health Benefits

All new and continuing students holding a University of Minnesota fellowship or at least a 25% graduate assistantship are eligible for coverage on the Graduate Assistant Health Plan. See the Department Administrator for an Enrollment Packet. Submit the Enrollment Form as soon as possible to the Graduate Assistant Insurance Office (N323 Boynton Health Service, 612-625-6936). The deadline to submit an enrollment form for fall semester coverage for most students is September 18, 2009. All graduate assistants who are eligible for the graduate health insurance will be charged a monthly premium fee.

The University will contribute to the summer premium for graduate assistants who were enrolled in the plan spring semester unless they fill out a Change or Cancellation of Coverage form (http://www.shb.umn.edu/twincities/ga/TC_Grad_Change_or_Cancel_Form.pdf). All Biomedical Engineering graduate students are required to pay their portion of the graduate assistant health care plan premium costs.

Complete information regarding graduate assistant health insurance is available at <http://www.shb.umn.edu/twincities/graduate-assistants.htm>. For information regarding enrollment, eligibility requirements, or general questions, contact the Graduate Assistant Insurance Office (N323 Boynton Health Service, 612-625-6936, umgahbo@umn.edu).

Should a student suffer an injury while performing duties as a graduate assistant, he/she must notify the supervisor as soon as physically possible following the injury. The supervisor will assess the situation, assist with arranging proper medical care, and begin the injury reporting process. Further information on the University of Minnesota's Workers Compensation policy is available at http://process.umn.edu/groups/ppd/documents/Policy/workers_comp.cfm.

Course Registration

General Policies

Registration for each semester begins approximately one month prior to the end of the previous term. Each student is required to register every fall and spring semester to maintain active status in the Graduate School. Students must re-apply for admission to the Graduate School if their student status becomes inactive. For more information see the Graduate School's policy at http://www.grad.umn.edu/current_students/registration/active_status.html.

The deadline for Fall 2009 registration is Monday, September 7, 2009 (the day before classes start). Students registering after this date will be assessed a late fee. Please see the One Stop registration web site at <http://onestop.umn.edu/onestop/registration.html> for complete information about fall semester registration. To register online, click on "Web registration," and log in using the X.500 and password.

All new graduate students should meet with the DGS to review their initial registration following orientation, as necessary. Thereafter, continuing graduate students should register with the approval of their assigned adviser.

For supported full-time students, failure to complete at least 13 credits during the fall semester of the first year, *unless pre-approved by the DGS*, constitutes failure to make satisfactory progress and may result in the termination of financial support.

Holds

Students must clear all registration holds each semester before they will be permitted to register. Student can monitor their holds by going to <http://onestop.umn.edu/onestop/registration.html> and clicking on “Holds” on the right (under “Quick Links”). A new student who has the hold “BACH DEGREE” on record must submit an official transcript or other evidence of graduation from the undergraduate institution to the Graduate Office of Admissions, 309 Johnston Hall. For any other holds, contact the office/department that placed the hold for instructions on how to clear it.

Approvals/Permissions

Registration for some courses may require approval from the department offering the course. Students who have questions or need registration approvals should speak to the Graduate Program Coordinator prior to the start of the semester.

Student Fees and Payment

Students are responsible for paying all fees by the due dates defined on the original fee statements. Fee statements are mailed, emailed, or printed for students shortly after registration. Students who are financially supported by the department will typically have fall and spring tuition covered by their fellowships or graduate assistantships. The cost of the student services fees and related fees, however, are assessed to all students registered each semester and are not covered by any departmental funding. Billing and payment information can be found at: <http://www.onestop.umn.edu/onestop/tuition.html>.

Course Numbering System

The University of Minnesota uses a four-digit course numbering system. Graduate students typically fulfill their course requirements by registering in courses at the 5xxx and 8xxx levels. In some cases (e.g., research-related coursework in a field/department that is outside the student’s previous experience), and with pre-approval of the adviser and DGS, a 4xxx-level course may be used toward degree course requirements. DGS pre-approval may be granted occasionally for a course at the 6xxx or 7xxx levels.

Full-Time Status for Graduate Assistants

Students who hold graduate assistantships must be registered as *full-time* students during each fall and spring semester in order to maintain their eligibility, tuition benefit, health benefits, etc. The registration requirements for maintaining full-time student status in BME are as follows:

Fall/Spring

Before they have completed their thesis credits, students must register for a minimum of 6 and maximum of 14 credits each fall and spring semester. The graduate assistant tuition benefit is capped at 14 credits per semester, so those who register for more than 14 credits will be responsible for paying the additional tuition themselves.

After finishing all required course and thesis/project credits, students may be eligible for Advanced Status (BMEn 8333/8444). Those approved for Advanced Status need only register for 1 credit each fall and spring in order to be considered full-time students. See below for more information.

Summer

DO NOT register for any summer credits without the explicit, written instruction of the Director of Graduate Studies or the Graduate Program Coordinator. Students serving as graduate assistants in the

spring do not need to register for any credits over the summer in order to remain eligible for their assistantships: their financial support, wages, etc., will continue through the summer. Those who do register for summer classes will need to pay for those credits themselves—the department does not cover summer tuition. There are exceptions, but a student (or adviser) who has questions about summer eligibility should contact the Graduate Program Coordinator *before* registering!

Master's Degree Requirements

M.S.-Plan A (thesis)

The Graduate School's "Graduate Degree Completion Procedures" for this degree plan are available online at http://www.grad.umn.edu/current_students/masters/plana.html. Check the website frequently for updates, and pay special attention to all milestones and deadlines in order to ensure timely degree completion.

Coursework

The M.S.-Plan A requires completion of at least 25 credits of classroom work, which must include the following:

- BME Core (2 courses selected from BME 5xxx course list – see ***Course Lists***)
- BME Seminars (2 semesters)
- Statistics (1 course; STAT 5021, 5302 or 5303 recommended)
- Biology Electives (2 courses, may include BME 5501)
- Technology Electives[†] (2 courses, 1 of which must be in engineering)
- Free Science/Technology Elective (1 course)

All core/elective courses must be at the 5xxx level or higher unless approved by the DGS.

All elective courses must be at least 3 credits unless approved by the DGS.

Electives must include 6 credits of minor/supporting program coursework taken outside the major field. See ***Minor/Supporting Program*** below for more information.

Thesis

In addition to the 25 credits of coursework, M.S.-Plan A students must complete 10 credits of BME Master's Thesis (BME 8777). The thesis must be based on research done by the student in collaboration with his/her adviser. Thesis credits cannot be transferred from other institutions and cannot be used towards the minimum course requirements for the degree. An M.S. student may register for thesis credits during any semester, with the adviser's approval.

