Table of Contents

I. Program Overview .............................................................................................................. 4

II. Curriculum ....................................................................................................................... 5

III. Program Policies ........................................................................................................... 7

IV. Designing Your Program and Course Registration....................................................... 10

V. Capstone and Graduation Procedures ........................................................................... 14

VI. University Policies and Resources ............................................................................... 17

VII. Appendices

   A. MCS Curriculum...................................................................................................... 24

   B. Capstone Handbook................................................................................................ 27
Introduction

The purpose of this handbook is to provide students in the Master of Chemical Sciences (MCS) Program with information vital to the successful completion of the program. In this handbook you will find information on academic requirements, recommended courses, program and University policies, and resources both inside and outside of Penn. This handbook is designed to provide general information and does not supplant official University publications, University web pages, or regular meetings with your advisor. You should plan to meet with your academic advisor at least once per term to discuss your progress and course selection. The MCS Associate Director is available for general, logistical, academic, and career advice. In addition, should you have questions that are not answered here or problems that you cannot resolve, you should consult your academic advisor or the MCS Associate Director immediately.
I. Program Overview

The Master of Chemical Sciences (MCS) at the University of Pennsylvania is a 10 Credit Unit (CU) non-thesis graduate program designed to prepare students for various professions in chemistry-related industries.

The MCS is designed to give you a well-rounded, mechanistic foundation in a blend of chemistry topics. The curriculum is structured with a combination of core concentration and elective courses, which allow you to focus on topics best suited to your interests and goals. As a culminating exercise, students must complete an individual project that demonstrates their ability to define a project, develop appropriate methods, complete research, and present the results in a clear and concise manner. Many MCS students select a format for this project that represents the profession they hope to enter.

Students may study in the MCS program part-time or full-time and may take either day or evening courses pre-approved by the student’s advisor and/or the program director. Part-time students are expected to complete their degree in no more than four years.

Relationship within the University

The MCS Program is housed in the School of Arts and Sciences (SAS), overseen by the SAS faculty, administered by the MCS Associate Director, and located in the Department of Chemistry. The program is administered through the College of Liberal and Professional Studies (LPS), which falls under Professional and Liberal Education.

Your enrollment status (part-time or full-time) will determine for which Penn services you are eligible. Full-time students are enrolled in 3 or 4 courses per semester, while part-time students are enrolled in 1 or 2 courses per semester. Students are permitted to change their status from full- to part-time and vice versa at any point in their career without seeking prior permission. However, international students should be aware that they must maintain their full-time status to meet visa requirements.
II. Curriculum

The following is the standard curriculum for MCS students. Students are required to complete at least 10 CUs of graduate-level course work for the MCS program. There are two required courses for the MCS program:

- MCS 599 – Proseminar taught during fall semester of the 1st year, and
- MCS 699 – Capstone, which students register for following completion of their research.

MCS 599 – Proseminar
A required course during a student’s first year, this class will review fundamental concepts regarding research design, the scientific method, searching scientific databases, ethical conduct, and professional scientific communication. Students will be required to give oral presentations and submit written assignments. This course will also acquaint students with issues, debates and current opinions in the study of chemistry, which should help them start defining their capstone project.

MCS 699 – Capstone
The research project, expected to span two terms with advisor approval, will culminate in a written capstone, which will count as 1 CU towards degree requirement.

Students also take 4-6 core courses in an area of concentration, which will allow them to acquire the skills necessary to master a sub-discipline and will help them prepare for their final capstone project. Ideally, each student builds on previous academic and professional experience when developing a concentration. The development of a concentration should be done in consultation with an academic advisor and the MCS Associate Director.

Areas of concentration in chemistry include:
- Biological
- Inorganic
- Organic
- Physical
- Material

Specific courses that fulfill each concentration are listed in Appendix A. Students also register for 2-4 electives in other concentrations areas in chemistry, physics, biology, or engineering with approval of the MCS Associate Director.

An optional Independent Studies course (MCS 910) provides opportunities to conduct laboratory research in the Department and learn specific analytical techniques appropriate for a future capstone project. The course may be repeated for credit with permission of the instructor, but only 1 CU may count toward the minimum 10 CUs required for the MCS degree.

Program of Study

Students should meet with their advisor each semester prior to registering for courses. This is especially important during a student’s first semester when a Program of Study (available through Penn in Touch) should be completed. The MCS Associate Director is also available for general, logistical, academic, and career advice.
Below is a sample course schedule for a full-time student completing the MCS degree with an area of concentration in Physical Chemistry.

