



GRADUATE STUDENT HANDBOOK

Drexel University – Department of Chemistry

CHEMISTRY GRADUATE PROGRAM

The purpose of this handbook is to provide graduate students with information and resources needed to complete their Drexel University Chemistry Graduate Degree. This document supplements the University policies.

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I. DEPARTMENT OF CHEMISTRY GRADUATE PROGRAM OVERVIEW

I.A. WELCOME

On behalf of the Chemistry Department at Drexel University, I extend to you a warm welcome. From our beginning as a part of the Chemistry and Chemical Engineering Department of Drexel Institute of Technology (which became Drexel University in 1971), we have evolved into a separate Department in the College of Arts & Sciences awarding both Masters and Doctoral degrees (the first PhD in 1968) in all major areas of chemistry.

At Drexel we have strong nationally and internationally recognized programs in the areas of analytical, atmospheric, inorganic, organic, physical, and polymer chemistry. In addition, Drexel encourages interdisciplinary activities. Several of our faculty actively collaborate with scientists in areas such as computational science, biological chemistry, and materials science.

Two of our Department's most important goals are to increase basic chemical knowledge and its application to fundamental basic research. At the same time, we want graduate students to appreciate practical applications of chemistry in solving the problems that we all face in the modern world. Our Department is small enough to provide each student with individual attention while maintaining a community of scholars (faculty, postdoctoral associates, graduate, and undergraduate students). The relatively small research groups enable close interaction between students and their Research Advisors. We regard such attention and interaction as important positive features of our program.

Within our Department, students and faculty are investigating diverse and exciting research problems (<https://drexel.edu/coas/academics/departments-centers/chemistry/>). The wide range of faculty interests ensures that we can stimulate the interest of students.

This handbook contains some important information with respect to your graduate career; please read it carefully and review the information, if necessary, with your Faculty Advisor. Of particular help is the checklist at the end of the handbook (Appendix).

Good luck and best wishes for your future in chemistry!

Joe P. Foley, PhD
Head of Department

I.B. ADVANCED DEGREE PROGRAMS IN CHEMISTRY

The Chemistry Department offers Master of Science (MS) and Doctor of Philosophy (PhD) degrees in Chemistry with specialization in the areas of:

- **Analytical Chemistry**
- **Atmospheric Chemistry**
- **Chemical Education**
- **Inorganic Chemistry**
- **Materials Chemistry**
- **Organic Chemistry**
- **Physical Chemistry**
- **Polymer Chemistry**

Several of the above areas have a biological component, e.g., bioanalytical, bioinorganic, bioorganic, and biophysical. While students are free to conduct research in any of the above areas, the cumulative qualifying examinations are limited to the following areas: analytical, biological, chemical education, inorganic, organic, physical, material and polymer. Students should consult the Graduate Advisor or the Graduate Program Committee (GPC) if they have questions or requests about the cumulative exam subjects.

The MS degree is awarded to students who show competency at the advanced level in the major areas of chemistry. Both a thesis and non-thesis MS option is available. Most full-time students complete the MS degree within two academic years.

The PhD degree is different from coursework-driven BS and MS degrees, in that it is self-driven, creative in nature and essentially research-based. The PhD degree is conferred in recognition of breadth of scholarship and scientific attainment plus demonstrated ability to investigate significant scientific problems independently and with insight. It is not earned through completion of courses, by accumulation of credits, or by the time spent in residency, which are secondary requirements. The role of the Research Advisor is to offer guidance and advice to the student, but it is ultimately the responsibility of the student to prosecute the research, develop original contributions to it, and obtain original results of significance suitable for presentation in a PhD thesis, itself written with an appropriately high degree of literary skill. A typical time for the completion of a PhD by a full-time student is 5 years after completing the baccalaureate degree.

I.C. ADMISSIONS REQUIREMENTS

I.C.1 GRADUATE SCHOOL REQUIREMENTS

Information regarding application materials, submission requirements and deadlines can be found on the website of the Graduate Admissions Office (<https://drexel.edu/admissions/grad>).

I.C.2 DEPARTMENTAL REQUIREMENTS

Both full-time and part-time students are required to have a BS in Chemistry or the equivalent. In other words, there must be evidence of adequate undergraduate preparation in chemistry, physics, and mathematics. Undergraduate chemistry coursework would typically include 34 semester (or 51 quarter) credits divided among general and inorganic chemistry (8-10 semester credits), analytical (6-8 semester credits), organic (6-8 semester credits), physical (6-8 semester credits) and unspecified chemistry electives (0-8). One to two semesters of college physics are also expected, along with differential and integral calculus. If some of the requirements are not met, an applicant may still be admitted but required to make up any significant deficiencies as determined by the Department.

For admission, it is strongly recommended that an applicant takes and reports to the Department results of the Graduate Record Examination (GRE) administered by Educational Testing Services, Inc. (Princeton, NJ). GRE scores are helpful to the Department and Office of Admissions. If the applicant wants to be considered for a Dean's Fellowship or a Provost's Fellowship (see [section IV. Graduate Support](#)). Exceptions to this requirement are made for internal applicants.

I.D. ADVANCED STATUS

I.D.1 POST-MASTERS STATUS

Students who have previously obtained an MS degree in chemistry may be eligible for post-MS status in Drexel's graduate program. Given that the graduate course sequence in one's major area (analytical, inorganic, organic, physical, and polymer) is usually helpful in preparing for the cumulative exams (cumes), students may prefer to apply for transfer credits from prior graduate coursework rather than post-MS status, since the transferring of credits does not accelerate PhD Candidacy requirements.

I.D.2 TRANSFER CREDITS

Up to 15 credits of graduate coursework at another university may be transferred for graduate credit at Drexel, in accord with the description in the "Transfer Credit" section in the University's Graduate College Academic Policies, Procedures and Guidelines

(<https://drexel.edu/graduatecollege/forms-policies/policies-procedures-guidelines/transfer-credit/>) and with the approval of the Graduate Advisor and the GPC. Credit transfer is initiated by consulting with the departmental Graduate Advisor or with the GPC Chairperson, who will normally be prepared to consider such requests only after the student has progressed through their third quarter of study in good academic standing. The granting of transfer credit usually necessitates some evaluation of the content of the prior coursework, and the results of registration exams are also taken into consideration in this regard. Naturally, any course that is counted toward a post-MS admission status cannot also be transferred in for the additional credits required for a Drexel degree.

II. ADVANCED DEGREE REQUIREMENTS

II.A ALL GRADUATE STUDENTS

The University's graduate degree requirements and policies are listed in the [Academic Policies, Procedures and Guidelines](#). This website contains a number of general requirements of Drexel's Graduate Studies for all graduate students enrolled in the MS and PhD programs. In order to earn a graduate degree, a student must complete all program and University requirements in a satisfactory manner. In addition to those requirements listed below, the Research Advisor may make additional requirements in the best interests of their student. The University requires all graduate students to maintain a cumulative GPA of at least 3.0 (B average).

II.A.1 REGISTRATION EXAMS

All graduate students, upon entering the program, are required to take at least 3 of the two-hour written registration exams in analytical, bio, inorganic, organic, and physical chemistry. The purpose of these exams is to help assess a student's preparation in chemistry to provide a basis for advice on which courses outside the student's major area to take.

Registration Exams are given in the week preceding the start of the fall term. If a student enters the program during another term, or fails to take at least 3 exams during the week before the start of fall term, they will be required to begin taking the registration exams on the first Saturday of the month following the entrance/admission to the program. Failure to complete at least 3 registration exams promptly can be considered a basis for a finding of "unsatisfactory progress" at the first-year progress check.

Non-matriculated students planning to take only one or a few courses for credit in a particular area will generally be required to take the registration exam in that area. For these and all other exams, active cell phones are not permitted in the exam room.

