

MS IN BIOMEDICAL ENGINEERING

Masters Program Objectives

The goal of the MS program in Biomedical Engineering at the University of Miami is to prepare students for successful careers in the biomedical industry, academia, or government (FDA, US Patent Office), or for further study in doctoral or health-related programs.

The educational objective of the program is to provide students with the technical and intellectual skills required to solve complex technical or scientific problems at the interface of engineering and medicine or biology.

Admission Requirements

The qualifications and documentation required for admission to the MS program in Biomedical Engineering are the same as for the College of Engineering.

The Department of Biomedical Engineering generally admits four types of students to its MS program:

- Students with undergraduate degrees in biomedical engineering and other engineering disciplines who seek advanced professional training or specialization in a particular area of biomedical engineering
- Professional engineers with degrees in other engineering disciplines who plan to enter the field of biomedical engineering
- Students with an undergraduate degree in Physics, Mathematics, Computer Science, Chemistry, Biology or other fields of natural or health science who seek to diversify their career opportunities by acquiring an engineering degree
- Students who are preparing for admission to advanced health-related or other professional programs such as medical school

Students in the last two groups are generally given conditional admission and required to take additional undergraduate courses in engineering, physics, and/or mathematics depending on their previous course work, as specified in the admission letter. The requisite courses will be prescribed by the Department Chair or Graduate Program Director during the first advising session.

Curriculum Requirements

The curriculum combines advanced coursework which provides depth in a specific area of concentration and advanced problem-solving skills, with supervised research or design in one of the laboratories of the faculty from the Department of Biomedical Engineering or the School of Medicine, or in the local biomedical industry.

Except for the Medical Physics program, there are no formalized graduate curricular tracks in the MS program. Master's students select a course of study together with the graduate advisor and/or with their mentor and the thesis committee (for the thesis option) based on their own needs or interests. Students can choose from any of the graduate course offerings, as long as they satisfy the general course requirements and the course prerequisites.

Required Core Courses

All students enrolled in the MS program in Biomedical Engineering are required to complete the following core graduate courses:

- Human Physiology Courses (BME 601 (<https://bulletin.miami.edu/search/?P=BME%20601>)/BME 602 (<https://bulletin.miami.edu/search/?P=BME%20602>)/BME 603 (<https://bulletin.miami.edu/search/?P=BME%20603>), 3 credits each). Students enrolled in the BS/MS program must take exactly two of these three courses, no more and no less. Other students must take a minimum of two of these courses and they can choose to complete all three.
- Regulatory Control of Biomedical Devices (BME 612, 3 credits)

The three human physiology courses are designed to provide a basic understanding of organ-level physiology and anatomy, neurophysiology, and cellular and molecular biology. Students with an MD from a medical school accredited by the World Health Organization are exempted from taking these courses. Students holding advanced degrees in the life sciences, or equivalent experience in the field, may also be exempt. Each such exception requires the approval of the Department Chairperson and Faculty member responsible for the course of concern. Students who receive an exemption, must replace the exempted course(s) with another 3-credit graduate course(s) that meets the degree requirements.

Students with a background in an engineering or scientific field with no prior exposure to biology/medicine are required to complete all three Unified Medical Sciences courses.

Non-Thesis MS Program

The MS non-thesis option is intended for students with an undergraduate degree in biomedical engineering or related disciplines who seek advanced training or specialization in a specific area of biomedical engineering; for professional engineers with undergraduate degrees in other disciplines who want to enter the field of biomedical engineering; and for students who want to prepare for admission to advanced health-related or other professional programs.

Graduation Requirements

Graduation requirements for the MS Non-Thesis Option include:

Code	Title	Credit Hours
24 Graduate-Level Course Credits Including: †		24
BME 612	Regulatory Control of Biomedical Devices	3
At least 2 of the following 3:		
BME 601	Biochemistry and Cellular Physiology for Engineers	
BME 602	Human Physiology for Engineers	
BME 603	Neurophysiology for Engineers	
MS Project		3
BME 707	Master's Project I	
BME 708	Master's Project II	
Total Credit Hours		30

† Graduate-level courses are courses that are 600 and above.

