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GRADING, EVALUATION OF PERFORMANCE. **27****GRADING SYSTEM.** **27****APPEAL OF GRADES.** **27****EVALUATION OF PERFORMANCE.** **27****ACADEMIC DISHONESTY AND RESEARCH MISCONDUCT.** **28****REGISTERING FOR COURSES AT THE MCW.** **28****REGISTERING FOR BIEN 6995 AND HCTM 6998.** **28****CONTINUOUS ENROLLMENT.** **28****HOLIDAY AND LEAVE POLICY.** **28****FINANCIAL AID.** **29****TYPES OF FINANCIAL AID.** **29**1. SCHOLARSHIPS. **29**2. FELLOWSHIPS. **29**3. TEACHING ASSISTANTSHIPS. **29**4. RESEARCH ASSISTANTSHIPS. **29**5. LOANS. **30**

INTRODUCTION

This handbook is designed to describe the requirements, policies and procedures that apply to graduate students in the Biomedical Engineering Department. It does not replace the Graduate School Bulletin, but rather it details additional department requirements for the completion of a graduate degree in Biomedical Engineering.

If you have questions concerning the graduate program you should consult the following Information Sources.

- The most recent edition of the **Marquette University Graduate School Bulletin**
- The Department's Director of Graduate Studies (DGS)
- Your academic advisor
- The Department of Biomedical Engineering: Post Office Box 1881, Milwaukee, WI 53201-1881. Telephone: 414-288-3375
- The Graduate School: Holthusen Hall, Room 305, 1324 W. Wisconsin Ave., Milwaukee, WI 53233, 414-288-7137.

The Graduate Programs – M.S., M.E., BS/MS, H.C.T.M. and Ph.D.

The Department of Biomedical Engineering at Marquette University offers two graduate programs in biomedical engineering at the master's level: thesis option (Master of Science, M.S.) and the course-only option (Master of Engineering, M.E.). At the doctoral level, the PhD in Biomedical Engineering is available.

The Department also coordinates one joint program with the Graduate School of Biomedical Sciences at the Medical College of Wisconsin: the M.S. in Healthcare Technologies Management (H.C.T.M).

Any of these programs may be pursued on a full-time or part-time basis. A residency period is required for the doctoral programs.

The accelerated 5-year BS/MS degree program is available to MU students that have demonstrated a capability for high achievement in the undergraduate Biomedical Engineering program. Full-time undergraduate students apply for the program in the Junior year. Accepted students may take graduate level courses for graduate credit and may also take certain upper division undergraduate courses (i.e.: BIEN 5xxx) for graduate credit. Students taking BIEN 5xxx courses must complete the additional work required by the course instructor to receive graduate level credit.

Student Classification.

1. Full-Time.

A student who takes seven or more credits in a regular semester or is otherwise pursuing graduate work on a full-time basis is considered to be a full-time student.

2. Part-Time.

A student who takes six or fewer credits in a regular semester is considered to be a part-time student.

3. Degree Student.

A student is a degree student if enrolled in a program leading to a degree. A student cannot be classified as a degree student unless the department has agreed to accept him or her into a program of study.

a. Regular.

A Regular status student has been admitted to the Graduate School and is working toward a degree in a particular program of study. Such students are eligible for tuition scholarships, graduate assistantships, and fellowships.

b. Probationary.

A student may be admitted to a degree program with probationary status if his or her academic performance is below Graduate School standards but if there is other evidence that he or she has the potential for successful graduate study. Upon completion of nine semester hours of work with an average grade of "B" (3.0) or better (with no grade lower than "C"), at least one-third of which must be at the 6000 course level, the probationary status is removed. A student who fails to remove his or her probationary status on completion of nine semester-hours work will not be permitted to remain in the Graduate School. A student on probation is not eligible to receive financial aid.

4. Non-Degree Student.

A student who chooses this status does not work toward a degree, but credits earned are graduate credits and may be certified as such to school boards or other authorities. Those students seeking non-degree admission must meet the same admission standards as those seeking admission to a degree program. There is no guarantee that credits earned while a non-degree student will later count toward a degree if the student is admitted to a degree program. A student who completes a master's or doctoral degree at Marquette will, upon application, be automatically classified as a non-degree student. Non-degree students may register for any course for which they have met the prerequisites and for which they have department permission.

a. Regular.

A regular student is clearly admissible to the Graduate School but is not seeking a degree.

b. Probationary.

A student whose past academic performance falls below Graduate School standards but shows other evidence of potential for successful graduate work may be granted probationary status. This status is identical to the probationary degree status except that this person is not seeking a degree.

c. Temporary.

A student who seeks to register for graduate courses and who appears to meet Graduate School admission standards but who has not submitted all necessary documentation to the Graduate School that is required for regular admission. Admission to this status is valid for only one semester. A student admitted as a temporary student must apply for and be admitted into one of the other

classifications before he/she will be allowed to register for courses in another semester.

Note: A change from non-degree status to degree status requires a new “Application for Admission” be submitted to the Graduate School.

Areas of Specialization.

Upon enrolling in the master’s or doctoral program in Biomedical Engineering, a student should select his or her area of specialization. Areas include: Biomechanics/Biomaterials, Systems Physiology, Bioinstrumentation/Computers, Functional Imaging, Rehabilitative Bioengineering, and Healthcare Technologies Management. The student’s Academic Advisor and Thesis/Dissertation Director then work with the student to design the appropriate curriculum and research program. This will include courses in engineering, biology, mathematics, and medicine, all of which are integrated with research laboratory experience.

General Requirements.

It is the responsibility of each student to be familiar with, and fulfill all of the requirements outlined below.

1. Academic Load.

The maximum load for a semester is 13 hours of course work. For summer session and inter-session courses, the maximum load is the number of hours equal to the number of weeks in the session. A graduate assistant may register for a maximum of 9 credit hours in a semester. The Dean of the Graduate School must approve all credit overloads.

2. Courses.

Courses numbered 6xxx and above are strictly graduate level courses. Specifically designated “upper division” courses at the 5xxx level may also be taken for graduate credit. For these 5xxx level courses to count toward a graduate degree, a grade of “B” or better is required. Furthermore, it is expected that graduate students in these courses will do extra work beyond that required for undergraduate credit.