II.A.2 COURSE AND ENROLLMENT REQUIREMENTS

All graduate students should complete 45 credits of coursework. General requirements for all chemistry students include:

- A sequence of three core courses must be completed in the student's major area of interest (or other area chosen in consultation with the respective Research Advisor). Possible sequences are:

Inorganic core sequence: CHEM 521/522/523/ (771 or 772¹)

Analytical core sequence: CHEM 530/531/755

Organic core sequence: CHEM 541/542/543

Polymer core sequence: CHEM 561/562/563

Physical core sequence: CHEM 557/558/ (554, 555, or 752)

- Other requirements specific to the MS or PhD degree as specified in sections [II.B.1](#) and [II.C.1](#), respectively

In the event that a required course is not offered for a protracted period of time due to low enrollment, the Graduate Advisor may make special allowances.

Finally, whereas the enrollment for a part-time student may vary, the minimum enrollment for all full-time students is nine credits per term. If you experience any difficulties in pre-registering for a class or research credits, please contact Laura D'Angelo, Assistant Director of Graduate Studies at lpd22@drexel.edu.

II.A.3 PLAN OF STUDY

The Plan of Study (PoS) should be completed in the in consultation with the Graduate Advisor and the student's Research Supervisor. Doctoral students must complete this information in the EForms system. Students should list; courses taken, courses to be taken, and provide tentative dates for their thesis proposal with seminar, and PhD defense. The Plan of Study must then be approved by the Research Advisor, the Graduate Advisor, and the Graduate Studies Office. Changes in the Plan of Study after submission must have the approval of the GPC.

¹ or other inorganic course (e.g., 774) with Graduate Advisor permission

II.A.4 ACADEMIC HONESTY

All students are expected to maintain the highest professional and academic ethics in all their efforts, whether these efforts involve research or coursework assignments. It is expected that Chemistry graduate students (and faculty) will follow the American Chemical Society's [Ethical and Professional Guidelines](#). Information about Drexel University's ethics policies is at <https://drexel.edu/provost/policies-calendars/policies/>. Of note, is the distinction between fair quotation and plagiarism. In general, when one uses the actual wording of a source, it must be placed between quotation marks and the source cited.

During 2007-2008, the Associate Vice-Provost for Graduate Studies put in place a procedure through which a student may appeal a decision made by the student's Department. The final arbiter in this appeal process will be the Provost. In any case, the chain of responsibility for such matters is: Graduate Advisor & Grad. Curriculum Committee → Head of Dept. → CoAS Associate Dean for Graduate Studies → Dean of College of Arts & Sciences → Dean of Graduate College → Provost.

II.A.5 DEPARTMENTAL SEMINAR

All full-time and part-time PhD students past their first year of study must enroll in CHEM 865, Chemistry Research Seminar, at least once per year. The outside speakers that we bring in provide students with an opportunity to obtain a broader perspective of research activities in a student's own and other fields of chemistry. All full-time students are encouraged to attend all departmental seminars unless it conflicts with a regularly scheduled teaching assignment.

First-year, full-time students (both MS and PhD) must attend 9 seminars per academic year (AY), and first-year, part-time students must attend 6 seminars per AY or the off-campus equivalent (see below). Attendance requirements outside of those required for CHEM 865 for second-year and later full-time PhD students is 9 additional seminars per AY. Non-thesis MS students should never register for CHEM 865 more than once because additional enrollments will not be counted toward the 45 credits needed for the degree.

For part-time PhD students, because it is recognized that attendance at Drexel chemistry seminars is often a logistical hardship if not an impossibility, they are allowed to substitute equivalent

attendance at either or both (i) local chemistry-related professional society meetings in which a seminar-length oral presentation is given and (ii) chemistry seminars at their place of employment assuming the latter are offered and available to the student. Evidence for each alternative off-campus seminar attendance must be provided to the

CHEM 865 instructor during the term in which the student registers for CHEM 865; such evidence includes but is not limited to (i) a picture of the seminar speaker's title slide or (ii) a confirmation of attendance by the research advisor who attended the same seminar. Registration into CHEM 865 should be once per academic year (AY) and in the term in which the part-time PhD student will have accumulated 9 equivalent off-campus seminar attendances; in most cases this will be in the spring term.

II.A.6 THESIS (MS) AND/OR DISSERTATION (PHD)

All full-time students who have received financial assistance from the Department are required to write a thesis or dissertation on original chemical research for their terminal degree (see the appropriate degree requirements below for more information). Exceptions to this requirement will be considered by the GPC on a case-by-case basis if and only if the research advisor supports the exception.

The thesis/dissertation must follow the guidelines found in the [Thesis Manual](#) maintained by the Graduate College, which includes directions and examples for referencing the primary scientific literature (i.e., peer-reviewed, scientific journal articles—a preferred source of information for the thesis), but does not provide examples for referencing either the secondary literature (books, monographs, edited books, handbooks, etc.) or information obtained from the internet (much less desirable except for peer-reviewed, on-line journals). Examples for referencing the secondary literature may be found in the instructions for authors of various peer-reviewed journals in the student's discipline (such as those published by the American Chemical Society); in addition to the book title, author/editor, and page numbers, it is generally a good idea to specify the chapter title and author when applicable.

MS Thesis:

- The student submits their thesis to a Thesis Review Committee of three readers consisting of their mentoring professor (research Advisor) and two other research active Chemistry Department faculty for approval (see [section II.B.2](#) below.) When the readers deem the thesis satisfactory, (possibly after one or more rounds of revisions) each member of this committee signs the "[Graduate Thesis/Dissertation Approval Form and Signature Page](#)", with one of readers other than the Research Advisor signing as Chair of the committee.
- The student obtains the following signatures on the "[Graduate Program Completion Form](#)":
 - Student signature: This one is obvious.
 - Academic Advisor: Write "NA". This is not applicable in the Chemistry Department.
 - Committee Chairperson: Whoever signed as Chair on the "[Graduate Thesis/Dissertation Approval Form and Signature Page](#)".

- Faculty Member of Supervising Professor: The Student's Research Advisor.
 - Department Head or Program Director: Chemistry Graduate Advisor. (Chemistry Department Head if the former is unavailable).
 - Division Director: Write "NA". This is not applicable in the Chemistry Department.
-
- The approved thesis should be submitted electronically to ProQuest in PDF format according including the completed Graduate Thesis/Dissertation Approval Form and Signature Page as the first page and the title page as the second page, according to the guidelines found on the [Drexel University Libraries website](#). If a student hasn't already published some of the research in their thesis but is planning to do so, the student has the option of delaying the public release of the thesis by placing a temporary embargo of up to one year on the thesis at the time of its submission.
 - The M.S student submits the signed Graduate Program Completion Form and copy of the ProQuest confirmation to Laura D'Angelo, Assistant Director of Graduate Studies for final degree clearance.

PhD Dissertation:

- Upon completion of the Dissertation Defense and within 48 business working hours, the Committee Chair should enter the committee decision in the EForms system.
- Each committee member, including the chair will then receive a notification from EForms asking whether they agree or dissent from the decision.
- Once all committee members have submitted their decision, the Committee Chair should "*Request Approvals*" (Student, DGS, Supervisor, and Graduate College). Completion of this step will open the Submit Thesis tab.
- The student should revise their thesis according to the Committee's feedback. Once the thesis is in its final version, the student should open the Submit Thesis tab in EForms, enter the title of the dissertation, the date, hit "*Save*" and "*Send Notification*".
- All Committee Members will need to approve the thesis in EForms. After all Committee Members approve it, the student should click "*Export to PDF*" to create the Dissertation Title Page. This page needs to be merged with thesis as the first page.
- The student must upload the completed final thesis to ProQuest <http://www.etdadmin.com/drexel>.
- The student should upload the acknowledgement receipt from ProQuest in the Supporting Documents of EForms.
- Upon uploading the receipt, the student must return to the Submit Thesis tab and select "*Yes*" for ProQuest receipt and click Save.

