PHD IN CHEMICAL, ENVIRONMENTAL, AND MATERIALS ENGINEERING

Overview

The Department of Chemical, Environmental, and Materials Engineering (CEM) offers a Doctor of Philosophy (Ph.D.) degree in Chemical, Environmental, and Materials Engineering with the following areas of emphasis:

- Chemical Engineering
- Environmental Engineering
- Materials Science and Engineering

The educational objectives of the Doctor of Philosophy program in Chemical, Environmental and Materials Engineering are to produce graduates whom:

1. Have advanced technical knowledge in at least one specialty area of chemical, environmental and materials engineering
2. Have advanced capability to apply advanced knowledge to engineering problems
3. Have made significant contributions in at least one specialty area of chemical, environmental, and materials engineering

The specialty areas of study for the Ph.D. include:

- Aerosols
- Water Systems
- Synthetic Biology
- Materials Synthesis

The College has embarked on six research thrust areas, and students can relate the above specialty areas to these and work on focused problems related to the six college wide research thrusts.

Students joining the PhD program in CEM will need 60 credits beyond a BS degree to graduate. Thirty of these will be course work units, and 30 will research credit units. For students who already have an earned Master of Science (in either civil, environmental, chemical, or materials engineering, or a closely related engineering field), the MS degree can count up to a maximum of 30 credits total, with approval of the Graduate Advisor and the student's PhD Committee. For students counting the maximum of 30 credits from an applicable MS degree, another 30 credits must be taken in residence at the University of Miami with a minimum of 15 of these 30 credits in course work units. All PhD students are required to engage in supervised research and defend a dissertation.

The following are the major requirements for the degree:

1. Take selected core classes in Year 1, and pass a Comprehensive Exam (first part of Qualifying Exam) at the end of Year 1
2. To demonstrate teaching participation, TA at least 2 classes, preferably in Year 2 or later.
3. Engage in research and defend a proposal by end of Year 2 (second part of Qualifying Exam), and be admitted to Candidacy.
4. Complete a PhD dissertation at end of program and defend the same to earn the degree. Students are encouraged to publish the results of their work in at least 1 refereed journal publication but preferentially 3.

The Program of Study is the student's specific set of coursework that defines the course requirements for graduation and must be approved by an advisory committee (known as the Supervisory Committee). Depending on whether the student already has an earned M.S. degree, the Ph.D. degree can typically be completed within two to five years.

Curriculum Requirements

Ph.D. in Chemical, Environmental, and Materials Engineering

Environmental Engineering Concentration

For a Ph.D. following an M.S.

For students who already have an earned M.S. (in civil, architectural, or environmental engineering), a minimum of 30 graduate-level credits are required beyond the M.S. degree with an average of "B" or better and no grade below a "C". Of the credits. The table presents an overview of the courses selection:

Code	Title	Credit Hours
At least 6 credits of lecture-based CEM courses at the 700-level (not Independent Study) such as the following:		**6**
CAE 730	Environmental Hydrology	

