

# ENGINEERING, MS: BIOMEDICAL ENGINEERING

The Master of Science in Engineering program is a flexible program designed to meet the needs of a wide variety of students. The program can be a stepping-stone on the way to further studies and the pursuit of advanced research, such as can be obtained by pursuing the PhD. Or the program can provide a pathway to professional advancement through greater technical knowledge and intellectual maturity. The student, with the help and approval of a major advisor, can choose from a wide range of courses from throughout the College of Engineering and Applied Science (CEAS), and where appropriate, from other schools and colleges.

Students entering the Master of Science in Engineering program must choose an area of concentration, from among the numerous choices offered. It is possible to complete the MS in Engineering without a concentration, but almost all students do complete one. The MS in Engineering program currently offers the following areas of concentration:

- Biomedical Engineering
- Civil Engineering
- Electrical and Computer Engineering
- Energy Engineering
- Engineering Management (admission to this concentration is suspended)
- Engineering Mechanics
- Industrial and Systems Engineering
- Manufacturing Engineering
- Materials Engineering
- Mechanical Engineering
- Occupational Biomechanics/Ergonomics

## Admission Requirements

### Application Deadlines

Application deadlines vary by program, please review the application deadline chart (<http://uwm.edu/graduateschool/program-deadlines/>) for specific programs. Other important dates and deadlines can be found by using the One Stop calendars (<https://uwm.edu/onestop/dates-and-deadlines/>).

### Admission

An applicant must meet Graduate School requirements (<http://uwm.edu/graduateschool/admission/>) plus these College requirements to be considered for admission to the program:

1. Undergraduate major in engineering, mathematics or a natural science.
2. Submission of official GRE (<http://uwm.edu/graduateschool/admission/#gre>) scores from a test taken within the last 5 years.
3. Reason statement explaining reasons for graduate study, specific interests, and background.

Applicants may be admitted with specific program-defined course deficiencies provided that the deficiencies amount to no more than two courses. The student is expected to satisfy deficiency requirements within three enrolled semesters. The deficiencies are monitored by the

individual graduate program unit. No course credits earned in making up deficiencies may be counted as program credits required for the degree.

## Credits and Courses

Minimum degree requirements are 30 credits for the thesis option and 31 credits for the non-thesis option as outlined below. Of the courses offered in the College only those numbered 400 and above may be taken for graduate credit for this degree. Independent study courses (699 and 999) may be included in the minimum course credit requirements provided approval of a program of study including them has been obtained prior to registration in such courses. Typically, no more than three credits of independent study are allowed in the MS Program. Guidelines on acceptable independent study courses are available in the CEAS Graduate Programs Office. A student may not use courses that formed part of the requirements of a baccalaureate degree for subsequent graduate credit, except when those courses were part of the CEAS Integrated BS/MS program.

## Thesis and Non-Thesis Options

Students will be required to either the Thesis or Non-Thesis option in their program of study. If the student chooses the Non-Thesis option, then as permitted by the student's department, the student must also choose between two methods of final evaluation: the Capstone Option and the Comprehensive Examination Option.

After 12 credits of coursework are completed, changes from Thesis to Non-Thesis option will not be allowed, except under exceptional circumstances to be considered on a case-by-case basis. Students may always change from a Non-Thesis to a Thesis option. Departments and faculty may make pursuing the Thesis option a requirement (or preference) of employment for TAs, RAs, and PAs.

## Thesis Option

All students are encouraged to undertake the thesis option. The degree requires the following:

Code	Title	Credits
Select a minimum of 12 credits in an approved technical program of studies		12
Select 9 credits of approved electives		9
EAS 701	Effective Academic Writing	1
EAS 702	Preparing Future Engineering Faculty & Professionals	2
Select 6 credits of thesis		6
<b>Total Credits</b>		<b>30</b>

At least 12 credits, not including thesis or the CEAS Graduate Seminar Course, must be in courses of 700 level or higher. At least 12 credits, including thesis, must be earned at UWM. The thesis may be written in absentia provided prior permission has been obtained from the major professor and the Associate Dean for Academic Affairs in the College of Engineering & Applied Science. Students in the thesis option must pass a final comprehensive examination, administered by the Master's Program Committee, partially in defense of the thesis.