- Finally, and still in EForms, the student should press “Request Approvals” (Student, Supervisor, DGS, and Graduate College).

II.A.7 TIME LIMIT FOR THE MS AND/OR PHD DEGREE

A doctoral student must complete their degree program within seven years and a master’s student must complete their degree program within five years of the initial date of matriculation (includes any time spent on a Leave of Absence). For more detail, please carefully read [Time to Completion/Length of Study Policy in the Graduate College](#) website.

II.B. MASTER OF SCIENCE DEGREE

II.B.1 COURSE REQUIREMENTS

The MS degree is awarded after satisfactory completion of a minimum of 45 credit hours in Chemistry and related fields. Specific course requirements are listed above in [section II.A.2](#). The remaining credits may be chosen from approved graduate courses within the Department, or other departments at Drexel offering courses related to the student's major area. These courses must be approved in advance by their Research Advisor and the departmental Graduate Advisor, who should seek input from the GPC in ambiguous cases. Thesis MS students must take the graduate course in Chemical Information Retrieval (CHEM 767).

II.B.2 THESIS OPTION

The chemistry faculty strongly recommends the Master’s thesis option but realizes that it is not always possible or necessary for M.S. students. Within the thesis option, up to fifteen credits of CHEM 997 Graduate Research may be counted towards the Master’s degree in chemistry. Additional CHEM 997 credits above this limit may be taken if needed to satisfy the 9 credit per term requirement for full-time students ([section II.A.2](#)), but they cannot be counted towards the MS degree. During the graduating quarter, a thesis MS student should be registered for CHEM 898, Master's Thesis.

During the first quarter of coursework a student should choose a Research Advisor with whom to collaborate in carrying out an original investigation in chemistry. The results will be written up in thesis form and submitted to a MS Thesis Review Committee consisting of the Research Advisor and two other departmental faculty suggested by the Research Advisor and approved by the GPC. The acceptance by this committee of the MS thesis completes the thesis option requirements for the MS degree. Both the Thesis Review Manual, which describes the preparation and required format of the thesis, and the library binding requirements are available online as described above in [section II.A.6](#). Note also Graduate College requirements: if one takes a Drexel MS degree (3.0

GPA required), one need to apply for readmission to the graduate program (i.e., as a PhD Applicant), and for this, a cumulative grade point average of 3.50 is required.

II.B.3. RESEARCH CREDITS FOR NON-THESIS M.S

Up to nine credits of CHEM 997 can be counted towards a terminal non-thesis MS degree. To do so, the student must submit a written report on the work that satisfies their Research Advisor. Students continuing without break toward the PhD degree may count up to 9 credits of thesis and/or research toward the MS degree, as long as they have at the point of graduation with their MS successfully passed their cumulative exams; three credits may be counted, if cumes have been commenced and at least two passed. The requirements are different for students in the BS/MS program; consult the Graduate Advisor or Department Head.

II.C. DOCTOR OF PHILOSOPHY DEGREE

PhD recipients must demonstrate scholastic breadth in chemistry as well as contribute significantly to scientific advancement in a chosen major area. Requirements of the program include: general coursework; sub-discipline proficiency ([see section II.C.2](#)); a course on searching the chemical literature and technical writing ([see section II.C.7](#)); a candidacy exam procedure; a thesis proposal; first authorship on a peer-reviewed paper ([see section II.C.9](#)); and successful publication of a PhD thesis (dissertation).

II.C.1 COURSE REQUIREMENTS

Drexel University requires that a minimum of 90 credits of graduate level courses must be completed for the PhD degree. Excluding research credits, the Chemistry Department requires a minimum of 21 credits of lecture coursework in chemistry, comprised of CHEM 767 (Chemical Information Retrieval), three core courses in the student's major area ([section II.A.2](#)), and three additional graduate lecture courses (core or elective), which cover two different chemistry areas outside the major area. Any remaining coursework will consist of more advanced graduate chemistry electives and special topics courses that are mutually agreed upon by the student and the Research Advisor. Ideally, these courses should be specified when a Plan of Study is submitted. Note that the Chemistry Department requires students to maintain a cumulative lecture course GPA of at least 3.0 in lecture courses offered by the Department. If the GPA of a full-time student has been below 3.0 for two consecutive terms by the end of the winter term of their second year (by the end of the spring term for a part-time student), the student will not be allowed to move forward to the Thesis Proposal with Seminar. Transfer of core course or elective credits from other institutions is possible, under conditions similar to those for the MS degree.

II.C.2 PROFICIENCY REQUIREMENT IN CHEMISTRY SUB-DISCIPLINES

The Chemistry Department requires PhD students to demonstrate a reasonable degree of proficiency in three sub-disciplines of chemistry—analytical, bio, inorganic, organic, and physical. This student must be highly proficient in their major area, and the major area could be one of the five areas already mentioned or a different area such as chemical education, atmospheric, materials, or polymer chemistry.

There are two ways in which proficiency in the above three sub-disciplines can be demonstrated:

1. Earning a score of 50%ile or higher on the registration exam in the given sub-discipline. All students will have this opportunity since all incoming students are required to take the registration exams.
2. Earning a C or better grade in a graduate-level core course in that area taken in the first year for full time and during the first or second year for part-time graduate students.

If a modest degree of proficiency in the four sub-disciplines of chemistry is not achieved by the end of a full time PhD student's first year, the student will be given the choice of switching to our Master's Degree program or leaving the graduate program entirely. For part time PhD students, the requirement must be met at the end of their second year.

II.C.3 WRITTEN (CUMULATIVE) EXAMS

Written exams designed to evaluate a student's knowledge of chemistry (normally in their major area of interest) are given monthly during the academic year and occasionally during the summer at the discretion of the faculty. They are normally held on the first Saturday of each month, in Disque 307 at 10:00 am; the exact dates and times are posted on the Chemistry Graduate Program SharePoint site.

All PhD students must begin taking cumulative exams no later than the beginning of their second year in the program. Cumulative exams must be taken sequentially, with one unexcused absence allowed, until **five points are accumulated, or ten exams have been taken**. Failure to accumulate 5 points after 10 exams is a basis for dismissal from the PhD program. The Department requires that the student is registered for at least one course during the term in which they take the first cume.

There are three possible outcomes of a cumulative exam: high pass (2 points), pass (1 point), and fail (0 points). Although the precise thresholds for a high pass and pass are determined by the cume-writer/grader and communicated to the cume-taker prior to the administration of the exam, the minimum thresholds are 75% and 50%, respectively.

First year cume options: Prior to the beginning of the second year in the PhD program, a student can elect to take **one** cumulative exam on the topic of their choosing² with no requirement to take a second cumulative exam in the first year. If a first-year student elects to take a **second** cumulative exam, however, then **that student must begin taking cumulative exams once a month without interruption** except for the summer period when no exams in the relevant sub- discipline are offered (August, September, and possibly July).

The topic(s) of the cumulative exams may, or may not, be announced prior to the exam, depending on the sub-discipline. It is a student's responsibility to make sure that the appropriate faculty member(s) is/are aware of the need to provide a cumulative exam for them to take in any given month. This is particularly so if the student is taking an exam outside their chemistry sub-discipline. At least three of the five passes must be in the student's selected area of specialization; it is therefore important that the area of specialization is chosen carefully in consultation with their Research Advisor.

II.C.4 CANDIDACY STATUS

Students in the Chemistry PhD program become doctoral candidates after successfully earning five cumulative exam points, completing 45 credits of graduate coursework, and passing their thesis proposal with seminar. Note that in the EForms system, and **for purposes of the EForms system only**, students pass the candidacy exam after earning five cumulative exam points and having completed 45 credits of graduate work.

To document candidacy in EForms, the Research Advisor and the Chair of the Graduate Program Committee must be appointed as the "Candidacy Committee". This "committee" will confirm that the student has met the above conditions for candidacy, which will be followed by approval by the Chemistry Graduate Advisor.

