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 School of Engineering website.

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

Admission requirements

<table>
<thead>
<tr>
<th>Degree</th>
<th>Semester(s) of entry</th>
<th>Deadline dates:</th>
<th>Test requirements:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph.D.</td>
<td>Fall (preferred)</td>
<td>Jun 1 (Jan 15 for financial assistance)</td>
<td>GRE-General</td>
</tr>
</tbody>
</table>

1
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**

**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.

<table>
<thead>
<tr>
<th>Core courses (choose three)</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>CLSE 650</td>
<td>Quantitative Analysis in Chemical and Life Science Engineering</td>
</tr>
<tr>
<td>CLSE 654</td>
<td>Equilibrium Analysis in Chemical and Biological Systems</td>
</tr>
<tr>
<td>CLSE 655</td>
<td>Nonequilibrium Analysis in Chemical and Life Science Engineering</td>
</tr>
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<td>CLSE 656</td>
<td>Advanced Chemical Reaction Engineering</td>
</tr>
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</table>

**Directed research**

This component emphasizes research directed toward completion of degree requirements under the direction of an adviser and advisory committee.

<table>
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<tr>
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<tr>
<td>CLSE 690</td>
<td>Research Seminar in Chemical and Life Science Engineering</td>
</tr>
<tr>
<td>CLSE 697</td>
<td>Directed Research in Chemical and Life Science Engineering</td>
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</table>

**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

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.

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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).

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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)