<table>
<thead>
<tr>
<th>FALL</th>
<th>COURSE</th>
<th>CUs</th>
<th>SPRING</th>
<th>COURSE</th>
<th>CUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 521</td>
<td>Statistical mechanics I</td>
<td>1</td>
<td>CHEM 522</td>
<td>Statistical mechanics II</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 523</td>
<td>Quantum chemistry I</td>
<td>1</td>
<td>CHEM 524</td>
<td>Quantum chemistry II</td>
<td>1</td>
</tr>
<tr>
<td>MCS 599</td>
<td>Proseminar</td>
<td>1</td>
<td>MCS 910</td>
<td>Independent studies</td>
<td>1</td>
</tr>
</tbody>
</table>

**SUMMER**

Work on capstone project

<table>
<thead>
<tr>
<th>FALL</th>
<th>COURSE</th>
<th>CUs</th>
<th>SPRING</th>
<th>COURSE</th>
<th>CUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work on capstone project</td>
<td></td>
<td></td>
<td>CHEM 525</td>
<td>Molecular spectroscopy</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 526</td>
<td>Chemical dynamics</td>
<td>1</td>
<td>STAT 500</td>
<td>Applied regression and</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>analysis of variance</td>
<td></td>
</tr>
<tr>
<td>MCS 699</td>
<td>Capstone</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total CUs** 10

**Capstone Project**

The capstone project lasts a minimum of 6 months and represents the culmination of an MCS student’s graduate study. It reflects each student’s concentration and the coursework that prepared him/her to undertake the proposed capstone project. It may also build upon the student’s previous academic or professional experience. Under no circumstances will previous work experience exclude students from the capstone requirement. The capstone component may be a choice of a Penn laboratory research project, an off-campus laboratory research project, or a literature-based review project, but ALL components will require an approved proposal prior to initiation (Appendix B) and a completed scientific report (guidelines in Appendix C).

The capstone proposal will be developed and approved by the student in collaboration with the student’s academic advisor, and either a secondary reader or an off-site project supervisor. Proposals for the capstone project are due at least 3 weeks prior to the start of the project, typically at the end of the spring semester. Final approval from the MCS Associate Director is also required before the project can begin.

**NOTE:** If a part-time student is currently working in the chemical industry, it is acceptable for them to complete their capstone project with their current employer; however, they must clearly demonstrate what new skills they will acquire through the experience.

Most students are expected to start their capstones at the end of the first academic year in the summer and conclude at the end of the fall semester of the second year. Depending on the capstone option selected, students may begin working on the project as early as the spring semester of their first year in the program. The course grade for capstone credit will be assigned by the primary reader, taking into consideration feedback received from the secondary reader (Appendix E). See Section V and Appendix B for additional details.
III. Program Policies

Academic Standards

Students in the MCS are expected to maintain the highest possible academic standards. To assure that students are making satisfactory progress toward their degree, the academic advisor and MCS Associate Director regularly review student performance.

The MCS Faculty Advisory Committee has adopted the following requirements for MCS students as they progress toward their degrees:

- Students must maintain a grade-point average of B (not B-) or better in lecture courses. "C" grades are considered failing grades and are not accepted for course credit toward graduation. If a student receives a C, they must retake that course or an equivalent course in their second year. Receiving two C grades may lead to dismissal from the program. The graduate committee reviews the academic performance of all students at the end of each term. Students may be asked to leave at the end of either the first or second term, based on academic performance.

- All students must be in good standing in order to remain in the MCS program and graduate, which means that they must maintain a minimum 3.0 GPA. No more than two courses with a grade below “B” may be counted toward the degree requirements. Students who receive a grade below a C+ or have more than one C+ will be reviewed by the MCS Faculty Committee and may be placed on academic warning or dismissed from the program. MCS students are limited to one incomplete (I, GR. U, or NR) at a time. Students with two or more incompletes on their transcript will have their registration automatically blocked until they complete those courses. Incompletes will automatically be turned to an “F” at the end of the semester following the term in which the Incomplete was received.

- Students must follow the Penn Code of Student Conduct; any student who violates the Code of Student Conduct will not be considered in good standing. Students must follow all guidelines for ethical conduct, research, and publication – please review these resources:
  - Penn’s Code of Academic Integrity
  - Penn Handbook for Students: Ethics and Original Research
  - Responsible Conduct of Research (National Science Foundation)
  - “On Being a Scientist” (National Academy of Sciences)

- Students must maintain regular contact with their academic advisor and MCS Associate Director. Academic advisors help students select courses appropriate for their area of concentration and facilitate career development by helping students build connections on and off campus. Academic advisors and off-site project supervisors guide development of the capstone project and review the capstone report. The academic advisor assigns the final grade for MCS 699 Capstone. Selecting an academic advisor requires preparation – prior to meeting with professors students should:
  - Visit the Chemistry Department’s website to learn about faculty members who could potentially serve as academic advisors
  - Read recent publications by the professor and their colleagues
  - If possible, attend seminars and/or group meetings

Students should then work with the MCS Associate Director who will facilitate the selection and assignment of an academic advisor. During your initial meeting with the professor who may serve
as your academic advisor, you should discuss pertinent academic information to confirm that your research interests fit with the goals of their laboratory.

