

# M.S. REQUIREMENTS FOR CHEMISTRY GRADUATE STUDENTS

## ***Department of Chemistry Graduate Education Mission***

The Department of Chemistry programs strive to achieve excellence in breadth of chemistry knowledge, critical analysis of the literature, and original, creative, and independent thinking. This document serves as a supplement to the general requirements for the graduate degree at the University of Vermont, as defined by the Graduate College (<http://www.uvm.edu/~gradcoll/>). The goal for Ph.D. students is to develop mastery of one's research area as well as a comprehensive understanding of all areas in chemistry.

## ***Graduate Student Ethics***

Graduate students are required to conduct themselves in an ethical and professional manner. This includes treating fellow students, faculty, staff, and undergraduates with due respect and courtesy at all times. Ethical academic standards are defined by the University of Vermont (UVM; <http://www.uvm.edu/~uvmppg/ppg/student/acadintegrity.pdf>), and contravention of these standards with regard to falsification of data, plagiarism, or misconduct in examinations and/or research will result in disciplinary action and possible dismissal from the Graduate program.

## ***The M.S. Program in Chemistry: From Admission to Graduation***

### ***I. Qualifying Exams***

Prior to registration, new graduate students in chemistry are given the American Chemical Society (ACS) standard examinations in analytical, inorganic, organic, and physical chemistry for qualifying purposes. A passing score for any exam is 50th percentile. The level of each of these examinations is essentially that of the final exam in a good undergraduate course in analytical, inorganic, organic and physical chemistry. The results of these multiple-choice examinations, the extent of undergraduate course work, and specific interests are used to determine a student's initial academic program.

Should a student not earn a passing grade on an exam, there are two mechanisms to rectify the deficiency: 1) Take (or audit, as appropriate) a recommended course in that discipline and receive a grade of B- or better or, 2) re-take the failed ACS exam and receive a passing grade. The generally recommended courses are:

Analytical:	CHEM 221
Inorganic:	CHEM 231
Organic:	CHEM 241
Physical:	CHEM 161 or 162 (audit only, not for graduate credit)

If the student enrolls in the recommended course during the first semester and does not earn at least a grade of B-, the failed qualifying exam must be re-taken and passed by the end of the second semester. If the recommended course is offered only during the second semester (CHEM 221, for example), the student may opt to re-take the qualifying exam at any time before the third semester. A given qualifying exam is only re-administered once per student.

All students pursuing the M.S. degree must satisfy the above requirements in *at least three of the four areas* of chemistry. One of those areas must be the area of specialization of the student. Should the student not pass the placement exam in the fourth area, they must demonstrate minimum competency in that area by auditing or taking for credit the recommended remedial course (listed above) and receiving a grade of “C” or better. **A student must satisfy these qualifying requirements before the start of the third semester in order to continue in the M.S. program.** (Note: Students entering the program in the spring semester are granted a one-semester extension of this rule).

## ***II. Course Requirements***

### Graduate College Requirements

The Graduate College requires that a minimum of 15 *graded* credits (i.e., credits contributing to the GPA) be obtained for *any* advanced degree. These credits must be for courses at the 200-level or above and must be accumulated as *a graduate student in residence at UVM*. A total of 30 hours (graded + ungraded) are required for the M.S. degree, most of which are accumulated as research credits under CHEM 391 (Master’s Thesis Research). A full-time graduate student will generally register for a *total* of 10 credit hours per semester. *Following completion of all credit requirements (i.e., 30 credits for M.S.), students should enroll for Continuing Registration (GRAD 900).*

### Chemistry Department Requirements

M.S. students are required to take a minimum of two core courses within their area of chemistry specialization (division). In addition, M.S. students must take a minimum of one distribution course (2 or 3 credits) of advanced level work in *one area outside of their division*. It should be noted that although the Chemistry Department requires only a minimum of three Chemistry courses for the M.S. degree, the Graduate College requires 15 graded credit hours in graduate-level coursework. The Department of Chemistry and Graduate College require that M.S. students maintain a minimum GPA of 3.00.

### Core Courses (by division)

Each division requires students to take specific upper-level graduate courses in their area of specialization, as detailed below. A grade of B- or better must be obtained for the course to satisfy the core course requirement.

<u>Division</u>	<u>M.S. Requirements</u>
Analytical	CHEM 221 and <i>one</i> of the following: CHEM 223, 225 or 226
Inorganic	CHEM 231 and either CHEM 234 or 236
Organic	CHEM 241 and either CHEM 242 or 251
Physical	CHEM 262 and either 264 or <i>one</i> approved 200- or 300-level course

If a specific required course is not offered during the student’s stay at UVM, then an appropriate substitute course must be arranged by the student in consultation with the division faculty members, subject to approval by the Graduate Standards Committee.