CAE 735	Water and Wastewater Engineering: Treatment and Reuse	
CAE 743	Risk Analysis	
Any lecture-based and/or Independent Study courses		**12**
CAE 630	Water Resources Engineering II	
CAE 631	Surface-Water Hydrology	
CAE 632	Ground-Water Hydrology	
CAE 633	Water-Quality Control in Natural Systems	
CAE 640	Environmental Chemistry	
CAE 641	Engineering Systems for Disease Control and Bioremediation	
CAE 642	Solid and Hazardous Waste Engineering	
CAE 730	Environmental Hydrology	
CAE 735	Water and Wastewater Engineering: Treatment and Reuse	
CAE 743	Risk Analysis	
Other courses with advisor approval such as the following:		
BME 635	Advanced Biomaterials	
BME 687	Finite Element Analysis for Engineers	
BME 695	Current Trends in Regenerative Medicine	
BME 702	Organs on Chips	
CAE 660	Sustainable Construction	
CAE 716	Fracture Mechanics	
ECE 643	BioNanotechnology	
MAE 632	Additive Manufacturing of Engineering Materials	
MAE 616	Introduction to Composite Materials	
ATM 624	Applied Data Analysis	
ATM 634	Introduction to Atmospheric Chemistry	
ATM 637	Natural Hazards: Atmosphere and Ocean	
ATM 651	Introduction to Atmospheric Dynamics	
ATM 652	Introduction to Atmospheric Physics	
ATM 731	Air-Sea Interaction	
ATM 732	Climate Dynamics	
ATM 762	Computer Models in Fluid Dynamics	
ATM 764	Atmospheric and Oceanic Turbulence	
RSM 611	Principles of Mass Spectrometry and Applications to Marine, Atmospheric, and Environmental Science	
RSM 672	Special Topics (Introduction to Science Policy)	
BMB 717	Nutrients, Enzymes, and Metabolic Flux	
CHM 641	Principles of Bonding and Reactivity in Inorganic Chemistry	
CHM 691	Topics in Chemistry (Organometallic Chemistry and Catalysis)	
12 credits of Doctoral Dissertation		**12**
CAE 830	Pre-Candidacy Doctoral Dissertation	
CAE 840	Post-Candidacy Doctoral Dissertation	
CAE 850	Research in Residence	
Total Credit Hours		**30**

* At least 18 credits in CEM

** A total of 6 credits of transfer and/or exchange coursework may be taken at another institution and used to satisfy the requirements for the Ph.D. degree. Only credits that have not been used towards another degree can be transferred.

Note: All courses, except Dissertation, are 3 credit hours unless otherwise indicated. Refer to the Additional Details section (below) for additional options and restrictions.

For a Ph.D. without prior M.S.

For students who do not have an M.S. (in civil, architectural, or environmental engineering), a minimum of 60 graduate-level credits are required beyond the B.S. degree with an average of "B" or better and no grade below "C". Of the 60 credits. The table presents an overview of the course selection:

Code	Title	Credit Hours
At least 12 credits of lecture-based CEM or other approved courses at the 700-level (not Independent Study) such as the following:		**12**
CAE 730	Environmental Hydrology	
CAE 735	Water and Wastewater Engineering: Treatment and Reuse	
CAE 743	Risk Analysis	
Any lecture-based and/or Independent Study courses		**18**
CAE 630	Water Resources Engineering II	
CAE 631	Surface-Water Hydrology	
CAE 632	Ground-Water Hydrology	
CAE 633	Water-Quality Control in Natural Systems	
CAE 640	Environmental Chemistry	
CAE 641	Engineering Systems for Disease Control and Bioremediation	
CAE 642	Solid and Hazardous Waste Engineering	
CAE 730	Environmental Hydrology	
CAE 735	Water and Wastewater Engineering: Treatment and Reuse	
CAE 743	Risk Analysis	
Other courses with advisor approval such as the following:		
BME 635	Advanced Biomaterials	
BME 687	Finite Element Analysis for Engineers	
BME 695	Current Trends in Regenerative Medicine	
BME 702	Organs on Chips	
CAE 660	Sustainable Construction	
CAE 716	Fracture Mechanics	
ECE 643	BioNanotechnology	
MAE 632	Additive Manufacturing of Engineering Materials	
MAE 616	Introduction to Composite Materials	
ATM 624	Applied Data Analysis	
ATM 634	Introduction to Atmospheric Chemistry	
ATM 637	Natural Hazards: Atmosphere and Ocean	
ATM 651	Introduction to Atmospheric Dynamics	
ATM 652	Introduction to Atmospheric Physics	
ATM 731	Air-Sea Interaction	
ATM 732	Climate Dynamics	
ATM 762	Computer Models in Fluid Dynamics	
ATM 764	Atmospheric and Oceanic Turbulence	
RSM 611	Principles of Mass Spectrometry and Applications to Marine, Atmospheric, and Environmental Science	
RSM 672	Special Topics (Introduction to Science Policy)	
BMB 717	Nutrients, Enzymes, and Metabolic Flux	
CHM 641	Principles of Bonding and Reactivity in Inorganic Chemistry	
CHM 691	Topics in Chemistry (Organometallic Chemistry and Catalysis)	
30 credits of Doctoral Dissertation		**30**
CAE 830	Pre-Candidacy Doctoral Dissertation	
CAE 840	Post-Candidacy Doctoral Dissertation	
CAE 850	Research in Residence	
Total Credit Hours		**60**