During fall semester, beginning in mid-September through mid-November, a weekly evening seminar series will feature 15-20 minute presentations given by 2-3 current faculty members. These short seminars are excellent opportunities to learn about research being conducted in the Chemistry Department. Student attendance at these seminars is suggested, regardless of area of concentration.

Academic Grievances

Evaluation of a student's performance in a course is the responsibility of the course instructor. Should a final grade in a course be disputed, the student must submit a written appeal to the instructor within the first two weeks of the academic semester immediately following the semester in which the grade was received. The instructor must respond in writing to the student within two weeks of receiving the written appeal. If, after receiving the written response from the instructor, the student still believes that the grade has been unfairly assigned, the student must submit a written appeal to the MCS Associate Director. If the Director believes the appeal demonstrates evidence of negligence or discriminatory behavior, the MCS Faculty Advisory Committee will review the student's appeal and make a recommendation. The decision of the Committee is final.

Enrollment Status

Inactive Status
Students who do not enroll in courses for four consecutive terms, including summer, will be considered inactive and will be automatically withdrawn from the program. Students who are withdrawn from the program will be required to apply for readmission to the program. Standard application fees will apply.

Leave of Absence
MCS students are not required to take courses in each term to remain active in the program. However, they must take one course every three semesters (including summer) to remain active. Students who discover that they are unable to continue with their coursework after three semesters, but wish to remain in the program, should consider requesting a leave of absence. These students should notify the MCS Associate Director in writing of their desire to take a leave and give their reason for the leave. A leave of absence can be taken for up to one year. If the student must extend the leave of absence for more than one year, they should request an extension in writing from the MCS Associate Director.

Provisional status
Some students seeking admission to the MCS are returning to school after a long absence or have undergraduate records that do not accurately reflect their academic ability. Those applicants may be accepted into the MCS provisionally. Applicants accepted as provisional admits must adhere to the following procedure:

- Students must complete two graduate level courses at Penn in the MCS program. One of the courses must be MCS 599 Proseminar.
- The student must receive a grade of "B" or better in both courses and must receive a favorable recommendation from the instructors of both courses.
Students who meet these requirements will be fully admitted into the program. If after two courses, students do not meet the requirements outlined above, they will not be able to continue in the MCS program.

Deferred Enrollment
Students who are admitted to the MCS program may defer their matriculation for up to one year. Students who wish to defer should notify the MCS Associate Director in writing of their intentions as early as possible. It is not necessary for deferred students to reapply. However, students must inform the MCS program if they enroll at any other institution prior to their matriculation at Penn, and they must submit final official transcripts of any coursework completed prior to their enrollment at Penn.

Transfer Credit
Students who enter the MCS program from the Non-Traditional Graduate program at the University of Pennsylvania may count up to 2 graduate-level courses towards their MCS degree. These courses must be submitted to the MCS Faculty Advisory Committee for approval during the first semester of matriculation in the MCS program. Only courses appropriate to the student’s degree program will be considered for approval.

Students who enter the MCS program from a graduate program at another university may not count any graduate-level courses towards their MCS degree. Similarly, courses taken outside the University of Pennsylvania during a student’s matriculation in the MCS program are not eligible for transfer credit.

Financial Aid
MCS students have limited eligibility for University-based fellowships, teaching and research assistantships, or scholarships; and students can also seek outside scholarship support (e.g., National Science Foundation, National Oceanic and Atmospheric Administration). U.S. citizens or permanent residents are eligible to apply for loans through Penn’s Office of Student Financial Services. Full-time students (taking 3 or more courses in a semester) may be eligible for full loan support, and part-time students (taking 1-2 courses in a semester) may be eligible for partial loan support. International students are not eligible for loans through the University.

Research Support
The MCS program does not have funding to support costs incurred during the conduct of student research. Funding for completion of research for the capstone project must be provided by the on-campus academic advisor and/or the off-campus organization sponsoring the student.
IV. Designing Your Program and Course Registration

Student Advising

Each student entering the MCS program will be assigned an academic advisor based on the concentration they have chosen. That advisor will guide the student through the initial course registration and program introduction. At the beginning of their first semester, students should meet with their academic advisor and define a Program of Study plan for their MCS career.

Students should meet with the MCS Associate Director at least once a semester to discuss their program progress and choose courses for the following semester. The worksheet available on Penn In Touch can help define a student’s Program of Study and coursework. Students should work with MCS Associate Director and their academic advisor to ensure that all degree requirements are fulfilled and the worksheet is completed for graduation.

