DAVID HAWKINS, CHAIR
Biomedical Engineering Graduate Group

RE: Biomedical Engineering Degree Requirements

Enclosed is a copy of the Biomedical Engineering graduate degree requirements as approved by Graduate Council on October 19, 2018. These degree requirements are now the official requirements for the Biomedical Engineering Graduate Group and will be posted on the Office of Graduate Studies program webpage:

https://grad.ucdavis.edu/programs/gbim

Thank you for your efforts on behalf of graduate education.

Sincerely,

Carlee Arnett, Chair
Graduate Council

CC: Amanda Kimball, Graduate Studies Analyst
    Christal Wintersmith, Graduate Group Coordinator
M.S. PROGRAM

1) Admissions Requirements

Admission to graduate standing in the Biomedical Engineering Graduate Group (BMEGG) requires a Bachelor’s degree in a discipline relevant to biomedical engineering. Successful applicants typically have an undergraduate GPA of 3.25 (out of 4.00) or greater. Applicants whose native language or language of instruction is not English are required to demonstrate English Language Proficiency with a score of 100 on the Test of English as a Foreign Language (TOEFL) internet-based test or a score of 8.0 from the International English Language Testing System (IELTS). A student may apply for admission for either an M.S. or a PhD. The M.S. is not prerequisite to the PhD, and completing the MS requirements does not guarantee admission to the PhD program. An M.S. student may continue into the PhD program if approval is obtained from the Biomedical Engineering Graduate Admissions Committee. When accepted initially into the PhD program, the student may plan their program so as to obtain both degrees, if desired.

A complete application for Graduate Study includes:
- Graduate Application Form
- Application Fee
- Transcript for each university attended
- Graduate Record Examination (General Test)
- Three letters of recommendation
- English proficiency examination for international applicants who have not studied at an English speaking University: TOEFL or other University approved examination.

These materials will be reviewed by Graduate Studies and the Biomedical Engineering Graduate Admissions Committee, after which the student will be notified of their decision.

The BMEGG expects strong competence in mathematics and engineering as necessary for successful completion of graduate study. Prior course work in these areas is emphasized in the evaluation of applications.

a) Prerequisites:

Students entering the Biomedical Engineering Graduate Group are expected to have completed a Bachelor’s degree in Engineering and the following courses (or equivalents). It is expected that students receive a letter grade when completing these courses.

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</tr>
<tr>
<td>ENG 6</td>
<td>Programming</td>
<td>4 units</td>
</tr>
<tr>
<td>STA 130A</td>
<td>Statistics</td>
<td>4 units</td>
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Descriptions of the courses listed above can be found in the General Catalog. To determine course
equivalence, consult a Graduate Advisor. Note that Quarter Units = 1.5 x Semester Units.

Applicants without Bachelor’s degree in Engineering may become eligible for admission by completing the following courses (or equivalents). It is expected that students receive a letter grade when completing these courses.

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Descriptions of the courses listed above can be found in the General Catalog. To determine course equivalence, consult a Graduate Advisor. Note that Quarter Units = 1.5 x Semester Units.

b) Deficiencies:

Although some deficiencies can, in principle, be resolved after admission to the BMEGG, this generally necessitates extending the time to degree. For example, students are cautioned that taking the Math 21 series in the program is the equivalent of a full year delay. Having this series completed prior to entry is highly desirable. For M.S. students it is also recommended that as much of the other general preparation coursework as possible be completed prior to beginning graduate study. If the prerequisite courses have not been completed prior to admission, then they must be completed by the end of the first year in the program by taking courses as approved by the Graduate Advisor.

2) Degrees Offered

The Graduate Group offers the following degrees:

a) Master of Science, with Thesis (Plan I)

This plan requires a minimum of 30 units of graduate and upper division courses, of which at least 18 must be graduate level engineering courses. In addition, a thesis is required. The research thesis serves as the capstone requirement.

This Plan requires more units than the UC Davis minimum, which are: 30 units of graduate and upper division courses (the 100 and 200 series only), at least 12 of which must be graduate work in the major field.
b) Master of Science, with Comprehensive Examination (Plan II)

This Plan requires a minimum of 38 units of graduate and upper division courses, of which at least 24 units must be graduate level engineering courses. A comprehensive final examination in the major subject is required of each candidate. No thesis is required. The capstone requirement is fulfilled by a Comprehensive written exam at the end of spring quarter year 1, with a 2nd chance to retake the exam if not passed within the next 12 months.

This Plan requires more units than the UC Davis minimum, which are: 36 units of graduate and upper division courses, of which at least 18 units must be graduate courses in the major field. Not more than 9 units of research (299 or equivalent) may be used to satisfy the 18-unit requirement.

3) Course Requirements

a) Master of Science with Thesis (Plan I)

Core Required Units = 17
1. Cell and Molecular Biology for Engineers (BIM 202) 4 units
2. Physiology for Bioengineers (BIM 204) 5 units
3. Acquisition and Analysis of Biomedical Signals (BIM 281) 4 units
4. Statistical Design of Experiments for Biomedical Engineering (BIM 283) OR Mathematical Methods for Biomedical Engineers (BIM 284) 4 units

Elective Units = 11
Elective courses should be determined in consultation with an advisor.

Total Letter-Graded Unit Requirement = 28 units
The courses above must be taken for a letter grade; the minimum acceptable grade in any course is a B- and the minimum overall GPA is 3.00. At least 18 of the 28 unit total completed for the degree must be graduate (200) level engineering courses.

Additional Course Requirement = 2 units
Seminar: students must enroll in the seminar course during each quarter it is offered until Advancement to Candidacy (BIM 290); 1 unit each—minimum of 2 units total.

Total Minimum Unit Requirement = 30 units
All courses must be satisfactorily completed as detailed above. Full-time students must enroll in 12 units per quarter; however, per UC regulations, students cannot enroll in more than 12 units of graduate level courses (200) or more than 16 units of combined undergraduate and graduate level courses (100, 200, 300) courses per quarter.

b) Master of Science with Comprehensive Exam (Plan II)

Core Required Units = 17
1. Cell and Molecular Biology for Engineers (BIM 202) 4 units
2. Physiology for Bioengineers (BIM 204) 5 units
3. Acquisition and Analysis of Biomedical Signals (BIM 281) 4 units
4. Statistical Design of Experiments for Biomedical Engineering (BIM 283) OR Mathematical Methods for Biomedical Engineers (BIM 284) 4 units
**Elective Units = 19**
Elective courses are specific to each student’s research focus, and these courses should be selected in consultation with an advisor.

**Total Letter-Graded Unit Requirement = 36 units**
The courses above must be taken for a letter grade; the minimum acceptable grade in any course is a B- and the minimum overall GPA is 3.00. At least 24 of the 36 unit total completed for the degree must be graduate (200) level engineering courses.

**Additional Course Requirement = 2 units**
Seminar: students must enroll in the seminar course during each quarter it is offered until Advancement to Candidacy (BIM 290) 1 unit each—minimum of 2 units total.

**Total Minimum Unit Requirement = 38 units**
All courses must be satisfactorily completed as detailed above. Full-time students must enroll in 12 units per quarter; however, per UC regulations, students cannot enroll in more than 12 units of graduate level courses (200) or more than 16 units of combined undergraduate and graduate level courses (100, 200, 300) courses per quarter.

c) **English Language Requirement**
Students who have not obtained an undergraduate or graduate degree at an approved English-medium institution, or who have not demonstrated strong English language proficiency through the TOEFL or IELTS exam are required to take appropriate English language courses, as described in Graduate Student Course Requirements – English as Second Language (GC-2018-02). Courses taken in satisfaction of this requirement do not count towards the minimum 30 (MS Plan I) or 38 (MS Plan II) units required for graduation.

4) **Special Requirements:**
There are no special requirements.