Non-Thesis MS Project

General description

All students enrolled in the MS non-thesis program must complete a two-semester 3 credit Master's project (BME 707 and BME 708), under the supervision of a project mentor and departmental project coordinator. The project must demonstrate the candidate's ability to solve complex scientific or technical problems at the interface of engineering and medicine or biology.

The MS project can be a research or design project. The project must include a significant research or design component contributed by the M.S. student, including, but not limited to, the design of an experiment or process; the development of a device, instrument, or system; the development of a computer program; the analysis of experimental data. Projects cannot be limited solely to the review of literature, the development of research or design proposals, or the collection of experimental data.

At the completion of their project, students must submit a written project report and complete a public oral defense of their project.

Project Mentor

Students who select the MS non-thesis track must identify a project mentor and select a project before they register for their second semester of full-time study. The project mentor is generally a primary faculty member of the Department of Biomedical Engineering. The role of the project mentor is to help the student identify a suitable project, to monitor the progress of the student, to provide guidance and training in the relevant topics, and to review the final report and presentation.

Students may complete their project under the supervision of a faculty member from another Department at the University of Miami, or from the local biomedical industry, under the following conditions:

- The student must receive the approval of the Department Chairman and Graduate Program Director.
- The student must identify a co-mentor who must be a primary faculty member of the Department of Biomedical Engineering. The co-mentor must be familiar with the topic of the proposed project. The role of the co-mentor will be to monitor the student progress and ensure that the Master's project report and presentation satisfy all of the relevant requirements.

Project Coordinator

The project coordinator is a member of the primary faculty of the Department of Biomedical Engineering who is responsible for teaching the BME 707/BME 708 course. The role of the project coordinator is to:

- Help students identify a project and mentor.
- Ensure that the projects satisfy the program objectives.
- Provide general guidance and graduate scholarship training.
- Ensure that the students are making suitable progress towards the project goals.

Project Abstract

Non-Thesis MS students must submit a one-page project abstract to the Department Chairman or Graduate Program Director and to the MS Project Coordinator at the time when they register for BME 707/BME 708. The abstract must include the name of the project mentor (and co-mentor, if any), the title of the proposed project, and a brief description of the goals of the project and proposed methods. The abstract must be approved by the mentor, MS Project Coordinator, and Department Chairman or Graduate Program Director before the student can start work on the project. (Project Abstract Template (http://bulletin.miami.edu/graduate-academic-programs/engineering/biomedical-engineering/biomedical-engineering-ms/Abstract_Template.pdf))

Project Report

Non-thesis MS students must submit a detailed report describing the work completed during the project. The report must describe the objectives and significance of the work, and summarize the activities completed by the student as part of the MS project. The report must demonstrate that the work performed by the student satisfies the general project criteria. The typical length of non-thesis M.S. project reports is 20 to 30 pages. If the project resulted in the submission of a full-length peer-reviewed scientific article, the article can be submitted in lieu of a report, as long as the following conditions are satisfied:

- The student must be the first author of the article.
- The article must reflect the work performed by the student as part of the project.
- The article must be submitted for publication in a peer-reviewed journal or conference proceedings volume.
- A one to two page introduction must be submitted to summarize the project goals and main outcomes.

The report must be reviewed and approved by the project mentor (and co-mentor, if any). Once the report is approved by the mentor(s), one printed copy and one electronic version in PDF format must be submitted to the Project Coordinator by the specified deadline. The final report must be approved and signed by the Project Mentor(s), Project Coordinator and Graduate Program Director or Department Chairman. (Signature Page Template (http://bulletin.miami.edu/graduate-academic-programs/engineering/biomedical-engineering/biomedical-engineering-ms/Signature_Page_Template.pdf))

Project presentation

Non-thesis MS students must give an oral presentation of their project. The oral presentation is generally scheduled during the scheduled final examination time of BME 707/BME 708 in the semester of graduation.