First Year Students will do the following:

- Take 6 CUs of coursework, including MCS 599 Proseminar fall semester
- In collaboration with the academic advisor and capstone supervisor, define a research project, draft and get approval of a proposal spring semester

Second Year Students will:

- Complete their research project, write their paper, and receive a grade for MCS 699 Capstone
- Make sure all requirements for graduation are met (see Section V. below).

Course Registration Procedures

Course Selection
Appendix A provides a list of approved courses for the MCS program. Additional chemistry and other types of courses offered at Penn are available online at the University’s Course Register. The Course Timetable is available online and lists when courses are offered each semester. If a student selects a course that does not appear on the approved MCS program list, they must seek approval from their MCS Associate Director as it may not be acceptable for the program.

Advance Registration
The course registration process involves two registration periods. The first is advance registration when students enter their requests for courses they wish to take. Students are encouraged to register during this period so that they have the best chance of getting into the courses they prefer. At the end of advance registration, a scheduling program processes all registration requests at the same time to determine who gets enrolled in the courses that have been requested. Students can then view in which of their preferred courses they have actually been enrolled. Students may advance register during a two-week period starting in late March for the following summer and fall terms and during a two-week period in late October/early November for the following spring term. Check the LPS Academic Calendar for the exact dates for Advance Registration.

Registration
The regular registration and add/drop period opens approximately three weeks after the advance registration request period has closed and students have been notified of their schedules. During the
regular registration period, students will know immediately whether or not they will be able to enroll in the course they are requesting. Students may register for courses through Penn InTouch (on-line registration). Registering through Penn InTouch requires the use of a personal computer and access to the Internet, and it is the recommended method of registration.

In order to access the system, students must have a PennKey. A PennKey SetUp Code is mailed to each new student’s home address to help them set-up this access.

Some important information to remember when registering for courses:

- Check with your academic advisor and the MCS Associate Director to be sure the course for which you are registering fulfilli$s a requirement for your degree.
- Courses must be taken for a normal letter grade in order to count toward the MCS degree; “pass/fail” or “audit” are not acceptable options.
- Only courses numbered 400 and above may count toward the degree (the first set of three digits after the course subject is the course number (e.g., MCS 599 001).
- As a master’s student, permission may be needed from the instructor to register for some graduate courses in other departments or schools.
- Full-time students should enroll in 3 or 4 courses; students are not permitted to enroll in more than 4 courses per semester.
- Part-time students should enroll in 1 or 2 courses per semester.

Permits
Courses that require special permission from the department or instructor are indicated in the course timetable as “Permit Required”. Permits are obtained from the department offering the course and entered electronically into the Student Record System (SRS). A permit is not a registration. Students must “claim” the permit by actually enrolling in the course through Penn InTouch. After both advance registration and regular registration are complete, the Registrar’s Office removes unused permits from students’ records.

Independent Studies
Students interested in pursuing an individualized study project on campus or joining a faculty member’s research team to learn specific laboratory skills should register for MCS 910 Independent Studies. Students should first communicate their interests to their advisor and the Associate Director of the MCS program prior to approaching a faculty member. They will facilitate the process of identifying an appropriate faculty member for the student. Students should bear in mind that faculty members are not required to supervise an Independent Studies course. An additional laboratory fee of $250 is required for this course. MCS students may register for up to two Independent Studies courses during their academic career; however, only one CU will count toward the minimum 10 CUs required for graduation.

Auditing Courses
MCS students may audit courses in the School of Arts and Sciences; however, they will be charged tuition and fees at the MCS tuition level. Audited courses will appear on the student’s transcript, but no grade will be issued and the course will not count toward the 10 CUs needed to complete the program. Most courses are open to auditors on a space-available basis.
Registering for Non-MCS Courses (also see “Permits”)
MCS students may register for graduate courses (numbered 400 or above) in other Penn departments and schools, if those courses are appropriate to the student’s program. Students should first consult with their MCS Associate Director to determine if the course is appropriate to their program prior to registering.

Students in the MCS program may need permission to register for courses outside the Department of Chemistry. In such cases, students should contact the MCS Associate Director. They may not be able to register until all students in the home department or school have had a chance to register. Permits will then be issued on a first-come first-served basis.

Course Changes
MCS students are subject to LPS registration and drop/add deadlines, which may be different than deadlines for other schools and departments. Students should consult the current LPS Course Guide or the LPS Academic Calendar for deadlines to make registration changes and view financial obligations. Students can make changes in Penn InTouch. Adherence to LPS deadlines is strictly observed. Should students need to drop or withdraw from a course beyond the deadline, they should contact their MCS Associate Director. It may be necessary to provide documentation of the situation that necessitates the drop or withdrawal, particularly if the student is requesting a refund of tuition.

Adding a Course
Students may add a new course through the second week of the term – but this is not recommended unless the student has been attending the course. After that, it will not be possible to add a course. Students should use Penn InTouch to add courses during this time.