5) **Committees**
a) **Admissions Committee**
Once the completed application, all supporting material, and the application fee have been received, the application will be submitted to the Admissions Committee. The Admissions Committee consists of at least 5 BMEGG faculty. Based on a review of the entire application, a recommendation is made to accept or decline an applicant’s request for admission. That recommendation is forwarded to the Dean of Graduate Studies for final approval of admission. Notification of admissions decisions will be sent by Graduate Studies.

b) **Advising Committee**
The Graduate Advisor (nominated by the Chair and approved by the Dean of Graduate Studies), and Major Professor, assists the student in developing the study plan. New students must submit the “Program of Study” to the graduate group within the first two weeks of the quarter. This plan should be updated quarterly until the final degree coursework is established. Full time students must register for a minimum of 12 units per quarter.

c) **Thesis Committee (Plan I)**
Students must complete and submit the *Candidacy for the Master’s Degree – Thesis Plan I* after completing one-half of their course requirements and at least one quarter before completing all degree
requirements, normally in the 3rd quarter. Students, in consultation with their major professor and
graduate advisor, nominate three faculty to serve on the Thesis Committee. These nominations are
submitted to the Office of Graduate Studies for formal appointment in accordance with Graduate
Council policy (DDB 80, Graduate Council B.1.). The major professor serves as Chair of the committee.

d) Comprehensive Examination Committee (Plan II)

The Comprehensive Examination Committee of 3-5 members will be appointed by the BMEGG
Executive Committee and will be responsible for writing and grading the Comprehensive Examination.

6) Advising Structure and Mentoring

   a) Graduate Advisors

Upon matriculation, each student is assigned to a Graduate Advisor. The Graduate Advisor to which
a student is assigned is that student’s first source of academic information and provides assistance
with the details of the BMEGG. The Graduate Advisor’s signature is the only signature recognized as
official by Graduate Studies on a variety of forms and petitions used by graduate students. In
particular, the Graduate Advisor is responsible for the following:

1. Review and approval of the program of study for every graduate student.

2. Review and action on each petition of a graduate student to take courses on an S/U basis and to
   make recommendations on petitions of graduate students to either drop or add courses beyond the
deadlines.

3. Review and approval of petitions for advancement to candidacy for the Master’s degree and
   recommendations for the composition of the Thesis committee.

4. Periodic review of student progress towards degree objectives, and, in particular, the annual Student
   Progress Assessment, concerning each student’s progress toward completion of degree requirements.

5. Review and recommendations to the Dean of Graduate Studies of applications for admission,
   reentry, change of major, change of degree objective, and for the approval of Planned Educational
   Leaves. The Graduate Advisor is available for consultation by direct appointment. The Graduate
   Advisor will adhere to all deadlines established by Graduate Studies. It is the responsibility of the
   student to meet these deadlines.

   b) Major Professor (Plan I)

The Major Professor is the faculty member who supervises the research that precedes the preparation
of a student’s thesis. The student is responsible for meeting with faculty who have research projects
in their area of research interest, in order to identify a Major Professor. The BMEGG recommends
that new students investigate potential lab matches by talking to current students, sitting in on lab
meetings, and participating in lab rotations. The BMEGG supports these efforts by hosting Meet the
Faculty seminars during the Fall Quarter. By the end of the second quarter of enrollment, each
graduate student must select a Major Professor and complete a Mentoring Agreement Form. Students
who have not successfully matched with a Major Professor will be assisted through advising by
Graduate Advisors and Graduate Program Coordinator. Students without a Major Professor at the end
of their 3rd Quarter will be considered to be making marginal or unsatisfactory progress toward their
degree plan and may be recommended to complete the MS Plan II. The Major Professor will be in
charge of the BIM 299 and 290C research course work, will assist with the selection of courses, and
is normally the Chair of a student’s Thesis (MS) Committee. The Major Professor also participates,
with the Graduate Advisor, in the annual Student Progress Assessment.

c) **Graduate Program Coordinator**
   The Graduate Program Coordinator is the student’s first source of administrative and programmatic information and assistance.

d) **Mentoring Guidelines**
   The Mentoring Guidelines can be found on the program website: https://bmegg.ucdavis.edu/student-info/general-information/.

7) **Advancement to Candidacy**
   Every student must file an official application for Candidacy for the Degree of Master of Science after completing one-half of their course requirements and at least one quarter before completing all degree requirements, typically in the 3rd quarter. The Candidacy for the Degree of Master form can be found online at: https://gradstudies.ucdavis.edu/current-students/forms-information. A completed form includes a list of courses the student will take to complete degree requirements. If changes must be made to the student’s course plan after they have advanced to candidacy, the Graduate Advisor must recommend these changes to Graduate Studies. Students must have their Graduate Advisor and thesis committee Chair sign the candidacy form before it can be submitted to Graduate Studies. If the candidacy is approved, the Office of Graduate Studies will send a copy to: the Thesis Committee Chair, the appropriate graduate staff person, and the student. If the Office of Graduate Studies determines that a student is not eligible for advancement, the graduate group and the student will be told the reasons for the application’s deferral. Some reasons for deferring an application include: grade point average below 3.0, outstanding “I” grades in required courses, or insufficient units.

8) **Thesis and Comprehensive Examination Requirements**

   a) **Thesis Requirements (Plan I)**

      A research project and resulting thesis are major components of the MS degree program (Plan I). The thesis research is carried out under the supervision of the Major Professor chosen by the student. By the 4th quarter, the student, together with the Major Professor, should identify two additional members of the Thesis Committee. The thesis must demonstrate the student’s proficiency in research methods and scientific analysis, and a thorough knowledge of the state-of-the-art of the student’s chosen field. Alternatively, the thesis must demonstrate the student’s ability to apply known techniques to realize a novel result. Thus, a Master’s thesis may take the form of:
      1. an original research contribution of limited scope.
      2. an advanced design project, either analytical or experimental.

      The student must file the original thesis with the Office of Graduate Studies formatted according to the requirements specified on the Graduate Studies website at https://grad.ucdavis.edu/current-students/academic-services-information/filing-thesis-or-dissertation. An exit seminar summarizing the thesis research is strongly encouraged.

   b) **Comprehensive Examination (Plan II)**

      Fulfillment of the Comprehensive Examination is the last requirement of the M.S. Plan II. A student may take the comprehensive examination once they have advanced to candidacy. However, it is important that the capstone requirement be completed at or near the end of the coursework for the Master’s degree; for most students, the exam is taken at the end of the 3rd quarter. The comprehensive
examination requirement is passing a written exam administered by Comprehensive Examination Committee. The comprehensive written exam will be offered each summer. The scope of the exam is the candidate’s core coursework.

Possible results of the examination are pass and not pass. Students who do not pass the exam are permitted one retake exam, which must be taken within 12 months. Should a student not pass the retake exam, they will be subject to disqualification from further graduate work in the program.

Once passed, the Master’s Report Form is signed by the Graduate Advisor and then forwarded to the Office of Graduate Studies. A candidate must be a registered student or in Filing Fee status at the time the program submits the form, with the exception of the summer period between the end of the Spring Quarter and the beginning of Fall Quarter. The program must file the report with Graduate Studies within one week of the end of the quarter in which the student’s degree will be conferred.