* At least 30 credits in CEM

** A total of 12 credits of transfer and/or exchange coursework may be taken at another institution and used to satisfy the requirements for the Ph.D. degree. Only credits that have not been used towards another degree can be transferred.

Note: All courses, except Dissertation, are 3 credit hours unless otherwise indicated. Refer to the Additional Details section (below) for additional options and restrictions.

Comprehensive Examination
A Ph.D. student must pass a Comprehensive Examination, generally taken at the end of the first year of study, before being allowed to defend a dissertation proposal. The Comprehensive Examination, administered by the student's Supervisory Committee, must consist of a written component, and may also include an oral component if deemed appropriate by the Supervisory Committee. Three outcomes of the examination are possible: *Pass, Fail,* and *Fail with option to re-take once*. For students retaking the exam, the Committee will determine a suitable time frame, but not to exceed 6 months.

Dissertation Proposal Defense
Subsequent to passage of the Comprehensive Examination, the student can defend his/her Dissertation Proposal to their Dissertation Committee. The Dissertation Proposal Defense is considered to represent the second part of the Qualifying Exam. Students may proceed to Admission to Candidacy upon successful completion of the Qualifying Exam. The Dissertation Committee is typically the same as the student's Supervisory Committee or, if not, has makeup equivalent to the Supervisory Committee. All Committee members must approve the Proposal.

Admission to Candidacy
Admission of the student to Candidacy is subject to passage of the Qualifying Exam which includes, the passage of the Comprehensive Examination and passage of the oral Dissertation Proposal Defense.

Dissertation Defense
The Ph.D. thesis must be defended to, approved by, and signed by the student's Dissertation Committee, which is typically the same as the student's Supervisory Committee or, if not, has a composition that is equivalent to the Supervisory Committee.

Additional Details
- Master's Design Project (e.g., CAE 604 (https://bulletin.miami.edu/search/?P=CAE%20604)) *will not* count towards the Ph.D. degree requirements.
- Internships, Practical Training, workshops, or other types of practicum are neither required nor optional credit-earning components in the established graduate curriculum (Program of Study). Credit earned through these experiences (such as UMI 605 (https://bulletin.miami.edu/search/?P=UMI%20605)) *will not* count towards any CEM degree requirements.
- At a minimum, a comprehensive exam and a final public oral examination in defense of the thesis are required.
- The Supervisory Committee (and Dissertation Committee) must have a minimum of 4 members, including:
- Committee Chair (Advisor) shall be full-time CEM faculty and a member of the Graduate Faculty.
- CEM faculty and a member of the Graduate Faculty
- A member of the University of Miami Graduate Faculty
- Non-CEM member with an earned PhD

Suggested Plan of Study

Ph.D. in Chemical, Environmental, and Materials Engineering

Environmental Engineering Concentration

M.S. to Ph.D. Pathway - Fall Admission

Year One		
Fall		**Credit Hours**
CAE 640	Environmental Chemistry	3
CAE 735	Water and Wastewater Engineering: Treatment and Reuse	3
CAE 830	Pre-Candidacy Doctoral Dissertation	1
	Credit Hours	**7**
Spring		
CAE 642	Solid and Hazardous Waste Engineering	3
CAE 743	Risk Analysis	3
CAE 830	Pre-Candidacy Doctoral Dissertation	1
	Credit Hours	**7**
Summer		
Comprehensive Examination (August)		
	Credit Hours	**0**
Year Two		
Fall		
CAE 641	Engineering Systems for Disease Control and Bioremediation	3