Advanced Master's Status

Upon completion of all M.S. coursework and thesis credits, students may be eligible for Advanced Master's Status. Students whose applications are approved by the adviser, DGS, and Graduate School can maintain their full-time student status by registering for just one credit of BME 8333 (FTE: Master's). This registration category is intended *only* for advanced M.S. students who have completed all their program coursework and required thesis credits, but are still working full-time on the research or writing of the thesis. These credits cannot be used to meet specific program course or credit requirements. Advanced Master's Status applications are available at http://www.grad.umn.edu/current_students/forms/g81.pdf or from the BME Graduate Program Coordinator. *Students must re-apply for Advanced Master's Status prior to the posted deadlines for each semester in which they intend to register for BME 8333.*

[†] Technology electives are courses offered in the Institute of Technology in engineering, physical sciences, and mathematics. Courses outside of IT with content predominantly in engineering, physical sciences, and/or mathematics may be counted toward this requirement with pre-approval of the DGS.

M.S.-Plan B (non-thesis)

The Graduate School's "Graduate Degree Completion Procedures" for this degree plan are available online at http://www.grad.umn.edu/current_students/masters/planb.html. Check the website frequently for updates, and pay special attention to all milestones and deadlines in order to ensure timely degree completion.

Coursework

The M.S.-Plan B requires completion of at least 35 credits of coursework, which must include the following:

- BME Core (2 courses selected from BME 5xxx course list – see ***Course Lists***)
- BME Seminars (2 semesters)
- Statistics (1 course; STAT 5021, 5302 or 5303 recommended)
- Biology Electives (2 courses, may include BME 5501)
- Technology Electives[†] (3 courses, 1 of which must be in engineering)
- Free Science/Technology Electives (2 courses)
- Plan B Project (see below)

All core/elective courses must be at the 5xxx level or higher unless approved by the DGS.

All elective courses must be at least 3 credits unless approved by the DGS.

Electives must include 6 credits of minor/supporting program coursework taken outside the major field. See ***Minor/Supporting Program*** below for more information.

Project

As part of the required 35 credits for the M.S.-Plan B degree, students must complete 2-3 credits of BME 8820 (Plan B Project). The project must be done in collaboration with the adviser and documented with a report. M.S.-Plan B students may register for Plan B Project credits during any semester, with the adviser's approval.

Industrial Internship

With the consent of the adviser, a student may arrange a 3-credit industrial internship, which requires a minimum of nine hours per week of supervised lab or industrial experience unrelated to the student's normal employment. Submission of a project proposal and final report to the adviser and DGS is required. The adviser is responsible for overseeing the internship and providing the final grade.

Minor/Supporting Program

For both Plan A and Plan B students, the electives must include 6 credits of minor or supporting program coursework to be completed outside BME in engineering, mathematics, the physical sciences, and/or the biological sciences.

If a minor is chosen, it will be included on the official transcript. A minor must be approved by the DGS of the program granting the minor. Students are advised to determine appropriate courses for fulfillment of minor requirements during their first semester of study.

Students choosing a supporting program in place of a minor must take at least one 8xxx-level elective as part of the supporting program. A supporting program is not included on the official transcript.

Transferring Courses

M.S. students must complete at least 60% of the course credits for their degree while formally enrolled in a University of Minnesota Graduate School academic program. With approval, the transfer of up to 40% of the degree program coursework may be allowed from any combination of the following: other graduate

[†] Technology electives are courses offered in the Institute of Technology in engineering, physical sciences, and mathematics. Courses outside of IT with content predominantly in engineering, physical sciences, and/or mathematics may be counted toward this requirement with pre-approval of the DGS.

institutions, other graduate-level units at the University of Minnesota (e.g., Law School, College of Education and Human Development, etc.), and/or Graduate School credits completed as a non-degree seeking student at the University of Minnesota. Students interested in counting transfer credits toward their degree requirements should schedule an appointment to discuss transfer options with the DGS during the first semester in the program.

M.S. students who believe they have taken courses for undergraduate credit that are equivalent to required BME graduate core courses may opt to take other Technology electives in lieu of core courses with the approval of the DGS.

Final Oral Examination

All M.S. students must perform a Final Oral Examination in defense of the thesis/project. The examination committee must consist of three faculty members: two from the Biomedical Engineering Graduate Faculty and one from the minor or supporting program field. Current Graduate School policy states that this exam must be closed to the public. In order to ensure that appropriate questions will be asked at the M.S. final defense, the student must provide the committee with:

- a) A set of the relevant University of Minnesota BME Core Course syllabi (a set for each year will be kept on file in the Graduate Program office)
- b) The BME M.S. Supplemental Degree form, available from the Graduate Program Coordinator

Satisfactory Progress

The Biomedical Engineering Graduate Program requires a minimum grade of B- for any course to be counted toward the M.S. degree. Non-seminar/-thesis classes taken S-N may be included only if the student provides written confirmation from the instructor that the grade would have been at least a B- on the A-F scale. In addition, the overall GPA of degree coursework must be at least 2.8.

Progress toward the M.S. degree is deemed satisfactory if the student has (a) completed all coursework by the end of the second semester, (b) initiated research during the second semester, and (c) submitted and defended the thesis/project by the end of two years from the date of initial registration in the Graduate School.

By the end of the first academic year of study, M.S. students should submit a Degree Program Form to the DGS for approval. The Degree Program Form is the formal statement of degree coursework and composition of the final examination committee. A supplemental departmental form available from the Graduate Program Coordinator must also be completed and submitted to the DGS for review along with the Degree Program Form.

All BME students are required to demonstrate their satisfactory progress by completing the Annual Progress Report (APR), which will be distributed by the BME Graduate Program Coordinator early each summer. The APR must be signed by the adviser for approval and then submitted to the department for review by the DGS. The lack of satisfactory progress as defined above is due cause for termination from the Biomedical Engineering Graduate Program. *It is understood that the timeline as described above will not apply to part-time students.*

It is crucial that all M.S. students frequently consult the Graduate School's *Graduate Degree Completion Procedures*, paying special attention to deadlines in order to ensure timely completion of the degree:

- Plan A (thesis) - http://www.grad.umn.edu/current_students/masters/plana.html
- Plan B (non-thesis) - http://www.grad.umn.edu/current_students/masters/planb.html

Doctoral Degree Requirements

The Graduate School's "Graduate Degree Completion Procedures" for the Ph.D. are available online at http://www.grad.umn.edu/current_students/doctoral/phdeddchecklist.html. Check the website frequently for updates, and pay special attention to all milestones and deadlines in order to ensure timely degree completion.