Project grade

The final grade for the project is given by the Project Coordinator. The final grade is a combination of a grade submitted by the Project Mentor(s) assessing the overall performance of the student on the project, and a grade given by the Project Coordinator assessing the quality of the oral presentation and report.

MS Thesis Program

The thesis option is typically selected by students who are oriented towards a career in academic or industrial research and development, or students who want to acquire an initial independent biomedical research experience before seeking admission to doctoral programs.

Graduation Requirements

Graduation requirements for the MS Thesis Option include:

Code	Title	Credit Hours
21 Graduate-Level Course Credits Including: †		21
BME 612	Regulatory Control of Biomedical Devices	3
At least 2 of the following 3:		
BME 601	Biochemistry and Cellular Physiology for Engineers	
BME 602	Human Physiology for Engineers	
BME 603	Neurophysiology for Engineers	
Thesis Work		6
BME 810	Master's Thesis	
Total Credit Hours		30

† Graduate-level courses are courses that are 600 and above.

MS Thesis

General Description

The Master's thesis is a research monograph which describes the significance of the research and summarizes the research activities completed as part of the MS degree requirements. The objective of the thesis is to evaluate the candidate's competence in the area of the MS research. The thesis must demonstrate that the research is original and that the candidate has the ability to solve complex scientific and/or technical problems at the interface of engineering and medicine or biology.

Thesis Mentor

Students who select the MS thesis track must identify a thesis mentor before they register for their second semester of full-time study. The thesis mentor must hold a primary or secondary faculty appointment in the Department of Biomedical Engineering. Exceptions can be made only with approval of the Graduate Program Director and Department Chairman.

The thesis mentor supervises the research work of the student and provides training and guidance in the relevant research topics, including design of experiments, experimental techniques, and scholarship activities. The mentor helps the student select a thesis topic and develop a plan, and chairs or co-chairs the thesis committee. The mentor works closely with the student to ensure that there is satisfactory progress towards the thesis goals.

Thesis Committee

The thesis must be approved by a thesis committee. The duties of the thesis committee are:

- to consult with and to advise students on their research;
- to meet, at intervals, to review progress and expected results;
- to read and comment upon the draft thesis;
- to meet, when the thesis is completed, to conduct the final oral examination and to satisfy itself that the thesis work is original; that it demonstrates the candidate's ability to solve complex scientific and/or technical problems at the interface of engineering and medicine or biology; that it is written in lucid and correct English; and that it is submitted in approved format.

The thesis committee will consist of not less than three members, with the following requirements:

- The committee chair shall be a Primary Faculty member of the Department of Biomedical Engineering, as well as a regular member of the Graduate Faculty. The Committee Chair is generally also the thesis mentor.
- A thesis mentor who is not a member of the Primary Faculty of the Department of Biomedical Engineering, can serve as Co-Chair of the Thesis Committee, together with a second Co-Chair who shall be a member of the primary faculty of the Department of Biomedical Engineering.
- It is an additional requirement of the Department of Biomedical Engineering that at least two committee members should be primary Faculty members from the Department.
- One committee member must be from outside the Department. Outside members of the thesis committee can include part-time faculty that teach within the Department.
- At least one committee member must be a regular member of the Graduate Faculty of the University of Miami.

The committee is nominated by the Graduate Program Director. Usually, the student consults with his/her research mentor and with the Chairperson or Graduate Program Director to select the Committee members.

Thesis Format and Deadlines

It is the duty of the student to ensure that the thesis defense is scheduled and that a final version of the thesis approved by the Dissertation Editor is submitted to the Dissertation Editor by the required deadlines set by the Graduate School. All information pertaining to the formatting and electronic guidelines for electronic thesis submission can be found on the Graduate School website (<https://grad.miami.edu/>).

Each thesis must be accompanied by a Certificate of Defense Approval for Master's Thesis (<https://grad.miami.edu/policies-and-forms/forms/>) signed by all members of the Committee. Forms can be downloaded from the Graduate School website.