II.C.5 DISSERTATION ADVISORY COMMITTEE

Following the completion of the cumulative exams, the PhD Candidate must select, in consultation with their Research Advisor, a Dissertation Advisory Committee (DAC). Assembling the committee and obtaining approval from the Graduate Advisor is the obligation of the student. In accordance with the University's general rules for the selection of doctoral student committees:

- The PhD student's Research Advisor serves only as an ex officio a member of the Committee and may contribute to the proceedings only if permitted by the Chair. (The Advisor may serve as part of the 3-person quorum for Annual Check of Progress meetings, and therefore should be listed as a committee member in EForms. Ideally the Advisor should be removed from the committee in EForms

² from among the topics announced by the faculty members who are writing cumulative exams that month.

before the pre-defense, but regardless of the EForms record, the Advisor serves only as an ex officio member for events other than Annual Check of Progress meetings.)

- The Committee **must** include one member from **outside the University** and must be a tenured or tenure-track research-active faculty member from an appropriate discipline in a PhD-granting institution. The external member should be an expert in the field of the student's research. The choice of the outside member must be approved by the GPC Chair.
- At least 3 committee members must be tenured or tenure-track members of the Drexel faculty. These members may hold a primary appointment from a department other than Chemistry as long as their expertise is appropriate, and they are approved by the Chemistry Graduate Advisor.
- At least 2 committee members must be outside the student's specific area of research.
- All members of the committee must be research active. Research active is someone who has published in the primary literature within the last 3 years or is currently advising graduate students. Ideally a majority (3 out of 5 committee members) should publish in the field of the student's research. In the case that sufficient expertise is not present in the Department a suitable solution is the use of 2 external members that are experts in the field of the student's research. Personality conflict is generally not a valid reason for excluding a faculty member in our Department from a committee, when that faculty member is an expert in the respective field of research. Research-active non-tenure track faculty from the Drexel Chemistry Department may serve as members of the committee, but not chair thereof.
- One voting member of the examining committee who is of emeritus/retired status from Drexel (as an "internal" member) or another chemistry graduate program is permissible.
- Note that although a total of five committee members is required by Drexel, a sixth is strongly recommended in case of some unavoidable absence. Additional members not fulfilling the above requirements may serve but have no vote.
- The Graduate Advisor has been asked by the faculty to make sure all committees are in line with the above rules. In some ambiguous cases, the Graduate Advisor will consult with the Chair of the GPC prior to making a decision. The Graduate Advisor can refuse to sign if the committee does not meet the above criteria, keeping in mind that committee members that are experts in the field of the student's research should be used unless such experts do not exist in the region.

Ideally, one should use the same committee, (or an appropriate subset thereof) for all Drexel PhD hurdles.

II.C.6 THESIS PROPOSAL WITH SEMINAR

The Thesis Proposal with Seminar takes place in two parts. First a written proposal is submitted. Only if the written proposal is approved may the student proceed to the oral exam. All PhD students are required to write a Thesis Proposal related to their research. Content and format are described below. After final acceptance of the written proposal the student will give a 30-45 minute Thesis Proposal Seminar presentation related to their research. The student's presentation will be followed by a question and answer session during which the student should demonstrate proficiency with regard to the broader context of his research project. Altogether, the student's presentation and the subsequent examination shall not last longer than two hours. The Thesis Proposal should, in part, help the student become more knowledgeable about their research project by (i) promoting a greater fundamental understanding about the student's own specific research project and (ii) providing context and perspective about previous accomplishments in the field by other research groups as well as their own. The Research Advisor is expected to provide considerable input to the student about the breadth and depth of the literature review, the essential papers to read (and comprehend), the historical and current topics to include and/or emphasize in the seminar, and of course the details of the research project.

The Thesis Proposal shall be no more than 10 pages in length including the text, reaction schemes, figures, and tables; references and a cover page are not included in the page count. The format for the body of the text is as follows: 1-inch margins, single-spaced, with a 12-point font such as Arial, Helvetica, or Times New Roman. The content is described above, and the student should also seek input from her/his Research Advisor throughout the writing process.

Full-time students are required to submit their proposals to the Chairperson of their Dissertation Advisory Committee (DAC) as early as practical during their course of study, but no later than the end of week 7 in the fall Quarter of the 3rd year. There is no official submission deadline for part-time students, but part-time students should submit their proposals to the Chairperson of their DAC as early as practical in their course of study. Moreover, part-time students are required to hold a 1st year progress check, and annual progress checks, (See [Annual Check of Progress](#)) on the same schedule as full-time students. Although consideration of part-time status will be made at these progress checks, failure to submit a satisfactory Thesis Proposal in a timely manner after completion of the cumulative exam requirement will be considered unsatisfactory progress toward degree completion, with consequences as specified in the [Annual Check of Progress](#) section.

The committee Chair is responsible for overseeing the review of the written proposal by all committee members within two weeks after its submission. Based on the individual

reviews, the committee Chair opts for one of the following decisions: (i) accept as submitted, (ii) minor revision, (iii) major revision, or (iv) reject. If the verdict is minor revision, a revised proposal must be submitted to the committee Chair within two weeks. A final decision on acceptance by the Chair must be made within a week. If the verdict is "major revision", a revised version must be submitted to the committee Chair within 6 weeks. The committee chair will then send the revised version to the members of the committee for their scrutiny. A final decision on acceptance has to be made within two weeks. For the revised proposal there are only two possible outcomes: accept or reject. If rejected, the student cannot proceed to the oral component. Once the Dissertation Committee has been appointed and approved but before the Proposal Defense, the student should enter the Proposal Title, date, time, and location of the Proposal Defense in the EForms system. After the proposal has been accepted, an oral exam has to take place within four weeks, exclusive of holidays.

The Chairperson of the DAC will appoint one member of the committee as minute taker. After the thesis proposal seminar and defense, the Dissertation Advisory Committee will convene in the absence of the student. The verdict by the committee will be pass or fail. It has to be documented in the minutes. The minutes have to be signed by all committee members. The Committee Chair should upload the minutes in EForms and all members should enter their decision. If the student fails, a second oral exam should be scheduled within 6 weeks. If the student fails the second exam as well, they will have to leave the program or pursue an MS degree.

For the Thesis Proposal Seminar and the preceding Thesis Proposal the following rules apply:

- Both must include a review of the essential literature (30-50% of seminar and paper)
- Students must distinguish between essential and non-essential background literature (they should not include everything that is vaguely relevant)
- Both must identify the gap in the knowledge base (or an interesting question or a new application) that the student's research aims to address in the future and discuss the initial steps towards addressing this gap. Explain the significance thereof. (20-50% of seminar and paper).
- Both must describe their research progress thus far, even if preliminary (10-30% of seminar and paper).
- The style of the paper should be similar to a research grant proposal or a targeted review article, but content should be as described above.
- References should be in proper and consistent format, see notes above about avoiding plagiarism and citation of sources. In their talk, references on each

slide are preferable, so the audience knows which reference goes with which idea.

Students who do not meet the above deadline will be required to present both the **first** Thesis Proposal Seminar and a **second** literature seminar within 3 months of the original deadline for the first Thesis Proposal Seminar, with the second seminar in an area outside the area(s) of the research group in which the student resides. Students who fail to meet the deadline for the second (penalty) literature seminar will be dismissed from the graduate program.

Further details worth noting regarding the Thesis Proposal Seminar are:

- The Thesis Proposal Seminar must be scheduled at least 3 weeks in advance (preferably more) and no later than four weeks after the written proposal has been accepted by the Dissertation Advisory Committee.
- It may be required to use a sign-up sheet, to ensure that student seminars are spaced out evenly throughout the term, and that seminars do not occur during finals week.
- The Research Advisor will advise the student on the suitability of their Thesis Proposal Seminar (breadth and depth of the literature search, the essential papers to read, the historical and current topics to include and/or emphasize, etc.), as well as the title and abstract that must be distributed at least 1 week in advance to the Chemistry Department for announcement/publicity purposes.
- The student must ensure that all the members of their Dissertation Advisory Committee know in advance the date, location and time of the Seminar.
- The title, abstract, date, time and location of the Thesis Proposal Seminar must be advertised in writing in the Department and on the departmental web site at least a week in advance.