Coursework

Over the summer the University approved a new set of Biomedical Engineering Ph.D. course requirements. Students joining the Ph.D. program in Fall 2009/Spring 2010 have the option of choosing either the current set of requirements (Set 1) or the newly approved curriculum (Set 2).

Set 1 (Current)

The Ph.D. requires completion of at least 33 credits of coursework, to include the following:

- BMEn 5xxx Core (3 courses selected from the BMEn 5xxx Core list – see ***Course Lists***)
- Graduate Seminars or Grand Rounds (4 semesters, 2 of which must be in BMEn 8601/8602; DGS approval required for Grand Rounds)
- Statistics (1 course; STAT 5021, 5302 or 5303 recommended)
- Biology Electives (3 courses, may include BMEn 5501)
- Technology Electives[†] (3 courses, 1 of which must be in engineering and 1 of which must have a mathematical focus)
- Free Science/Technology Elective (1 course; coursework relevant to science and technology, such as public policy, ethical/historical aspects, etc., may be approved by the DGS)
- Thesis (24 credits of BMEn 8888)

All core/elective courses must be at the 5xxx level or higher unless approved by the DGS.

All elective courses must be at least 3 credits unless approved by the DGS.

Electives must include 12 credits of minor/supporting program coursework taken outside the major field. See ***Minor/Supporting Program*** below for more information.

Set 2 (New)

The Ph.D. requires completion of at least 33 credits of coursework, to include the following:

- BMEn 8xxx Core (2 courses selected from BMEn 8xxx Core list – see ***Course Lists***)
- Graduate Seminars or Grand Rounds (4 semesters, 2 of which must be in BMEn 8601/8602; DGS approval required for Grand Rounds)
- Statistics (1 course; STAT 5021, 5302 or 5303 recommended)
- Biology Electives (3 courses, may include BMEn 5501)
- Technology Electives[†] (4 courses, 2 of which must be in engineering and 1 of which must have a mathematical focus)
- Free Science/Technology Elective (1 course; coursework relevant to science and technology, such as public policy, ethical/historical aspects, etc., may be approved by the DGS)
- Thesis (24 credits of BMEn 8888)

All core/elective courses must be at the 5xxx level or higher unless approved by the DGS.

All elective courses must be at least 3 credits unless approved by the DGS.

Electives must include 12 credits of minor/supporting program coursework taken outside the major field. See ***Minor/Supporting Program*** below for more information.

[†] Technology electives are courses offered in the Institute of Technology in engineering, physical sciences, and mathematics. Courses outside of IT with content predominantly in engineering, physical sciences, and/or mathematics may be counted toward this requirement with pre-approval of the DGS.

Minor/Supporting Program

The Ph.D. electives must include a minimum of 12 credits of minor or supporting program coursework to be completed outside BME in engineering, mathematics, the physical sciences, and/or the biological sciences.

If a minor is chosen, it will be included on the official transcript. A minor must be approved by the DGS of the program granting the minor. Students are advised to determine appropriate courses for fulfillment of minor requirements during their first semester of study.

If a supporting program is chosen, it must be composed of a coherent set of courses, possibly embracing several disciplines, including at least one 8xxx-level elective. A supporting program will not appear on the transcript.

Directed Research

A Ph.D. student may register during any semester for Directed Research (BME 8710). A final report for the Directed Research project must be turned in to the project adviser, who is responsible for assigning the student a grade, and to the DGS upon approval by the project adviser. *The Directed Research project must be distinct from the student's thesis research.* To ensure minimal overlap between the two projects, BME 8710 may be included in the degree program only if the project is advised by someone other than the student's thesis adviser. BME 8710 may be counted for a maximum of three credits of technology electives and does not satisfy the math, engineering, or 8xxx requirements.

Transferring Courses

With approval from the DGS, courses may be transferred from other graduate institutions and/or other graduate-level units at the University of Minnesota. A maximum of 12 credits completed while in non-degree seeking status at the University of Minnesota may be transferred into the degree program. Students interested in counting transfer credits toward their degree requirements should schedule an appointment to discuss transfer options with the DGS during the first semester in the program.

Ph.D. students who believe they have taken courses for undergraduate credit that are equivalent to required BME graduate core courses may opt to take other Technology electives in lieu of core courses with the approval of the DGS.

Dossier/Written Preliminary Examination

The Written Preliminary Examination (WPE), also known as the dossier, is completed and submitted to the Graduate Program to assess the student's ability to successfully complete a Ph.D. thesis. The deadline for submission of the dossier is July 15 (or the following weekday if July 15 falls on a weekend) of the second year of residence in the Ph.D. program for students who began in fall semester. **Observing the deadline is considered part of making satisfactory progress towards the degree requirements. Thus, failure to submit the dossier by the July 15 of the second year of residence in the program will result in suspension from payroll and loss of pay until the dossier is submitted.**

The bound dossier should consist of:

- A statement of the student's personal and educational background, areas of specialization or competence, and plans for the future
- A clearly, accurately, and concisely written thesis proposal, including
 - a) introductory description of the problem with literature survey, including motivation and significance
 - b) description of proposed experimental and/or analytical approach
 - c) results, if applicable, based on pilot tests, feasibility studies, or research completed to date
 - d) summary of direction the research project is likely to take, techniques to be developed to complete the research

- Additional written documentation supporting the student's ability to pursue doctoral research, such as special studies, reports, or manuscripts (related or unrelated to the thesis) illustrating independent and original work; and manuscripts or reprints of previously-published research papers
- A copy of the Degree Program Form (available from the BME Grad Program Coordinator, or at http://www.grad.umn.edu/current_students/forms/gs89a.pdf), approved by the adviser(s). The Degree Program Form is the formal statement of degree coursework and composition of the Oral Preliminary Examination (OPE) committee. The OPE committee must consist of at least **four** members, comprised of (a) at least **three** members of the BME Graduate Faculty, including the adviser; and (b) at least **one** member from the minor/supporting program, who must hold a Graduate Faculty appointment in a department outside of BME.
- An unofficial transcript and a supplemental departmental form (available from the BME Grad Program Coordinator, or <http://www1.umn.edu/bme/PDFFiles/pdf/PhDsupplemental.pdf>) must also be completed and submitted to the DGS for review along with the Degree Program Form.

While the literary standards of the dossier are comparable to those of the Ph.D. thesis, the purpose of the dossier is to demonstrate ability to formulate, describe, and conduct an original research project rather than to present polished results, although tangible progress is expected.

