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 with a minimum undergraduate GPA of 3.25 (out of 4.00). For students who have completed an MS degree, a minimum graduate GPA of 3.50 is normally required. However, admissions decisions are made on a case-by-case basis. An applicant may apply for admission to either the MS only or the PhD track. Students in the MS only track may, subject to approval by the Graduate Group, apply to transfer to the PhD track. Students in the PhD track 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 Program are expected to have completed the following courses or their equivalents. Students self-identify as focusing their research in one of three research tracks: Biomedical Imaging; Cellular and Molecular Systems; Musculoskeletal Biomechanics. Research tracks may require additional prerequisites (noted below) to prepare students for track-specific courses. Descriptions of the courses listed below can be found in the General Catalog. To determine course equivalence, consult a Graduate Adviser.

<table>
<thead>
<tr>
<th>UC Davis Course</th>
<th>Course Topic</th>
<th>Quarter Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 9A-9C</td>
<td>Physics (Calculus based)</td>
<td>15 units</td>
</tr>
<tr>
<td>PHY 9D</td>
<td>Modern Physics</td>
<td>4 units*</td>
</tr>
<tr>
<td>MAT 21A-21D</td>
<td>Calculus, Vector Analysis</td>
<td>16 units</td>
</tr>
<tr>
<td>MAT 22A-B</td>
<td>Linear Algebra, Differential Equations</td>
<td>6 units</td>
</tr>
<tr>
<td>BIS 2A</td>
<td>Cellular Biology</td>
<td>5 units</td>
</tr>
<tr>
<td>CHE 2A</td>
<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>
</tr>
<tr>
<td>ENG 45</td>
<td>Engineering (materials)</td>
<td>4 units*</td>
</tr>
<tr>
<td>ENG 100</td>
<td>Engineering (elect systems)</td>
<td>3 units</td>
</tr>
<tr>
<td>STA 130A</td>
<td>Statistics</td>
<td>4 units</td>
</tr>
</tbody>
</table>
*Students electing the Biomedical Imaging track are required to have taken a course in modern physics (PHY 9D or equivalent), but not necessarily engineering materials (ENG 45 or equivalent). Students electing the Musculoskeletal Biomechanics track are required to have taken an engineering materials course but not necessarily a modern physics course.

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 acquired 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 Adviser.

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, a final oral examination, and no exit seminar. BME requires three examinations (preliminary, 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. Mathematical Methods for Biomedical Engineers (BIM 284) 4 unit
   b) Elective Units = 23
      Elective courses are specific to each student’s specialization or track and will be determined with an adviser. Tracks include: Biomedical Imaging, Cellular and Molecular Systems, and Musculoskeletal Biomechanics.
   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 20 of the 40 unit total must consist of graduate (200) level engineering courses.
   d) Additional Course Requirement = 10 units
      1. Scientific Integrity for Biomedical Engineers (BIM 209) 2 units
         *must be taken prior to Advancement to Candidacy
      2. Teaching Assistant Training Practicum (BIM 396) 1-4 units
         *must be taken prior to Advancement to Candidacy
      3. 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 7 units total
   e) Total Minimum Unit Requirement = 50 units
All courses must be satisfactorily completed as detailed above. At least 12 units of the 50-unit total are required in courses emphasizing biological sciences. 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.

4) Special Requirements: N/A

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. 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 Adviser (and Major Professor) assists the student in developing the study plan. New students must submit the “Program of Study” to the graduate program 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
      In preparation for the Qualifying Examination 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 Major Professor can be a member of the committee, but may not chair it. 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 Adviser must endorse these members and nominate them for approval by the Office of Graduate Studies; it is within the adviser's purview to reject the student’s selections if he/she 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 chairperson is required to be a member of the BMEGG and is normally the Major Professor. The
Graduate Adviser must endorse these members and nominate them for approval by the Office of Graduate Studies; it is within the adviser's purview to reject the student’s selections if he/she 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 Advisers

Because the BMEGG is a broad interdepartmental program, each student’s program of study will necessarily include research in a specific area of specialization. For this reason, upon matriculation, each student is assigned to a Graduate Adviser in the track in which it is anticipated that the dissertation research will fall. Adviser assignments will be changed if the student changes his/her area of specialization.

The Graduate Adviser 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 Adviser’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 Adviser 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, and, in particular, reviewing an annual report 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 Adviser is available for consultation by direct appointment. The Graduate Adviser 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. By the end of the third quarter of enrollment, each graduate student must select a Major Professor. He/she 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.