Dropping a Course
Students may drop a course with no financial obligation until the published deadline in the current LPS Course Guide (approximately two weeks into the term). Students may also drop a course between the second and fourth weeks of the term, but in so doing they will incur a 50 percent financial obligation for the tuition and fees for the dropped course. Absence from class does not constitute a drop, nor does notifying the instructor. Students can officially drop a course through Penn InTouch through the second week of the term. After the second week of the semester, students must contact the MCS Associate Director directly to drop a course. When making registration changes via Penn InTouch, it is always advisable to double check and make sure the changes have taken effect before logging-out. Students may also want to contact the MCS Associate Director to confirm that the dropped courses are no longer on their schedules. Students who fail to drop a course officially may receive a grade of F and will be required to pay the full tuition rate.

Changing Grade or Credit Status of a Course
All courses must be taken for a letter grade if they are to be counted toward the minimum CU requirement for graduation. However, students may register for courses that they do not want to count for their program on an audit or Pass/Fail basis. Before doing so, however, they should discuss this with their MCS advisor. Once they have done so, students may change their status in a course from credit to audit, from a letter grade to Pass/Fail, or from Pass/Fail to a letter grade until the deadline listed in the current LPS Academic Calendar for “Last day to change grade status in a course”. No change is permissible after the published deadline. Auditors pay full tuition and fees.
Withdrawing from a Course
Students may withdraw from a course after the deadline to drop a course has passed (approximately four weeks into the term). To withdraw, students must see the MCS Associate Director, submit a Withdrawal Form outlining the reasons for the request, and obtain written approval from the instructor. Normally, permission is granted and a W (withdrawal) is recorded on the transcript.

After the published withdrawal deadline, students are permitted to withdraw only under extraordinary circumstances, which must be documented. Students who withdraw from a course have full financial obligation, except in documented cases of illness, military service, or other extraordinary circumstances, when they may petition for a 50 percent refund.

Note: Dropping a course is not the same as withdrawing from a course. Withdrawing from a course occurs after the drop deadline and carries with it full financial obligation. In addition, the student’s transcript will have a "W" next to the title of the course. However, if a student drops a course during the normal Add/Drop period, no record of that course will appear on the transcript.

Master’s Continuation Registration
MCS students who have completed all course work toward the degree, but have not completed their capstone project for a grade in MCS 699, will be automatically enrolled in the non-credit Master’s Continuation course (MCS 990) for every subsequent semester until the Capstone course is complete. This includes the summer semester; therefore, if a student does not complete their capstone in May, they will be automatically enrolled in Master’s Continuation during the summer. If the Capstone is not completed by August, the student will be automatically enrolled in Master’s Continuation for the fall semester. The cost of thesis registration is less than the cost of a regular course and keeps the student status active (check with the MCS Associate Director for the current tuition rate). Students enrolled in Master’s Continuation have access to the library and maintain their Penn e-mail accounts. Should a student wish to extend Master’s Continuation registration beyond two semesters, they must receive permission from the MCS Faculty Advisory Committee. Students not completing the program requirements after two semesters of Master’s Continuation may be withdrawn from the program.

Student Status
Students with visa, immigration restrictions, and/or loan requirements should be aware of their student status. Students are considered full-time if they meet one of the following criteria:

- Student is enrolled in 3 or 4 courses in a single semester
- Student is enrolled in the Capstone course (MCS 699)
- Student is enrolled in the Master’s Continuation course (MCS 990)

If a student is enrolled in two or fewer courses in a single semester (other than Capstone or Master’s Continuation), they are considered part-time. Students who meet the requirements of a full-time student are automatically enrolled in Penn’s student health insurance coverage unless they show proof of coverage through another source.
V. Capstone and Graduation Procedures

Faculty Readers and Project Mentors

Two faculty / expert academic readers are required for the capstone project. They will help the student develop the capstone proposal, approve both the proposal and the final Capstone scientific report, and will ultimately assign a grade for MCS 699. A more detailed description of the readers’ roles and responsibilities is included in Appendix B (Capstone Handbook).

Students should attempt to identify their faculty readers as early as possible in their career. If they are having difficulty identifying faculty readers, the MCS Associate Director can recommend likely prospects among the faculty. However, it is the student’s responsibility to contact the potential readers and discuss their project ideas in depth.

The proposal must be submitted to the MCS Associate Director for final approval prior to the student beginning their research work.

Capstone Project

The capstone project should last a minimum of 6 months and represents the culmination of an MCS student’s graduate study. Under no circumstances will previous work experience exclude students from the capstone requirement. Your research project should focus on a topic you decide upon in consultation with your academic advisor. You will need to show a grasp of the theoretical underpinnings of the research you undertake and be able to justify the reasons for the research. The capstone may be a choice of a Penn laboratory research project, an off-campus laboratory research project, a literature review or data management based project, but ALL components will require an approved proposal prior to initiation (Appendix B, Capstone Handbook), oral presentation, poster presentation, and a complete scientific report.