The adviser must approve the dossier before it is submitted to the committee for review. The student will identify two readers from his/her OPE committee (excluding the adviser) to evaluate the dossier. The DGS will choose a third reader from the BME Graduate Faculty who is not on the student's committee. To facilitate this process, the student must submit the names of his/her OPE committee members to the DGS along with a title and abstract of the thesis proposal.

Final approval of the dossier is official when the DGS and the adviser sign the Graduate School Preliminary Written Examination Report (provided by the Graduate Program Coordinator). The student will receive copies of the evaluation forms completed by the three readers and should discuss them with the adviser prior to the Oral Preliminary Examination (OPE). If the dossier is not approved, the student must meet with the adviser to identify deficiencies that can be resolved, or to consider whether studies should terminate with the M.S. degree.

Oral Preliminary Examination

Immediately following the approval of the dossier by all three readers, the student must submit the signed Preliminary Written Examination Report to the Graduate School in order to be allowed to schedule the Oral Preliminary Examination (OPE). The OPE must be completed and passed prior to the drop/add deadline for fall semester so that the student can register for thesis credits (BMEn 8888) fall and spring. It is the student's responsibility to schedule the OPE with the committee members and the Graduate School. In order to allow sufficient time for the readers to evaluate the dossier and to minimize scheduling difficulties, the OPE should be scheduled sometime between mid-August and the day preceding the fall drop/add deadline.

The DGS will assume that the student has contacted the faculty listed as committee members, that the committee members hold appropriate Graduate Faculty appointments, and that they have agreed to serve on the OPE committee. The adviser typically chairs the committee.

Please keep in mind the following regulations regarding the Oral Preliminary Examination:

- Only OPE committee members may attend.
- The examination begins with a presentation, not to exceed 30 minutes, about the proposed research in order to establish the ability to formulate, describe, and conduct an original research project.
- The OPE determines whether the student has mastered the material in the major and minor/supporting fields at the level the committee deems appropriate for advancement to doctoral candidacy. Thus, the examination is not restricted to a discussion of the research proposal, but will include questions related to coursework in the major and minor/supporting fields.

- The adviser, who chairs the committee, is responsible for the conduct of the exam (i.e. ensuring that a line of questioning is appropriate and observing Graduate School procedures).

In order to ensure that appropriate questions will be asked at the OPE, the student must provide the committee with:

- a) A set of the relevant University of Minnesota BME Core Course syllabi (a set for each year will be kept on file in the Graduate Program office)
- b) The BME Ph.D. Supplemental Degree form, available from the department website at <http://www1.umn.edu/bme/PDFFiles/pdf/PhDsupplemental.pdf>

Passing the OPE constitutes official candidacy for the Ph.D. There are no further examinations until the final defense of the doctoral thesis. Failing the OPE may result in either a recommendation to repeat the exam, or to terminate graduate studies with or without completion of the M.S. degree.

Thesis

The Graduate School requires doctoral students to complete 24 thesis credits in order to earn the degree. Only after passing the OPE is a student eligible to register for thesis credits. BME students should register for 12 thesis credits (BME 8888) in both the fall and spring semesters of their third year, after successfully completing the OPE.

While registered for thesis credits, the student should submit a Thesis Proposal Form (available at http://www.grad.umn.edu/current_students/forms/GS63A.PDF) to the Graduate School for approval. The Thesis Proposal Form is the formal statement of the proposed thesis research and composition of the Final Oral Examination committee. The committee must consist of at least **four** members, comprised of (a) at least **three** members of the BME Graduate Faculty, including the adviser; and (b) at least **one** member from the minor/supporting program, who must hold a Graduate Faculty appointment in a department outside of BME. Further instructions for the committee composition are included on the Thesis Proposal Form. The Final Oral Examination committee is often, but not necessarily, the same as the OPE committee.

Thesis Defense/Final Oral Examination

Upon completion of the thesis, the Ph.D. candidate must defend it in the Final Oral Examination. The Final Oral Examination may take place only after the thesis has been judged ready for defense by the committee. At least one week prior to the exam, the student must officially schedule it with the Graduate School using the online form at http://www.grad.umn.edu/current_students/finalschedule/. The Final Oral Examination consists of a public seminar in which the candidate presents the thesis, and to which the scholarly community is invited. (The student should provide a title, abstract, time, and location to the BME Graduate Program Coordinator to announce the defense at least one week in advance.) A closed meeting between the candidate and the appointed examining committee immediately follows the thesis presentation. The candidate is then excused, and a vote is taken. The Final Oral Examination is limited to the thesis and relevant subject areas.

The adviser is responsible for ensuring the inclusion of appropriate modifications and required revisions, if any, in the final thesis. The Final Oral Examination Report will not be signed and submitted to the Graduate school until all revisions have been made.

Advanced Doctoral Status

Upon completion of all Ph.D. coursework and thesis credits, students are eligible for Advanced Doctoral Status. Students whose applications are approved by the adviser and DGS can maintain their full-time student status by registering for just one credit of BME 8444 (FTE: Doctoral). This registration category is intended *only* for advanced Ph.D. students who have completed all their program coursework and required thesis credits, but are still working full-time on the research or

writing of the thesis. These credits cannot be used to meet specific program course or thesis credit requirements. Advanced Doctoral Status applications are available at http://www.grad.umn.edu/current_students/forms/g79.pdf or from the BME Graduate Program Coordinator. *Students must re-apply for Advanced Doctoral Status prior to each semester in which they intend to register for BMEn 8444.*

Satisfactory Progress

The Biomedical Engineering Graduate Program requires a minimum grade of B- for any course to be counted toward the Ph.D. In addition, the overall GPA of degree coursework must be at least 2.8. Progress toward the Ph.D. is deemed satisfactory if the student has successfully completed the OPE by the fall drop/add deadline of the third year in the program. After that point, satisfactory progress is determined by the thesis adviser, who will inform the student and the DGS if there are problems.

A Ph.D. student in the BMEGP is expected to earn his/her degree within 4-5 years from the date of initial registration in the Graduate School. Students are required to meet with the doctoral committee at least once each year, beginning with the second year of residence in the program. Meeting with the committee for the OPE and final defense constitutes two of the required meetings; during each intervening year, the student must schedule a meeting with the committee, and the adviser must provide the DGS a summary of the sentiment of the committee regarding the student's progress, indicating the date the meeting occurred, and the committee members in attendance.

Finally, Ph.D. candidates must have submitted a first-author manuscript to a peer-reviewed journal before completion of the program. Evidence of submission must be provided to the DGS.