9) Normative Time to Degree
a) Master of Science with Thesis (Plan I):
   Normative Time to Advancement to Candidacy: 4 Quarters
   Normative Time to Degree: 6 Quarters

b) Master of Science with Comprehensive Examination (Plan II):
   Normative Time to Advancement to Candidacy: 3 Quarters
   Normative Time to Degree: 4 Quarters

10) Typical Time Line and Sequence of Events

Full-time students enrolled in the M.S. program are expected to broadly adhere to the following timetable. The numbers indicate the consecutive quarter of enrollment:

<table>
<thead>
<tr>
<th></th>
<th>MS Plan I</th>
<th>MS Plan II</th>
<th>with deficiencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take coursework</td>
<td>1, 2, 3, 4</td>
<td>1, 2, 3, 4</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Select Major Professor</td>
<td>2</td>
<td>n/a</td>
<td>per plan</td>
</tr>
<tr>
<td>Select a Master’s Thesis committee (Plan I)</td>
<td>2</td>
<td>n/a</td>
<td>per plan</td>
</tr>
<tr>
<td>File an Application for Candidacy which includes a plan of study</td>
<td>3</td>
<td>3</td>
<td>per plan + 1</td>
</tr>
<tr>
<td>Pass the Comprehensive Examination (Plan II)</td>
<td>3</td>
<td>3</td>
<td>per plan + 1</td>
</tr>
<tr>
<td>File a Master’s Exam Report Form – Plan II</td>
<td>4</td>
<td>n/a</td>
<td>per plan + 1</td>
</tr>
<tr>
<td>Complete the thesis, gain approval from the committee and submit to the Office of Graduate Studies (Plan I)</td>
<td>6</td>
<td>n/a</td>
<td>per plan + 1</td>
</tr>
</tbody>
</table>

Full-time students enrolled in the MS Plan I program and who have entered with adequate preparation are expected to adhere to the following timetable:

<table>
<thead>
<tr>
<th>Year One - Fall</th>
<th>Year One - Winter</th>
<th>Year One - Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIM 202: Cell &amp; Molec Biol</td>
<td>284: Math Methods (alt)</td>
<td>Choose a thesis topic</td>
</tr>
<tr>
<td>BIM 204: Physiology</td>
<td>BIM 290: BME Seminar</td>
<td>Choose thesis committee</td>
</tr>
<tr>
<td>BIM 290: BME Seminar</td>
<td>Electives</td>
<td>BIM 281: Acquisition &amp; Analysis</td>
</tr>
</tbody>
</table>
The exceptions would be for students who must complete a period of remedial coursework and for part-time students. For students completing the remedial coursework, the same requirements apply following the remedial period.

Full-time students enrolled in the MS Plan II program and who have entered with adequate preparation are expected to adhere to the following timetable:

11) Sources of funding

a) Fellowships and Scholarships

The Graduate Student Support section of the Office Graduate Studies normally handles matters concerning centrally administered fellowships and scholarships. This office should be contacted for relevant information concerning sources, eligibility requirements and amounts ([https://grad.ucdavis.edu/financial-support/internal-fellowships](https://grad.ucdavis.edu/financial-support/internal-fellowships)). Note: to be eligible for fellowships, domestic students must complete the Free Application for Federal Student Aid (FAFSA) available at [https://fafsa.ed.gov/](https://fafsa.ed.gov/).

b) Teaching Assistantships

Teaching Assistantships (TAs) are provided by various departments and programs across the UCD campus. Any graduate student can apply for a TA position in any program that offers a course for which the student is qualified. The student must apply through the program of interest and there is no restriction on the number of applications that can be made at any one time. Thus to improve the chances of obtaining a TA position, it is beneficial to make multiple applications.

Theoretically, TA positions are given to the most qualified applicants. However, in practice, many programs give preference to students in that program. Programs that have provided TA positions to BMEGG students in the past include the following:

- Department of Biomedical Engineering
- Department of Mechanical and Aerospace Engineering
- Department of Materials Science and Engineering
The amount of funding depends on the level of the appointment, with two levels representing normative appointments. A 50% appointment, which is the maximum, requires a time commitment of about 20 hours/week while a 25% appointment requires a time commitment of about 10 hours/week. In either case, the appointment also provides a registration fee remission.

c) Graduate Student Researchers
Graduate Student Research (GSR) positions are provided by individual faculty members. Students interested in GSR support must approach faculty who are conducting sponsored projects where the skills possessed by the student may be used to advantage. Traditionally, students work as a GSR on a project which also serves to satisfy the thesis requirement.

d) Work-Study Awards
Work-Study awards are available to domestic students from the Federal Work-Study program and administered through the BMEGG. A request for nominations goes out to faculty and students, usually at the end of the Spring Quarter. To be considered for such an award, students must first file a completed Free Application for Federal Student Aid (FAFSA), which is available on-line at https://fafsa.ed.gov/ by May 15 preceding the call for nominations. Based on financial information that each student provides on the FAFSA form, the Graduate Financial Aid Office will determine the amount of eligibility, if any. Faculty may nominate eligible students for consideration by guaranteeing matching GSR support. Awards are made based on a number of criteria that consider degree objective, academic record (both GPA and progress), major professor, financial need, and receipt of previous awards.

A work/study award pays approximately 75% of a 25% GSR step I salary for one quarter. The balance is paid from a research account of the student’s Major Professor. More than one unit may be awarded to a student during the academic year and summer quarter. If the award is given for an academic quarter, then the award also pays 75% of the registration fees for that quarter. Although awards are given primarily for 25% appointments, it is still possible to be supported at the maximum level that is 50% by supplementing the award with an additional 25% appointment as either a GSR or a TA.

e) Loans
Loans are provided through the Office of Financial Aid. As with Work-Study awards, students desiring loans must fill out the FAFSA form. Eligibility for loans is determined from the information provided on this form.

12) PELP, In Absentia, and Filing Fee status.
Information about PELP (Planned Educational Leave), In Absentia (reduced fees when researching out of state) and Filing Fee status can be found on the Grad Studies website: https://grad.ucdavis.edu/policies.

Attachments

Biomedical Engineering □M.S. Curriculum
Extended List of Common Graduate Electives for Biomedical Engineering
PH.D. PROGRAM

1) Admissions Requirements

Admission to graduate standing in the Biomedical Engineering Graduate Group (BMEGG) requires a Bachelor’s degree in a discipline relevant to biomedical engineering. Successful applicants typically have an undergraduate GPA of 3.25 (out of 4.00) or greater. For students who have completed an MS degree, a minimum graduate GPA of 3.50 is normally required. Applicants whose native language or language of instruction is not English are required to demonstrate English Language Proficiency with an overall score of 100 on the Test of English as a Foreign Language (TOEFL) internet-based test or a score of 8.0 from the International English Language Testing System (IELTS). An applicant may apply for admission to either the MS or the PhD degree objective. Students in the MS degree objective may, subject to approval by the Graduate Group, apply to transfer to the PhD degree objective. Students in the PhD degree objective can earn an MS enroute to the PhD.

A complete application for Graduate Study includes:

- Graduate Application Form
- Application Fee
- Transcript for each university attended
- Graduate Record Examination (General Test)
- Three letters of recommendation
- English proficiency examination for international applicants who have not studied at an English speaking University: TOEFL or other University approved examination.

a) Prerequisites:

Students entering the Biomedical Engineering Graduate Group are expected to have completed a Bachelor’s degree in Engineering and the following courses (or equivalents). It is expected that students receive a letter grade when completing these courses.

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<td>STA 130A</td>
<td>• Statistics</td>
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Descriptions of the courses listed above can be found in the General Catalog. To determine course equivalence, consult a Graduate Advisor. Note that Quarter Units = 1.5 x Semester Units.

Applicants without Bachelor’s degree in Engineering may become eligible for admission by completing the following courses (or equivalents). It is expected that students receive a letter grade when completing these courses.

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<td>• Chemistry</td>
<td>5 units</td>
</tr>
<tr>
<td>ENG 6</td>
<td>• Engineering (programming)</td>
<td>4 units</td>
</tr>
<tr>
<td>ENG 17</td>
<td>• Engineering (circuits)</td>
<td>4 units</td>
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</table>
ENG 100  • Engineering (electrical systems)  3 units
STA 130A • Statistics  4 units

Descriptions of the courses listed above can be found in the General Catalog. To determine course equivalence, consult a Graduate Advisor. *Note that Quarter Units = 1.5 x Semester Units.*

b) Deficiencies:

Applicants with three or more prerequisite deficiencies are substantially less competitive than fully prepared students and are unlikely to be accepted for admission. Although some deficiencies can be resolved after admission to the BMEGG, this generally necessitates extending the time to degree. The amount of financial support provided by the BMEGG to students with significant deficiencies in preparation may be limited. If the prerequisite courses have not been completed prior to admission, then they must be completed by the end of the first year in the program by taking courses as approved by the Graduate Advisor.