3. Required Courses.

In the Master of Science in Biomedical Engineering program, students are required to complete three credit hours of physiology. All doctoral students are expected to successfully complete three credit hours of physiology.

4. Pre-requisite Coursework for Students Enrolling Without Engineering Degree.

Students admitted into the Biomedical Engineering graduate program who do not have an engineering degree must complete prerequisite engineering course work. A list of required courses follows:

- Mathematics: Calculus through Differential Equations
- Programming: Knowledge of C or C++ or FORTRAN or JAVA
- Basic Sciences: Two semesters of Physics [strongly recommended: one semester of Biology]
- Engineering Sciences: 4 courses from the following list of 12, with grade of B or better:

Circuits 1	e.g., EECE 2010	Statics and Dynamics	e.g., MEEN 2122
Circuits 2	e.g., EECE 2020	Materials Science	e.g., MEEN 2460 or 3460
Analog Electronics	e.g., EECE 3030	Mechanics of Materials	e.g., MEEN 2130
Digital Electronics	e.g., EECE 2030	Fluid Dynamics	e.g., MEEN 3320 or 4320
Linear Systems	e.g., EECE 3020	Thermodynamics	e.g., MEEN 3310
Data Structures	e.g., COSC 2010	Computer Hardware	e.g., COEN 4710

5. Independent Study Courses.

Independent study courses (BIEN 6995) are offered for capable and highly motivated students. They are not intended as substitute courses for those offered through the Department of Biomedical Engineering. Rather, they are intended to provide a unique tutorial experience in which topics not covered in the existing curriculum may be explored in detail. Normally only one such course can be used for degree requirements.

a. Approval and Contract

Students taking a BIEN 6995 course must complete, at registration, both an "Approval Form for BIEN 6995" and a "BIEN 6995 Course Contract." Approval is required of the course director, the academic advisor and Chairperson of Biomedical Engineering. The Biomedical Engineering Graduate Committee reviews all BIEN 6995 courses.

b. Summary Report

A summary report including a list of references must be submitted by the student to the Biomedical Engineering Graduate Committee no later than two weeks after the end of classes in the semester in which the course is taken.

6. Undergraduate Students in Graduate Courses

a. Undergraduate Credit.

An undergraduate senior may, with the permission of the Graduate Dean, register for a 6xxx level graduate course for undergraduate credit if the student has a "B" (3.0 or better) average and the current program is such as to allow for involvement in graduate level work. To do so the student must have the written approval of the Chairperson of Biomedical Engineering, the Dean of the College of Engineering and the Graduate School Dean which are given on a form entitled (available in the College of Engineering office): "Petition for Permission to Enroll in a Graduate Level Course in Partial Fulfillment of Undergraduate Degree Requirements."

b. Graduate Credit.

An undergraduate senior may, with the permission of the Graduate School Dean, register for a 5xxx level or 6xxx level graduate course for eventual graduate credit if the student has a "B" (3.0 or better) average. Such courses cannot be used to meet undergraduate degree requirements. Once admitted to a graduate program a student having successfully completed such courses must petition the Graduate School Dean to have these courses count toward the degree requirements. Normally these courses will be accepted, but no guarantee is given, particularly if

the grades received are not appropriate or if the courses do not fit into a unified course program. To register for such courses the student must have the written approval of the Chairperson of Biomedical Engineering, the Dean of the College of Engineering, and the Graduate School Dean, which are provided on the form entitled: "Petition for Permission to Enroll in a Graduate Level Course in Partial Fulfillment of Undergraduate Degree Requirements." The form is available on the Graduate School's website: <http://www.grad.mu.edu/forms/index.shtml>.

c. Application for Degree.

Prior to the deadline posted in the Graduate Bulletin, each student planning to graduate must file an "Application for Degree" with the Graduate School Office.

Advising System.

The advising system is designed to assist and guide the graduate student from the first day of admission into graduate school. The process includes an orientation meeting, distribution of the Graduate Student Handbook and assignment of an academic advisor.

1. Orientation Meeting.

At the beginning of each academic year, all graduate students are required to attend an orientation meeting organized and held by the Department Chairperson. During this meeting, topics including financial aid, general policies, program requirements, special course offerings and areas of research will be presented and discussed.

2. Academic Advisor.

When a student is admitted to the graduate program in Biomedical Engineering, an advisor in his or her area is assigned by the Director of Graduate Studies to assist with any problems and in course selection. The Academic Advisor will assist the student in preparing a coursework plan, and for MS and PhD programs the Academic Advisor will also help the student identify an appropriate Thesis/Dissertation Director.

3. Thesis/Dissertation Director (MS and PhD Programs).

A student selects, with Department approval, his or her Thesis or Dissertation Director. This choice is reflected on the "Master's Thesis Outline Form" or on the "Doctoral Program Planning Form" and "Dissertation Outline Form" as the 'advisor'. The Thesis/Dissertation Director can be designated as the Academic Advisor. A student may have more than one academic advisor, with access to student electronic records. A student must have at least one Academic Advisor who is a primary faculty in the Department of Biomedical Engineering (see program descriptions for MS and PhD programs for committee membership requirements). A student may request an addition or change of Academic Advisor by requesting the change in writing to the Director of Graduate Studies, and providing the names of the current and proposed Academic Advisors. The Director of Graduate Studies will review the request. If the change is allowed, electronic access to the student's records will be given to the new Academic Advisor(s). In those instances in which an advisor is changed after submission of the Thesis Outline Form, Dissertation Outline Form and/or Doctoral Program Planning Form, the student is required to submit a new version or amendment indicating the new advisor. This 'advisor' should be the Thesis or Dissertation Director.

List of Appropriate Forms and Documents.

Students are required to obtain the forms from the Graduate School to ensure that they are the latest versions. Most are available from their Web site (<http://www.grad.mu.edu/forms/index.html>).