### Approved Distribution Courses

Students are required to take graduate-level chemistry courses in areas outside of their chosen division so as to ensure a broader knowledge of chemistry. The courses listed below currently satisfy the distribution requirements. A student must earn a B- or better for a course to satisfy the distribution requirement.

<i>Analytical</i>	CHEM 221, 223, 225, 226, 227, 228
<i>Inorganic</i>	CHEM 231, 234, 236, 237, 238
<i>Organic</i>	CHEM 241, 242, 251, 257, 258
<i>Physical</i>	CHEM 262, 264, 267, 268
<i>Related Science</i>	BIOC 301 or 302, CHEM 205, 206, 214

Graduate courses offered outside the Department may also be counted towards the 30 credit hours required for the M.S. degree and are often desirable in areas that are interdisciplinary in nature (e.g., medicinal chemistry, solid state chemistry, chemical physics, etc.). The exact program of courses should be determined in consultation with the student's research advisor and Graduate Studies Committee (Section III).

### **III. The First Year**

#### **Choosing a Research Advisor**

In the fall semester (typically in early October), each faculty member gives a short presentation describing their research interests, attended by all new graduate students. Using this information to narrow their research options, students meet individually with faculty members with whom they have common interests. Students are strongly encouraged to discuss research with several members of the chemistry faculty and to not restrict themselves to one area or group. Students need to submit a *written* letter or *e-mail* indicating their 1<sup>st</sup> and 2<sup>nd</sup> choice of research advisor to the Department Chair *before the end of the fall semester*. Students entering in the spring semester should choose their research advisor before the end of the spring semester.

A student's interests may straddle the research of two faculty members. For this reason, a student may develop a joint research project with two research advisors. A student may select a research advisor who is a faculty member in a division other than that in which they propose to take their major coursework.

#### **Graduate Studies Committee**

A multidisciplinary Graduate Studies Committee is formed to provide oversight for the student's progress toward an advanced degree. The members of the Graduate Studies Committee are assembled during the second semester of the student's first year. The Graduate Studies Committee will form the nucleus of the student's annual review, research proposal, and dissertation defense committees. This committee should be chosen in consultation with the student's research advisor and *shall consist of the research advisor and two additional Chemistry*

*faculty members*, one of whom must be outside of the student's division. The Graduate *Standards* Committee, a departmental committee that monitors the progress of all graduate students, must be notified *in writing* of the composition of the student's Graduate Studies Committee, once established.

The three-member Graduate Studies Committee is sufficient to provide oversight and academic advising for students. However, the Graduate College requires that a faculty member who does not have an appointment in chemistry serve as chair of a student's Thesis Committee. It is suggested that the student select this 'outside member' when the Graduate Studies Committee is formed. If desired, a graduate student may add an extra faculty member to their Graduate Studies Committee and/or their Thesis Defense Committee at a later time.

The Graduate Studies Committee is specifically charged with evaluating the student's annual progress through the program. However, the Graduate Studies Committee is a research and educational resource, serving as an "extended research advisor," and not a judicial body. The members of a student's Graduate Studies Committee are available for consultation regarding research, academic, or other matters relevant to graduate education.

### ***CHEM 318 – Current Topics in Chemistry (spring)***

Following the current chemical literature is an essential component to gaining a deeper understanding of chemistry and for success in research. Beginning in the *spring* semester of the first year, all graduate students will register for CHEM 318 (0-1 credit). This course is a "journal club." Students and faculty in the division will meet for a semiformal presentation by one of the students on a current article in the literature, followed by informal discussion of that topic. Not every student will present in a given semester, but all students are required to attend and are expected to contribute to the discussion. Students who present in a given semester register for one credit, and those who do not present register for zero credits. The presentations will typically consist of the review of one major article from the literature and supporting supplementary articles. The specific details, such as scheduling and criteria for presentations, are determined by each division, and these details can be found in the course syllabus. An additional requirement for this course is attendance at *all* Departmental Seminars. Students will be given a grade of either Satisfactory (S) or unsatisfactory (U) for the 'Current Topics' course. Note: completion of two (2) credits of CHEM 318, or two presentations, is required by the end of the sixth semester.

### ***CHEM 380 – Chemical Investigations***

In the spring semester of the first year, all students will register for CHEM 380, Chemical Investigations (1 credit). CHEM 380 serves as the student's first Annual Report and is the first checkpoint towards an advanced degree. For CHEM 380, each student presents a brief (4–5 page) report to their Graduate Studies Committee, introducing their proposed project and the initial results obtained in the laboratory. The first Annual Report will include relevant background from the literature, a statement of the relevance of the proposed research, preliminary results, and a general plan for continued research. Submission of this report to the members of the Graduate Studies Committee will be followed by a brief presentation (~20–30 minutes) and a discussion period. The discussion will serve to probe the student's general knowledge of the research area, and may pose questions that can be addressed in the student's second-year dossier.