CAE 830	Pre-Candidacy Doctoral Dissertation	4
	Credit Hours	**7**
Spring		
CAE 730	Environmental Hydrology	3
CAE 830	Pre-Candidacy Doctoral Dissertation	4
Dissertation Proposal (Admission to Candidacy)		
	Credit Hours	**7**
Summer		
Research		
	Credit Hours	**0**
Year Three		
Fall		
CAE 840	Post-Candidacy Doctoral Dissertation	1
	Credit Hours	**1**
Spring		
CAE 840	Post-Candidacy Doctoral Dissertation	1
	Credit Hours	**1**
	Total Credit Hours	**30**

Direct B.S. to Ph.D. Pathway - Fall Admission

Year One		
Fall		**Credit Hours**
CAE 630	Water Resources Engineering II	3
CAE 640	Environmental Chemistry	3
CAE 735	Water and Wastewater Engineering: Treatment and Reuse	3
	Credit Hours	**9**
Spring		
CAE 642	Solid and Hazardous Waste Engineering	3
CAE 743	Risk Analysis	3
Elective (700 level)		3
	Credit Hours	**9**
Summer		
Comprehensive Examination (August)		
	Credit Hours	**0**
Year Two		
Fall		
CAE 633	Water-Quality Control in Natural Systems	3
CAE 641	Engineering Systems for Disease Control and Bioremediation	3
CAE 830	Pre-Candidacy Doctoral Dissertation	1
	Credit Hours	**7**
Spring		
CAE 730	Environmental Hydrology	3
CAE 830	Pre-Candidacy Doctoral Dissertation	4
	Credit Hours	**7**
Summer		
Research		
	Credit Hours	**0**
Year Three		
Fall		
CAE 730	Environmental Hydrology	3
CAE 830	Pre-Candidacy Doctoral Dissertation	4

Dissertation Proposal (Admission to Candidacy)		
	Credit Hours	**7**
Spring		
CAE 840	Post-Candidacy Doctoral Dissertation	7
	Credit Hours	**7**
Summer		
Research		
	Credit Hours	**0**
Year Four		
Fall		
CAE 840	Post-Candidacy Doctoral Dissertation	7
	Credit Hours	**7**
Spring		
CAE 840	Post-Candidacy Doctoral Dissertation	7
Dissertation Defense		
	Credit Hours	**7**
	Total Credit Hours	**60**

Admission Requirements

All applicants to the graduate program are required to submit official academic transcripts, GRE scores (optional for some MS programs), and a minimum of three letters of reference. Specific admission criteria are described in this Bulletin under Engineering (https://bulletin.miami.edu/graduate-academic-programs/engineering/) - General Admission Requirements.

Applicants who hold a bachelor's degree in a field other than chemical, environmental or materials engineering may be admitted to the graduate program (and to candidacy, if applicable) upon completion of (a) the regular graduate degree requirements, and (b) 31 undergraduate deficiency credits, which include:

1. Calculus (6 credits)
2. Advanced Mathematics
   - Differential Equations, or other mathematics similar in rigor (3 credits)
   - Probability and Statistics (3 credits)
3. General Chemistry (3 credits)
4. Calculus-based Physics (7 credits)
5. Statics (3 credits)
6. Engineering Science related to area of study (3 credits)
   - Examples of Engineering Science courses include Mechanics of Materials, Fluid Mechanics, Dynamics, and Thermodynamics
7. Engineering Design related to area of study (3 credits)
   - Examples of Engineering Design courses include Water-Resources Engineering I and Water Quality Control Systems

The deficiency courses listed above apply to students without an earned undergraduate degree in engineering, while the Engineering Science and Engineering Design courses apply to students with an earned undergraduate degree in engineering, but not necessarily in chemical, environmental, and materials engineering.