Most students are expected to start at the end of the first academic year in the summer and conclude at the end of fall semester of the second year. Depending on the capstone option selected, students may begin working on the project as early as the spring semester of their first year in the program. The course grade for capstone credit (MCS 699) will be assigned by the primary reader, taking into consideration feedback received from the secondary reader.

In addition to the capstone scientific report, students are expected to defend their research via oral presentation and create a poster detailing their work. These posters will be put on display at the end of the academic year for faculty and students to view during a special event prior to graduation.

The final product of a student’s research is their scientific report. Students should write their reports by working closely with their readers and following the format provided in Appendix B (Capstone Handbook). The capstone proposal will be developed and approved by the student in collaboration with the student’s readers. Final approval from the MCS Associate Director is also required.

Registering for the Capstone

Before a student begins the capstone project, a Capstone Project Proposal (Appendix B) must be submitted to the MCS Associate Director. This proposal must be approved prior to the student
**beginning their research work.** Final capstones submitted without prior approval of subject matter and approved advisors, may not be accepted for completion of the degree requirements. Students should register for MCS 699 Capstone during the semester a final grade will be assigned.

**Writing the Capstone**
The capstone may take one of two forms: a review paper based on a specific topic covered in the literature or a scientific report based on research completed. While it is not necessary that the work be publishable in a scholarly journal, this is strongly encouraged.

**Table 1. Capstone and Graduation Timetable**

<table>
<thead>
<tr>
<th>Copy of approved capstone proposal due in MCS office</th>
<th>Last day of classes in the term prior to the term the student intends to complete the capstone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduation application</td>
<td>Spring Term: Feb 1</td>
</tr>
<tr>
<td></td>
<td>Summer Term: June 1 (Feb 1 if you wish to participate in May Ceremony)</td>
</tr>
<tr>
<td></td>
<td>Fall Term: Oct 1</td>
</tr>
<tr>
<td>Capstone project report completed and approved</td>
<td>Submit final copy of report no later than one week after the last day of classes to the MCS Office</td>
</tr>
<tr>
<td>Project supervisor evaluation</td>
<td>Submit signed form to MCS office no later than one week after the last day of classes</td>
</tr>
</tbody>
</table>

**Forms**
There are four forms which need to be completed for the Capstone:
- Capstone Project Proposal (Appendix B)
- Project Supervisor Evaluation (Appendix B)
- Capstone Project Evaluation /MCS 699 course grade (Appendix B)
- [Scholarly Commons Application](#) (to publish the student’s work in Penn’s online repository)

**Graduation Procedures**

Students, who fail to complete their capstone project during the spring semester prior to graduation, must remain “active” in all subsequent terms in order to complete their MCS program and graduate. The final capstone paper is due to the capstone readers and project supervisor at least two weeks prior to the end of term (students should check with these individuals to see if they will need additional time for review and grading). Students who have not submitted their final capstone paper and Certification of Completion of Capstone Project/Course Grade form within one week of the end of classes in the semester for which they intend to graduate will be registered automatically for *Master’s Continuation* (MCS 990) in the subsequent term and for each and every term thereafter (including summer) until the completed and approved capstone is submitted to the MCS program.

Students must reapply online for graduation in the term during which they plan to complete the capstone. Thus, if a student does not complete the capstone in the semester in which they originally applied, they must re-apply for graduation in the next semester. The student’s graduation date will be posted for the term in which they complete their capstone and receive a grade.

The [Graduation Application Form](#) should be completed online at the beginning of the term in which the student intends to complete the program and graduate. Specific deadlines to apply for graduation can be found on the web page where the Graduation Application Form is provided.
VI. University Policies and Resources

Enrollment Status

MCS students who are enrolled for three courses per term are considered full-time students and will be billed the full general fee. This fee covers access to many of the services described below. MCS students enrolled in one or two courses per term are considered part-time students. However, students enrolled in the Capstone (MCS 699) or Master’s Continuation (MCS 990) courses are considered full-time.

Student Identification

Once a student is enrolled at Penn, a student ID number (Penn ID) will be issued, and this ID is used for registration and other transactions throughout the University. Students should never give out their social security number via email or fax. Once matriculated, the Penn ID number or the last four digits of the social security number are all that is necessary.

PennCard

The PennCard is the official University of Pennsylvania identification for students, faculty, and staff. The PennCard provides access to University facilities, services, cash convenience and more. To obtain a PennCard, students should bring a valid form of photo ID (driver’s license, passport, etc.) to the PennCard Center located upstairs in the Penn Bookstore located at 36th and Walnut. Only active students registered for courses in the current or upcoming term may receive a PennCard, which should be carried at all times.