2) Dissertation

The Biomedical Engineering Graduate Group offers the Ph.D. degree under Plan C. This plan specifies a three member (minimum) dissertation/final examination committee and a final oral examination. The BMEGG requires two examinations (qualifying and final oral examination) and a dissertation.

3) Course Requirements (50 units minimum)

a) Core Required Units = 17
   1. Cell and Molecular Biology for Engineers (BIM 202)  4 units
   2. Physiology for Bioengineers (BIM 204)  5 units
   3. Acquisition and Analysis of Biomedical Signals (BIM 281)  4 units
   4. Statistical Design of Experiments for Biomedical Engineering (BIM 283) OR Mathematical Methods for Biomedical Engineers (BIM 284)  4 units

b) Elective Units = 23
   Elective courses are specific to each students’ research focus and will be determined with an advisor.

c) Total Letter-Graded Unit Requirement = 40 units
   The courses above must be taken for a letter grade; the minimum acceptable grade in any course is a B- and the minimum overall GPA is 3.50. At least 30 of the 40 total letter-graded units must consist of graduate (200) level engineering courses.

d) Additional Course Requirement = 10 units
   1. Scientific Communication for Biomedical Engineers (BIM 201)  1 unit
      *must be taken prior to Advancement to Candidacy
   2. Scientific Integrity for Biomedical Engineers (BIM 209)  2 units
      *must be taken prior to Advancement to Candidacy
   3. Teaching Assistant Training Practicum (BIM 396)  1-4 units
      *must be taken prior to Advancement to Candidacy
   4. Seminar: students must enroll in the seminar course during each quarter it is offered until Advancement to Candidacy (BIM 290)  1 unit each—minimum of 6 units total
e) Total Minimum Unit Requirement

All courses must be satisfactorily completed as detailed above. Full-time students must enroll in 12 units per quarter; however, per UC regulations, students cannot enroll in more than 12 units of graduate level courses (200) or more than 16 units of combined undergraduate and graduate level courses (100, 200, 300) courses per quarter.

f) English Language Requirement

Students who have not obtained an undergraduate or graduate degree at an approved English-medium institution, or who have not demonstrated strong English language proficiency through the TOEFL or IELTS exam are required to take appropriate English language courses, as described in Graduate Student Course Requirements – English as Second Language (GC-2018-02). Courses taken in satisfaction of this requirement do not count towards the minimum 50 units required for graduation.

4) Special Requirements: none

5) Committees

a) Admissions Committee

Once the completed application, all supporting material, and the application fee have been received, the application will be submitted to the Admissions Committee. The Admissions Committee consists of at least 5 graduate group faculty. Based on a review of the entire application, a recommendation is made to accept or decline an applicant’s request for admission. The recommendation is forwarded to the Dean of Graduate Studies for final approval of admission. Notification of admissions decisions will be sent by Graduate Studies.

b) Advising Committee

The Graduate Advisor (and Major Professor) assists the student in developing the study plan. New students must submit the “Program of Study” to the graduate group within the first two weeks of the quarter. This plan should be updated quarterly until the final degree coursework is established. Full time students must register for a minimum of 12 units per quarter.

c) Qualifying Examination Committee

Students, in consultation with their Major Professor, must identify a Ph.D. Qualifying Exam Committee composed of five faculty members and complete the Qualifying Examination Application Form. The Qualifying Examination Application Form can be found online at: https://grad.ucdavis.edu/current-students/forms-information. The Major Professor can be a member of the committee, but may not serve as the chairperson. At least three committee members must be BME Graduate Group members, one of which will be selected to chair the committee. At least one member must be from outside the BME Graduate Group. The Graduate Advisor must endorse these members and nominate them for approval by the Office of Graduate Studies; it is within the advisor's purview to reject the student’s selections if the advisor deems that the committee is not appropriately constituted. One attribute of an appropriately constituted committee is that the faculty members represent broadly the various disciplines included in Biomedical Engineering as well as the area of the student's primary interest. The Office of Graduate Studies must approve all appointments to the examination committee.

d) Dissertation Committee

After passing the Qualifying Examination, students must establish their Dissertation Committee and Advance to Candidacy. Students, in consultation with their Major Professor, must identify a Dissertation Committee composed of three to five faculty members and complete the Candidacy for the Degree of Doctor of Philosophy, Plan C Form. The Candidacy for the Degree of Doctor of Philosophy, Plan C Form can be found online at: https://grad.ucdavis.edu/current-students/forms-
The chairperson is required to be a member of the BMEGG and is normally the Major Professor. The Graduate Advisor must endorse these members and nominate them for approval by the Office of Graduate Studies; it is within the advisor's purview to reject the student’s selections if the advisor deems that the committee is not appropriately constituted. One attribute of an appropriately constituted committee is that the faculty members represent broadly the various disciplines included in Biomedical Engineering as well as the area of the student's primary interest. The Office of Graduate Studies must approve all appointments to the examination committee.

6) Advising Structure and Mentoring

a) Graduate Advisors

Upon matriculation, each student is assigned to a Graduate Advisor. The Graduate Advisor to which a student is assigned is that student’s first source of academic information and provides assistance with the details of the BMEGG. The Graduate Advisor’s signature is the only signature recognized as official by Graduate Studies on a variety of forms and petitions used by graduate students. In particular, the Graduate Advisor is responsible for the following:

1. Review and approval of the program of study for every graduate student.

2. Review and action on each petition of a graduate student to take courses on an S/U basis and to make recommendations on petitions of graduate students to either drop or add courses beyond the deadlines.

3. Recommendations, after consultation with the student and the student’s Major Professor, for composition of Ph.D. Qualifying Examination and Dissertation Committees.

4. Periodic review of student progress towards degree objectives, using the Student Progress Assessment (SPA) system, and, in particular, reviewing an annual report concerning each student’s progress toward completion of degree requirements, including as a degree Candidate.

5. Review and recommendations to the Dean of Graduate Studies of applications for admission, reentry, change of major, change of degree objective, and for the approval of Planned Educational Leaves.

The Graduate Advisor is available for consultation by direct appointment. The Graduate Advisor will adhere to all deadlines established by Graduate Studies. It is the responsibility of the student to meet these deadlines.

b) Major Professor

The Major Professor is the faculty member who supervises the research that precedes the preparation of a student’s thesis or dissertation. The student is responsible for meeting with faculty who have research projects in their area of research interest, in order to identify a Major Professor. The BMEGG recommends that new students investigate potential lab matches by talking to current students, sitting in on lab meetings, and participating in lab rotations. The BMEGG supports these efforts by hosting Meet the Faculty seminars during the Fall Quarter. By the end of the second quarter of enrollment, each graduate student must select a Major Professor and complete a Mentoring Agreement Form. Students who have not successfully matched with a Major Professor will be assisted through advising by Graduate Advisors and Graduate Program Coordinator. Students without a Major Professor at the end of their 3rd Quarter will be considered to be making marginal or unsatisfactory progress toward their degree and may be recommended to complete the MS Plan II. The Major Professor will be in charge of the BIM 299 and 290C research course work, will assist with the selection of courses, and is normally the Chair of a student’s Dissertation (PhD) Committee. The Major Professor also participates, with the Graduate Advisor, in the annual Student Progress Assessment.
c) Graduate Program Coordinator
   The Graduate Program Coordinator is the student’s first source of administrative and programmatic
   information and assistance.

d) Mentoring Guidelines
   The Mentoring Guidelines can be found on the program website:

7) Advancement to Candidacy
   The student is eligible for Advancement to Candidacy after successful completion of all graduate group degree
   requirements and after passing the Qualifying Examination, normally by the 7th quarter. In order to remain
   eligible for academic appointments (TA, GSR, AI, etc.), students must pass their qualifying examination by the
   end of the 9th quarter.

