

# M.S. REQUIREMENTS FOR CHEMISTRY GRADUATE STUDENTS

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

The Department of Chemistry graduate program strives to endow M.S. students with a breadth of chemistry knowledge, help them develop the ability to critically analyze the chemical literature, and foster in them the capacity for 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 M.S. 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 (<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***

The M.S. in Chemistry degree may be earned in one of two options, both of which address an original hypothesis. Option A: (1) Completion of twelve credits of Master's Laboratory Thesis Research (CHEM 391) and submission of the resulting thesis, followed by a successful defense; and (2) completion of at least thirty credits of graduate work (courses and laboratory research). Or Option B: (1) Completion of six credits of Master's Literature Thesis Research (CHEM 395); and (2) completion of at least thirty credits of graduate work (courses and literature research). Other than the activities associated with the two tracks (laboratory research vs. literature research), both options follow the same general trajectory.

## ***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 to assess fundamental knowledge in the chemistry disciplines. A passing score for any exam is 50<sup>th</sup> 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, one of which, or both, may be used by the student: (1) take 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. Any individual qualifying exam is only re-administered once per student. The generally recommended courses are:

Analytical:	CHEM 221
Inorganic:	CHEM 231
Organic:	CHEM 241
Physical:	CHEM 260

If the student enrolls in the recommended course and does not earn at least a grade of B-, the failed qualifying exam must be re-taken and passed by June 15 of the student's first full year.

All students pursuing the Master's degree must satisfy the above requirement in at least three of the four areas of chemistry. One of those must be the area of specialization of the student. Should the student not pass the placement exam in the fourth area, he or she must demonstrate minimum competency in that area by auditing or taking for credit the recommended remedial course (listed above) and receive a grade of C or better. Failure to satisfy this requirement in two areas automatically leads to dismissal from the graduate program.

Students entering the program in the spring semester must take all qualifying exams upon arrival. For these students, the "graduate progress clock" starts with the next fall's entering class of graduate students.

## **II. General 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) or CHEM 395 (Independent Literature Research Project). A full-time graduate student will generally register for a *total* of 9 credit hours in the fall and spring semesters and 5 credit hours of either Chem 380, Chem384, Chem 391, Grad 901, Grad 902, or Grad 903 in the summer. *Following completion of all credit requirements (i.e., 30 credits), students should enroll for Continuing Registration (GRAD 90X).*

### ***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 meet a distribution requirement by taking a minimum of one course of advanced level work in *one area outside of their division*. Courses that are valued at 1 credit may not be used to satisfy any coursework requirement, and only one 2-credit course may be used. 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 the Graduate College require that M.S. students maintain a minimum GPA of 3.00.

### ***Divisional Core Courses***

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.

<b>Division</b>	<b>M.S. Core Course Requirements</b>
Analytical	CHEM 221 and one 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 264

If a particular 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 student's Graduate Studies Committee (see Section III), subject to approval by the departmental Graduate Affairs Committee (a departmental committee that monitors the progress of all graduate students).

### ***Approved Distribution Courses***

Students are required to take graduate-level chemistry courses in areas outside of their chosen division so as to ensure a broad knowledge of chemistry commensurate with an M.S. degree. 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.

<b>Division</b>	<b>M.S. Distribution Course Requirements</b>
Analytical	CHEM 221, 223, 225, 226, 227, 228
Inorganic	CHEM 231, 234, 236, 237, 238
Organic	CHEM 241, 242, 251, 257, 258
Physical	CHEM 260, 262, 264, 267, 268
Related science	BIOC 301, 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. Courses not enumerated above must be approved by the Graduate Affairs Committee.

### ***Annual Checklist***

All enrolled graduate students are expected to complete an annual checklist in May of each year. The purpose of the Annual Checklist is to promote timely completion of the requirements for graduation. The student should submit their annual checklist through the designated online portal no later than May 31. Students that have not submitted their annual report will not be permitted to complete Chem380, Chem381, Chem384, or advance to candidacy.