All BME students are required to demonstrate their satisfactory progress by completing the Annual Progress Report (APR), which will be distributed by the BME Graduate Program Coordinator early each summer. The APR must be signed by the adviser for approval and then submitted to the department for review by the DGS. The lack of satisfactory progress as defined above is due cause for termination from the Biomedical Engineering Graduate Program.

It is crucial that all Ph.D. students frequently consult the *Graduate Degree Completion Procedures* (http://www.grad.umn.edu/current_students/doctoral/phdeddchecklist.html), paying special attention to deadlines in order to ensure timely completion of the degree.

Course Lists

BMEn 5xxx Core Courses

The following core courses are for students completing M.S.-Plan A, M.S.-Plan B, and Ph.D.-Set 1 requirements:

- BMEn 5001 – Advanced Biomaterials
- BMEn 5101 – Advanced Bioelectricity and Instrumentation
- BMEn 5201 – Advanced Biomechanics
- BMEn 5311 – Advanced Biomedical Transport Processes
- BMEn 5351 – Cell Engineering
- BMEn 5401 – Advanced Functional Biomedical Imaging

BMEn 8xxx Core Courses

The core courses listed below are for students completing Ph.D.-Set 2 requirements.

*Please note that these courses will count toward the BMEn Core requirement for the duration of the program for students entering in Fall 2009. However, the courses will be reviewed by the department at the end of the 2009-2010 academic year to determine whether they should continue to count as the BMEn Core courses. The list of approved core courses may therefore change for students entering the program in Fall 2010 and later.

- BMEEn 8001 – Polymeric Biomaterials
- BMEEn 8101 – Biomedical Digital Signal Processing
- BMEEn 8201 – Advanced Tissue Mechanics
- BMEEn 8301 – Functional Biomedical Imaging
- BMEEn 8431 – Controlled Release: Materials, Mechanisms, and Models
- BMEEn 8501 – Nonlinear Dynamics in Biomedical Engineering (being taught Fall 2009 as a Special Topics course, BMEEn 8900, by Prof. Alena Talkachova)

Elective Courses

The elective course requirements can be satisfied by selecting courses from the following list. This list is representative only, and in many cases courses listed are the first in a sequence. More advanced courses are also available in these areas of study. These courses may also be useful in developing the supporting program. It is not necessary that all electives be on this list, or that they be from the same heading. These are only classes that were deemed valuable for some students. Students must consult the DGS of the minor program, if a minor is desired, concerning required coursework. **All 4xxx-level courses, whether appearing on this list or not, require pre-approval by the DGS for credit towards degree requirements. Under no circumstance may two 4xxx-level courses be used in the degree program.**

Course Classifications:

S(tatistics)	Statistics/Tech elective
T(echnology)	Tech elective
B(iology)	Biology elective
F(ree)	Free elective ONLY
M(ath)	Tech elective with Math emphasis
C(ore)-5	5xxx Core course
C(ore)-8	8xxx Core course

Courses by Topic

The following elective courses have been arranged by topic to facilitate course selection and composition of the degree program coursework.

Biotransport

BMEEn	5311	C-5	Advanced Biomedical Transport Processes
BMEEn	8431	C-8	Controlled Release: Materials, Mechanisms, and Models
ChEn	5759	T	Principles of Mass Transfer in Eng & Biological Eng.
ChEn	8101	M	Fluid Mechanics I: Change, Deformation, Equations of Flow
ChEn	8201	M	Applied Mathematics I: Linear Analysis
ChEn	8301	T	Physical Rate Processes I: Transport
ME	4331	T	<i>Thermal Engineering Laboratory</i>
ME	5341	T	Case Studies in Thermal Engineering and Design
ME	5351	M	Computational Heat Transfer
ME	8341	M	Conduction
ME	8345	M	Computational Heat Transfer and Fluid Flow
ME	8381	T	Bioheat and Mass Transfer
Phys	5401	F	Physiological Physics
Phys	5402	T	Radiological Physics

Biology

BioC	5001	B	Biochemistry, Molecular, and Cellular Biology
BMEEn	5001	C-5	Advanced Biomaterials
BMEEn	8001	C-8	Polymeric Biomaterials
BMEEn	8431	C-8	Controlled Release: Materials, Mechanisms, and Models
BMEEn	5444	B	Muscle
BMEEn	5501	B	Biology for Biomedical Engineers

<i>GCD</i>	4111	<i>B</i>	<i>Histology: Cell and Tissue Organization</i>
<i>GCD</i>	8103	<i>B</i>	Human Histology
<i>GCD</i>	8136	<i>B</i>	Techniques of Biological Electron Microscopy
<i>GCD</i>	8151	<i>B</i>	Cell Structure and Function
<i>MedC</i>	8760	<i>B</i>	Design of Peptidomimetics
<i>MICA</i>	8003	<i>B</i>	Immunity and Immunopathology
<i>MICA</i>	8004	<i>B</i>	Cellular and Cancer Biology
<i>MICA</i>	8007	<i>B</i>	Cell Biology and Biochemistry of the Extracellular Matrix
<i>MicB</i>	4131	<i>B</i>	<i>Immunology</i>
<i>MicB</i>	4151	<i>B</i>	<i>Molecular and Genetic Bases for Microbial Diseases</i>
<i>Phsl</i>	5061	<i>B</i>	Principles of Physiology for Biomedical Engineering
<i>Phsl</i>	5511	<i>B</i>	Advanced Neuromuscular Junction Physiology (short course)

Biomaterials

<i>AEM</i>	4511	<i>T</i>	<i>Mechanics of Composite Materials</i>
<i>BMEEn</i>	5041	<i>T</i>	Tissue Engineering
<i>ChEn</i>	4101	<i>T</i>	<i>Chemical Engineering Thermodynamics</i>
<i>MatS</i>	4212	<i>T</i>	<i>Ceramics</i>
<i>MatS</i>	4214	<i>T</i>	<i>Polymers</i>
<i>Phys</i>	5081	<i>T</i>	Introduction to Biopolymer Physics

Biomechanics

<i>AEM</i>	4511	<i>T</i>	<i>Mechanics of Composite Materials</i>
<i>AEM</i>	5401	<i>T</i>	Intermediate Dynamics
<i>AEM</i>	5501	<i>M</i>	Continuum Mechanics
<i>AEM</i>	5503	<i>M</i>	Theory of Elasticity
<i>AEM</i>	8511	<i>M</i>	Advanced Topics in Continuum Mechanics
<i>AEM</i>	8531	<i>T</i>	Fracture Mechanics
<i>BMEEn</i>	5041	<i>T</i>	Tissue Engineering
<i>BMEEn</i>	5201	<i>C-5</i>	Advanced Biomechanics
<i>BMEEn</i>	5212	<i>T</i>	Tissue Mechanics
<i>BMEEn</i>	8201	<i>C-8</i>	Advanced Tissue Mechanics
<i>ME</i>	5228	<i>M</i>	Intro to Finite Element Modeling, Analysis and Design
<i>ME</i>	5247	<i>T</i>	Stress Analysis, Sensing and Transducers
<i>ME</i>	5281	<i>T</i>	Analog and Digital Control
<i>ME</i>	5286	<i>T</i>	Robotics