## Non-Thesis Capstone Option

Code	Title	Credits
Select a minimum of 18 credits in an approved technical program of studies		18
Select 9 credits of approved electives		9

EAS 701	Effective Academic Writing	1
Select 3 credits of a capstone project, using a 3 credit course that allows flexible independent study (either the Independent Study course or a specific capstone course)		3
<b>Total Credits</b>		<b>31</b>

In addition to the requirements listed in the table above, at least 15 credits must be of 700 level or above.

For the capstone project, the student must submit a written proposal and receive approval from the advisor. The capstone project should be designed with the intent of leading to creative work based on the student's background, and should be the equivalent of 3 credits of work to be completed over a single semester. Upon completion of the capstone, the student must submit a written report and give an oral presentation of the project to the Master's Program Committee for approval.

### Non-Thesis Comprehensive Examination Option

Code	Title	Credits
Select a minimum of 21 credits in an approved technical program of studies		21
Select 9 credits of approved electives		9
EAS 701	Effective Academic Writing	1
<b>Total Credits</b>		<b>31</b>

In addition to the requirements listed in the table above, at least 15 credits must be of 700 level or above.

Mastery of the courses taken in the program of study may be demonstrated by one of the following:

1. The student submits a dossier of work, and passes an oral examination given by the Master's Program Committee; or
2. The student passes a written master's comprehensive examination when it is offered by the department.

Departments allowing a written examination option will offer such exams at least once per semester, and will announce the date of the exam at least 60 days prior to the exam. The department also must provide a written description of the topics covered on the exam, including text books and chapters.

### Biomedical Engineering Concentration

A minimum of 15 credits of qualifying graduate courses from the list below. May include up to 3 credits each of BME 990 and BME 999. Also, students must take at least 16 credits of engineering courses.

#### Qualifying Courses

Code	Title	Credits
BME 733	Sensors and Systems	3
BME 890	Special Topics:	3
BME 990	Masters Thesis *	1-9
BME 999	Advanced Independent Study *	1-3
COMPSCI/ELECENG 710	Artificial Intelligence	3
ELECENG/MECHENG 701	Advanced Linear System Analysis	3
COMPSCI/ELECENG 711	Introduction to Machine Learning	3
COMPSCI/ELECENG 712	Image Processing	3

ELECENG/MECHENG 718	Nonlinear Control Systems	3
ELECENG 737	Medical Imaging Signals and Systems	3
ELECENG 765	Introduction to Fourier Optics and Optical Signal Processing	3
ELECENG 810	Foundations for Advanced Machine Learning and Signal Processing	3
MECHENG 715	Numerical Methods in Engineering	3
BMS 765	Molecular Pathophysiology	3
OCCTHPY 701	Advanced Measurement and Instrumentation in Health Care	3
PH 702	Introduction to Biostatistics	3
PH 704	Principles and Methods of Epidemiology	3
PH 706	Perspectives on Community & Behavioral Health	3
PH 711	Intermediate Biostatistics	3
PH 712	Probability and Statistical Inference	3
PHYSICS 705	Molecular, Cellular, and System Biophysics	3
PHYSICS 706	Biophotonics	3
PHYSICS 782	Physics of Medical Imaging	3

\* A maximum of 3 credits of BME 990 or 999 may be included.

## Additional Requirements

### Major Professor as Advisor

The Graduate School requires that the student have a major professor to advise, supervise, and approve the Program of Study before registering for courses. The College will assign the incoming student to an initial advisor at the time of admission. A student may change advisors with the consent of the new advisor, approval by the Associate Dean for Academic Affairs, and upon notification of the student's current advisor.

### Program of Study

During the first semester the student, in consultation with the major professor, develops a program of study, obtains the consent of the advisor and submits it to the CEAS Graduate Programs Office for approval by the Associate Dean. To make subsequent changes, the student must follow the same process. Graduation requires successful completion of courses from an approved program of study. Students are recommended to obtain approval for an amended program of study before taking a course not on the current program of study.

### Master's Program Committee

The Master's Program Committee is proposed by the major professor in consultation with the student. The Committee must include at least three graduate faculty, not all of whom are in the same department.

### Time Limit

The student must complete all degree requirements within five years of initial enrollment.