CHEMISTRY (PHD)

Doctor of Philosophy in Chemistry
Unit: College of Arts and Sciences (http://louisville.edu/artsandsciences/intro) (GA)
Department: Chemistry (http://louisville.edu/chemistry)
Program Website (http://louisville.edu/chemistry/academics/graduate-studies)
Academic Plan Code(s): CHEMPHD

Program Information
The Department of Chemistry offers graduate programs leading to the MS and PhD degrees in chemistry with options in analytical chemistry, biochemistry, biomolecular structure and engineering, inorganic chemistry, organic chemistry, physical chemistry, and chemical physics.

The general requirements for admission to the Graduate School, for admission to candidacy, and for the doctoral degree are stated in the appropriate sections of this catalog. The following additional provisions apply to the programs leading to the Doctor of Philosophy in Chemistry.

Admission Requirements
Students seeking a graduate degree in chemistry should meet the following requirements:

1. A BA or BS degree in chemistry or in a related field such as physics, engineering, or mathematics. It is expected that students will have obtained a background in chemistry equivalent to 36 credit hours of undergraduate coursework. Students planning to pursue graduate study in chemical physics may substitute some of the chemistry hours with advanced courses in physics or mathematics beyond those required for a BA or BS in chemistry. Students with inadequate preparation will be required to register for specific courses in the area of deficiency. Some of these courses, subject to approval by the department, may be accepted for graduate credit. Admission to graduate study in chemical physics is made on the recommendation of the entrance committee for that option.

2. A minimum quality point standing of 3.0/4.0.

3. Submission of Graduate Record Examination scores (students with successful admission generally obtain quantitative and verbal scores totaling 1000 or more with an analytical score of 2.5 or totaling 900 or more with an analytical score of 3.0).

In individual cases, the conditional admission of a student who does not satisfactorily meet the above requirements may be recommended by the department to the Graduate School. If admission is granted, that student will be subject to those conditions specified by the department or Graduate School as being necessary to remedy the conditional admission.

Program Requirements
A minimum of 30 credit hours of graduate credit is required. At least 15 credit hours must be in chemistry courses. An overall GPA of 3.0 must be maintained. Other master’s degree details are included in the Degree Requirements section (http://catalog.louisville.edu/graduate/general-policies-procedures-requirements/degree-requirements) of this catalog.

Coursework

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 691</td>
<td>Research</td>
<td>1-15</td>
</tr>
<tr>
<td>CHEM 692</td>
<td>Research</td>
<td>1-15</td>
</tr>
<tr>
<td>CHEM 695</td>
<td>Seminar 1</td>
<td>1-3</td>
</tr>
<tr>
<td></td>
<td>Research Areas (6 courses from at least 3 of 6 divisions) 2</td>
<td>12-20</td>
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</tbody>
</table>

Minimum Total Hours

<table>
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<tr>
<th>Units</th>
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<td>30</td>
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1 Enrollment in the chemistry research course for the first three semesters of graduate study is required.


Courses
Students must pass a minimum of six graduate courses from at least three of six divisions (or research areas) with a minimum grade of C in any one course. A C-minus grade is considered unacceptable. The areas are: Analytical Chemistry, Biochemistry, Inorganic Chemistry, Organic Chemistry, Physical Chemistry, and Physics. For every A-minus grade or better that is received, students with an MS degree may waive one lecture course, up to a maximum of 2 courses.

An overall GPA of 3.0 or greater is required by the Graduate School. In addition, a GPA of 3.0 or greater is required in lecture courses by the department.

Mentor
The research mentor must be selected during the first semester. Students are required to interview a minimum of three chemistry faculty (more are recommended) and have them sign the Mentor Selection Form. The student may choose a mentor after obtaining three signatures. If the mentor agrees to accept the student, the mentor will initial the Mentor Selection Form and the student should submit it for final approval by the department Director of Graduate Studies.

Seminar
Enrollment in the chemistry research course (CHEM 695) for the first three semesters of graduate study is required. The student must present a literature seminar related to their research or on a topic of current chemical interest in the second or third semester of his/her program (excluding summer).