1. Available from the Graduate School:

- *Application for Degree*
- *Application for Financial Aid*
- *Continuous Enrollment Registration Form (pdf)*
- *Drop, Add, Audit Form*
- *Master's Degree Transfer Credit Request (pdf)*
- *Master's Thesis Outline Form – Outline for Dissertation, Thesis or Professional Project*
- *Thesis and Professional Project Directives*
- *Doctoral Program Planning Form*
- *Doctoral Program Planning Form Amendment*
- *Doctoral Dissertation Outline – Outline for Dissertation, Thesis or Professional Project*
- *Dissertation Directives*

2. Available from the Department:

- *Approval Form for Independent Study Course BIEN 6995*
- *Independent Study Course Contract*
- *Five Year Bachelor of Science / Master of Science Program Requirements*

If you have questions concerning dates and deadlines, refer to the Marquette University Graduate School Academic Calendar published annually.

It is each student's responsibility to satisfy all program requirements, ensure that all forms are completed and filed appropriately, and that all deadlines are met. All Graduate Students must notify the Biomedical Engineering Office of their intent to graduate at the same time they notify the Graduate School.

MASTER'S DEGREE PROGRAMS

Master of Science Degree in Biomedical Engineering

This degree is awarded in recognition of marked scholarly attainment in a major area of specialization. Students are required to complete a thesis and pass a comprehensive examination.

a. Admission Requirements.

a. Educational Background.

Graduates of accredited colleges or universities that have earned a bachelor's degree in various engineering, physical science or life science disciplines, or equivalent are eligible for admission to the Master of Science Degree program in Biomedical Engineering. Only those applicants whose undergraduate record shows promise of success in graduate study are admitted. To qualify for admission, applicants must have, as a minimum, approximately a "B" average (3.0 GPA) in their total post-secondary school education. Students admitted into the Biomedical Engineering graduate program who do not have an engineering degree must complete prerequisite engineering course work.

b. Application for Admission.

All applicants, regardless of status sought, must submit the following documents at least six weeks in advance of registration with the Graduate School. Normally, no application is considered for admission until it is complete. The required documents are:

- Completed "Application for Admission"
- Official transcripts of undergraduate and graduate records, sent directly to the Graduate School by the issued institution. If a transcript or mark sheet is not in English, the applicant must supply a translation.
- Three letters of recommendation.
- Results of the Graduate Record Examination.
- Application fee (non-refundable).
- International students must submit results of the TOEFL exam.
- Admission is not official until the student is notified in writing of acceptance by the Graduate School. Admission cannot be made final until an official transcript has been received indicating the conferral of an undergraduate degree.
- If a student fails to register for courses within two years after the date of application for admission, the student's file will be discarded.

b. Course Work

A total of thirty credit hours are required. A thesis is mandatory, and a student must register for 6 hours of thesis credit. Of the remaining 24 credits, the following apply:

- At least 9 credits must be taken at the 6xxx level or above (6 credits of which must be in BIEN, exclusive of BIEN 6995 (independent study)).
- A minimum of 12 hours of course work must be taken in Biomedical Engineering, exclusive of 3 credits of BIEN 6995 (independent study).
- A minimum of 3 credits (up to 6 credits) in physiology. This requirement is waived for any student who has successfully completed BIEN 5700, Systems Physiology (or equivalent).
- The remaining courses must be selected from among those that are eligible for graduate credit in science and engineering programs. Up to 3 credits from certain HCTM courses may be counted. They include HCTM 6200 (Biomedical Technology Assessment - 3 credits), HCTM 6300 (Biomedical Technology Standards and Regulations – 2 credits), HCTM 6400 (Ethics of Technology Utilization - 1.5 credits), HCTM 6500 (Product Development of Medical Devices – 2 credits), and HEAL 6840 (Environment of Healthcare Delivery - 2 credits).

a. Transfer of Graduate Credit.

A maximum of 6 semester hours of approved graduate work in a Master's Program from other institutions may be transferred into a student's Master's Program with consent of the Graduate School Dean and the Department Chairperson. Under special circumstances, when courses from other institutions are directly comparable in content to those at Marquette, up to 12 semester hours may be transferred. A course will be considered for transfer credit only if the grade is "B" or better and the course is completed for graduate credit at the institution at which it was taken. Students applying for transfer credit must complete the appropriate form available from the Graduate School Office after completion of at least 6 semester hours at Marquette (9 semester hours if on probation).

b. Independent Study Course (BIEN 6995).

The Biomedical Engineering Graduate Committee reviews all BIEN 6995 courses. A summary report including a list of references must be submitted by the student to the Biomedical Engineering Graduate Committee no later than two weeks after the end of classes in the semester in which the course is completed. A maximum of 3 credits of BIEN 6995 course work is credited toward the 12 hrs of 6xxx level course requirements. Note that (BIEN 6995 cannot be used to satisfy the requirement of 9 credits of 6xxx level BIEN courses).

c. Grades.

Satisfactory academic work is not solely determined by course grades. However, grades are an important factor in the evaluation process. A minimum GPA of 3.0 is required to graduate, and students with a GPA under 3.0 are placed on probationary status. An "I" grade will be regarded as a "C" grade in evaluating academic progress in the Biomedical Engineering Program. Incomplete grades must be cleared by the date specified in the academic calendar or they will automatically become the grade of IP (permanent incomplete).

d. Academic Progress.

The Thesis Director and/or Academic Advisor will submit a biannual academic

progress report to the Department regarding each graduate student. The Chairperson of Biomedical Engineering evaluates the academic progress of all graduate students at the end of each academic semester. If a student is not performing satisfactory work, the student and the Dean of the Graduate School will be notified in writing. The student may be counseled to withdraw or placed on warning. The Dean of the Graduate School will be asked to drop students counseled to withdraw.

e. Thesis Requirements.

Each master's degree student must submit an outline of the proposed thesis on a "Outline for Dissertation, Thesis, Professional Project or Essay" form for approval by the Thesis Director, the Chairperson of Biomedical Engineering, and the Dean of the Graduate School. An acceptable master's degree thesis must meet each of the following four conditions:

- The thesis must reflect the student's originality, creativity, and imaginative work.
- The thesis must demonstrate the student's research ability. This includes (a) a critical analysis of the relevant literature and (b) an engineering contribution to the state of the art or originality in problem solving.
- The thesis must be well written and professionally presented.
- The format of the thesis must follow the "Thesis Directives" issued by the Graduate School.

f. Thesis Committee.