Transfer students, who have obtained candidacy status at another institution can have their status recognized if the Graduate Program Committee deems respective requirements at the student's former institution equivalent to those of our program. Minimal requirements are an oral exam comparable with our Thesis Proposal seminar and the passing of some type of comprehensive or cumulative exam. The student should have a comparable number of credits taken in their portfolio. Their coursework should have involved at least two semester courses or three-quarter courses in the field of their specialization.

The following deviation from the composition of the DAC is allowed for the thesis proposal and oral exam:

The member from outside of Drexel University is not required, as long as there is a member from outside the Drexel Chemistry Department present and at least 5 members are present. This is another reason it is desirable to have a 6th member of the DAC.

The Dissertation Advisory Committee members will ask questions specific to the research seminar, as well as general questions related to the candidate's intellectual preparedness for the remaining graduate program experience. Combined with the student's presentation, the time for questioning of the student by the committee shall not exceed two hours. Following the committee's questioning, the student will be excused, and the committee will reach a decision, which will then be conveyed immediately by the Chairperson to the student. A satisfactory outcome enables the student to continue toward the PhD degree (begin taking or continue taking cumulative exams, etc.).

II.D. ANNUAL CHECK OF PROGRESS

Within two months of the first Anniversary date of joining the PhD program, all students, regardless of full-time or part-time status, are required to hold a 1st year progress check with at least three members of their Thesis Proposal Committee. The principal purpose of the meeting is to advise the student on whether they have made satisfactory progress in research, especially during their first summer in the program. The sub-committee will also ascertain if the student has made adequate academic and research progress to continue in the PhD program, transition to the MS program, or leave the program entirely and will forward their recommendation to the GPC. Consideration of part-time status will be made at these progress checks.

All students, regardless of full-time or part-time status, are required invite their full DAC to an Annual Check of Progress, which must subsequently be held with at least three members of their DAC during the window from Monday of week 2 winter term through Friday of week 5 Spring term of their third year, fourth year, etc. A student who has made satisfactory progress at the time of their 1st year progress check, and at the time of their oral thesis proposal exam, may petition the Chemistry Graduate Advisor to have the oral thesis proposal exam count also for the 3rd year check on progress. For a student who expects to hold the final defense within six months, the pre-defense may substitute for the annual progress check.

Students must arrange for this meeting and inform the Graduate Advisor and the GPC chair once the meeting has been scheduled. They should send a three-page report about their research progress one week before their meeting with the committee. That report summarizes their accomplishments, itemizes if and how the specific expectations set forth by the committee at the previous Check of Progress meeting were met, and lists their publications and conference presentations. At the meeting the student will present his or her research to

their DAC, which will discuss with them the content of the presentation and the progress of their research. The annual review should be comprised of a 20-minute presentation and 30 minutes of questions or of a combination not to exceed 50 minutes. After the meeting the DAC will meet, review the committee's report from the previous Check of Progress, and discuss the performance, including whether the expectations from the previous report were adequately met. The performance can be judged as either "satisfactory", "needs improvement" or "unsatisfactory". If the verdict is "needs improvements" or "unsatisfactory" the DAC will stipulate corrective actions with regard to future performance. In the case of unsatisfactory performance, the student will be asked to convene another meeting after 6 months, at which their progress and their compliance with suggestions will be checked by the committee. If the latter deems the performance still as "unsatisfactory", the DAC will recommend to the GPC to dismiss the student from the graduate program. In the case of a "needs improvement" judgment at the end of a regular annual meeting the student has to obtain a "satisfactory" on their performance at their next annual meeting. Two consecutive "needs improvement" judgments will be considered as "unsatisfactory" and will trigger another review after 6 months as described above. In *all* cases, the committee will decide, in consultation with the student's research advisor, whether the expectations from the previous check of progress were adequately met and set specific expectations for the next check of progress meeting. All decisions of the DAC will be documented by minutes or video recording and subsequently recorded by the committee chair in Eforms, or in the case of the 1st year progress check, transmitted to Director of Graduate Studies for archiving.

II.E. COMMUNICATION REQUIREMENT

The communication or language requirement may be satisfied by completing a graduate course in Chemical Information Retrieval (CHEM 767) or Technical Writing (e.g., COM 510) if the latter is approved by the Research Advisor.

II.F. THESIS PRE-DEFENSE

The PhD Candidate will meet with his or her full DAC including its outside member at approximately 6 months prior to planned thesis defense in order to ensure that the student

has laid the foundation for the submission of a thesis that is meritorious of the PhD degree and a successful final defense. It is the student's responsibility to schedule this meeting with their committee. The student must have submitted a manuscript for publication in a peer-reviewed journal to meet the publication requirement stipulated in [section II.H](#) as a pre-condition for scheduling the Thesis Pre-Defense. The student is required to submit the following documents to each member of the DAC at least 2 weeks in advanced of the scheduled meeting:

- an abstract of the pre-defense talk
- a one-page thesis completion plan
- a tentative list of the chapter titles of the thesis
- a current list of the student's publications

During the meeting the student should give a ~30-minute oral presentation that briefly summarizes their research and their dissertation completion plan. This will be followed by 30 - 60 minutes of discussion, to include both student discussion with the committee and a committee-only discussion. The DAC will provide feedback on the student's completion plan and advise the student on recommended work to ensure a successful defense. There is no formal timeline for when the defense must be scheduled - the student may defend when ready, taking into account the feedback from the DAC. Students are strongly advised, however, to expect that 6 months will be needed and are discouraged from scheduling a pre-defense meeting only a few months prior to a desired defense date.

In the case of extensive critical feedback from the DAC a second, follow-up meeting with the DAC may be recommended by the committee chair or student.

II.G. THESIS AND FINAL DEFENSE

A PhD thesis, the heart of the PhD degree, must be written and correctly formatted by the student, accepted by the Research Advisor, presented to the PhD Final Oral Defense Committee, and defended orally. A copy of the Thesis Style Manual may be downloaded from the Additional Information section of the Drexel Libraries webpage, "[Theses and Dissertation](#)." According to university requirements, the presentation and oral defense must be scheduled in the EForms system "**at least four (4) weeks prior to the final defense.**" In the Dissertation Defense tab, the student should enter the dissertation title, date, time, and location of their dissertation defense and select "Defense Notification". Prior to scheduling the Dissertation Defense in EForms, the student should review the Dissertation Committee and ensure it is correct.

Members of the student's PhD Final Oral Defense Committee should be selected in mutual consultation with the student's Research Advisor (see [section II.C.5.](#))

The Committee is the same as the Dissertation Advisory Committee.

It is the responsibility of the student, not their Research Advisor, to submit an acceptable PhD thesis. However, the final defense is not to be scheduled until (i) the Research Advisor and the Graduate Advisor have approved the PhD Final Oral Defense Committee, and (ii) the student has published at least one peer-reviewed article in a scientific journal that is part of their PhD research (see [section II.H.](#)).