   After passing the Qualifying Examination, the student must file the appropriate paperwork with the Office of
   Graduate Studies and pay the candidacy fee in order to be officially promoted to Ph.D. Candidacy. Refer to
   the Graduate Council website for additional details regarding the Doctoral Qualifying Examination at
   https://grad.ucdavis.edu/policies.

8) Examination and Dissertation requirements:
   The Biomedical Engineering Graduate Group offers the Ph.D. degree under Plan C and requires two
   examinations:

   a) Examination 1 is an oral Qualifying Examination taken upon completion of the coursework and all
      other requirements described above, normally by the 7th quarter. The examination must be
      completed within nine quarters of matriculation to the graduate group. Students who do not
      complete the examination within the prescribed time frame will be subject to disqualification from
      the program unless the Graduate Advisor has granted a written extension with specified conditions.
      The purpose of the qualifying examination is to assess a student's potential for completing dissertation
      research that will be of sufficient quality to merit publication in a peer-reviewed journal. Once
      students have passed the exam and advanced to candidacy, they are no longer required to take any
      additional course work.

      For this exam, a dissertation plan will be prepared in consultation with the student’s major professor
      and include a statement of scientific aims, a section on background and significance, a description of
      methods, presentation of any preliminary work, and presentation of anticipated results and alternative
      approaches. The written plan will follow the NIH R01 format: 13 pages maximum, excluding
      references, and will be formatted with 11 point font, single space, and 1 inch margins. The plan must
      be submitted to each member of the oral Qualifying Examination Committee at least two weeks
      prior to the examination. The plan must be sufficiently detailed to appreciate the importance of the
      biomedical problem, the relationship of the problem to previous relevant research, and the
      engineering methods that will be used or developed to solve the problem including their justification.
      The plan and the student’s command of the field is defended before a 5-member committee with
      representation both from engineering and biology/medicine, as described above in the
      Committees section. The oral presentation should be approximately 30 minutes, excluding
      questions; the total exam will last 2-3 hours in length. The committee will ensure that the student
      has both breadth and depth of knowledge of the field and provide guidance to the student regarding
      their research plan. The student should not provide refreshments for the committee.
b) **Examination 2** is a final oral examination taken after preparation of a written Ph.D. dissertation. Each student will prepare and present a seminar defending the scientific importance of their dissertation before a 3 or more member Dissertation Committee and interested faculty and graduate students in the program. Following the open presentation, the audience will be excused and the committee will continue to examine the student regarding the presentation and dissertation work. This examination is usually restricted to the members of the committee, but may be open to faculty members and guests, with the consent of the student and all the members of the dissertation committee. The Chair of the Dissertation Committee completes the **Report of Final Examination for PhD, Plan C Form** and submits it to the Office of Graduate Studies by the final examination date listed on the academic calendar.

c) **The Dissertation:** The recipient of a Ph.D. degree is understood to possess thorough knowledge of a broad field of learning and to have given evidence of distinguished accomplishment in that field. The degree is a demonstration of critical ability and powers of imaginative synthesis. The degree also signifies that the recipient has presented a doctoral dissertation containing an original contribution to knowledge in their chosen field of study. The doctoral dissertation must demonstrate the ability to carry out a program of advanced research and to report the results in accordance with standards observed in recognized scientific journals. The dissertation format is determined by the student in consultation with the Major Professor and Dissertation Committee. There are two common formats. One entails introductory, methods, results, discussion, and conclusion/future directions chapters. The other involves a series of chapters that reflect journal articles that resulted from the dissertation research with introductory and summary chapters that tie together these journal article chapters in the context of the overarching goals of the dissertation.

The doctoral dissertation is based upon research carried out under the guidance of a Major Professor who is a member of the Graduate Group in Biomedical Engineering. A minimum of two additional faculty members aid in guiding the research program and constitute the Ph.D. Dissertation Committee. Although there is close communication between the student and the Major Professor, consultations shall also occur at reasonable time intervals (six months) between the candidate and the Ph.D. Dissertation Committee meeting as a group. This continuous flow of information will improve the guidance of the committee during the execution of the project. The student must file the original dissertation with the Office of Graduate Studies according to the requirements specified on the Graduate Studies website at [https://grad.ucdavis.edu/current-students/academic-services-information/filing-thesis-or-dissertation](https://grad.ucdavis.edu/current-students/academic-services-information/filing-thesis-or-dissertation).

9) **Normative Time to Degree**
   a. Normative Time to Advancement to Candidacy: 6 Quarters
   b. Normative Time in Candidacy: 9 Quarters

10) **Typical Time Line and Sequence of Events**
    
    Full-time students enrolled in the Ph.D. program and who have entered with adequate preparation are expected to adhere to the following timetable:

<table>
<thead>
<tr>
<th>Year One - Fall</th>
<th>Year One - Winter</th>
<th>Year One - Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIM 201: Scientific Communication in BME</td>
<td>Choose a Major Professor</td>
<td>BIM 209: Scientific Integrity</td>
</tr>
<tr>
<td>BIM 202: Cell &amp; Molec Biology</td>
<td>BIM 284: Math Methods (alt)</td>
<td>BIM 281: Acquisition &amp; Analysis</td>
</tr>
<tr>
<td>BIM 204: Physiology</td>
<td>BIM 290: BME Seminar</td>
<td>BIM 283: Statistical Design (alt)</td>
</tr>
</tbody>
</table>
Year Two - Fall | Year Two - Winter | Year Two - Spring
--- | --- | ---
BIM 290: BME Seminar | Elective | BIM 290: BME Seminar
Elective | Elective | Elective
Choose a Major Professor | Choose a dissertation topic | BIM 290: BME Seminar

Year Two - Summer
Qualifying Exam (Exam 1)
Advancement to PhD candidacy

Year Three to Six
Dissertation Research and Completion
Dissertation Defense (Exam 2)

The exceptions would be for students who must complete a period of remedial coursework and for part-time students. For students completing the remedial coursework, the same requirements apply following the remedial period. For students entering with a related MS degree, more rapid progress is expected.

11) Sources of funding

a) Fellowships and Scholarships

1. Graduate Studies Based
The Graduate Student Support section of the Office Graduate Studies normally handles matters concerning centrally administered fellowships and scholarships. This office should be contacted for relevant information concerning sources, eligibility requirements, and amounts ([https://grad.ucdavis.edu/financial-support/internal-fellowships](https://grad.ucdavis.edu/financial-support/internal-fellowships)). Note: to be eligible for fellowships, domestic students must complete the Free Application for Federal Student Aid (FAFSA) available at [https://fafsa.ed.gov/](https://fafsa.ed.gov/).

2. BMEGG Based
BMEGG Fellowships are typically provided to first year students. Students interested in being considered for a program-based fellowship should apply before the January 15 deadline of each year to be considered for the following academic year. The primary criteria used in granting fellowships are academic performance as measured by GPA, degree objective, and progress towards degree objective. Fellowship funds can only be disbursed during the academic year and can be given as a non-resident tuition fellowship (NRTF), as registration fee fellowship, and as a stipend that has no restriction. Note: to be eligible for fellowships, domestic students must complete the Free Application for Federal Student Aid (FAFSA) available at [https://fafsa.ed.gov/](https://fafsa.ed.gov/).

3. Other
Beyond the fellowship support available from the above internal sources, substantial opportunities exist for obtaining support from outside sources. Sources of pre-doctoral funding for Biomedical Engineering graduate students are the National Science Foundation, National Institutes of Health,
and Department of Defense. Only students with exceptional GPAs will be competitive for fellowship support from these sources. Award amounts typically cover all fees and living expenses for a multi-year period.

b) Teaching Assistantships

Teaching Assistantships (TAs) are provided by various departments and programs across the UCD campus. Any graduate student can apply for a TA position in any program that offers a course for which the student is qualified. The student must apply through the program of interest and there is no restriction on the number of applications that can be made at any one time. Thus, to improve the chances of obtaining a TA position, it is beneficial to make multiple applications.