Evaluation Forms

The student is responsible for distributing dissertation evaluation forms (http://bulletin.miami.edu/graduate-academic-programs/engineering/biomedical-engineering/biomedical-engineering-ms/SACS_Graduate_Rating_Grid_Rubric_2016.pdf) to the members of the Thesis Committee for the final oral examination. The evaluation forms are used to assess the overall quality of the graduate program at the Department, College, and University level. The evaluation forms are available on the Graduate School and Department of Biomedical Engineering websites. The completed forms must be collected by the Thesis Mentor and forwarded to the Office Manager at the Department of Biomedical Engineering.

Transfer to MS Non-Thesis Program

Students enrolled in the MS thesis program who do not wish to complete their thesis can transfer to the MS non-thesis program and graduate from the MS program under the following conditions:

- The transfer must be approved by the Department Chair or Graduate Program Director.
- All requirements of the MS non-thesis option must be satisfied, including completion of a two-semester 3 credit Master's project (BME 707 and BME 708), submission of a project report, and oral defense of project. Completed thesis credits may count towards the three credit MS project requirement.

MS in Biomedical Engineering: Medical Physics

The MS in Biomedical Engineering offers a special track in Medical Physics. The objective of the Medical Physics program is to provide advanced knowledge in the field of therapeutic medical physics, and to provide the training required for students to become licensed medical physicists. This program is coordinated by the Department of Biomedical Engineering and the Department of Radiation Oncology at the School of Medicine.

The program is opened to students enrolled in the regular MS program, as well as the dual degree (BS/MS) program. Candidates are required to have completed the course work of a physics minor, that must include Modern Physics (PHY 360 or equivalent), before they start their course work in the Medical Physics program.

Students in the Medical Physics specialization must complete Human Physiology for Engineers (BME 602) and one of the remaining two courses from the human physiology (BME 601 or BME 603) course series, and 23-credits in the core curriculum in the area of medical physics:

Code	Title	Credit Hours
BME 601 or BME 603	Biochemistry and Cellular Physiology for Engineers Neurophysiology for Engineers	3
BME 602	Human Physiology for Engineers	3
BME 620	Medical Imaging Systems: X-ray and CT	3
BME 621	Medical Imaging Systems: MRI, NMI and Ultrasound	3
BME 681	Radiation Biology and Physics	3
BME 682	Radiation Therapy Physics	3
BME 683	Radiation Protection	3
BME 701	Professionalism and Ethics for Engineers and Medical Physicists	1
BME 781	Radiation Dosimetry and Physics	3
BME 783	Radiation Therapy Physics Clinical Rotation	3
BME 784	Medical Physics Journal Club	1
Thesis or project		3-6
BME 707 & BME 708 or BME 810	Master's Project I and Master's Project II Master's Thesis	
Total Credit Hours		32-35

Any remaining credits required to complete the degree must satisfy the general requirements of the MS program. Students enrolled in the MS program in Medical Physics may require a total of 32 credits (non-thesis option) or 35 credits (BS/MS and thesis option) to complete the program requirements.

The topic of the non-thesis MS project (BME 707/BME 708), or MS thesis must be related to medical physics. In general, the project is co-supervised by Faculty from the Department of Biomedical Engineering and the Department of Radiation Oncology.

Sample Plan of Study

Non-Thesis MS Program

A typical curriculum for the MS non-thesis option is shown in the following table. The course sequence and timeline can be adjusted based on individual needs. The minimum residence requirement for the MS degree is two semesters in full-time study or the equivalent in part-time work.

First Semester		Credit Hours
Course Credits		12
Identify Mentor		
Submit Project Abstract		
	Credit Hours	12
Second Semester		
Course Credits		9
BME 707	Master's Project I	1
	Credit Hours	10
Third Semester		
Course Credits		6
BME 708	Master's Project II	2
	Credit Hours	8
	Total Credit Hours	30

Sample Plan of Study

MS Thesis Program

A typical curriculum for the MS thesis option is shown in the following table. The course sequence and timeline can be adjusted based on individual needs. The minimum residence requirement for the MS degree is two semesters in full-time study or the equivalent in part-time work.