PennKey

A PennKey is required to authenticate, or verify, an individual’s identity for many of Penn’s networked computer systems and services. Authorized users need a PennKey and password to access such resources as Penn InTouch (course registration), Canvas (used in most classes), certain library resources, and public campus computers. A PennKey is also required to obtain a Penn email address. New students should receive either a letter or an email with information on how to create a PennKey and password within a few days of their admission to the MCS program.

Penn InTouch

Penn InTouch provides secure access via the Internet to a variety of information, including:

- Online registration and schedule planning tools
- Academic records and transcript orders
- Student billing and payment information
- Financial aid application status and awards
- Student loan application status, disbursements and loan history
- Student employment/work-study information and job listings
- Updating your emergency contacts and address information
- Privacy settings for release of academic and financial information to parents and others
- Direct Deposit enrollment for student refunds and work-study payroll.
Email

All students enrolled at the University of Pennsylvania are eligible for a Penn email address free of charge. Even if the student plans to use a non-Penn email account, they should also establish a Penn address. The MCS Associate Director will send program information to the Penn address and also contact students with important information through this system. Course instructors will be given this address as well and will expect to contact students in this way. Should students wish, they may forward email from their Penn address to another account through Penn’s webmail site. Instructions on how to create and use a Penn email account are available through SAS Computing.

Academic Support Services

The Weingarten Learning Resources Center, located at 3702 Spruce Street, Suite 300, provides professional consultation services in skills such as academic reading, writing, study strategies, and time management. This academic support is provided through a variety of services and programs including the very popular series of study skills workshops offered at the beginning of each fall and spring term for LPS students. Special workshop series is also offered for international students. For more information about the Weingarten Learning Resources Center, visit their web site or call 215-573-9235.

Other Academic Support Services include:

- Grad/Undergraduate Mentoring Program – Provide guidance for an undergraduate student
- Comprehensive, professional services and programs for students with disabilities
- Upward Bound and Veterans Upward Bound – Academic and financial services for low-income and first-generation college students and veterans
- Marks Family Writing Center – For support with writing assignments

Room reservations

Students can reserve rooms in our building for any academic purpose (e.g., study session with a recitation or lab section, a group meeting, presentation practice session). There are some rooms that are under our department control, and some that are called “central pool” classrooms. The latter are controlled by the Registrar, but are still available for our use.

- Department controlled rooms include:
  - Vagelos 2000, 3000, 4000
  - Makineni Conference Room
  - Lynch Lecture Hall

  For these rooms, contact the receptionist at the front desk to reserve them. You may want to do this in person to ensure that the room you want is available for the day and time that you need it. The receptionist can always tell you which room is available if your first choice is already reserved.

- Central pool classrooms include:
  - Classroom #109 (off the lobby)
  - Classroom #119 (off the lobby)
  - Classroom #514 (5th floor by elevators)
  - Classroom B-13 (in the basement)
For the central pool classrooms, please keep in mind that during the regular school year, these rooms are heavily used for classes throughout the University, not just the Department. To reserve these rooms, you must request them online through Penn ISC Classroom Technology Services.

Student Disabilities Services

The Office of Learning Resources includes the Student Disabilities Services (SDS), which provides comprehensive professional services and programs for students with disabilities to ensure equal academic opportunities and participation in University sponsored programs. Reasonable accommodation to a qualified student’s known disability may be provided to assure equal access. Penn invites students with disabilities to identify themselves at any time during their course of study as enrolled students. Although the self-identification process is confidential and completely voluntary, it is required for those requesting accommodation. SDS may be contacted via their website, by phone at 215-573-9235, and by TDD at 215-746-6320.

Career Counseling

The University provides career counseling through the Career Services office. A wide variety of resources are available online that can help students explore career development strategies, write effective cover letters and resumes, and hone their networking and interview skills. To make an appointment with a counselor, visit the Career Services website or contact the office at 215-898-7531. The Career Services office is located on the ground floor of the McNeil Building.

Student Health Information

The University provides outpatient medical care to students through its Student Health Service (SHS). The SHS offers an array of clinical services, including initial and follow-up treatment of acute medical illness and injury, management of chronic health problems, health screening and preventive care. All full-time students must carry coverage for care at SHS, either through payment of the Clinical Fee or through enrollment in the Penn Student Insurance Plan (PSIP). Full-time students who have private or employer-sponsored insurance do not have to purchase the student plan, but they must still pay the clinical fee for coverage at SHS. Coverage for the Student Health Service (either through the clinical fee or through enrollment in PSIP) is optional for part-time students.

In addition to providing medical care and preventive medicine services, SHS offers special workshops on stress reduction and smoking cessation, as well as travel information, immunizations, acupuncture, massage, and other services.