One or more members of the examining committee will often be willing to read and comment on at least one draft of the thesis before presentation of the finished version to the committee for the defense. However, a copy of the finished thesis must be received by each member of the examining committee no later than two weeks prior to the final defense. The date, time, location and title of the final defense must be announced publicly in writing and on the departmental web site at least one week prior to the date of the oral presentation. Inclusion of a brief abstract with the announcement is encouraged. When scheduling the final defense, once a student has confirmed that every member of their committee is available on the proposed day and time of their defense, they should then ask the Department Office Coordinator to reserve a suitable room. The final defense of the PhD thesis consists of two parts:

- A public 40-60 minute seminar on the thesis research followed by general questions from the audience with the committee in attendance.
- A private (candidate plus committee) question/answer session (Final Oral Exam), convening shortly after the public seminar. This part of the defense will be documented by minutes. The chairperson of the Final PhD Defense Committee will appoint a committee member as the minute taker. The minutes have to be signed by all committee members.
- After the public seminar and private thesis exam, the Thesis Defense Committee will convene in the absence of the student. The committee will judge the thesis and oral performance separately. For the thesis, the possible outcomes are: (i) accepted, (ii) minor revisions requested, (iii) major revisions requested, or (iv) declined. Minor revisions of the thesis have to be submitted to the committee chair within two weeks after which he or she will decide on the thesis acceptability. If major revisions are requested, the revised thesis has to be sent to all committee members only after they found the revision acceptable. In each case, the final acceptability of the thesis is contingent on the student having carried out the required revision to the satisfaction of the committee chair (for minor revisions) or the committee (for major revisions). If the committee declines the thesis, the student will not be able to graduate with a PhD and will have to leave the program. For the oral exam, the possible results are pass or fail. If the student fails, the oral exam can be repeated within three months after the thesis defense. Extension of the three-month period requires the approval of the Graduate Program Committee and will be granted only under exceptional circumstances. If the student fails the second oral exam, the student will not be able to graduate with a PhD and will have to leave the program.

II.H. PUBLICATION REQUIREMENT

The publication of scientific articles in discipline-appropriate, peer-reviewed journals is the primary method for disseminating research results to the broader scientific community. Given

that the dissemination of such results is essential for the advancement of science as well as an essential skill for the individual scientist, every PhD Candidate must submit to the Graduate Advisor, at the same time that the PhD. Thesis Pre-Defense is scheduled, evidence of at least one (1) peer-reviewed publication in a scientific journal that is part of her/his PhD research and on which they are the first author, which documents that they contributed the majority of the experimental and/or theoretical results. Acceptable evidence is either (i) an electronic copy (pdf) of the published article or (ii) a DOI number that enables the access to a copy of the paper or (iii) a letter (or email) from the journal editor confirming that the article has been accepted. Importantly, the submission of a manuscript for publication in a peer-reviewed journal without its subsequent acceptance does not fulfill the publication requirement. In cases where the fulfillment of the requirement is ambiguous for whatever reason, the issue will be adjudicated by the GPC. Students shall be advised that this paragraph stipulates a minimal requirement. The Research Advisor has the right to expect a higher productivity for graduation. Without this approval, no student can generally move towards their final defense.

II.I USE OF A SCIENTIFIC ARTICLE AS A CHAPTER OR PORTION OF A CHAPTER IN A DISSERTATION

When a given chapter in a dissertation is based in whole or in part on a scientific journal article (published, in press, or submitted), the full bibliographic citation of the article should be listed on the title page of the chapter, along with an estimate and brief description of the relative contributions of all authors.

III. GRADUATE ADVISING

Students who have selected a Research Advisor should consult that person for information and advice on the graduate program in chemistry. For more general or procedural information, full-time students should consult with the departmental Graduate Advisor, while part-time students should confer with either the departmental Graduate Advisor or the Chair of the GPC.

In the case of some irresolvable disagreement between the student and the Research Advisor, the student should consult with the Graduate Advisor and the Department Head. The next four levels of appeal are (i) the Associate Dean for Graduate Studies in the College of Arts & Sciences (CoAS), (ii) the Dean of CoAS, (iii) the Vice-Provost for Graduate Studies, and (iv) the Provost of the University, the latter being the final arbiter. Please check the Graduate College's and/or Provost's website(s) for a formal appeals procedure.

IV. GRADUATE SUPPORT

Financial aid is typically available in the form of a teaching fellowship (TF), research fellowship (RF), and/or tuition remission. Exceptional applicants will also be nominated for a supplemental Dean's Fellowship or Provost's Fellowship. Teaching assistantships and tuition remission are available from the Department on a competitive basis and are therefore not automatically given to every student who is admitted into our graduate program. Both incoming and resident graduate students are considered by request for a departmental TF/tuition remission. RFs are available from individual faculty members via their research grant funds. Please note that the university does not allow a student to hold any other employment in addition to a full teaching or research assistantship.

IV.A. TEACHING FELLOWSHIP (TF)

The current standard Teaching Fellowship (TF) is a 12-month, October-September appointment. Teaching Fellows are required to teach for three out of the four quarters (normally Fall-Winter-Spring); the possibility of not teaching during a quarter other than Summer is dependent on departmental teaching needs. Students with TFs and RFs usually also receive tuition remission for the (substantial) costs of graduate tuition. MS students are not eligible for TF support at Drexel, and tuition remission is normally not awarded without an accompanying TF or RF appointment.

In return for departmental support (TF and tuition remission), the Chemistry Department expects each teaching fellow to carry out his or her duties conscientiously and responsibly. Failure to do so (e.g., not enforcing the eye protection or other safety requirements in lab classes) can result in the loss of the fellowship. If, because of some emergency (such as illness or getting snowed- in during winter), the TF is unable to attend a class, they have to make sure that he/she has made a mutual "back-up" agreement with another instructor, so that one can take the other's place at short notice. The faculty generally does likewise.

The duties of a teaching fellow are somewhat similar to those of the other teaching staff in the Department, generally involving the instruction and guidance of undergraduates in laboratory and recitation classes, most frequently in freshman chemistry courses (CHEM 101-CHEM 167). Each TF works in conjunction with, and under the guidance of one of the chemistry faculty, who has responsibility for the design and execution of the course sequence, and for giving the lectures in the course. When assigned to a course, the TF should therefore consult with the faculty member who is in charge of the course to determine what a student's duties will be for the coming quarter.

The types of activities in which one will find oneself involved include: running labs and recitations; grading of students' lab reports, recitation quizzes and exams; and helping faculty to develop and prepare materials for labs and exams. This translates into an average

of 6-8 hours per week of classroom activity (22 quarter contact hours per year), plus roughly twice that number of hours per week of related work outside the classroom.

New TFs are usually assigned to one of the freshman sequences. Because these are large courses, there are often substantial numbers of recitation and/or lab instructors involved, so that it is necessary to hold informational/organizational meetings weekly; attendance at these meetings is mandatory unless the instructor in charge specifies otherwise.

IV.B. TUITION REMISSION

Remission of graduate tuition is awarded to full time students and only in conjunction with graduate teaching or research fellowships. It covers the full tuition. Contingent on the student's teaching and research performance, a PhD student can generally expect TF support or a combination of TF and RF support (*vide infra*) for a period of not more than five years. After these five years, student's research advisor can keep them on RF support until the seven-year limit stipulated by the Drexel University rules is reached. In the absence of such support, students can apply for an extension of their TF support on a quarterly basis. Applications should include a short summary of a student's progress, a research plan for the upcoming quarter and a reasonable prediction of the time at which the student will have their thesis defense. A letter from the research advisor must accompany the application. Applications have to be sent to the Graduate Program Committee which recommends a course of action to the Department Head. The committee's recommendation depends on the student's productivity, the number of conference presentations, the results of their annual evaluations and their performance as teaching assistant. If an extension of the TF-support is granted, the student will receive 100% tuition remission for the quarter covered by the TF support. If a student is not receiving TF or RF support, they have to pay the tuition for one credit per term and the respective enrollment fees. Under no circumstances will the TF support be extended for a seventh year. Decisions about TF-support beyond a student's fifth year in the program do not depend on whether the student has received RF support (*vide infra*) during the five-year period.

IV.C. RESEARCH FELLOWSHIP (RF)

A Research Fellowship (RF) may be arranged with the Research Advisor if sufficient grant funds are available; the stipend is determined by the Research Advisor. Full tuition remission is generally included in the student's support. Part of the working relationship between a Research Advisor and a research student is that there must be a mutual agreement as to what tasks and responsibilities are involved in a particular RF. When one becomes interested in doing research work with a given faculty member, one may want to inquire about the possibility of a Research Fellowship. MS students are eligible for RF support at Drexel.