The Thesis Committee is comprised of at least, three members approved by the Department Chairperson. The Director must have a faculty appointment at Marquette University. At least one person on the Committee must be a full-time faculty member in the Department of Biomedical Engineering. Copies of the thesis must be submitted by the student to the Thesis Committee at least two weeks in advance of the thesis defense and oral comprehensive examination.

g. Graduate School Criteria for Serving as Chairperson of a Thesis or Dissertation Committee.

The chairperson of the committee must be a regular faculty member, have competence in the proposed domain area, hold a terminal degree in his or her discipline, and be an active scholar.

h. Thesis Defense and Oral Comprehensive Examination.

All candidates for a master's degree must defend their thesis work to the satisfaction of the thesis committee. Additionally, they must successfully pass a comprehensive examination on the total graduate program of studies. If a student fails the examination, the Department will review the student's entire record, and, if warranted, a second (final) examination will be given. The Comprehensive Exam is normally administered at the time of the Thesis Defense.

The Thesis Director will inform the Chairperson of Biomedical Engineering of the outcome of the examination, who in turn files this information with the Graduate School in a "Master's Comprehensive Exam Report" form. It is the obligation of the student to arrange a time and place on campus for his/her thesis defense and oral comprehensive examination that are suitable for all committee members, and to meet all appropriate deadlines indicated in the Graduate School "Academic Calendar."

i. Time Limitations.

A student must complete all of the requirements for a Master's Degree within six years. If courses from other universities are transferred into a degree program at Marquette and if those courses were taken prior to work at Marquette, the beginning date of the first course will be used to establish the beginning of the student's time period.

j. Learning Objectives.

The Learning Objectives of the Biomedical Engineering Master of Science (M.S.) training program, and their assessment, provide tools that ensure continuous quality improvement. Graduates earning the M.S. degree will be able to:

- **Demonstrate critical thinking skills:** This is measured via the thesis defense and a survey sheet that is completed by each of the thesis committee members. This requires: demonstration of the execution of a well-thought-out research project plan; completion of an independent research experience; ability to critically evaluate work of others in the thesis-related research area.
- **Communication of Technical Information Appropriately for Audience:** This is measured via the thesis defense and a survey sheet that is completed by each of the thesis committee members. This requires: a professional quality oral and graphic presentation; a professional quality written thesis.
- **Demonstrate Technical Proficiency in at least one area of Biomedical Engineering:** This is measured via the thesis defense and a survey that is completed by each of the thesis committee members. This requires: demonstration of factual knowledge of engineering and life science; the ability to critically evaluate the work of others in thesis related research area.
- **Critical Evaluation of the Application of Scientific Methods in Addressing Biomedical Engineering Problems:** This is measured via the thesis defense and a survey that is completed by each of the thesis committee members. This requires: effective use of library and electronic resources for literature research; defensible conclusions and main arguments supported by research; ability to solve interdisciplinary problems.

CHECKLIST for MASTER OF SCIENCE DEGREE in BIOMEDICAL ENGINEERING

Master of Science Students can use the following checklist to assist in course scheduling

- _____ 6 thesis credits BIEN 6999
- _____ 24 non-thesis credit hours (minimum)
- _____ 3 credits in physiology (minimum)
- _____ 12 credits of BIEN courses (minimum) (excludes 6995)
- _____ 9 credits of 6xxx level courses (minimum)
- _____ 6 credits of BIEN or BIOL 6xxx level courses (minimum)
- _____ A minimum GPA of 3.0
- _____ BIEN 6953, Department Seminar, each semester

Five-Year BS/MS Program in Biomedical Engineering.

1. Program Description.

This program allows students to earn both their master of science degree and a bachelor of science in biomedical engineering in five years. Students currently enrolled in the undergraduate biomedical engineering program at Marquette University with a GPA of 3.50 or above may apply for admission to the five-year program during their junior year. Students must submit an application to the Graduate School, indicate their interest in the five-year program, and meet all other admission criteria as stated in the Application Requirements section. GRE test scores must be submitted before the start of the fifth year.

Students may take master's level courses in their senior undergraduate year. These graduate courses (maximum of 9 credit hours) count towards both the undergraduate and graduate degrees. The remaining courses are taken during the students' fifth year. Work on the students' theses research begins the summer between the junior and senior years. Students will continue to gain research laboratory experience the summer between the senior and fifth year, continuing through the final year, culminating in preparation of a written thesis and defense. Upon completion of the first term as master's candidates, students must petition the Graduate School to transfer courses taken as undergraduates to the master's degree.

2. Admission Requirements.

- In Fall semester (usually November), the Chair meets with Junior students that are interested in the 5-yr. BS/MS program or graduate school in general.
- The 5-yr program is available to co-op students. Their eligibility would be determined by where they are in the co-op schedule. For co-op students, there is a change noted below.
- In Spring the Department sends an invitation to apply to the 5-yr program to all juniors with a 3.5 GPA or above.
- Those who are interested complete the regular graduate student admissions packet except for the GRE scores. The GRE must be taken before their 5th year, but not before they apply as juniors.
- These applications are circulated among the Biomedical Engineering Department faculty for acceptance recommendations.
- Students are notified of their admission decisions and are assigned an academic advisor. Note that acceptances are provisional and the student will still need to have a final undergraduate GPA of ≥ 3.0 and "acceptable" GRE scores before they are fully admitted to the Graduate program.

3. Program Requirements.

- Students will be given a welcoming letter from the Department and a course planning form. They will discuss the form and the course choices with their advisor before

choosing Fall senior-level courses. The advisor should keep a copy of this form in the student's file, or it can be kept in the department office, if preferred.

- Students must register for graduate credit in these three senior classes: BIEN 5320 and their two BIEN electives. This is done by filling out a "Permission to Enroll in a Graduate Course" form (available online at the Graduate School website, http://www.marquette.edu/grad/forms_index.shtml). One form has to be filled out for each of the three classes, and must be submitted before registration for the respective class. Note: Co-op students do not receive graduate credit for their co-op experience, so they would take BIEN 5320 and one BIEN elective (6 credits total) for graduate credit.
- Students must take their GRE exam and have scores back to MU before the Fall semester of their 5th year. The GRE is now taken via computer, so a variety of dates are available. They can pick up a GRE Registration bulletin from the Graduate School. This bulletin lists the testing facilities, charges, etc. as well as an application to take the test.
- During the winter break or early in January of their 5th year, students must transfer the 9 graduate credits they took as seniors to their graduate degree program. This is done by filling out a "Master's Degree Transfer of Credit Request" form from the Graduate School. The form cannot be submitted until the student completes one semester of graduate study.
- In the 5th year, students need to register for 7 credits or more to maintain full-time status. These seven credits include thesis credits. If students are not enrolled in at least 7 credits per semester they must fill out a continuous enrollment form (from the Graduate School website), which will maintain their full-time status.
- A total of 30 credit hours of graduate level courses inclusive of thesis credits, 6xxx level and above, and approved upper division undergraduate courses.
- Students apply for graduation using the normal procedures.