Theoretically, TA positions are given to the most qualified applicants. However, in practice, many programs give preference to students in that program. Programs that have provided TA positions to BMEGG students in the past include the following:

- Department of Biomedical Engineering
- Department of Mechanical and Aerospace Engineering
- Department of Materials Science and Engineering
- College of Biological Sciences
- Department of Mathematics

The amount of funding depends on the level of the appointment. Two levels of appointments are normal. A 50% appointment, which is the maximum, requires a time commitment of about 20 hours per week while a 25% appointment requires a time commitment of about 10 hours per week. In either case, the appointment also provides a registration fee remission.

c) Graduate Student Researchers

Graduate Student Research (GSR) positions are provided by individual faculty members. Students interested in GSR support must approach faculty who are conducting sponsored projects where the skills possessed by the student may be used to advantage. Usually students work as a GSR on a project which also serves to satisfy the dissertation requirement. However this is not always the case.

d) Work-Study Awards

Work-Study awards are available to domestic students from the Federal Work-Study program and administered through the BMEGG. A request for nominations goes out to faculty and students usually at the end of the Spring Quarter. To be considered for such an award, students must first file a completed Free Application for Federal Student Aid (FAFSA) available on-line at [https://fafsa.ed.gov/](https://fafsa.ed.gov/) by May 15 preceding the call for nominations. Based on financial information that each student provides on the FAFSA form, the Graduate Financial Aid Office will determine the amount of eligibility, if any. Faculty may nominate eligible students for consideration by guaranteeing matching GSR support. Awards are made based on a number of criteria that consider degree objective, academic record (both GPA and progress), major professor, financial need, and receipt of previous awards.

A work-study award pays approximately 75% of a 25% GSR step III salary for one quarter. The balance is paid from a research account of the student’s Major Professor. More than one unit may be awarded to a student during the academic year and summer quarter. If the award is given for an academic quarter, then the award also pays 75% of the registration fees for that quarter. Although awards are given primarily for 25% appointments, it is still possible to be supported at the maximum level that is 50% by supplementing the award with an additional 25% appointment as either a GSR or a TA.
e) Loans

Loans are provided through the Office of Financial Aid. As with Work-Study awards, students desiring loans must fill out the FAFSA form. Eligibility for loans is determined from the information provided on this form.

12) PELP, In Absentia, and Filing Fee status.
Information about PELP (Planned Educational Leave), In Absentia (reduced fees when researching out of state), and Filing Fee status can be found on the Grad Studies website: https://grad.ucdavis.edu/policies.

13) Leaving the Program Prior to Completion of the PhD Requirements
Should a student leave the program prior to completing the requirements for the PhD, they may still be eligible to receive the Masters if they have fulfilled all the requirements (see Master’s section). Students can use the Change of Degree Objective form available from the Registrar’s Office: http://registrar.ucdavis.edu/local_resources/forms/D065-graduate-major-degree-change.pdf.

Attachments

Extended List of Common Graduate Electives for Biomedical Engineering
Ph.D. Curriculum
BMEGG PhD Qualifying Examination Guidelines
Biomedical Engineering □ M.S. Curriculum

The following FOUR core courses or their equivalent must be successfully completed by all doctorate seeking students.

<table>
<thead>
<tr>
<th>Course #</th>
<th>Course Title</th>
<th>QTR</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIM 202</td>
<td>Cell/Molecular Biology for Engineers</td>
<td>F</td>
<td>4</td>
</tr>
<tr>
<td>BIM 204</td>
<td>Physiology for Engineers</td>
<td>F</td>
<td>5</td>
</tr>
<tr>
<td>BIM 281</td>
<td>Acquisition and Analysis of Biomedical Signals</td>
<td>S</td>
<td>4</td>
</tr>
<tr>
<td>BIM 283</td>
<td>Statistical Design of Experiments for BME (OR)</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>BIM 284</td>
<td>Mathematical Methods for Biomedical Engineering</td>
<td>W</td>
<td>4</td>
</tr>
</tbody>
</table>

Technical electives are required to build a cohesive academic training. Technical electives should be selected in consultation with a Graduate Advisor.

Additional electives are required to fulfill a minimum total of 28 letter-graded units for MS Plan I and 36 letter-graded units for MS Plan II. These courses should be selected in consultation with your major professor and/or the graduate advisor to develop a strong academic coursework sequence. For approved courses, consult the Extended List of Common Graduate Electives in Biological and Medical Sciences. The Graduate Group may approve other topics.

MS Plan I students must complete at least 28 letter-graded units including a minimum of 18 graduate engineering units. Additional BIM 290 courses must be taken to reach 30 units.

MS Plan II students must complete at least 36 letter-graded units including a minimum of 24 graduate engineering units. Additional BIM 290 courses must be taken to reach 38 units.
**MS Graduate Coursework Checklist**

Name: ______________

Plan I or II (circle)

### CORE (17 units):

<table>
<thead>
<tr>
<th>Course</th>
<th>Quarter</th>
<th>Units</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIM 202 Cell/Molecular biology for engineers</td>
<td>F</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>BIM 204 Physiology for Bioengineers</td>
<td>F</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>BIM 281 Acquisition &amp; Analysis of Biomedical Signals</td>
<td>S</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>BIM 283 Statistical Design of Experiments for BME (OR)</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIM 284 Mathematical Methods for BME</td>
<td>W</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

### Elective (11-19 units, depending on plan):

<table>
<thead>
<tr>
<th>Course</th>
<th>Quarter</th>
<th>Units</th>
<th>Grade</th>
</tr>
</thead>
</table>

### Other Course Requirements:

<table>
<thead>
<tr>
<th>Course</th>
<th>Requirement Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIM 290 BME Seminar (each quarter until advanced)</td>
<td></td>
</tr>
</tbody>
</table>

Graduate Advisor _____________________________________ Date ______________
## Extended List of Common Graduate Electives for Biomedical Engineering

### Biomedical Engineering

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIM 210</td>
<td>Introduction to Biomaterials</td>
</tr>
<tr>
<td>BIM 211</td>
<td>Design of Polymeric Biomaterials and Biological Interfaces</td>
</tr>
<tr>
<td>BIM 212</td>
<td>Biomedical Heat and Mass Transport Processes</td>
</tr>
<tr>
<td>BIM 213</td>
<td>Principles and Applications of Biological Sensors</td>
</tr>
<tr>
<td>BIM 214</td>
<td>Continuum Biomechanics</td>
</tr>
<tr>
<td>BIM 215</td>
<td>Biomedical Fluid Mechanics &amp; Transport Phenomena</td>
</tr>
<tr>
<td>BIM 216</td>
<td>Advanced Topics in Cellular Engineering</td>
</tr>
<tr>
<td>BIM 217</td>
<td>Mechanobiology in Health and Disease</td>
</tr>
<tr>
<td>BIM 218</td>
<td>Microsciences</td>
</tr>
<tr>
<td>BIM 221</td>
<td>Drug Delivery Systems</td>
</tr>
<tr>
<td>BIM 222</td>
<td>Cytoskeletal Mechanics</td>
</tr>
<tr>
<td>BIM 223</td>
<td>Multibody Dynamics</td>
</tr>
<tr>
<td>BIM 225</td>
<td>Spatial Kinematics and Robotics</td>
</tr>
<tr>
<td>BIM 228</td>
<td>Skeletal Muscle Mechanics: Form, Function, Adaptability</td>
</tr>
<tr>
<td>BIM 232</td>
<td>Skeletal Tissue Mechanics</td>
</tr>
<tr>
<td>BIM 232</td>
<td>Soft Tissue Mechanics</td>
</tr>
<tr>
<td>BIM 239</td>
<td>Advanced Finite Elements and Optimization</td>
</tr>
<tr>
<td>BIM 240</td>
<td>Computational Methods in Nonlinear Mechanics</td>
</tr>
<tr>
<td>BIM 241</td>
<td>Introduction to Magnetic Resonance Imaging</td>
</tr>
<tr>
<td>BIM 242</td>
<td>Introduction to Biomedical Imaging</td>
</tr>
<tr>
<td>BIM 243</td>
<td>Radiation Detectors for Biomedical Applications</td>
</tr>
<tr>
<td>BIM 246</td>
<td>Magnetic Resonance Technology</td>
</tr>
<tr>
<td>BIM 249</td>
<td>Microsensor Design and Fabrication</td>
</tr>
<tr>
<td>BIM 251</td>
<td>Medical Image Analysis</td>
</tr>
<tr>
<td>BIM 252</td>
<td>Computational Methods in Biomedical Imaging</td>
</tr>
<tr>
<td>BIM 255</td>
<td>Nanoscale Imaging for Molecular Medicine</td>
</tr>
<tr>
<td>BIM 257</td>
<td>Fundamentals of Tissue Optics and Biomedical Applications</td>
</tr>
<tr>
<td>BIM 262</td>
<td>Cell and Molecular Biophysics for Bioengineers</td>
</tr>
<tr>
<td>BIM 264</td>
<td>Synthetic and Systems Engineering of Cells</td>
</tr>
<tr>
<td>BIM 270</td>
<td>Biochemical Systems Theory</td>
</tr>
<tr>
<td>BIM 271</td>
<td>Gene Circuit Theory</td>
</tr>
<tr>
<td>BIM 272</td>
<td>Tissue Engineering</td>
</tr>
<tr>
<td>BIM 273</td>
<td>Integrative Tissue Engineering and Technologies</td>
</tr>
<tr>
<td>BIM 286</td>
<td>Nuclear Imaging in Medicine and Biology</td>
</tr>
<tr>
<td>BIM 287</td>
<td>Concepts in Molecular Imaging</td>
</tr>
<tr>
<td>BIM 288</td>
<td>Living Matter: Physical Biology of the Cell</td>
</tr>
</tbody>
</table>