Cumulative Exams
Students must complete a series of written cumulative examinations within their division designed to show broad knowledge in their chosen area. Cumulative exams begin in the second semester and are given the third week of January, February, March, September, October, and November. Each division will write a unique exam each month covering topics from undergraduate course content within that division, graduate-level content from the current and prior semester, and content from the current literature and/or departmental seminars. Exams are scored on a scale of 0–3 points in half-point increments. Students must score 2.0 or higher on at least four exams and accumulate 11 points within their research division by the end of the nineth consecutive exam to qualify for the PhD program. An absence from an exam, unless excused by the Director of Graduate Studies, is scored as 0 and constitutes an attempt.
Research
Research credit will be taken through courses CHEM 691 and CHEM 692 with the graduate mentor listed as the instructor.

Dissertation Committee
The student will select his/her Dissertation Committee in consultation with the research mentor during the first four semesters of study. The committee consists of the research mentor, a chemistry faculty in the same division, a chemistry faculty in a different division, and a faculty member from a different department. Students may add an additional chemistry faculty to the committee if they choose to. Students must have each committee member sign the Dissertation Committee Form and submit it to the chemistry office.

Research Proposal (RP)
The research proposal (RP) must be completed by the end of the fifth semester (excluding summers) without exception. If it is not completed within the fifth semester, the student will not be in good standing and may be dismissed from the program. Evaluation of the RP is made by the student’s graduate advisory committee (dissertation committee), which is chaired by the research mentor. The RP is intended to demonstrate the student’s ability to develop, explain, and defend a research idea that the student plans to conduct in the laboratory or on a completely original idea if desired. The proposal should present preliminary results from the student’s research and/or from the literature and develop one original hypothesis fully with an explanation of experimental details and expected results. The student should show how the hypothesis will be tested experimentally and provide plans for different outcomes. The student should also communicate the importance of the work and how it will provide new fundamental knowledge to the field, a solution to an important problem, or a potential application. Students are expected to demonstrate their originality, innovation and understanding of the scientific process. This requirement includes a written research proposal and an oral presentation/examination. The requirements of each are described below.

Written Research Proposal
The written RP is strictly limited to six pages (single-spaced, 1-inch margins) including figures, but not including references. Treat the written proposal as if you were actually submitting it as part of a job application or for funding. It should clearly and concisely present your proposed research and why it should be funded. This should include a brief summary and introduction to outline the problem, why it is important, and what progress others in the field have made. It should state a hypothesis that your planned work will test and specific aims of the research. The proposal may provide preliminary data from research or literature and should describe what will be done, why this system was selected, how it will be done, what are the expected results, how success will be determined, and what is the impact if successful. The new proposed work should take up the bulk of the written RP (three–four pages). The proposal should be well referenced in the style of a major journal in your field. Carefully proofread your proposal and have a trusted friend proofread it as well. Typos, poor grammar, low-quality graphics, and “simple mistakes” detract from your scientific argument and make the work appear sloppy, disorganized, and of low quality. The written RP is to be revised at least once by the research advisor before being submitted to the committee at least one week prior to the oral presentation/examination. The committee may return unsatisfactory written proposals to the student and delay the oral examination until at least one week after an acceptable rewrite is received.

Oral Presentation/Examination
Treat the oral presentation/examination as if the written RP was submitted with a job application and you were called for an interview to present it. Do not assume that everyone knows the proposal as well as you, they don’t. It is your responsibility to present the proposed work in a clear and fluid manner to an audience that is not intimately familiar with your proposal. The presentation should be professional. Expect frequent interruptions during your presentation and be prepared to answer questions on your proposal, techniques related to it, and contributions of others in the field. The oral presentation can be given on PowerPoint, but with no more than 20 slides total (including any supplemental slides). A student failing the oral examination may repeat it only one time, at the discretion of the student’s graduate advisory committee.

The MS degree (non-thesis) will be awarded upon successful completion of the research proposal.

Research
Progress in research will be evaluated by the research mentor in consultation with the Dissertation Committee.

Research Seminar
A one-hour seminar on the student’s dissertation research project is to be given before the end of the eighth semester (excluding summers). This seminar does not require the student to enroll in CHEM 695, but the student should contact the CHEM 695 instructor to schedule a time and date and for evaluation criteria. The seminar will be judged as pass/fail.