N.B.: Awarding any form of financial aid to 5-yr students who have not received their Bachelor's degree yet is not advisable. It is very important to realize that any financial aid offered to an undergraduate student will likely decrease the student's financial aid award by the same amount or more, perhaps doing more harm than good. For this reason, all awards should be discussed in detail with the Graduate School early in the funding decision process.

Master of Engineering (M.E.) Degree in Biomedical Engineering.

This non-thesis degree program includes coursework in existing Biomedical Engineering graduate programs of study, upper division undergraduate courses that carry graduate credit, coursework taken outside of the Department offerings, and performance evaluation via a final written examination (capstone comprehensive written exam).

4. Program Requirements.

- A total of 30 credit hours of graduate level courses, 6xxx level and above, and approved upper division undergraduate courses.
- A minimum of 15 credit hours must be taken in BIEN (Biomedical Engineering) courses.
- Up to 12 credits of upper division undergraduate courses that carry graduate credit may be taken with permission of the M.E. Program Director (Director of Graduate Studies).
- Up to six credit hours may be taken in HCTM (Healthcare Technologies Management) courses.
- Up to two graduate level courses may be taken outside of the Department area with permission of the M.E. Program Director (Director of Graduate Studies).
- One readings course: A faculty member will determine the title and topic, which should link various areas of Biomedical Engineering, e.g. bioinstrumentation, biomechanics, biocomputers, imaging, rehabilitation engineering, biotechnology, bioethics and proper use of human subjects. This requirement can be managed via the existing BIEN 6995 "Independent Readings and Research" course.
- Capstone comprehensive written exam

5. Admission Criteria.

Currently established admissions criteria apply (see below).

a. Basic Requirements.

- A bachelor's degree from a recognized college or university, or the equivalent foreign degree, in engineering or science.
- Ideally, a 3.00 grade point average or better on a 4.00 scale. Graduate admission is based on a number of criteria, and applicants may be admitted with a slightly lower GPA if other criteria indicate future success in the program

b. Detailed Admission Requirements.

- A Bachelor's degree in engineering or science from a recognized college or university.

- Completed graduate school application with accompanying fee.
- Three letters of recommendation - at least one from the current employer.
- A copy of undergraduate transcripts.
- A one-page statement of purpose (Why do you want to earn this degree?).
- The GRE may be required.
- The TOEFL may be required.
- An optional interview with the M.E. Program Director (Director of Graduate Studies) prior to final acceptance into the program.

c. Restrictions on Financial Assistance.

No financial assistance (fellowships, research and teaching assistantships) will be provided to students in the non-thesis degree program. It is assumed that employers will fund the education of these students or they will be self-funded. Students who are enrolled in the current thesis-required program and are receiving funding from the Department of Biomedical Engineering may neither convert nor apply to the non-thesis program.

6. Program Objectives and Requirements.

There are three “core” or common course requirements that are mandated for graduate students in this program for all areas of study. These courses provide students with essential foundational information, as determined by the faculty. The courses provide a means for consistently assessing student and program performance.

a. The three core course requirements.

- *Biomedical Instrumentation:* BIEN 5329 (Upper Division)
- *Physiology:* BIEN 5700 or BIOL 3702 or equivalent (Upper Division)
- *Technical Elective:* HCTM 6200 (Biomedical Technology Assessment) or HCTM 6500 (Product Development of Medical Devices)

b. Learning Objectives.

The Learning Objectives of the Biomedical Engineering Master of Engineering (M.E.) training program, and their assessment, provide tools that ensure continuous quality improvement. Graduates earning the M.E. degree will be able to:

- Synthesize information in the two fields of engineering and life science. This outcome will be measured through the required Readings Course and the capstone comprehensive written examination and evaluated by Program faculty.

- Write an article length paper on interdisciplinary biomedical engineering topics. This outcome will be measured by successful completion of the Readings Course requirement.
- Appropriately communicate technical information to specific audiences. This outcome will be measured via a high technical quality of the Readings Course and via the quality of the capstone written examination evaluated by the program faculty.
- Describe the economic, legal, ethical, and regulatory aspects of healthcare delivery and medical device development. Feedback from employers of ME program graduates, evaluation of student performance in the Readings Course, and a final faculty evaluation of students will be used to measure this outcome.

7. Example Plans of Study for the Master of Engineering Degree.

Students may choose to follow a plan of study that roughly corresponds to one of our existing emphasis areas of graduate study. The sample study plans below reflect the flexibility that is built into the M.E. degree program. Furthermore, these plans are designed for an academic progress pace that is reasonable for students from industry. The existing areas are:

- BioComputers
- BioImaging
- BioInstrumentation
- BioMechanics
- BioRehabilitation.

Refer to the following pages for recommended full-time study plans for each of these areas.

a. A recommended full-time plan for BioComputer focused Master of Engineering studies:

Course	Description	Cred
Fall Semester Year One		
BIEN 5700 or BIOL 3702 or equiv.*	Physiology Requirement	3
BIEN 5320	Biomedical Instrumentation Design	3
Graduate Elective	BIEN, EECE, MATH, etc. as appropriate	3
Spring Semester Year One		
BIEN 5220	Embedded Biomedical Instrumentation	3
Graduate Elective	BIEN, EECE, MATH, etc. as appropriate	3
Summer Session		
HCTM Elective**	HCTM 6300 & 6500 or 6300 & 6400 or 6500 & 6400	3
Fall Semester Year Two		
BIEN 6300	Microprocessor Based Biomedical Instrumentation	3
BIEN BioComputer Elective	Such as BIEN 5610 {160}, 6600 {237}, 6300 {240}, 6310 {249}, 6240 {252}	3
Spring Semester Year Two		
BIEN 6200	Advanced Topics in Biomedical Computing	3
BIEN 6995	Required Readings Course	3

*Credit may be given for having previously completed BIEN 5700 (or equivalent) with a B or better grade.