IV.D. ALL BUT DISSERTATION (ABD) STATUS

“All but dissertation” (ABD) status is reserved for PhD candidates that have completed the pre-defense requirement. ABD should only be requested if all experiments are completed, and all data collected that are needed for the dissertation.

Use of ABD status shall be limited to three academic terms. Furthermore, ABD status should not be requested when a Leave of Absence (LoA) is appropriate.

One term of ABD status may be requested from the Chemistry Graduate Advisor, who will recommend ABD to the Graduate College if appropriate. Before recommending a second term of ABD status, the Chemistry Graduate Advisor must obtain the approval of the Chemistry Graduate Program Committee. A third term of ABD status will be recommended only upon unanimous approval of the Chemistry GPA and the Chemistry Department Head.

IV.E. FINANCIAL SUPPORT FOR ATTENDING SCIENTIFIC MEETINGS

Departmental resources are available to support PhD-level graduate students who want to attend a national or international meeting in their field of research. Any request for departmental support should be coupled to attempts to secure funding from the Teck-Kah Lim Graduate Student Travel Subsidy of the Graduate College (for national meetings) or from the Office of International Programs (for international meetings). If the student’s Research Advisor has extramural funding, it is expected to partially support their student. A request for departmental support should be submitted to the Department Head at least two months in advance of the event. Requests can be submitted prior to the acceptance of an abstract, but the availability of the money is contingent on the acceptance of the abstract and the documented participation of the student. The expectation is for third year students and beyond to be supported for one conference per year. The decision about the request and the level of support will depend on the Department’s financial situation.

IV.F. SATISFACTORY PROGRESS

Continuation of any of the above forms of financial aid is contingent on satisfactory academic and research performance. Performance is evaluated annually by the Graduate Program Committee and based upon the student’s academic transcript and research progress reports ([see section II.D](#)). The Department generally supports PhD students (via stipend and/or tuition remission) for no more than 20 quarters of graduate work from the date in which they entered the graduate program, except in the case of a department-approved leave of absence. Support beyond the first 20 quarters is strictly at the discretion of the Department and/or the Research Advisor if the latter has funds to support a graduate student.

V. COURSE SELECTION

V.A. CORE COURSES

V.A.1 ANALYTICAL CHEMISTRY

CHEM 530, Spectroscopic Methods, Fall: Introduction to optics, interaction of electromagnetic radiation with matter, design of optical instruments, survey of spectroscopic methods of analysis.

CHEM 531, Chromatographic Methods, Winter: Principles of separation, resolution theory, pressure- and voltage-driven flow, separative and dispersive transport, survey of chromatographic instrumentation (pumps, injectors, columns, detectors), survey of chromatographic separation modes and applications

CHEM 755, Mass Spectrometry, Spring: Basic interpretive skills for organic & biochemical analysis; survey of ionization methods, ion selection or separation techniques and detection; applications in chemistry & biology.

V.A.2 INORGANIC CHEMISTRY

CHEM 521, Inorganic Chemistry I, Fall: Review of electron-counting rules (including 18-e Rule) & their correlation with structure. Molecular symmetry. Coordination complexes: structure, constitution, isomerism & chirality; complexation in solution, the chelate effect; HSAB concept. X-Ray diffraction applied to inorganic molecules: utilization of CIF files; Bond Valence Sum; lattice types. Qualitative MO approach for homonuclear systems.

CHEM 522, Inorganic Chemistry II, Winter: Group theory with applications to the bonding, magnetic and optical properties of inorganic molecules. Transition metal cations in crystal fields of various symmetries, crystal field stabilization energy. Molecular orbital construction for polyatomic and centric molecules. Spectroscopy/structure relationships for inorganic molecules (first part).

CHEM 523, Inorganic Chemistry III, Spring: Redox potentials and basic electrochemical methods; inorganic spectroscopy and structure (continued); reaction kinetics; metalloprotein examples.

CHEM 771, Organometallic Chemistry: Structures, reactivity, mechanisms of important organometallic complexes and reactions. Applications in organic synthesis and polymer chemistry.

CHEM 772, Bioinorganic Chemistry: Metal transport and storage in biological systems, structure and function of metalloenzymes, reaction mechanisms, synthetic systems for metalloenzyme modeling.

V.A.3 ORGANIC CHEMISTRY

CHEM 543, Organic Chemistry III, Fall: Mechanisms of organic reactions and the techniques of studying them: acyl and alkyl substitution, carbocations, carbanions, free radicals, carbenes, nitrenes, ylides, simple kinetics, isotopic labeling, cross-overexperiments, acidity concepts, substituent effects, Hammett equation.

CHEM 542, Organic Chemistry II, Winter: Static or "Classical" Stereochemistry (stereoisomerism, chirality, stereogenic and chirotopic atoms, internal stereocomparisons [homotopic and heterotopic groups and faces, prochirality, applications to NMR, asymmetric syntheses, biochemical problems such as enzymereactions and configurational determinations], conformational analysis of cyclic andacyclic molecules. Dynamic Stereochemistry (relationships between structure, geometry and reactivity, physical methods of conformational determinations, use of stereochemistry mechanistic studies.

CHEM 541, Organic Chemistry I, Spring: Spectroscopic methods of analysis, including mass spectrometry (MS, principles of MS, the mass spectrum, fragmentation mechanisms, special topics), Infrared (IR, principles of IR spectroscopy, the infrared spectra of functional groups), Ultraviolet Spectroscopy (UV, principles of UV, UV absorption by organic functional groups, special topics); Nuclear Magnetic Resonance (NMR, theory of NMR, Proton NMR (chemical shifts, coupling constants, structural determination using NMR, shift reagents and Chiral solvating agents), Carbon NMR (FT-NMR, chemical shifts, special topics).

V.A.4 PHYSICAL CHEMISTRY

CHEM 557, Physical Chemistry I: Spectroscopy, Winter, every other year, alternating with CHEM 558: Schrödinger's equation and particle-wave duality, atomic structure and spectra, optical spectroscopy on molecules (rotational, vibrational and electronic spectra) molecular symmetry, emission and absorption of light, time independent andtime dependent perturbation theory, magnetic resonance spectroscopy.

CHEM 555, Quantum Chemistry of Molecules I, Fall: Covers general properties of operators; Schrödinger's equation and its solutions for a particle in a box; harmonicoscillator, tunneling problems, rigid rotor, and the hydrogen atom; approximation methods; and absorption of radiation and selection rules.

CHEM 558, Physical Chemistry II: Statistical Thermodynamics, Winter, every other year, alternating with CHEM 557: Covers statistical mechanics of distinguishable and indistinguishable particle systems, statistical definition of entropy, canonical andgrand canonical ensembles, Fermi-Dirac and Bose-Einstein statistics, physics of phase transitions, ideal and non-ideal mixtures, physical chemistry of

polymers and thermodynamic functions for both systems and chemical equilibrium, diffusion and friction.

CHEM 752, Biophysical Chemistry, Spring (depending on demand): Peptide conformation, protein structure, peptide and protein folding, intrinsically disordered proteins, heme proteins, electron transfer proteins, enzyme kinetics, membrane biophysics, biophysical techniques (X-ray, NMR, fluorescence, vibrational spectroscopy).

CHEM 554, Chemical Kinetics, Spring, generally every other year: Focuses on experimental and theoretical considerations of chemical reaction rates.

V.A.5 POLYMER CHEMISTRY

CHEM 561, Polymer Chemistry I, Fall: Scope of polymer chemistry & science; structure/property relations; step (condensation), free-radical, cationic anionic, group-transfer, ring-opening polymerization; stereochemistry of polymerization; coordination and metathesis polymerization; non-classical chain polymerization; inorganic polymers; reactions and degradation of polymers; template polymerization; biological polymers.