### Biological and Agricultural Engineering

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EBS 130</td>
<td>Dynamic Modeling of Processes in Biological Systems</td>
</tr>
</tbody>
</table>
EBS 165  Bioinstrumentation and Control
EBS 175  Rheology of Biological Materials
EBS 239  Magnetic Resonance Imaging in Biological Systems
EBS 265  Design and Analysis of Engineering Experiments

Chemical Engineering
ECH 161A  Biochemical Engineering Fundamentals
ECH 161B  Bioseparations
ECH 161L  Bioprocess Engineering Laboratory
ECH 170  Introduction to Colloid and Surface Phenomena
ECH 206  Biochemical Engineering
ECH 226  Enzyme Engineering
ECH 245  Micro-/Nano-Technology in Life Sciences
ECH 246  Advanced Biochemical Engineering
ECH 265  Emulsions, Microemulsions and Bilayers

Civil Engineering
ECI 201  Introduction to Theory of Elasticity
ECI 203  Inelastic Behavior of Solids
ECI 205  Continuum Mechanics
ECI 211  Advanced Matrix Structural Analysis
ECI 212A  Finite Element Procedures in Applied Mechanics
ECI 212B  Finite Elements: Application to Linear and Nonlinear Structural Mechanics Problems

Electrical Engineering
EEC 146A  Integrated Circuits Fabrication
EEC 210  MOS Analog Circuit Design
EEC 245  Micro-/Nano-Technology in Life Sciences
EEC 246  Advanced Projects in IC Fabrication
EEC 249  Nanofabrication
EEC 260  Random Signals and Noise
EEC 264  Estimation and Detection of Signals in Noise

Mechanical Engineering
MAE 208  Measurement Methods in Fluid Mechanics and Combustion
MAE 228  Introduction to BioMEMS

Material Science
EMS 230  Fundamentals of Electron Microscopy
EMS 230L  Laboratory for Electron Microscopy
EMS 243  Kinetics of Phase Transformation in Engineering Materials
EMS 245  Micro-/Nano-Technology in Life Sciences
EMS 248  Fracture of Engineering Materials
EMS 251  Applications of Solid State Nuclear Magnetic Resonance Spectroscopy

Biological Science
BIS 101  Genes and Gene Expression
BIS 102  Structure and Function of Biomolecules
BIS 103  Bioenergetics and Metabolism
BIS 104  Regulation of Cell Function

**Molecular and Cellular Biology**

MCB 120L  Biochemistry Laboratory
MCB 121  Molecular Biology of Eukaryotic Cells
MCB 122  Structure and Function of Proteins
MCB 123  Behavior and Analysis of Enzyme and Receptor Systems
MCB 140L  Cell Biology Laboratory
MCB 141  Cellular Regulation of Gene Expression
MCB 142  Advanced Cell Biology: Contractile and Motile Systems
MCB 161  Molecular Genetics
MCB 162  Human Genetics
MCB 164  Advanced Eukaryotic Genetics
MCB 200C  Current Techniques in Biophysics
MCB 221A  Physical Biochemistry
MCB 263  Biotechnology Fundamentals and Application

**Neurobiology, Physiology, and Behavior**

NPB 100  Neurobiology
NPB 101  Systemic Physiology
NPB 101L  Systemic Physiology Laboratory
NPB 105  Introduction to Computer Models
NPB 112  Neuroscience
NPB 113  Cardiovascular, Respiratory and Renal Physiology
NPB 127  Comparative physiology: circulation
NPB 160  Advanced cellular neurobiology
NPB 245  Computational Models of Cellular Signaling

**School of Medicine**

CHA 202  Human Microscopic Anatomy
PMD 210  Introduction to Human Pathology

**School of Veterinary Medicine**

APC 420  Physiology and Pathophysiology of the Liver
VMD 402  Structure and Function of the Cardiorespiratory System
VMD 430  Principles of Radiology and Radiographic Interpretation
VMD 452  General Pathology
VMD 459  Systemic Pathology
Biomedical Engineering □ Ph.D. Curriculum

The following FOUR core courses or their equivalent must be successfully completed by all doctorate seeking students.

<table>
<thead>
<tr>
<th>Course #</th>
<th>Course Title</th>
<th>Quarter</th>
<th>Units</th>
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<tbody>
<tr>
<td>BIM 202</td>
<td>Cell/Molecular Biology for Engineers</td>
<td>F</td>
<td>4</td>
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<tr>
<td>BIM 204</td>
<td>Physiology for Engineers</td>
<td>F</td>
<td>5</td>
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<tr>
<td>BIM 281</td>
<td>Acquisition and Analysis of Biomedical Signals</td>
<td>S</td>
<td>4</td>
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<tr>
<td>BIM 283</td>
<td>Statistical Design of Experiments for BME (OR)</td>
<td>S</td>
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<tr>
<td>BIM 284</td>
<td>Mathematical Methods for Biomedical Engineering</td>
<td>W</td>
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Technical electives are required to build a cohesive academic training. Technical electives should be selected in consultation with a Graduate Advisor.

At least THREE additional electives are required to fulfill a minimum total of 40 units prior to taking the qualifying exam. These courses should be selected in consultation with your major professor and/or the graduate advisor to develop a strong, cohesive academic coursework sequence. For approved courses, consult the Extended List of Common Graduate Electives in Biological and Medical Sciences. The Graduate Group may approve other topics.

PhD students must complete 30 units of graduate engineering courses and 10 additional elective units for a total of 40 units with a 3.5 GPA.