**Although the credit total for any combination of two HCTM Summer courses is greater than three, only three are needed for the M.E. degree. The actual credit total will appear on the student's transcript.

b. A recommended full-time plan for Bioluminescence focused Master of Engineering studies:

Course	Description	Cred
Fall Semester Year One		
BIEN 5700 or BIOL 3702 or equiv.*	Physiology Requirement	3
BIEN 5320	Biomedical Instrumentation Design	3
Graduate Elective	BIEN, EECE, MATH, etc. as appropriate	3
Spring Semester Year One		
BIEN 5500	Medical Imaging Physics	3
Graduate Elective	BIEN, EECE, MATH, etc. as appropriate	3
Summer Session		
HCTM Elective**	HCTM 6300 {211} & 6500 {230} or 6300 {211} & 6400 {212} or 6500 {230} & 6400 {212}	3
Fall Semester Year Two		
BIEN 6210	Biomedical Signal Processing	3
BIEN Bioluminescence Elective	Such as BIEN 5610, 5510, 6600, 6320, 6240	3
Spring Semester Year Two		
BIEN 6220		3
BIEN 6995	Required Readings Course	3

*Credit may be given for having previously completed BIEN 5700 (or equivalent) with a B or better grade.

**Although the credit total for any combination of two HCTM Summer courses is greater than three, only three are needed for the M.E. degree. The actual credit total will appear on the student's transcript.

c. A recommended full-time plan for BiolInstrumentation focused Master of Engineering studies:

Course	Description	Cred
Fall Semester Year One		
BIEN 5700 or BIOL 3702 or equiv.*	Physiology Requirement	3
BIEN 5302	Biomedical Instrumentation Design	3
Graduate Elective	BIEN, EECE, MATH, etc. as appropriate	3
Spring Semester Year One		
BIEN 5220	Embedded Biomedical Instrumentation	3
Graduate Elective	BIEN, EECE, MATH, etc. as appropriate	3
Summer Session		
HCTM Elective**	HCTM 6300 & 6500 or 6300 & 6400 or 6500 & 6400	3
Fall Semester Year Two		
BIEN 6310	Microprocessor Based Biomedical Instrumentation	3
BIEN BiolInstrumentation Elective	Such as BIEN 5600, 6600, 6300, 6310, 6390, 6220	3
Spring Semester Year Two		
BIEN 6320	RF Applications in Biomedical Engineering	3
BIEN 6995	Required Readings Course	3

*Credit may be given for having previously completed BIEN 5700 (or equivalent) with a B or better grade.

**Although the credit total for any combination of two HCTM Summer courses is greater than three, only three are needed for the M.E. degree. The actual credit total will appear on the student's transcript.

d. A recommended full-time plan for BioMechanics focused Master of Engineering studies:

Course	Description	Cred
Fall Semester Year One		
BIEN 5700 or BIOL 3702 or equiv.*	Physiology Requirement	3
BIEN 5320	Biomedical Instrumentation Design	3
Graduate Elective	BIEN, MEEN, MATH, etc. as appropriate	3
Spring Semester Year One		
BIEN 5710	Analysis of Physiological Models	3
Graduate Elective	BIEN, MEEN, MATH, etc. as appropriate	3
Summer Session		
HCTM Elective**	HCTM 6300 & 6500 or 6300 & 6400 or 6500 & 6400	3
Fall Semester Year Two		
BIEN 6450	Musculoskeletal Biomechanics 1	3
BIEN BioMechanics Elective	Such as BIEN 5600, 6400, 6410, 6430, 6431, 6600	3
Spring Semester Year Two		
BIEN 6451	Musculoskeletal Biomechanics 2	3
BIEN 6995	Required Readings Course	3

*Credit may be given for having previously completed BIEN 5700 (or equivalent) with a B or better grade.

**Although the credit total for any combination of two HCTM Summer courses is greater than three, only three are needed for the M.E. degree. The actual credit total will appear on the student's transcript.

e. A recommended full-time plan for BioRehabilitation focused Master of Engineering studies:

Course	Description	Cred
Fall Semester Year One		
BIEN 5700 or BIOL 3702 or equiv.*	Physiology Requirement	3
BIEN 5320	Biomedical Instrumentation Design	3
Graduate Elective	BIEN, EECE, MEEN, MATH, etc. as appropriate	3
Spring Semester Year One		
BIEN 5710	Analysis of Physiological Models	3
Graduate Elective	BIEN, EECE, MEEN, MATH, etc. as appropriate	3
Summer Session		
HCTM Elective**	HCTM 6300 & 6500 or 6300 & 6400 or 6500 & 6400	3
Fall Semester Year Two		
BIEN 6610	Rehabilitative Biosystems	3
BIEN BioRehabilitation Elective	Such as BIEN 5600, 5620, 5630, 6600, 6310, 6200, 6210, 6220	3
Spring Semester Year Two		
BIEN 6620	Modeling Rehabilitative Biosystems	3
BIEN 6995	Required Readings Course	3

*Credit may be given for having previously completed BIEN 5700 (or equivalent) with a B or better grade.

**Although the credit total for any combination of two HCTM Summer courses is greater than three, only three are needed for the M.E. degree. The actual credit total will appear on the student's transcript.

Master of Science Degree in Healthcare Technologies Management.

The Healthcare Technologies Management Program is jointly offered by Marquette University and the Medical College of Wisconsin. It is an interdisciplinary graduate program that combines business, technology, and healthcare, and leads to a Master of Science degree in Healthcare Technologies Management from both institutions. The objectives of the program are to:

- Supplement students' technical backgrounds with formal coursework in business and management;
- Develop students' understanding of the economic and regulatory environments of healthcare delivery;
- Prepare students for placement and/or advancement into clinical, industrial, or consulting environments;
- Train engineering professionals capable of managing the design, development, commercialization, and regulatory compliance of medical devices, and the implementation, utilization, and assessment of hospital-based healthcare technologies.

1. Admission Criteria.

a. Educational Background.