The list represents the minimum number of required deficiency credits for each subject area. Additional deficiency credits may also be warranted based upon the recommendations of a student's advisor and/or Supervisory Committee. Students should be cognizant that the deficiency course list is not exhaustive and may not necessarily include all pre-requisite courses needed to enroll in their desired graduate-level coursework. A student must still satisfy the pre-requisites of graduate-level courses prior to enrollment. Therefore, ample care should be taken when planning a Program of Study upon matriculation.

Prior Coursework Evaluation: Students may be exempt from individual deficiency courses if they have already completed these deficiency credits at another institution. A student's prior coursework can be evaluated and shall be based upon a student's official transcript. A delegated CEM Faculty member in the student's primary area of study shall determine which, if any, deficiency credits have already been satisfied. Questions regarding the

equivalency of coursework (completed at another institution) to its counterpart here at the University of Miami shall be addressed by the relevant department and instructor at the University of Miami.

Prior Work Experience: In rare cases, students may be able to satisfy specific deficiency credits if they can demonstrate a substantive knowledge of the subject area through examination using written/oral assessment and supportive evidence such as peer-reviewed journal articles authored by the student, professional licenses, or other quantifiable experience. An examination of all evidence of experience shall be vetted by the relevant instructor at the University of Miami prior to making a recommendation to the CAE Graduate Program to either waive or require deficiency credits for a specific subject area.

Course Selection and Enrollment: Undergraduate-level deficiency courses at the University of Miami typically range between the 100 and 400 levels. The student shall enroll in the corresponding courses identified in the undergraduate CEM curriculums to satisfy the deficiency credits for Calculus, Advanced Mathematics, Chemistry, Physics, and Statics. To satisfy the deficiency credits for Engineering Science and Engineering Design, the student's advisor and/or Supervisory Committee will select courses on an individual bases. If a student has not yet selected an advisor nor established a Supervisory Committee, the Graduate Program Director shall serve as the student's advisor in the interim. The Graduate Program Director will identify coursework in consultation with a delegated faculty member in the student's area of study.

In accordance with Graduate School Policy, a student in deficiency status may not enroll in supervised research, but is permitted to enroll in graduate-level courses as long as the student has satisfied the course pre-requisites.

Mission

The mission of the Department of Chemical, Environmental, and Materials Engineering is to:

- Provide high-quality undergraduate and graduate education in chemical, environmental, and materials engineering that will prepare graduates for professional careers and a lifetime of learning.
- Conduct high-quality research that will advance the current body of knowledge and engage in new discoveries to improve the quality of human life; and
- Serve the engineering profession and society through active involvement in professional organizations and contribution of professional expertise.

The departmental mission will be accomplished by providing an integrated and multidisciplinary scientific education. Graduates from this department will be involved in the transfer of scientific discoveries to modern technologies and novel products that benefit society and minimize the impact on the environment. They will be trained to address multi-scale aspects of generating clean energy, producing novel and superior materials, and utilizing the biological revolution to manufacture new products. They will be involved in the development and manufacture of consumer products, as well as in design, operation, and control of processes in a variety of industries (e.g. petroleum, petrochemical, chemical, consumer products, semiconductor, environmental technologies, advanced materials, food, feed and pharmaceuticals).

Goals

The educational objectives of the Ph.D. program are to produce graduates whom:

- Have advanced technical knowledge in at least one specialty area of chemical, environmental, or materials engineering;
- Have advanced capability to apply advanced knowledge to engineering problems; and
- Have made significant contributions in at least one specialty area of chemical, environmental, or materials engineering.

Specialty areas include aerosols, water, synthetic biology, and materials synthesis.

Student Learning Outcomes

- Students will demonstrate an advanced knowledge of the discipline (mathematics, science, and engineering), including methodology relevant to a specialty area.
- Students will demonstrate an advanced ability to identify, formulate, and solve engineering problems to carry out supervised research.
- Students will demonstrate an advanced ability to generate technical contributions and effectively communicate them to the scientific community.