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: http://www.bme.ucdavis.edu/graduate/info.html

7) Advancement to Candidacy
The student is eligible for Advancement to Candidacy after successful completion of all graduate program 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.

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 http://gradestudies.ucdavis.edu/gradcouncil/Doctoral%20Qualifying_Examination.

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

a) Examination 1 is a preliminary examination taken after three quarters of study. It is a comprehensive test of the material covered in the graduate core courses and fundamental concepts based on the content of prerequisite coursework. The purpose of this exam is to test the student’s ability to integrate information from the various courses and to solve analytical problems. The examination is graded by appropriate faculty in the BME Graduate Group. Possible grades are pass, retake (once only), and fail. The retake exam will be given within 1 month of the preliminary examination. Should a student fail the retake exam, he/she will be recommended to the Dean of Graduate Studies for disqualification from the program.

b) Examination 2 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 four quarters of passing Examination 1 (or sooner) and within 1 quarter following completion of the required coursework. Students who do not complete the examination within the prescribed time frame will be subject to disqualification from the program unless the Graduate Adviser 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 not 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 be 15 pages maximum, excluding references, and will be formatted with 12 point font, single space, and 1 inch margins. At least two weeks prior to the examination, the plan must be submitted to each member of the oral Qualifying Examination Committee. 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. Food and/or drinks should not be brought to the examination.

Additional information is provided in the BMEGG Qualifying Exam Guidelines handout.

c) Examination 3 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 his/her 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 Plan C Defense Form and submits it to the Office of Graduate Studies by the final examination date listed on the academic calendar.

d) 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 his or her 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 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. Further, to improve communication between the candidate and the committee, the candidate should regularly submit short abstracts, similar to those required at scientific meetings, stating the progress or the difficulties which are encountered. 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 http://gradstudies.ucdavis.edu/students/filing.html.

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:

    | Year One - Fall          | Year One - Winter          | Year One - Spring          |
    |--------------------------|-----------------------------|----------------------------|
    | BIM 204: Physiology      | Choose a Major Professor    | BIM 209: Scientific Integrity |
    | BIM 284: Math Methods    | BIM 202: Cell & Molec Biology | BIM 281: Acquisition & Analysis |
    | BIM 290: Scientific Communication in BME | BIM 290: BME Research | BIM 290: BME Research Seminar |
    | BIM 290: BME Research Seminar | Elective | Elective |
    | Elective                 |                              | Preliminary Examination (Exam 1) |
    | Choose a Major Professor |                              | Choose a dissertation topic |

    | Year Two - Fall          | Year Two - Winter           | Year Two - Spring          |
    |--------------------------|-----------------------------|----------------------------|
    | BIM 290: BME Seminar     | BIM 290: BME Seminar        | BIM 290: BME Seminar       |
    | BIM 396: Teaching Experience | Elective                  | Elective                   |
    | Elective                 | Choose qualifying exam committee | Qualifying Exam Preparation |
    | Dissertation Research    | Qualifying Exam Preparation | Dissertation Research      |

    | Year Two - Summer        |                              |                            |
    |--------------------------|-----------------------------|----------------------------|
    | Qualifying Exam (Exam 2) |                              |                            |
    | Advancement to PhD candidacy |                        |                            |

    | Year Three to Six        |                              |                            |
    |--------------------------|-----------------------------|----------------------------|
    | Dissertation Research and Completion |                  |                            |
    | Dissertation Defense (Exam 3) |                    |                            |

    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 (http://gradstudies.ucdavis.edu/ssupport/internal_fellowships.html). Note: to be eligible for fellowships, domestic students must complete the Free Application for Federal Student Aid (FAFSA) available at http://www.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 http://www.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. To be considered for an award from these sources, students must apply during their first quarter of their first year of graduate study. Applications are available from the Graduate Advisers. Only students with exceptional GPAs will be competitive for fellowship support from these sources. Although the application process is lengthy, the reward is worth the investment because the 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 Aeronautical Engineering
- Department of Chemical Engineering and Materials Science
- 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/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. 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 http://www.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 in the Graduate Student Handbook: [http://www.gradstudies.ucdavis.edu/publications/](http://www.gradstudies.ucdavis.edu/publications/)

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 degree requirements section).

**Attachments**

Extended List of Common Graduate Electives for Biomedical Engineering
Biomedical Imaging → Ph.D. Curriculum
Cell and Molecular Systems → Ph.D. Curriculum
Musculoskeletal Biomechanics → Ph.D. Curriculum
BMEGG PhD Qualifying Examination Guidelines