Graduates of accredited colleges or universities with a bachelor's degree in various engineering disciplines or equivalent are eligible for admission to the M.S. program in Healthcare Technologies Management. Only those applicants are admitted whose undergraduate record shows promise of success in graduate study. To qualify for admission, applicants must have, as a minimum, approximately a "B" average (3.0 GPA) in their total post-secondary school education.

b. Detailed Admission Requirements.

All applicants, regardless of status sought, must file the following documents at least six weeks in advance of registration with the Graduate School. Normally, no file is considered for admission until it is complete. The materials are:

- "Application for Admission".
- Official transcripts of undergraduate and graduate records, sent directly to the Graduate School by the institution concerned. If a transcript or mark sheet is not in English, the applicant must supply a translation.
- Three letters of recommendation.
- Results of the GRE General (Aptitude), MCAT or GMAT exams.
- Essay describing career goals and reason for interest in program.
- Application fee (non-refundable).
- International students must submit results of the TOEFL exam.
- Admission is not official until the student is notified in writing of acceptance by the Graduate School. Admission cannot be made final until an official transcript has been received indicating the conferral of an undergraduate degree.
- If a student fails to register for courses within two years after the date of application

for admission, the student's file will be discarded.

2. Course Work.

The program consists of 15 courses representing 37.5 credit hours. Courses are offered in the evenings to accommodate working engineers and are taught at both institutions. Students may enroll as full or part-time students. Full-time students can complete the program in three semesters. The program includes courses in healthcare technologies management and in business/management. All business courses are taught as part of the Executive MBA program at Marquette University.

3. Required Course Work.

- | | | |
|--------------|--|-------------|
| • HCTM 6100: | Survey of Biomedical Engineering Technology | 3 credits |
| • HEAL 6840: | Environment of Healthcare Delivery | 2 credits |
| • HCTM 6200: | Biomedical Technology Assessment | 3 credits |
| • HCTM 6300: | Biomedical Technology Standards and Regulations | 2 credits |
| • HCTM 6400: | Ethics of Technology Utilization | 1.5 credits |
| • HCTM 6500: | Product Development of Medical Devices | 2 credits |
| • HCTM 6969: | Seminar: Special Topics in Healthcare Technologies Management (1.0 credit - spans two semesters 0.5 credit/semester) | 1 credit |
| • HCTM 6995: | Applied Biomedical Engineering Project | 3 credits |
| • | (3 credits-spans three semesters-1 credit/semester) | |
| • ACCO 6000: | Accounting Foundations | 2 credits |
| • ACCO 6100: | Managerial Accounting | 3 credits |
| • MARK 6100: | Marketing Management | 3 credits |
| • FINA 6100: | Financial Management | 3 credits |
| • MANA 6100: | Organizational Behavior | 3 credits |

4. Transfer of Graduate Credit.

A maximum of 6 semester hours of approved graduate work in a Master's Program from other institutions may be transferred into a student's Master's Program with consent of the Graduate School Dean and the Program Director. Under special circumstances, when courses from other institutions are directly comparable in content to those at Marquette, up to 12 semester hours may be transferred. A course will be considered for transfer credit only if the grade is "B" or better and the course was completed for graduate credit at the institution at which it was taken. Students applying for transfer credit must complete the appropriate form available from the Graduate School Office after completion of at least 6 semester hours at Marquette (9 if on probation).

5. Independent Study Course HCTM 6995.

During the first semester, students will identify an independent study project or internship involving the management of healthcare technologies, and present it to the faculty for approval. Project selection will be based on the career goals and interests of the student. Faculty and industry/hospital advisors will be available to assist students. Projects will be completed during the third semester and a final report will be presented to program faculty.

6. Electives.

One technical elective and one professional development elective are also required and are chosen according to the student's interests and career goals. All electives must be approved by the Program Director.

7. Grades.

Satisfactory academic work is not solely determined by course grades. However, grades are an important factor in the evaluation process. A GPA of 3.0 is required to graduate, and students with a GPA under 3.0 are placed on probationary status.

8. Time Limitations.

A student must complete all of the requirements for a Master's Degree within six years. If courses from other universities are transferred into a degree program at Marquette and if those courses were taken prior to work at Marquette, the beginning date of the first course will be used to establish the beginning of the student's time period.

9. Learning Outcomes.

The Learning Objectives of the Biomedical Engineering Master of Science in Healthcare Technologies Management (M.S.) training program, and their assessment, provide tools that ensure continuous quality improvement. Upon graduation from the Healthcare Technologies Management Program, all students will have:

- a. acquired knowledge and developed skills needed to manage the personnel and processes required for the
- b. design, development, commercialization, and regulatory compliance of medical devices and
- c. assessment and implementation of hospital-based healthcare technologies,

and will be able to:

- a. apply knowledge of fundamental business operations (marketing, finance, accounting, and organizational behavior) to the management of healthcare technology and
- b. describe the economic, legal, ethical, and regulatory aspects of healthcare delivery and medical device development.

Grading, Evaluation of Performance.

Grading System.

The letter grades A, AB, B, BC, C, F, W, SC/SNC, UC/UNC, I and X will be assigned for graduate course work at the end of each semester. Detailed explanations of these grades are given in the Marquette University Graduate School Bulletin.

Appeal of Grades.

Any student may consult his or her instructor about the grades received for work done. The exercise of this right neither requires a fixed procedure nor is subject to procedural conditions. Final graduate course grades assigned in the Department of Biomedical Engineering may be appealed following the procedures given below, provided that this action is initiated before the first day of class of the next regular semester following the issuance of the grade.

1. The student must consult with the instructor to determine the reasons for the grade. When there are special circumstances, the Chairperson of the Department of Biomedical Engineering may waive the requirement of consultation with an instructor.
2. When the student is not satisfied with the reasons given by the instructor, he/she may present his/her case in writing to the Chairperson. The student should present all evidence of his/her performance and may request that all other pertinent material be supplied by the instructor.
3. When the Chairperson has examined the appeal and after consultation with the instructor the Chair will: (1) Inform the student that no further department action is to be taken; or (2) convene a committee to review the appeal.
4. The Chairperson will appoint a committee of three regular faculty members of the Department of Biomedical Engineering. The Chairperson may sit on the committee.
5. The committee may proceed from written evidence or may consult the instructor and/or the student according to its judgment.
6. The committee shall give one of three decisions: (1) That the grade given will remain; (2) That the instructor will reconsider the grade in light of what the committee discovered and that the instructor's reconsidered grade will stand; or (3) That the committee recommends a change of grade to the Dean of the Graduate School.
7. The decision of the committee should be the final action inside the Department and any appeal beyond the Department must be made to the Dean of the Graduate School.