Additional Course Requirement = 10 units
1. Scientific Communication for Biomedical Engineers (BIM 201) 1 unit
2. Scientific Integrity for Biomedical Engineers (BIM 209) 2 units
3. Teaching Assistant Training Practicum (BIM 396) 1-4 units
4. Seminar: students must enroll in the seminar course during each quarter it is offered until Advancement to Candidacy (BIM 290) 1 unit each— minimum of 6 units total
Ph.D. Graduate Coursework Checklist

Graduate engineering (30 units):

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Elective (10 units):

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Other Course Requirements:

<table>
<thead>
<tr>
<th>Course</th>
<th>Requirement Complete</th>
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<tbody>
<tr>
<td>BIM 201  Scientific Communications for BME</td>
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<tr>
<td>BIM 209  Scientific Integrity for Biomedical Engineers</td>
<td></td>
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<tr>
<td>BIM 290  BME Seminar (each quarter until advanced)</td>
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<tr>
<td>BIM 396  Teaching Assistant Training Practicum</td>
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Exam

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<tr>
<th>Exam</th>
<th>Date Taken</th>
<th>Result</th>
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<tbody>
<tr>
<td>Qualifying Exam</td>
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<tr>
<td>Defense</td>
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Graduate Advisor ___________________________ Date ________________
STUDENT RESPONSIBILITIES

- Prior to nomination of the QE committee, the student should discuss potential QE members with their Major Professor and Graduate Advisor.
- The QE committee should be formed at least 3 months prior to the exam. Form available at https://grad.ucdavis.edu/current-students/forms-information.
- The student should meet with each nominated QE committee member at least once before the scheduled examination. Frequency, duration, and number of meetings between an individual committee member and the student are decided by those two individuals. The purpose of the meetings should be to understand the committee member's expectations for the student's performance on the QE, to identify relevant material and approaches for preparation, and to familiarize the faculty with the student's proposed research.
- The student must contact each member of the QE committee to determine dates and times available for the QE, and then notify each QE committee member of the final date, time, and location of the QE.
- The student must reserve a room for the QE for at least 4 hours for the date and time; the typical time for the examination process is about 3 hours. Conference rooms in GBSF can be reserved at https://somapp.ucdmc.ucdavis.edu/scheduling/GBSF/index.cfm.
- In coordination with the Chair of the QE committee, the student must provide each QE committee member with a written project proposal two to four weeks before the scheduled examination.
- The written proposal should be structured like an NIH R01-formatted research proposal, maximum 13 pages in length, not including references. The proposal should be single spaced with 11 pt Arial/Times New Roman font and no less than 0.5 inch margin.
- The student should prepare a 30 minute presentation on the project proposal to be presented at the start of the examination.
- The student should not provide refreshments for the committee.

FACULTY RESPONSIBILITIES

- Each committee member is responsible for meeting with the student at least once before the scheduled examination. Frequency, duration, and number of meetings between an individual committee member and the student are decided by those two individuals. The purposes of the meetings are to communicate expectations for the student's performance for the QE, to offer the student relevant material and approaches for preparation, and to become familiar with the student's proposed research.
- The members of the QE committee share the responsibility for ensuring the QE is fair and reasonable.
FORMAT AND ADMINISTRATION OF THE EXAMINATION

- The general guidelines for administration of the QE, including responsibility of the QE committee chair, options for passing, not passing, or failing, and advancement to candidacy are available from Graduate Studies.
- All members of the QE committee must meet formally as a group with the student to administer the QE and to assess the student's overall performance on the examination.
- All committee members are required to attend (as required by the Academic Senate), and should actively participate, during the entire scheduled QE of the student.

ASSESSMENT OF STUDENT PERFORMANCE BY THE COMMITTEE

- The QE should attempt to assess the student's performance with respect to their ability of independent and critical analysis; ability to apply principles and knowledge in the subject area; knowledge of current and contemporary issues in the student's proposed research area; general knowledge of science; ability to integrate information and to reason based on examples or situations not necessarily related to their proposed research; and ability to hypothesize, extrapolate, and synthesize ideas.
- Although the student will have passed the required graduate coursework, QE committee members may feel free in the course of the examination to address issues of mastery of core course material as well as other formal courses.
- The student should be able to demonstrate an appropriate depth and breadth of knowledge in the area of their research.
- Assessment of student performance should consider the student's knowledge of concepts in relevant preparatory courses, ability to defend methods and concepts, justify analyses, and critically assess the strengths and weaknesses of their proposed research, and to be able to provide appropriate reasoning behind the research. Committee members should refrain from making conclusions as to the ultimate disposition of the QE until the final phase of the process when the QE committee deliberates the final decision.
- Assessment of student performance should not be based on such factors as the nature or perceived scientific merit of the proposed research, future career goals, academic affiliations, faculty mentorship, or funding potential of the proposed research.
- The possible exam results are:
  - Pass – No conditions may be appended to a pass decision.
  - Not Pass – with the option to retake all or part of the exam within a specified time period; or to satisfy specific requirements.
  - No Exam – if at any time during the exam the committee determines that the student is unable to continue, whether due to illness or other extreme circumstances. The chair must notify Graduate Studies of the circumstances of this decision.
  - Fail – the exam may not be repeated.
- In order to declare a ‘pass’, the QE committee must be unanimous in agreeing that the student has passed the examination overall.
- A ‘pass' on the qualifying exam indicates that the student's performance has been judged to be of sufficiently high quality to recommend the student to be advanced to candidacy to pursue the formal research phase of their graduate education in biomedical
• A decision of ‘pass’ is unconditional in that no additional requirements of the student can be made as a condition for a ‘pass’. For example, a student who performs poorly on one specific part of the QE cannot be expected to audit or take an additional course or complete additional instructional work as a condition for a ‘pass’.

• In the event of a ‘not pass’ on the first examination, the chair will communicate to the student verbally, in the presence of all other committee members, and in writing the reasons for the ‘no pass’, the deficiencies that have to be fulfilled, and the specific time frame in which they must be fulfilled. The student may be required to retake all or part of the examination, as determined by the QE committee. The second QE must be scheduled by the chair of the QE committee, in consultation with the student, with all of the same members of the QE committee as soon as specific requirements, including any coursework, can be satisfied. The second QE should take place in the most expedient and specified time frame based on student deficiencies that need to be fulfilled, preferably within six months of the first QE.

• If, at any time during the QE, the chair of the QE committee determines that the student is unable to continue the examination, whether due to illness or other extreme circumstances, the committee may declare a ‘no exam' and must notify Graduate Studies of the committee's decision and the circumstances. In the event of a ‘no exam', the chair is responsible for rescheduling the QE, in consultation with the student, as soon as circumstances permit.

• The QE committee is not required to reach a unanimous decision. Procedures for handling a split committee vote are documented by Graduate Studies. In the event of a split committee vote, the chair of the QE committee will submit to Graduate Studies, with a copy to the student’s file, a written summary of the committee vote and decision, accompanied by letters supporting the majority and minority viewpoints, and any documentation offered by the student. The letters from committee members should address the student's performance in the individual areas of the examination, as well as performance overall. Graduate Studies will render the final decision, as described in the Graduate Advisors Handbook.

• If the student ‘fails' the first or second QE, then they may be disqualified from continuing in the PhD program.

• Four outcomes are possible for a second QE: ‘pass', ‘fail', ‘no exam', or ‘split vote'.  
• Assessment of performance in the second QE should be based on evidence of substantial improvement in areas in which the committee considered the student to be weak or ‘not pass', as communicated to the student at the completion of the first QE.

RESPONSIBILITIES OF THE CHAIR OF THE COMMITTEE

• The chair of the QE committee facilitates the examination process and ensures that the process is conducted in a professional manner, is fair and reasonable, both to the student and to the BMEGG, and upholds the high academic standards for graduate education at the University of California. The chair is responsible for ensuring that committee members share in these responsibilities.

• At the beginning of the QE, the chair should review for the student and committee
members the process to be followed and the expectations for the QE.

• In the presence of all the QE committee, the chair delivers the committee's final decision to the student.

• The chair of the QE committee signs the QE Report and the Advancement to Candidacy form indicating the final decision of the QE committee.

• In the event of a 'not pass' on the first QE or 'no exam' on the first or second QE, the chair is responsible for rescheduling the QE, in consultation with the student, as soon as specific requirements, including coursework, can be satisfied or circumstances permit.

• In the case of a split decision by the QE committee, the chair directs the process by which material is prepared and sent to Graduate Studies, including submission of a written summary of the committee vote and decision, accompanied by letters supporting the majority and minority viewpoints, and any documentation offered by the student.