CHEMISTRY, DOCTOR OF PHILOSOPHY (PH.D.) WITH A CONCENTRATION IN CHEMICAL PHYSICS

Program goal
The Department of Chemistry is committed to the dual mission of teaching and research at the bachelor’s, master’s and doctoral level. In teaching, the purpose is to provide high quality education in chemistry to students in preparation for professional careers at all levels. In research, the goals are to advance the science of chemistry, to keep faculty on the forefront of the field and to maintain an educational program consistent with the latest technology and development of the discipline. Service to the chemical profession is also an important aspect of the department’s activities.

Student learning outcomes
1. Demonstrate expertise (breadth and depth) in chemistry
2. Demonstrate appropriate ability to design and conduct experimental research
3. Demonstrate ability to analyze data critically and to design experiments independently
4. Develop competency in the responsible conduct of research
5. Develop effective oral and written communication skills

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.grad.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-regis/)

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-regis/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-regis/grad/grad-info/)

Other information
The Department of Chemistry graduate handbook is available online (http://chemistry.vcu.edu/graduate-programs/graduate-handbook/).

Apply online at graduate.admissions.vcu.edu (http://www.grad.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</td>
<td>Mar 15</td>
<td>GRE-General</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>Nov 15</td>
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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/), the following requirements represent the minimum acceptable standards for admission:

1. Have a bachelor’s degree from an accredited college or university with 30 credit hours in chemistry or in physics.
2. Admission on a provisional basis is possible for a student temporarily lacking this expected chemistry background or in physics.

Degree requirements
In addition to general VCU Graduate School graduation requirements (http://bulletin.vcu.edu/academic-regis/grad/graduation-info/), students are required to complete course work in core and elective courses and to conduct significant research.

1. Credit hour requirements: Students in the Ph.D. in Chemistry program are required to earn a minimum of 60 graduate-level credit hours beyond the baccalaureate. At least one-half of the credit hours presented for graduation must be at the 600 level or higher.
2. Proficiency exams: Students entering the chemical physics concentration must pass proficiency examinations in two areas of chemistry and two areas of physics (mechanics, electricity...
Curriculum requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required didactic courses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHEM 510</td>
<td>Atomic and Molecular Structure</td>
<td>3</td>
</tr>
<tr>
<td>or PHYS 580</td>
<td>Quantum Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 511</td>
<td>Chemical Thermodynamics and Kinetics</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 612</td>
<td>Modern Statistical Mechanics: Fundamentals and Applications</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 576</td>
<td>Electromagnetic Theory</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 641</td>
<td>Solid State Physics</td>
<td>3</td>
</tr>
</tbody>
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Recommended electives

Select nine credit hours of the following, in consultation with adviser: 9

CHEM 512: Applied Molecular Modeling
CHEM 550: Introduction to Polymer Chemistry
CHEM 591: Topics in Chemistry
CHEM 610: Applied Quantum Chemistry
CHEM 611: Molecular Spectroscopy
CHEM 615: Chemical Thermodynamics
CHEM 616: Chemical Kinetics
CHEM 620: Advanced Inorganic Chemistry I
CHEM 634: Surface Science
CHEM 635: Spectrochemical Analysis
CHEM 691: Topics in Chemistry
NANO 650: Experimental Techniques in Nanoscience I
NANO 651: Experimental Techniques in Nanoscience II
PHYS 550: Techniques in Material Research
PHYS 571: Theoretical Mechanics
PHYS 573: Analytical Methods in Physics

Other required courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 690</td>
<td>Special Topics</td>
<td>1</td>
</tr>
<tr>
<td>or PHYS 691</td>
<td>Directed Research</td>
<td>5</td>
</tr>
<tr>
<td>or PHYS 697</td>
<td>Directed Research</td>
<td>30</td>
</tr>
</tbody>
</table>

Students must earn a minimum of 24 credit hours in didactic graduate courses, not including credit for CHEM 690, CHEM 692, CHEM 693 or CHEM 697.

At least 12 credit hours of the 24 required didactic course credit hours must be CHEM graduate courses. Therefore, depending on the choice of PHYS 510 or PHYS 580 above, at least 3 to 6 credit hours chosen from the list of recommended electives must be CHEM graduate courses, respectively.

Students are expected to participate in the chemistry and/or physics department seminar program by enrolling in CHEM 690, CHEM 692 or PHYS 690 every spring and fall semester. At least two formal talks are to be presented in the seminar program by enrolling twice in CHEM 692 (one credit hour).

Students are expected to enroll in CHEM 693 within their first year of enrollment.

Students are expected to enroll in CHEM 697 or PHYS 697 (one credit hour minimum) every spring and fall semester. Up to 15 credit hours of PHYS 697 can be used to satisfy the minimum requirement of 30 credit hours of directed research. If the required 60 credit hours for the degree is not fulfilled after completion of all other course requirements, then additional credit hours of CHEM 697 can satisfy the remaining credit hours for the degree.

The minimum total of graduate credit hours required for this degree is 60.

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Program website: chemistry.vcu.edu (http://chemistry.vcu.edu/)