Evaluation of Performance.

The Academic Advisor and/or Dissertation Advisor will submit biannual academic progress reports to the Department regarding each graduate student. The Chairperson of Biomedical Engineering evaluates the academic progress of all graduate students at the end of the semester. If a student is not performing satisfactory work, the student and the Dean of the Graduate School will be notified in writing.

The Student may be counseled to withdraw. The Dean of the Graduate School may be asked to place the student on probation, register a voluntary withdrawal, or administratively withdraw students so counseled.

Academic Dishonesty and Research Misconduct.

Upon detection of academic dishonesty, the student involved will automatically receive an "F" grade in the course. Beyond this, additional credit for graduation may be required or expulsion from the school may result depending on the nature of the offense and the Graduate Dean's decision according to University policy. Refer to the Graduate Bulletin for "Definitions of Academic Dishonesty" and its consequences and to the University statement regarding "Research Misconduct".

Registering for Courses at the MCW.

Once you have decided which courses you will be taking at the Medical College of Wisconsin, you must inform the BIEN Department's Administrative Assistant. Take for example the Human Physiology course at the MCW – you would first contact the Administrative Assistant and provide her with the course number, professor, and number of credits. This procedure assures that you get MU credit for taking the class. She will grant consent for you to register. Next, you must register at MU for BIEN 6947. Choose the section that corresponds to the total number of credits you're taking at the MCW that semester. Furthermore, you **MUST** register at the MCW. Your earned grade will show up on your MU transcript. **NOTE:** the MCW classes may start considerably earlier or later than MU classes and the weekly meeting schedule may vary. It is your responsibility to register for BIEN 6947.

Registering for BIEN 6995 and HCTM 6998.

To enroll in BIEN/HCTM 6995/6998, you must fill out both the "Approval for Independent Study Course 6995" and the "BIEN/HCTM 6995/6996/6998 Independent Study Course Contract" forms available in the BIEN Office, Olin 206. The first form must be signed by the Course Director and the Department Chairperson. The second form must be signed by you, the Course Director, and the Department Chairperson. Both forms must be turned in to the BIEN Office at least two weeks before the start of classes.

Continuous Enrollment.

You must request continuous enrollment when you are not registered for any specific course work at MU (when finished with coursework and thesis or dissertation credits, but still doing your research work) or when you are not carrying sufficient course load so as to maintain full-time enrollment status. To request continuous enrollment, you must fill out the "Graduate School Continuous Enrollment Registration Form" and pay the appropriate fee. This completed form must be signed by your advisor and returned to the Biomedical Engineering office, Olin room 206. Consent will be provided for you to enroll. You must register for BIEN/HCTM 9xxx {8xxx} according to the nature of your continuous enrollment. The details are explained on the form, which is included at the end of this handbook. The Bursar will bill you the appropriate fee for continuous enrollment.

Holiday and Leave Policy.

Teaching Assistant, Research Assistant and Research Fellow Holidays and Leave.

Ten-month (academic year) Teaching Assistants and Research Assistants are contracted to work from August 1st to May 31st. Full-time, twelve-month RA's and Research Fellows work 12

months per year. For each week of the 10 or 12 month award, the TA or RA is expected to work a minimum of 20 hours per week beyond the work that pertains to the thesis or to the laboratory course TA assignment. Exceptions include the following holidays: New Year's Day, Martin Luther King Day, Good Friday, Easter Monday, Memorial Day, Independence Day, Labor Day, Thanksgiving, Christmas, and New Year's Eve. These holidays are the University's Administrative holidays, not the Academic (or student) holidays. Twelve month Research Fellows and 12 - month RA's are allowed to take up to 2 weeks vacation per year.

You must discuss any deviations from the above with your thesis/dissertation director.

Financial Aid.

Types of Financial Aid.

Five major categories of financial aid are available to degree-status graduate students in Biomedical Engineering: scholarships, fellowships, teaching assistantships, research assistantships, and loans. Students admitted on probation are not eligible for financial aid, but may be considered once probation has been removed. The term of financial aid is normally for one academic year (10 months), but in some instances may be for one semester (5 months). Limited amounts of financial aid are available during the summer.

Students seeking financial aid other than loans are normally required to submit an "Application for Financial Aid" to the Graduate School no later than February 15 of the academic year prior to the one for which aid is being sought. For more information see http://www.marquette.edu/grad/finaid_index.shtml.

1. Scholarships.

Scholarships are available through the Graduate School. These cover tuition only and range from 1 to 12 credit hours per semester. No service is required of the student in return for a scholarship.

2. Fellowships.

Fellowships are available through the Graduate School. Fellowships provide a stipend and, in some cases, tuition remission. No service is required of the student. Students (especially Doctoral students) are urged to seek the fellowship assistance available from various external government institutes, foundations, and other organizations.

3. Teaching Assistantships.

Teaching assistantships provide students with a stipend and 9 credit hours of tuition remission per semester. In return the students are expected to satisfactorily perform 20 hours of teaching-related assignments per week. Students with teaching assistantships are normally limited to a 9 credit-hour load per semester.

4. Research Assistantships.

Research assistantships also provide students with a stipend and 9 credit hours of tuition remission per semester. In return the students are expected to satisfactorily perform 20 hours of research-related assignments per week. Students with research assistantships are normally limited to a 9 credit-hour load per semester. Research assistantships are also available from individual faculty members with research grants.

5. Loans.

Loan assistance is available to assist qualified students who, without such aid, would be unable to attend the University. Students are eligible for student loans if they are attending the University on at least a half-time basis and are in good academic standing. No applicant will be considered for loan assistance until he/she has been formally admitted to the Graduate School. For specific information on loans and other resources available to graduate students attending Marquette, refer to the Marquette University Financial Aid brochure. This brochure is available from the Office of Student Financial Aid, Marquette University, Milwaukee, WI 53233. Telephone: (414) 288-7390.