Biomedical Instrumentation and Imaging

<i>BMEEn</i>	5101	<i>C-5</i>	Advanced Bioelectricity and Instrumentation
<i>BMEEn</i>	5801	<i>M</i>	Biomedical Ultrasound
<i>BMEEn</i>	8101	<i>C-8</i>	Biomedical Digital Signal Processing
<i>BMEEn</i>	8501	<i>C-8</i>	Nonlinear Dynamics in Biomedical Engineering
<i>EE</i>	4111	<i>T</i>	<i>Advanced Analog Electronics Design</i>
<i>EE</i>	4501	<i>T</i>	<i>Communications Systems</i>
<i>EE</i>	4541	<i>T</i>	<i>Digital Signal Processing</i>
<i>EE</i>	5141	<i>T</i>	Introduction to Microsystem Technology
<i>EE</i>	5531	<i>M</i>	Probability and Stochastic Processes
<i>EE</i>	5811	<i>T</i>	Biomedical Instrumentation
<i>EE</i>	5821	<i>T</i>	Biological System Modeling and Analysis
<i>Phys</i>	5401	<i>F</i>	Physiological Physics
<i>Phys</i>	5402	<i>T</i>	Radiological Physics

Biostatistics

<i>PubH</i>	7440	<i>M</i>	Introduction to Bayesian Analysis
<i>Stat</i>	5021	<i>S</i>	Statistical Analysis
<i>Stat</i>	5302	<i>S</i>	Applied Regression Analysis
<i>Stat</i>	5303	<i>S</i>	Designing Experiments

Cell/Matrix Science, Tissue Engineering

BMEEn	5041	T	Tissue Engineering
AEM	4511	T	<i>Mechanics of Composite Materials</i>
AEM	5501	M	Continuum Mechanics
MatS	4214	T	<i>Polymers</i>
MICA	8007	B	Cell Biology and Biochemistry of the Extracellular Matrix

Mathematics

BMEEn	8501	C-8	Nonlinear Dynamics in Biomedical Engineering
Math	4242	M	<i>Applied Linear Algebra</i>
Math	4428	M	<i>Mathematical Modeling</i>
Math	4457	M	<i>Methods of Applied Mathematics I</i>
Math	4458	M	<i>Methods of Applied Mathematics II</i>
Math	4567	M	<i>Applied Fourier Analysis</i>
Math	5445	M	Mathematical Analysis of Biological Networks
Math	5487	M	Computational Methods for Differential and Integral Equations in Engineering and Science I
Math	5488	M	Computational Methods for Differential and Integral Equations in Engineering and Science II
Math	5587	M	Elementary Partial Differential Equations I
Math	8202	M	General Algebra
Math	8253	M	Algebraic Geometry

Medical Devices, Medical Microelectromechanical Devices and Instruments

BMEEn	5101	C-5	Advanced Bioelectricity and Instrumentation
BMEEn	5151	T	Introduction to BioMEMS and Medical Microdevices
BMEEn	8101	C-8	Biomedical Digital Signal Processing
BMEEn	8301	C-8	Functional Biomedical Imaging
EE	4111	T	<i>Advanced Analog Electronics Design</i>
EE	4541	T	<i>Digital Signal Processing</i>
EE	5141	T	Introduction to Microsystem Technology
EE	5171	T	Microelectronic Fabrication
EE	5333	T	Analog Integrated Circuit Design
EE	5811	T	Biomedical Instrumentation
ME	5286	T	Robotics
ME	8221	T	New Product Design and Business Development I
Phys	5401	F	Physiological Physics
Phys	5402	T	Radiological Physics

Medical Information Systems

CSci	4041	T	<i>Algorithms and Data Structures</i>
CSci	4061	T	<i>Introduction to Operating Systems</i>
CSci	5211	T	Data Communications and Computer Networks
CSci	5511	T	Artificial Intelligence I
HInf	5430	T	Health Informatics I
HInf	5431	T	Health Informatics II
HInf	8405	T	Advanced Topics in Health Informatics I
IDSc	8511	T	Conceptual Topics & Research Methods in Information & Decision Sciences

Neural Engineering

BMEEn	5411	T	Neural Engineering
CGSC	8040	B	Cognitive Neuroscience
NSC	5201	B	Computational Neuroscience I: Membranes and Channels
NSC	5202	T	Theoretical Neuroscience: Systems and Information Processing
NSC	5661	B	Behavioral Neuroscience
NSCI	5101	B	Introduction To Neuroscience for Graduate Students

Courses by Number

Elective courses are arranged here by department/number to aid registration.

All of the courses within this box require advisor approval to count towards your degree.

AEM	4511	T	Mechanics of Composite Materials
ChEn	4101	T	Chemical Engineering Thermodynamics
CSci	4041	T	Algorithms and Data Structures
CSci	4061	T	Introduction to Operating Systems
EE	4111	T	Advanced Analog Electronics Design
EE	4501	T	Communications Systems
EE	4541	T	Digital Signal Processing
GCD	4111	B	Histology: Cell and Tissue Organization
Math	4242	M	Applied Linear Algebra
Math	4428	M	Mathematical Modeling
Math	4457	M	Methods of Applied Mathematics I
Math	4458	M	Methods of Applied Mathematics II
Math	4567	M	Applied Fourier Analysis
MatS	4212	T	Ceramics
MatS	4214	T	Polymers
ME	4331	T	Thermal Engineering Laboratory
MicB	4131	B	Immunology
MicB	4151	B	Molecular and Genetic Bases for Microbial Diseases

