

ENGINEERING, DOCTOR OF PHILOSOPHY (PH.D.) WITH A CONCENTRATION IN CHEMICAL AND LIFE SCIENCE ENGINEERING

Program mission

The mission of the Ph.D. in Engineering degree program is to provide graduate students with learning opportunities for acquiring a broad foundation of engineering knowledge, an in-depth original research experience at the frontiers of engineering, and skills for lifelong learning and professional development. Graduates of this program will pursue careers in research and development or academia.

1. **Advanced research skills:** To produce graduates who possess the necessary advanced analytical, technical and research skills in engineering and the sciences – responds directly to the higher goal of fulfilling the needs of industry, academe and research laboratories for effective, productive engineers, professors and researchers
2. **Communication:** To produce graduates who possess a facility with both written and oral communications – emanates from the requirement that engineers, researchers and professors must be able to interact and share ideas with others in the work environment, and at a higher level, be capable of creative self-expression, conveying knowledge and leadership
3. **Advanced problem-solving:** To produce graduates who demonstrate creativity and innovation in solving technological problems – stems from the realization that new knowledge and new solutions to existing problems are necessary to meet the needs of our changing society and to advance the quality of human life

Student learning outcomes

1. **Apply advanced knowledge of mathematics, science or engineering:** Graduates will demonstrate an ability to apply advanced knowledge of mathematics, science or engineering.
2. **Communicate effectively:** Graduates will demonstrate an ability to communicate effectively.
3. **Identify, formulate and solve engineering problems:** Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
4. **Demonstrate abilities in research:** Graduates will demonstrate the ability to identify pertinent research problems, to formulate and execute a research plan, to generate and analyze research results, and to communicate those results through oral presentations and written publications. Graduates will be able to creatively solve the research problems posed.

VCU Graduate Bulletin, VCU Graduate School and general academic policies and regulations for all graduate students in all graduate programs

The VCU Graduate Bulletin website documents the official admission and academic rules and regulations that govern graduate education for all graduate programs at the university. These policies are established by the

graduate faculty of the university through their elected representatives to the University Graduate Council.

It is the responsibility of all graduate students, both on- and off-campus, to be familiar with the VCU Graduate Bulletin as well as the Graduate School website (<http://www.graduate.vcu.edu>) and academic regulations in individual school and department publications and on program websites. However, in all cases, the official policies and procedures of the University Graduate Council, as published on the VCU Graduate Bulletin and Graduate School websites, take precedence over individual program policies and guidelines.

Visit the academic regulations section for additional information on academic regulations for graduate students. (<http://bulletin.vcu.edu/academic-regs>)

Degree candidacy requirements

A graduate student admitted to a program or concentration requiring a final research project, work of art, thesis or dissertation, must qualify for continuing master's or doctoral status according to the degree candidacy requirements of the student's graduate program. Admission to degree candidacy, if applicable, is a formal statement by the graduate student's faculty regarding the student's academic achievements and the student's readiness to proceed to the final research phase of the degree program.

Graduate students and program directors should refer to the following degree candidacy policy as published in the VCU Graduate Bulletin for complete information and instructions.

Visit the academic regulations section for additional information on degree candidacy requirements. (<http://bulletin.vcu.edu/academic-regs/grad/candidacy>)

Graduation requirements

As graduate students approach the end of their academic programs and the final semester of matriculation, they must make formal application to graduate. No degrees will be conferred until the application to graduate has been finalized.

Graduate students and program directors should refer to the following graduation requirements as published in the Graduate Bulletin for a complete list of instructions and a graduation checklist.

Visit the academic regulations section for additional information on graduation requirements. (<http://bulletin.vcu.edu/academic-regs/grad/graduation-info>)

Other information

Student handbook (<http://www.egr.vcu.edu/current-students/graduate-student-services/resources-forms>) is available on the College of Engineering website.

Apply online at graduate.admissions.vcu.edu (<http://graduate.admissions.vcu.edu>).

Admission requirements

Degree:	Semester(s) of entry:	Deadline dates:	Test requirements:
Ph.D.	Fall (preferred)	Jun 1 (Jan 15 for financial assistance)	GRE-General

Spring	Nov 15	International students require TOEFL (a minimum score of 100 in the TOEFL exam is required to be considered for financial assistance)
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In addition to the general admission requirements of the VCU Graduate School (<http://bulletin.vcu.edu/graduate/study/admission-graduate-study/admission-requirements>) and the College of Engineering, applicants to the chemical and life science engineering concentration must have a B.S. degree in chemical engineering or a closely related discipline.

Acceptance of an applicant is based upon the recommendation of the admissions committee with approval of the program chair and the College of Engineering's associate dean for graduate studies.

Degree requirements

In addition to the VCU Graduate School graduation requirements (<http://bulletin.vcu.edu/academic-regs/grad/graduation-info>), students must meet the following requirements.