First Semester		Credit Hours
Course Credits		12
Identify Mentor & Project		
Credit Hours		12
Second Semester		
Course Credits		9
BME 810	Master's Thesis	3
Credit Hours		12
Third Semester		
Course Credits		3
BME 810	Master's Thesis	3
Credit Hours		6
Total Credit Hours		30

Students who are not able to complete their thesis during the 3rd semester and have completed all 30 required credits of graduate work, must enroll in 0 credits of Research in Residence (BME 820 (<http://bulletin.miami.edu/search/?P=BME%20820>)) to maintain full-time student status.

Sample Plan of Study

MS Program in Medical Physics

Typical curricula for each option of the MS program in Medical Physics are shown in the following tables. The course sequence and timeline can be adjusted based on individual needs. The minimum residence requirement for the MS degree is two semesters in full-time study or the equivalent in part-time work. Students can also complete the BS/MS program in Medical Physics.

MS without Thesis

Year One		Credit Hours
First Semester		
BME 620	Medical Imaging Systems: X-ray and CT	3
BME 681	Radiation Biology and Physics	3
BME 682	Radiation Therapy Physics	3
Credit Hours		9
Second Semester		
BME 621	Medical Imaging Systems: MRI, NMI and Ultrasound	3
BME 683	Radiation Protection	3
BME 781	Radiation Dosimetry and Physics	3
Identify Co-Mentors		
Submit Project Abstract		
Credit Hours		9
Year Two		
First Semester		
BME 602	Human Physiology for Engineers	3
BME 603	Neurophysiology for Engineers	3
BME 701	Professionalism and Ethics for Engineers and Medical Physicists	1
BME 707	Master's Project I	1
BME 784	Medical Physics Journal Club	1
Credit Hours		9
Second Semester		
BME 708	Master's Project II	2
BME 783	Radiation Therapy Physics Clinical Rotation	3
Credit Hours		5
Total Credit Hours		32

MS with Thesis*

Year One		Credit Hours
First Semester		
BME 620	Medical Imaging Systems: X-ray and CT	3
BME 681	Radiation Biology and Physics	3
BME 682	Radiation Therapy Physics	3
Credit Hours		9
Second Semester		
BME 621	Medical Imaging Systems: MRI, NMI and Ultrasound	3
BME 683	Radiation Protection	3
BME 781	Radiation Dosimetry and Physics	3
Credit Hours		9
Year Two		
First Semester		
BME 602	Human Physiology for Engineers	3
BME 603	Neurophysiology for Engineers	3
BME 701	Professionalism and Ethics for Engineers and Medical Physicists	1
BME 784	Medical Physics Journal Club	1
BME 810	Master's Thesis	3
Credit Hours		11
Second Semester		
BME 783	Radiation Therapy Physics Clinical Rotation	3
BME 810	Master's Thesis	3
Credit Hours		6
Total Credit Hours		35

*Students who are not able to complete their thesis during the 3rd semester and have completed all 30 required credits of graduate work, must enroll in 0 credits of Research in Residence (BME 820 (<http://bulletin.miami.edu/search/?P=BME%20820>)) to maintain full-time student status.

Mission

The mission of the Biomedical Engineering Program is to prepare future leaders in biomedical engineering who are motivated to create a positive impact on human health, medicine, and industry.

Goals

The educational objective of the program is to provide students with the technical and intellectual skills required to solve complex technical or scientific problems at the interface of engineering and medicine or biology.

Student Learning Outcomes

- High level ability to apply knowledge of mathematics, science and engineering to formulate and solve relevant biomedical engineering problems.
- Ability to communicate the scientific and technical research effectively in writing and oral presentations.
- Ability to conduct supervised research and development.