AEM	5401	T	Intermediate Dynamics
AEM	5501	M	Continuum Mechanics
AEM	5503	M	Theory of Elasticity
AEM	8511	M	Advanced Topics in Continuum Mechanics
AEM	8531	T	Fracture Mechanics
BioC	5001	B	Biochemistry, Molecular, and Cellular Biology
BMEEn	5041	T	Tissue Engineering
BMEEn	5151	T	Introduction to BioMEMS and Medical Microdevices
BMEEn	5212	T	Tissue Mechanics
BMEEn	5411	T	Neural Engineering
BMEEn	5444	B	Muscle
BMEEn	5501	B	Biology for Biomedical Engineers
BMEEn	5801	M	Biomedical Ultrasound
CGSC	8040	B	Cognitive Neuroscience
ChEn	5759	T	Principles of Mass Transfer in Eng & Biological Eng.
ChEn	8101	M	Fluid Mechanics I: Change, Deformation, Equations of Flow
ChEn	8201	M	Applied Mathematics I: Linear Analysis
ChEn	8301	T	Physical Rate Processes I: Transport
ChEn	8754	M	Systems Analysis of Biological Processes
CSci	5211	T	Data Communications and Computer Networks
CSci	5511	T	Artificial Intelligence I
EE	5141	T	Introduction to Microsystem Technology
EE	5171	T	Microelectronic Fabrication
EE	5333	T	Analog Integrated Circuit Design
EE	5531	M	Probability and Stochastic Processes
EE	5811	T	Biomedical Instrumentation
EE	5821	T	Biological System Modeling and Analysis
GCD	8103	B	Human Histology
GCD	8136	B	Techniques of Biological Electron Microscopy
GCD	8151	B	Cell Structure and Function
HInf	5430	T	Health Informatics I
HInf	5431	T	Health Informatics II
HInf	8405	T	Advanced Topics in Health Informatics I

IDSc	8511	T	Conceptual Topics & Research Methods in Information & Decision Sciences
Math	5445	M	Mathematical Analysis of Biological Networks
Math	5487	M	Computational Methods for Differential and Integral Equations in Engineering and Science I
Math	5488	M	Computational Methods for Differential and Integral Equations in Engineering and Science II
Math	5587	M	Elementary Partial Differential Equations I
Math	8202	M	General Algebra
Math	8253	M	Algebraic Geometry
ME	5228	M	Intro to Finite Element Modeling, Analysis and Design
ME	5247	T	Stress Analysis, Sensing and Transducers
ME	5281	T	Analog and Digital Control
ME	5286	T	Robotics
ME	5341	T	Case Studies in Thermal Engineering and Design
ME	5351	M	Computational Heat Transfer
ME	8221	T	New Product Design and Business Development I
ME	8341	M	Conduction
ME	8345	M	Computational Heat Transfer and Fluid Flow
ME	8381	T	Bioheat and Mass Transfer
MedC	8760	B	Design of Peptidomimetics
MICA	8003	B	Immunity and Immunopathology
MICA	8004	B	Cellular and Cancer Biology
MICA	8007	B	Cell Biology and Biochemistry of the Extracellular Matrix
NSC	5201	B	Computational Neuroscience I: Membranes and Channels
NSC	5202	T	Theoretical Neuroscience: Systems and Information Processing
NSC	5661	B	Behavioral Neuroscience
NSCI	5101	B	Introduction To Neuroscience for Graduate Students
Phsl	5061	B	Principles of Physiology for Biomedical Engineering
Phsl	5511	B	Advanced Neuromuscular Junction Physiology (short course)
Phys	5081	T	Introduction to Biopolymer Physics
Phys	5401	F	Physiological Physics
Phys	5402	T	Radiological Physics
PubH	7440	M	Introduction to Bayesian Analysis
Stat	5021	S	Statistical Analysis
Stat	5302	S	Applied Regression Analysis
Stat	5303	S	Designing Experiments

Biomedical Engineering Graduate Faculty

Membership in the Biomedical Engineering Graduate Faculty is subject to periodic change. Consult the BME website (http://www1.umn.edu/bme/html/grad_fac.html) or the Graduate School's list (http://www.grad.umn.edu/faculty_rosters/faculty.html) as necessary. For current faculty contact information, please consult the online directory at <http://search.umn.edu/>.