### ***Individual Development Plans***

In accord with Graduate College and federal guidelines, all graduate students must complete an individual development plan (IDP) in May of each year. The purpose of the individual development plan is professional development of the graduate student, and preparation for a post-graduate career. Enrolled graduate students should prepare an IDP using the departmental template and submit the plan to their research advisor no later than the Friday following the last day of final exams of the spring semester. The research advisor and graduate student will then schedule a

meeting for a date no later than May 31 to discuss the IDP. The graduate student must submit the final version of their IDP to the Graduate Affairs committee and their Graduate Studies committee no later than June 30. Students that have not submitted their IDP will not be permitted to complete Chem380, Chem381, Chem384, or advance to candidacy.

### **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, which must be 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 indicate their 1<sup>st</sup> and 2<sup>nd</sup> choice for research advisor to the Department Chair in writing *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 also act as 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, two additional Chemistry faculty members, and one faculty member not in the Chemistry Department. Of the three Chemistry faculty, one must be outside of the student's division. The Chair of the Graduate Affairs Committee must be notified *in writing* of the composition of the student's Graduate Studies Committee, by the student, once the committee has been established.

The four-member Graduate Studies Committee is sufficient to provide oversight and academic advising for students. It should be noted that the Graduate College requires that a faculty member who does not have an appointment in Chemistry serve as chair of a student's dissertation committee. If desired, a graduate student, in consultation with their research advisor, may add an extra faculty member to their Graduate Studies Committee and/or the dissertation 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 also a research and educational resource, serving as an "extended research advisor". 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***

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. When enrolled with zero credits, the grade will be based on attendance and participation. Completion of two (2) credits of CHEM 318, or three presentations, is required by the end of the 6<sup>th</sup> semester.

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

In the summer I semester following their first year, all students will register for CHEM 380, Chemical Investigations (1 credit). The foundation of CHEM 380 is the student’s first Annual Report and is the first checkpoint towards an advanced degree. This document is a brief (4–5 pages) progress summary report to the student’s Graduate Studies Committee, which encompasses the proposed laboratory research project (Option A) or literature research topic (Option B), and the initial results obtained in the laboratory or from the library, respectively. The first Annual Report will include relevant background from the literature, a statement of the relevance of the proposed research or literature topic, 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 Chem 380 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 CHEM 380 instructor of record must be informed by the student of the intent to present, with one week’s warning so that the public portion of the presentation may be attended by those who are interested.

Annual Reports are to be submitted to the members of the Graduate Studies Committee at least one week in advance of their presentation and presentations must be given prior to the end of the summer I semester. The Graduate Studies Committee collaborates on a written evaluation of the Annual Report and presentation, as well as the student’s first-year progress. It is the responsibility

of the student's research advisor to submit the written evaluation to the Chair of the Chemistry Graduate Affairs Committee.

#### ***IV. Continuation in the M.S. Program***

By the end of June, the Graduate Affairs Committee will have reviewed the progress of all first-year graduate students in the M.S. program. Sections I, II, and III each contain one requirement that must be met in order to remain in the M.S. program.

*Qualifying Exams.* A Master's student must satisfy the qualifying exam requirement in at least three of the four areas. If the student is not able to meet the requirement in more than one area, the student will be informed that he/she cannot matriculate in the Chemistry Department's graduate program.

*Course Work.* If a student fails to maintain a 3.00 GPA, the Graduate Affairs Committee shall put the student on notice that his/her progress will be monitored, and that the GPA deficiency is expected to be remedied by the end of the second year.

*Research Progress.* The first Annual Report contains a judgement by the three faculty members most closely aware of the student's research progress. If the Annual Report is not a positive validation of the student's research progress, the Graduate Affairs Committee shall put the student on notice that a major improvement in research progress is expected to occur by the second-year review (CHEM 384).

The Graduate Affairs Committee will send each first-year student a letter by the end of June,

#### ***V. The Second Year***

##### ***CHEM 318 – Current Topics in Chemistry***

All students will continue to enroll in the 'Current Topics' course relevant to his or her division. If not presenting, they must still attend departmental seminars and contribute to divisional presentations in order to receive a grade of S in the 'Current Topics' course.

##### ***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 short synopsis with annotated bibliography 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 to C-, or F. A grade of "F" for the 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.

### ***CHEM 384 – Advanced Topics in Chemistry [Advancement to Candidacy]***

One semester before a student intends to graduate, but no later than 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 research topic, a detailed record of research progress, and future directions. This culminates in a short (20-30 minutes) presentation followed by a comprehensive oral examination.