The first Annual Report serves as a mechanism for ensuring that the student is in a strong position to obtain significant research results and has embarked on an academic trajectory that will lead to an advanced degree. The presentation is a forum for the student to keep their Graduate Studies Committee informed about their research. As such, the report and presentation should survey the relevant literature but, more importantly, it should give the basic rationale and importance of the work, the specific goals of the project, the methodologies to be employed, and the experimental progress to date. The audience will include, at a minimum, the students and faculty in that student's division, members of the student's Graduate Studies Committee, and other interested people.

Reports are due by the end of the first week of June and presentations are typically given during the following week. The Graduate Studies Committee provides a written evaluation of the annual report and presentation, as well as the student's first-year progress, to the Chair of the Chemistry Graduate Standards Committee.

#### **IV. The Second Year**

##### ***CHEM 318 – Current Topics in Chemistry (fall and spring)***

All students will continue to enroll in the 'Current Topics' course relevant to their division.

##### ***CHEM 381 – Graduate Seminar***

In the fall semester of the second year, all graduate students register for CHEM 381 (1 credit) and present a topical seminar, outside of their principal area of research, to the Department. A topic for a seminar from the chemical literature is chosen by the student in consultation with the CHEM 381 instructor.

While this is an important presentation, students typically spend no more than three weeks in preparation. At the start of the semester, the course instructor will determine a schedule for when the seminars will be presented. A 300-word abstract with annotated bibliography (~10–15 references from refereed journals) is to be distributed to the faculty *at least one week in advance of the presentation to the Department*. The seminar will be graded on a scale of A, B, C or F. A grade of "F" on any seminar will require that it be repeated no later than the following semester. The topic of a repeat seminar will be chosen in consultation with the seminar instructor. Other details of the course can be found in the course syllabus. Students enrolled in both CHEM 381 and 318 will not be required to give a presentation for their 'Current Topics' course, however they must still attend department seminars and contribute to divisional presentations in order to receive a grade of 'Satisfactory' in the 'Current Topics' course.

##### ***CHEM 384 – Advanced Topics in Chemistry***

In the spring semester of the second year, M.S. students must enroll in CHEM 384 (2 credits). This course is an independent study which provides a student with the opportunity to demonstrate comprehensive, fundamental knowledge, in the context of their research, needed to pursue an M.S. degree. The process begins with the preparation of a dossier consisting of an extensive introduction to the student's thesis, a detailed record of research progress, and future directions. This culminates in a short (10-15 minute) presentation followed by a comprehensive

oral examination. The dossier should be approximately 12-15 pages in length, and should address key background literature, experimental protocols, results, and expected directions. By this time, the student should have a detailed understanding of the key experiments to be performed and the fundamental questions to be addressed in the thesis. Although the dossier is similar to the first annual report, it is more comprehensive and should demonstrate a student's aptitude for completing M.S.-level research.

The comprehensive oral examination will assess general knowledge in all areas of chemistry with a focus on the student's division. While the advisor may give minimal assistance during a student's preparation for the exam, they will serve principally as an observer during the presentation and oral examination. The candidate is graded, based on the dossier and examination, on the following scale: S (ready for M.S.-level work) or U (recommend dismissal from the program). The dossier and oral exam must be completed by the end of the academic year, defined in this document as the last day of regularly scheduled classes in the spring semester according to the official UVM Academic Calendar (<http://www.uvm.edu/~rgweb/calendar/>).

After the examination, the Graduate Standards Committee, in consultation with the student's Graduate Studies Committee, will review the records of M.S. candidates and recommend either continuation of the degree or dismissal from the program. The Graduate Standards Committee will notify the student's Graduate Studies Committee, in writing, of the results of their review. Recommendation for dismissal is rare and is only made following discussion by and vote of the entire chemistry faculty.

*Following completion of all credit requirements (i.e., 30 credits), students should enroll for Continuing Registration (GRAD 900).*

### ***Time Limits for the M.S. Degree***

The Graduate College has established a maximum allowed time of three (3) years to complete the M.S. degree. Students will have one year, following a satisfactory CHEM 384 review, to complete coursework, research, and thesis requirements for the M.S. degree.

## ***V. The Third Year***

### ***CHEM 318 – Current Topics in Chemistry (fall and spring)***

All students will continue to enroll in the Current Topics course relevant to their division.