M.S./Ph.D. Adviser	Position	Department	Research Interests
Taner Akkin, Ph.D.	Assoc Profess	Biomedical Eng	Biomedical Optics and Imaging
Alptekin Aksan, Ph.D.	Assist Professor	Mechanical Eng	Biostabilization and Biopreservation
Edgar Arriaga, Ph.D.	Assist Professor	Analytical Chemistry	Bioanalytical Instrumentation
James Ashe, M.D.	Assoc Professor	Neuroscience	Neural Control of Movement
Shai Ashkenazi, Ph.D.	Assist Professor	Biomedical Eng	Bioimaging, Instrumentation
Roberto Ballarini, Ph.D.	Professor	Civil Engineering	Biomechanics
Victor Barocas, Ph.D.	Assoc Professor	Biomedical Eng	Biomechanics
John Bischof, Ph.D.	Assoc Professor	Biomed Eng., ME	Thermal Therapies, Cryopreservation
Michael Bowser, Ph.D.	Assist Professor	Chemistry	Bioanalysis/Microfluidics/Neurochemistry
Wei Chen, Ph.D.	Assoc Professor	Radiology	Magnetic Resonance Imaging
Tianhong Cui, Ph.D.	Assoc Professor	Mechanical Eng	MEMS/NEMS, Flexible Electronics
Kevin Dorfman, Ph.D.	Assist Professor	CEMS	Microfluidics BioMEMS
William K. Durfee, Ph.D.	Assoc Professor	Mechanical Eng	Muscle Skeletal Bio
Emad Ebbini Ph.D.	Assoc. Professor	Elec./Comp Eng	Signal/Image Processes
Timothy Ebner, M.D., Ph.D.	Professor	Neuroscience	Neuroscience
Arthur Erdman, Ph.D.	Professor	Mechanical Eng	Mech Design/MEMS
Stanley Finkelstein, Ph.D.	Professor	Lab Med & Path.	Patient Monitoring/Sig. Proc./Informatics
John Foker, M.D.	Professor	Surgery	Prostheses (Cardiac Valves)
Geoffrey Ghose, Ph.D.	Assoc Professor	Neuroscience	Neuroscience
William Gleason, Ph.D.	Assoc Professor	Lab Med & Path.	Carbohydrate Polymeric Biomaterials
Bruce Hammer, Ph.D.	Assoc Professor	Radiology	NMR Imaging
Bin He, Ph.D.	Professor	Biomedical Eng	Imaging
Robert Hebbel, M.D.	Professor	Medicine	Biorheology
Goran Hellekant, Ph.D.	Professor	Neurophysiology (UMD)	Physiology and Pharmacology
James Holte, Ph.D.	Assoc Professor	Elec/Comp Eng	Biomedical Modeling
Wei-Shou Hu, Ph.D.	Professor	CEMS	Cellular Engineering, Bioreactor Technology
Allison Hubel, Ph.D.	Assoc. Professor	Mechanical Eng	Culture and Cryopreservation
Paul Iaizzo, Ph.D.	Assoc Professor	Anest./Physiology	Thermal Regulation and Muscle Physiology
Efrosini Kokkoli, Ph.D.	Assistant Professor	CEMS	Biomimetic Surface Eng
Paul Letourneau, Ph.D.	Professor	Neuroscience	System Development
Jack Lewis, Ph.D.	Professor	Orthop Surgery	Orthopedic Biomechanics and Biomaterials
Hugh Lim, Ph.D.	Assist Professor	Biomedical Eng	Neural Prostheses, Auditory Neuroscience
James McCarthy, Ph.D.	Professor	Lab Med & Path.	Cell Adhesion and Migration/Cell Eng
Greg Metzger, Ph.D.	Assoc Professor	Radiology	MRI
Joachim Mueller, Ph.D.	Professor	Physics and Astronomy	Biomedical Optics
Theoden Netoff, Ph.D.	Assist Professor	Biomedical Eng	Neural Engineering
Thomas Novacheck, M.D.	Assoc Professor	Orthopaedic Surgery	Orthopaedic Surgery
David Nuckley, Ph.D.	Assist Professor	Physical Med/Rehab	Orthopaedic Biomechanics
David Odde, Ph.D.	Assoc Professor	Biomedical Eng	Neural Tissue Eng, Cytoskeleton
Sang-Hyun Oh, Ph.D.	Assist Professor	Electric/Comp Eng	Nanofabrication and Photonics
Hans Othmer, Ph.D.	Professor	Mathematics	Mathematical Biology
Klearchos Papas, Ph.D.	Assist Professor	Surgery	Tissue Optimization
Richard Poppele, M.D.	Professor	Neuroscience	Neurobiology
Rajesh Rajamani, Ph.D.	Associate Professor	Mechanical Eng	Advanced Controls and Microsensors
A. David Redish, Ph.D.	Assist Professor	Neuroscience	Biomolecular Engineering
Osha Roopnarine, Ph.D.	Assist Professor	Biochem/Mol.Bio/BP	Biochem Function
Jonathan Sachs, Ph.D.	Assist Professor	Biomedical Eng	Biophysics/Biochemistry
Michael H. Schwartz, M.D.	Assist Professor	Orthopaedic Surgery	Biomechanics
Wei Shen, Ph.D.	Assist Professor	Biomedical Eng	Biomedical Eng
Ronald Siegel, Ph.D.	Professor	Pharmacy	Drug Delivery
Narendra Simha, Ph.D.	Assoc Professor	Biomedical Eng	Tissue Mechanics
Fotis Sotiropoulos, Ph.D.	Professor	Civil Eng	Computational Fluid Dynamics
Ephraim Sparrow, Ph.D.	Professor	Mechanical Eng	BioHeat and Mass Transfer
Alena Talkachova, Ph.D.	Assist Prof	Biomedical Eng	Cardiac Bioengineering
Doris Taylor, Ph.D.	Professor	Cardiovascular	Cardiovascular Repair.
David Thomas, Ph.D.	Professor	Biochem/Mol Bio/BP	Molecular Dynamics of Muscles
Gerald Timm, Ph.D.	Professor	Urological Surgery	Artificial Muscle Development
Robert Tranquillo, Ph.D.	Professor	BME/CEMS	Cardiovascular and Neural Tissue Engr
Kamil Ugurbil, Ph.D.	Professor	Radiology	CMRR
Pierre-Francois Van de Moortele, M.D./Ph.D.	Assist Professor	Radiology	Medical Imaging
Thomas Vaughan, Ph.D.	Assoc Professor	Radiology	Medical Imaging
Chun Wang, Ph.D.	Assist Professor	Biomedical Eng	Biomedical Engineering
Timothy Wiedmann, Ph.D.	Professor	Pharmaceutics	Drug Delivery
Jay Zhang, M.D., Ph.D.	Professor	Medicine	Cardiology, NMR, MRI

M.S. Adviser ONLY	Position	Department	Research Interests
*Faculty in this section cannot advise Ph.D. students			
Alan Bank, M.D.	Assoc Professor	Medicine	Cardiology
Joan Bechtold, Ph.D.	Assoc Professor	Orthop Surgery	Orthopaedic Biomechanics
Patrick Bolan, Ph.D.	Assist Professor	Radiology	MRI
Matthew Chafee, Ph.D.	Assist Professor	Neuroscience	Neuroscience
Michel Cramer-Bornemann	Assist Professor	Neurology	Sleep Disorders Medicine
Michael Garwood, M.D.	Professor	Radiology	MR Spectroscopy & Imaging
Ramesh Harjani, Ph.D.	Assoc Professor	Elec/Comp Eng	Integrated Circuits, MEMS
Susanta K. Hui, Ph.D.	Assist Professor	Therapeutic Radiology	Tomotherapy
Robert LaPrade, M.D.	Assist Professor	Orthopaedic Surgery	Complex knee ligament injury
Paula Ludewig, Ph.D.	Assoc Professor	Physical Med/Rehab	Musculoskeletal Injury and Rehabilitation
Keith Lurie, M.D.	Assoc Professor	Medicine	Cardiology
Jeffrey McCullough, M.D.	Professor	Lab Med & Path	Lab Med & Path
Charles Truwit, M.D.	Assoc Professor	Radiology/Neurology	Interventional Radiology

Additional Campus Resources

Boynton Health Service
612-625-8400
<http://www.bhs.umn.edu/>

Center for Teaching and Learning Services
315 Science Classroom Building
612-625-3041
teachlrn@umn.edu; <http://www1.umn.edu/ohr/teachlearn/>

Opportunities for International TAs & SPEAK Test
315 Science Classroom Building
612-625-3041
teachlrn@umn.edu; <http://www1.umn.edu/ohr/teachlearn/nonnative/speak/index.html>

Graduate Assistant Employment
170 Donhowe Bldg.
612-624-7070
<http://www1.umn.edu/ohr/gae/>

Graduate Assistant Health Benefits Office
N323 Boynton Health Service
612-624-0627
<http://www.shb.umn.edu/twincities/graduate-assistants.htm>

Graduate School Student Services
316 Johnston Hall
612-625-3490
<http://www.grad.umn.edu/>

International Student and Scholar Services
190 Hubert H. Humphrey Center
612-626-7100
iss@tc.umn.edu; www.iss.umn.edu

Registrar, Student Services Center
200 Fraser Hall
612-624-1111
<http://www.onestop.umn.edu/onestop/services.html>

One Stop, Financial
200 Fraser Hall
612-624-1111
<http://www.onestop.umn.edu/>