Publications
It is normally expected that prior to the Research Seminar, at least one manuscript based on the student’s research would have been submitted to a peer-reviewed journal. The student’s contribution must be substantial to both the scientific content and the drafting of the manuscript. At least one research article based on the student’s dissertation research must either be published or accepted for publication in a peer-reviewed journal before scheduling the PhD dissertation defense. It is highly recommended that the student distribute the published manuscript(s) and any submitted manuscripts to the members of her/his Dissertation Committee.

Dissertation
A written dissertation describing the research program is submitted a minimum of 14 days before the defense. The defense consists of a one-credit hour seminar followed by an oral examination with the Dissertation Committee.

Chemistry Courses

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<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
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<tbody>
<tr>
<td>CHEM 620</td>
<td>Optical Spectrochemical Methods of Analysis</td>
<td>3</td>
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<tr>
<td>CHEM 621</td>
<td>Electroanalytical Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 622</td>
<td>Analytical Separations</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 625</td>
<td>Advanced Analytical Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 626</td>
<td>Special Topics in Analytical Chemistry</td>
<td>1-3</td>
</tr>
<tr>
<td>CHEM 628</td>
<td>Special Topics in Synthesis and Analysis</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 630</td>
<td>Advanced Topics in Chemical Analysis</td>
<td>1</td>
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Biochemistry Division

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<tr>
<th>Code</th>
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<tbody>
<tr>
<td>CHEM 645</td>
<td>Advanced Biochemistry I</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 647</td>
<td>Advanced Biochemistry II</td>
<td>4</td>
</tr>
</tbody>
</table>
CHEM 648 Systems Biochemistry: Principles and Practices 3
CHEM 681 Modern Biochemistry I 3
CHEM 682 Modern Biochemistry II 3
CHEM 684 Biophysical Chemistry 3
CHEM 685 Special Topics in Biochemistry 1-3

**Inorganic Division**

CHEM 550 Group Theory and its Chemical Applications 3
CHEM 653 Main Group Chemistry 3
CHEM 654 Advanced Coordination Chemistry 3
CHEM 655 Special Topics in Inorganic Chemistry 1-3
CHEM 656 Special Topics in Inorganic Chemistry 1-3
CHEM 659 Solid State Chemistry 3

**Organic Division**

CHEM 557 Bio-Organic Phenomena 3
CHEM 670 Chemistry of Heterocyclic Compounds and Alkaloids 3
CHEM 671 Advanced Polymer Chemistry 3
CHEM 675 Special Topics in Organic Chemistry 1-3
CHEM 677 Mechanisms and Theory in Organic Chemistry 3
CHEM 678 Advanced Organic Chemistry: General Survey 3
CHEM 679 Advanced Organic Synthesis 3

**Physical Chemistry Division**

CHEM 660 Advanced Physical Chemistry 3
CHEM 661 Chemical Thermodynamics 3
CHEM 665 Special Topics in Physical Chemistry 1-3
CHEM 666 Special Topics in Physical Chemistry 1-3
CHEM 667 Reaction Kinetics 3
CHEM 668 Electrochemistry 3
CHEM 672 Quantum Chemistry 3
CHEM 684 Biophysical Chemistry 3
CHEM 687 Molecular Spectroscopy 3

**Physics**

PHYS 605 Theoretical Mechanics 3
PHYS 611 Electromagnetic Theory I 3

The following courses are not offered by a specific division or are common to all divisions. CHEM 651 and CHEM 652 can count towards the course requirements with approval of the Chemistry Department Director of Graduate Studies.

<table>
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<tr>
<th>Code</th>
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<tbody>
<tr>
<td>CHEM 503</td>
<td>Special Topics in Chemistry</td>
<td>1-3</td>
</tr>
<tr>
<td>CHEM 591</td>
<td>Chemistry for Teachers I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 632</td>
<td>Chemical Education for Secondary Teachers</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 651</td>
<td>Independent Study</td>
<td>1-3</td>
</tr>
<tr>
<td>CHEM 652</td>
<td>Independent Study</td>
<td>1-3</td>
</tr>
<tr>
<td>CHEM 688</td>
<td>X-Ray Crystallography and Its Application to Molecular Structure</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 691</td>
<td>Research</td>
<td>1-15</td>
</tr>
<tr>
<td>CHEM 692</td>
<td>Research</td>
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<tr>
<td>CHEM 695</td>
<td>Seminar</td>
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