The dossier should be approximately 15 pages in length, and should be a continuation of, and include, the work presented in the CHEM 380 document. It should address key background literature, experimental protocols, results, and expected directions (for Option A); or key background literature, areas that have been reviewed, and anticipated areas to be reviewed (for Option B). By this time, the Option A student should have a detailed understanding of the key experiments to be performed; the Option B student should be conversant in the areas to be reviewed. Both must demonstrate an awareness of 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 show a student's aptitude for pursuing M.S.-level research. Furthermore, the report should include the thesis content outline, as well as an anticipated timeline towards the defense.

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 Advancement Exam, he/she 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 before the end of the spring semester of the second year.

After the examination, the Graduate Affairs Committee, in consultation with the student's Graduate Studies Committee, will review the records of the M.S. candidate and recommend either continuation of the degree or dismissal from the program. The Graduate Affairs 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.

### ***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/paper requirements for the M.S. degree.

*Following completion of all credit requirements (i.e., 30 credits), students should enroll for Continuing Registration (GRAD 90X).*

## ***VI. 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.

#### ***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 consists of the following 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 the Advancement to Candidacy Exam (CHEM 384). 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. Participation in the 'Current Topics' course provides a comprehensive overview of current issues of relevance.

Upon completion of these requirements, the Master's student must schedule a meeting with the Chair of the Graduate Affairs Committee to review the records and transcripts. Immediately following, formal notification of the student's passing of the Comprehensive Examination will then be communicated to the Graduate College by the Chair of Graduate Affairs via a memo.

### ***VII. Thesis Defense***

M.S. students are required to write and defend an original thesis. The Graduate Studies Committee will have been formed, and will act as the thesis defense committee (with the faculty member from outside the Chemistry Department serving as its 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 Graduate Studies Committee for their review. The outline is subsequently modified, if necessary, by the student. The thesis is distributed 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 Graduate Studies Committee.

The Chairperson of the thesis defense committee is charged with communicating the outcome of the defense by submitting the Defense Examination Record Form and any Change of Grade forms to the Graduate College Dean's Office within 3 days of the defense. The student should, as a courtesy, inform the Chair of the Graduate Affairs Committee of the outcome as well, so that such can be noted in the official files.

The Graduate College maintains specific requirements for the format of the thesis and timetable for submission. Please refer to <https://www.uvm.edu/graduate/resources> for more information. Both Option A and Option B Master's students are to follow these same guidelines for their theses.

### ***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 his/her progress through the program by keeping the Graduate Affairs Committee (Chair) up to date.*

Year	Fall	Spring
1	<ul style="list-style-type: none"> <li>• Qualifying Exams [August]</li> <li>• <u>Coursework</u>: Distribution/Core requirements</li> <li>• Choose research advisor [November]</li> </ul>	<ul style="list-style-type: none"> <li>• Form Graduate Studies Committee (GSC), and report its composition</li> <li>• <u>Coursework</u>: Distribution/Core requirements; CHEM 318 – <i>Current Topics</i></li> <li>• Satisfy placement requirements</li> <li>• CHEM 380 – <i>Chemical Investigations</i></li> <li>• Annual Checklist</li> <li>• Individual Development Plan (IDP)</li> </ul>
2	<ul style="list-style-type: none"> <li>• <u>Coursework</u>: Distribution/Core requirements; CHEM 318</li> <li>• CHEM 381 – <i>Graduate Seminar</i></li> </ul>	<ul style="list-style-type: none"> <li>• <u>Coursework</u>: Distribution/Core requirements; CHEM 318</li> <li>• CHEM 384 – <i>Advanced Topics in Chemistry</i></li> <li>• Written dossier to GSC and oral examination</li> <li>• Annual Checklist</li> <li>• Individual Development Plan (IDP)</li> </ul>
3	<ul style="list-style-type: none"> <li>• <u>Coursework</u>: CHEM 318</li> <li>• Notify Graduate Affairs Chair after Comprehensive Exam components have all been satisfied [at least 6 months prior to submission of dissertation]</li> </ul>	<ul style="list-style-type: none"> <li>• <u>Coursework</u>: CHEM 318</li> <li>• Annual Checklist</li> <li>• Individual Development Plan (IDP)</li> <li>• M.S. Thesis Defense</li> </ul>