A minimum of 60 credit hours beyond the bachelor's degree, including research credit hours, is required for the Ph.D. in Engineering. Students holding the master's degree must complete a minimum of six credit hours in concentration course work and 18 credit hours in dissertation research. The student's adviser must approve all course work. Ph.D. students must take a minimum of 30 credit hours (including research) beyond the master's degree. No elective courses may be used for both M.S. and Ph.D. degrees. At least half of the credit hours required in the student's program must be those designated as exclusively for graduate students, that is, at the 600 level or above.

A minimum of three years of study, including research, is necessary to complete all requirements for the Ph.D. A period of residence of at least three consecutive semesters is required. Residency is defined as registration for at least nine credits per semester. A time limit of eight calendar years, beginning at the time of first registration, is placed on work to be credited toward the Ph.D.

Ph.D. qualifying examinations

In order to advance to doctoral candidacy, the student must pass the written qualifying examination. The written examination focuses on the subject matter deemed critical as a foundation in the program. The examination is largely based on material covered in required course work and its application to theoretical and practical problems. The written examination also assesses the ability of the student to integrate information and display an appropriate mastery of problem-solving capabilities and technical writing. Graduate students may not take the comprehensive exam if their overall GPA is less than 3.0. Students must also have a minimum GPA of 3.0 for courses within the program in order to take the comprehensive exam. For further details, see the graduate program director or the program chair.

Admission to candidacy

Before admission to doctoral candidacy, students must have:

1. Completed required course work
2. Successfully completed the comprehensive examinations
3. Fulfilled all additional departmental requirements

A student may seek admission to candidacy for the Doctor of Philosophy degree without first completing the research and thesis portion of the Master of Science degree.

Dissertation research

The student must conduct a substantial original investigation under the supervision of the permanent adviser and prepare a dissertation reporting the results of this research and analyzing its significance in relation to existing scientific knowledge.

When the dissertation has been completed, copies in accepted form and style are submitted to the members of the advisory committee. The committee members decide upon the acceptability of the candidate's dissertation. A favorable unanimous vote is required to approve the dissertation and all examiners are required to vote.

If the advisory committee accepts the dissertation for defense, the candidate appears before them for a final oral examination. This examination is open to the public. The final oral examination will be limited to the subject of the candidate's dissertation and related matters. A favorable vote of the candidate's advisory committee and no more than one negative vote shall be required for passing the final oral examination. All committee members must vote. There shall be an announcement of the candidate's name, department and title of dissertation, together with the day, place and hour of the final oral examination at least 10 working days in advance.

Curriculum requirements

M.S. to Ph.D. curriculum

Course	Title	Hours
Concentration component		
This component allows the student to pursue a series of courses that focus on a specific field of engineering and serve as the student's primary engineering discipline.		
Core courses (choose three)		9
CLSE 650	Quantitative Analysis in Chemical and Life Science Engineering	
CLSE 654	Equilibrium Analysis in Chemical and Biological Systems	
CLSE 655	Nonequilibrium Analysis in Chemical and Life Science Engineering	
CLSE 656	Advanced Chemical Reaction Engineering	
Directed research		
This component emphasizes research directed toward completion of degree requirements under the direction of an adviser and advisory committee.		21
CLSE 690	Research Seminar in Chemical and Life Science Engineering	
CLSE 697	Directed Research in Chemical and Life Science Engineering	

Total Hours 30

Total graduate credit hours required (minimum) 30

Students entering the doctoral program with a B.S. degree, but not the M.S., will require a minimum of 60 post-baccalaureate credit hours (30 for M.S. level and an additional 30 for Ph.D. level).

B.S. to Ph.D. curriculum

Course	Title	Hours
Concentration component - CLSE course work		
This component allows the student to pursue a series of courses that focus on a specific field of engineering and serve as the student's primary engineering discipline.		
CLSE 650	Quantitative Analysis in Chemical and Life Science Engineering	3
CLSE 654	Equilibrium Analysis in Chemical and Biological Systems	3
CLSE 655	Nonequilibrium Analysis in Chemical and Life Science Engineering	3
CLSE 656	Advanced Chemical Reaction Engineering	3
Additional CLSE course work at the 500 level or higher		9
Option electives - engineering or science course work		
This component allows the student to take courses in either engineering or science with approval of the student's adviser (e.g. CLSE, ENGR, CHEM courses, 500 level or higher).		12
Directed research		
This component emphasizes research directed toward completion of degree requirements under the direction of an adviser and advisory committee.		27
CLSE 690	Research Seminar in Chemical and Life Science Engineering	
CLSE 697	Directed Research in Chemical and Life Science Engineering	
Total Hours		60

Total graduate credit hours required (minimum) 60

Graduate program director

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Program website: chemical.egr.vcu.edu (<http://chemical.egr.vcu.edu>)