**BIOMEDICAL ENGINEERING**
**M.S. AND Ph.D. DEGREE REQUIREMENTS**
**Revised: June 7, 2017**
**Graduate Council Approval: October 19, 2018**

## 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.

| UC Davis Course | Course Topic | Quarter Units |
|---|---|---|
| BIS 2A | • Cellular Biology | 5 units |
| CHE 2A | • Chemistry | 5 units |
| ENG 6 | • Programming | 4 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.*

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.

| UC Davis Course | Course Topic | Quarter Units |
|---|---|---|
| PHY 9A-9C | • Physics (Calculus based) | 15 units |
| MAT 21A-21D | • Calculus, Vector Analysis | 16 units |
| MAT 22A-B | • Linear Algebra, Differential Equations | 6 units |
| BIS 2A | • Cellular Biology | 5 units |
| CHE 2A | • Chemistry | 5 units |
| ENG 6 | • Engineering (programming) | 4 units |
| ENG 17 | • Engineering (circuits) | 4 units |
| 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:**

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:

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

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:

| Year One - Fall | Year One - Winter | Year One - Spring |
|---|---|---|
| BIM 202: Cell & Molec Biol | 284: Math Methods (alt) | Choose a thesis topic |
| BIM 204: Physiology | BIM 290: BME Seminar | Choose thesis committee |
| BIM 290: BME Seminar | Electives | BIM 281: Acquisition & Analysis |

| | | |
|---|---|---|
| Elective | | BIM 283: Statistical Design (alt) |
| Choose a Major Professor | | BIM 290: BME Seminar |
| | | Elective |

| Year Two - Fall | Year Two - Winter | Year Two - Spring |
|---|---|---|
| BIM 290: BME Seminar | BIM 290: BME Seminar | BIM 290: BME Seminar |
| Thesis Research | Thesis Research | Thesis Research |

Year Two - Summer

- Thesis Research and Completion
- File Thesis

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:

| Year One - Fall | Year One - Winter | Year One - Spring |
|---|---|---|
| BIM 202: Cell & Molec Biol | 284: Math Methods (alt) | BIM 281: Acquisition & Analysis |
| BIM 204: Physiology | BIM 290: BME Seminar | BIM 283: Statistical Design (alt) |
| BIM 290: BME Seminar | Electives | BIM 290: BME Seminar |
| Elective | | Elective |
| | | Prepare for Exam |

Year One - Summer

- Complete Comprehensive Exam

## 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). Note: to be eligible for fellowships, domestic students must complete the Free Application for Federal Student Aid (FAFSA) available at 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