### ***GRAD 397 – Comprehensive Examination requirement***

The Graduate College mandates that any advanced degree requires completion of a Comprehensive Examination. In the Department of Chemistry, the Comprehensive Examination is broken into three parts:

(1) Completion of qualifying examinations and coursework. The course requirements are constructed to add breadth to the student's study in areas of chemistry not directly related to their research area. The qualifying examinations establish a broad knowledge base in all major areas of chemistry.

(2) Successful completion of CHEM 384 and oral examination. The second-year dossier and oral

examination is a comprehensive review of the student's fundamental understanding of chemistry

(3) Completion of a total of two (2) credits of CHEM 318. It is essential for scientists to be able to critically analyze and discuss the chemical literature. The 'Current Topics' course leans on the multidisciplinary nature of research to provide a comprehensive overview of current issues of relevance.

Upon completion of these requirements, M.S. students enroll in GRAD 397. This is a zero-credit 'course,' required by the Graduate College, which indicates satisfactory completion of the graduate comprehensive examination requirement. The Graduate Standards Committee is notified prior to enrollment in this course.

### **VII. Thesis Defense**

M.S. students are required to write and defend an original thesis. In the semester when the student intends to defend their M.S. thesis, they must enroll in Grad 399, a zero credit course required by the Graduate College for graduation. Before the student begins writing their thesis, the Thesis Committee must have been formed that now includes a member from outside of the Chemistry Department to serve as the Chairperson. The student's research advisor has the option of requiring additional members, if deemed appropriate. A detailed outline of the thesis is then presented to the Thesis Committee for their review. The outline is subsequently modified, if necessary, by the student. The thesis is presented to the committee members at least two weeks prior to the date of the oral defense. The defense consists of a formal public presentation of the thesis work followed by a closed oral examination by the Thesis Committee.

The Graduate College maintains specific requirements for the format of the thesis and timetable for submission. Please refer to <http://www.uvm.edu/~gradcoll/forms/guidelines.pdf> for more information.

### **VIII. Financial Support**

During the academic year, graduate students typically receive financial support either in the form of a teaching assistantship (T.A.) from the chemistry department or a research assistantship (R.A.) from their research advisor's grant. Graduate students will automatically be considered for T.A. support by the department through either their fifth year (Ph.D.) or second year (M.S.) in the program; T.A. support for third-year M.S. candidates will be considered on an individual basis. Summer support is not guaranteed, but it is unusual for a student not be appointed to a T.A. or R.A. during the summer months. All support, of course, is dependent upon the student's satisfactory performance both as a T.A. and in their research.

## IX. Suggested Timetable for Graduate Requirements

NOTE: The student is responsible for documenting their progress through the program by keeping their Graduate Record Progress (GRP) form up to date.

Year	Fall	Spring
1	<ul style="list-style-type: none"> <li>• (August) Qualifying Exams</li> <li>• <u>Coursework:</u> <ul style="list-style-type: none"> <li>○ Distribution/Core requirements</li> </ul> </li> <li>• (November) Choose research advisor</li> </ul>	<ul style="list-style-type: none"> <li>• Form Graduate Studies Committee (GSC)</li> <li>• <u>Coursework:</u> <ul style="list-style-type: none"> <li>○ Distribution/Core requirements</li> <li>○ CHEM 318 (<i>Current Topics</i>)</li> </ul> </li> <li>• Satisfy placement requirements</li> <li>• By June 8<sup>th</sup>: CHEM 380 – <i>Chemical Investigations</i> (Annual Report to GSC)</li> <li>• By June 15<sup>th</sup>: Annual Report presentation to GSC</li> </ul>
2	<ul style="list-style-type: none"> <li>• <u>Coursework:</u> <ul style="list-style-type: none"> <li>○ Distribution/Core requirements</li> <li>○ CHEM 318</li> </ul> </li> <li>• CHEM 381 – <i>Graduate Seminar</i></li> </ul>	<ul style="list-style-type: none"> <li>• <u>Coursework:</u> <ul style="list-style-type: none"> <li>○ Distribution/Core requirements</li> <li>○ CHEM 318</li> </ul> </li> <li>• CHEM 384 – <i>Advanced Topics in Chemistry</i></li> </ul> <p>* Written dossier and oral examination*</p>
3	<ul style="list-style-type: none"> <li>• <u>Coursework:</u> <ul style="list-style-type: none"> <li>○ CHEM 318 (a total of two credits are required before the end of the sixth semester)</li> </ul> </li> <li>• Enroll in GRAD 397 after completion of CHEM 384, 2 satisfactory credits of CHEM 318, and at least 6 weeks prior to thesis defense</li> </ul>	<ul style="list-style-type: none"> <li>• <u>Coursework:</u> <ul style="list-style-type: none"> <li>○ CHEM 318</li> </ul> </li> <li>• [M.S. Thesis Defense – GRAD 399]</li> </ul>