CHEM 562, Polymer Chemistry II, Winter: Kinetics and thermodynamics of polymerization; theories for and control of step-polymerization and gelation; copolymerization composition; polymerization-depolymerization equilibria; polymer characterization; determination of molecular weight and its distribution by end-group analysis, membrane osmometry, vapor-phase osmometry, light-scattering, solution viscosity, and gel-permeation chromatography.

CHEM 563, Polymer Chemistry III, Spring: Basic concepts on the properties of materials; rubber elasticity; morphology; viscoelasticity; T_g and T_m theories; thermal analysis; dynamic mechanical analysis; X-ray diffraction; spectroscopic techniques; thermodynamics of polymer solutions; conformational analysis and computational methods; basic testing, fabrication and processing; electrical, optical and magnetic properties; frontiers in polymer research.

V.B. SPECIAL TOPICS COURSES

In addition to the 'permanent' graduate courses listed in the Graduate Catalog, each quarter the graduate faculty offer a variety of special topics courses (CHEM 680-OXX & other CHEM 700- CHEM 800 level courses) worth 3 credits each. A listing of both permanent elective and special topics elective courses is given below. These courses are not usually taken during the first couple of quarters of study, because they usually have content more specialized than that of the core courses and are often more research oriented. Consult the Graduate Catalog and the quarterly class listing schedule for more information.

Several elective courses are seminar-style courses in the various areas of Chemistry. Not all courses are offered every year, so if a student is interested in a particular course, they should contact the listed faculty member for course schedule information. Note that the number of these course credits that can be counted toward the requirements for the MS or PhD is not unlimited (particularly for seminar-type courses); students should consult the Graduate Advisor regarding this issue. This also applies to CHEM 865 (Chemical Research Seminar), credit for which can be counted once toward the MS degree.

| Course | Course Title | Usual Instructor | Notes |
|----------|--|--------------------|-------|
| CHEM 571 | Chemistry of Biomolecules | Xi | |
| CHEM 680 | Special Topics (general) | | |
| CHEM 751 | Magnetic Resonance in Chemistry | | |
| CHEM 752 | Biophysical Chemistry | Schweitzer-Stenner | 1 |
| CHEM 753 | Chemical Instrumentation Lab | Owens | 1,3 |
| CHEM 767 | Chemical Information Retrieval | Sohlberg | 1 |
| CHEM 772 | Inorganic Biochemistry | | 1 |
| CHEM 774 | Electrochemistry for Chemists | | 1 |
| CHEM 780 | Experimental NMR Lab | | 2 |
| CHEM 788 | Atmospheric Chemistry | Wood | |
| CHEM 789 | Experimental Design & Statistics in Chemistry | Owens | 1 |
| CHEM 792 | Advanced Organic Synthesis I | N.A. | 1 |
| CHEM 793 | Advanced Organic Synthesis II | N.A. | 1 |
| CHEM 794 | Organic Reaction Mechanisms | N.A. | |
| CHEM 862 | Topics in Inorganic Chemistry | | 1 |
| CHEM 865 | Chemistry Research Seminar | Ji | 4 |
| CHEM 866 | Topics in Polymer Chemistry | | |
| CHEM 868 | Topics in Analytical Chemistry: Modern Liquid Chromatography, Chromatographic Data Acquisition & Interpretation, Capillary Electrophoresis | Foley | 1 |
| CHEM 997 | Research | | |
| CHEM 898 | MS Thesis | | 5 |
| CHEM 998 | PhD Dissertation | | 6 |

Notes:

- (1) These courses have been offered recently.
- (2) This course has CHEM 541 as prerequisite/co-requisite.
- (3) Should not be taken for more than 6 credits total.
- (4) This course is normally scheduled to meet almost weekly during the Fall, Winter, and Spring quarters. All full-time graduate students are expected to attend Department seminars every term unless they have a teaching or class conflict.
- (5) For MS- thesis option candidates only.

(6) Enrollment for “PhD Candidates” only.

VI. SELECTION OF RESEARCH ADVISOR

All graduate students wishing to engage in research are required to select a Research Advisor who is a full-time, tenure-track faculty member in the Department. It is possible to perform graduate research under the direction of one of the research faculty associated with the Department as a co-advisor, but the Research Advisor must be in full agreement with the arrangement.

It is expected that incoming students have already selected their research advisor after their interview. In cases that this had not happened, a PhD student should speak with as many of the faculty as possible, including all those in the student’s major area of interest, about present and future research plans.

All full- and part-time PhD students must choose their Research Advisor no later than the end of the **first** quarter of the first year. When talking to faculty members about their research, feel free to ask for reprints of recent papers, preprints of papers in press, and planned research as reflected in submitted research proposals. When both the student and the faculty member reach agreement regarding the general area of research to be done for the PhD thesis, the student should fill out the Plan of Study in EForms. Thus, a student is expected to start research not later than at the beginning of their second quarter of residence at Drexel. If a student intends to obtain a thesis-option MS degree, it’s advisable to commence that research as soon as possible as well.

Even with the best planning it sometimes becomes necessary for a student to switch Research Advisors. It is recommended that the student discuss the situation with either the Graduate Advisor or Department Head. Students may switch Research Advisors once during their graduate program and a new Research Advisor must be appointed within 4 weeks after leaving the original Research Advisor’s group. Except under exceptional circumstances approved by the GPC and Department Head, switching Research Advisors for a **second** time is **not** permitted.

VII. APPENDIX

VII.A. TIMELINE CHECKLIST

| Timeline (PhD Students) | EForms | Deadline |
|---|------------------------|---|
| Year 1 | | |
| Appoint Research Advisor. Research Advisor will need to confirm the appointment. DGS will need to approve | Supervisor Appointment | End of Fall quarter (or earlier) |
| Discuss with Research Advisor all courses needed and complete the Plan of Study in EForms system. A detailed list of courses can be attached in the Supporting Documents' step if necessary. | Plan of Study | End of Fall quarter (or earlier) |
| Demonstrate proficiency in four sub-disciplines: analytical, inorganic, organic, and physical by any these ways: (a) Earning a score of 50%ile or higher on each registration exam. (b) Earning a B or better grade in core courses of those areas. | | End of Spring (or Summer -point c) |
| Year 2 | | |
| Select Dissertation Committee for first annual check of progress | | 1st week of Fall |
| Annual Check of Progress (1st check) | | Week 7 of Fall |
| Complete all required courses | | End of Spring quarter |
| Complete cumulative exams (achieve 5 points) | | End of Spring quarter |
| Complete candidacy requirements | Candidacy Exam | End of Spring quarter |
| Year 3 | | |
| Select Dissertation Committee (in consultation with Research Advisor and DGS Approval). | Dissertation Committee | Before week 4th in the Fall |
| Thesis Proposal | Proposal Defense | As early as practical but no later than the end of week 7 in the Fall quarter |
| Annual Check of Progress | Annual Review | End of Spring quarter |
| Year 4+ | | |

| | | |
|--|----------------------|---|
| Annual Check of Progress | Annual Review | End of every Spring quarter |
| Thesis Pre-Defense | | At least 6 months prior to planned thesis defense |
| Submit to the Graduate Advisor an electronic copy of a peer-reviewed publication in which the student is the first author | | At least 4 weeks prior to final defense |
| Prior to the final defense of the dissertation, finalize the PhD Final Oral Defense Committee Appointment (update "Dissertation Committee" in EForms if necessary), and schedule the defense (enter date, title, location) | Dissertation Defense | At least 4 weeks prior to final defense |
| Deliver printed copy of dissertation to each member of the Final Oral Defense Committee | | At least 2 weeks prior to final defense |
| After passing the oral defense and all revisions have been made and approved by the Dissertation Committee submit thesis to ProQuest (following Library instructions). | Submit Thesis | Hard University deadlines on each term |