Immunization Requirements
Students enrolled in the MCS program are part of the University community and benefit from the University’s efforts to provide a safe and healthy environment. All MCS students are required to comply with immunization requirements upon first enrolling in credit courses. To comply, students should complete an Immunization Worksheet. Incoming fall semester students who are not in compliance with the University's immunization requirements will be placed on registration hold for the spring semester.
Students are advised to call SHS at 215-746-3535 or consult their website for the most accurate and up-to-date information on student health requirements. The SHS office is located at 3535 Market St, Suite 100. Be sure to bring your PennCard and insurance information whenever you go for medical care. For hours and other information refer to the Student Health website.

Student health insurance does not include dental insurance. The University of Pennsylvania has a dental school, which offers low-cost dental insurance to the University community.

Counseling and Psychological Services

Counseling and Psychological Services (CAPS) are for students of the University of Pennsylvania. All counseling services are free and confidential. Their office hours are 9am -5pm, Monday, Tuesday and Friday and 9am – 7pm Wednesday and Thursday. If students have an emergency that cannot wait until the next day, they should call the Hospital of the University of Pennsylvania (HUP) operator at 215-349-5490 and ask for the CAPS clinician on call. Please note that this HUP operator number is only for emergencies. To call regarding an appointment, a prescription or other non-urgent issues, please contact CAPS during regular office hours at 215-898-7021.

CAPS provides a variety of counseling services, including individual therapy, couples/family therapy, group therapy, crisis management, referral services, and outreach and prevention.

A variety of workshops throughout the year are also offered by CAPS, and topics have included:
- Stress Management
- Coping with Depression
- Crisis Intervention
- Body Image Issues
- Suicide Prevention
- Surviving Trauma
- Effective Communication Skills
- How to Help a Friend
- Secrets to Grad School Success
- Respecting Diversity
- Test Anxiety
- Grief and Loss Issues

All workshops are free of charge for members of the Penn community. Please check their website for details.

Student Financial Services

Student financial aid, including applications and disbursement of money, are handled through Student Financial Services. Their offices are located in room 100 of the Franklin Building at 3451 Walnut Street. Call 215-898-1988 or visit their website for deadlines and other information.

Penn Bookstore

Located on the corner of 36th and Walnut Street, the Penn Bookstore carries textbooks and trade books as well as stationery, art supplies, school supplies, gifts, and other items. The Computer Connection,
within the Bookstore, also carries computers, software, and computer supplies at student rates. Visit the website or call 215-898-7595 for store hours and additional information.

Computer Resources

Information Systems and Computing offers advice, training, consulting services and computer support to Penn students living on campus. The Computer Resource Center (CRC) serves as a distribution center for supported software to any person with a University affiliation and is located in Suite 202 Sansom West (Grad Tower B), 3650 Chestnut Street. The entrance is located off Steve Murray's Way (mid-block between 36th and 37th on Chestnut). Students will need their PennCard for access to the building. Go to the website or call 215-898-1847 for more information regarding hours and services available.

Computer Labs are available to students in several places on campus. A valid PennKey is required to log onto the workstations, and reservations can be made online.

Libraries

The University of Pennsylvania has several libraries. Van Pelt Library, the main University library, is located at 3420 Walnut Street (the entrance is on the College Green across from College Hall). There is a wealth of information and resources available through these libraries, including the Weigle Information Commons (WIC), which is located in the Van Pelt Library and offers training in various applications, like Excel and Photoshop. Through WIC, students can reserve study rooms, use the Digital Media Lab to print posters, and borrow equipment.

Recreation Facilities

MCS students have access to all of the recreation facilities available to the University community. For information regarding hours, fitness programs, locker rentals, etc. go to their website.

Information for International Students

International students are responsible for maintaining their proper student visa status. The office of International Student and Scholar Services (ISSS) is an important resource for all international students. Any questions about visas, international student tax issues, etc. should be directed to their advisors. They are located at 3701 Chestnut Street, Suite 1W and be reached by calling 215-898-4661 or sending an email to isss@pobox.upenn.edu.

Federal regulations require that F-1 and J-1 international students register their presence at Penn. This process, known as the check-in procedure, has two steps: 1) completion of the New Student Arrival Information online form and 2) attendance at one of the Immigration Document Review and Presentation Sessions. Both steps must be completed after arrival in the United States but within 20 days of the program start date listed on Penn's I-20 or DS-2019. F-1 transfer students must complete the new student check-in process within 15 days of the program start date listed on Penn's I-20. The ISSS handbook has a lot of helpful information for international students new to Penn.

If you are planning to travel and would like a letter stating that you are a current student in good standing, please send an email to the graduate coordinator at chemgrad@sas.upenn.edu to request the letter.
International students with English as a second language are encouraged to use the resources available through the English Language Programs (ELP). They offer testing, consulting services, and cross-cultural training in addition to language instruction. The MCS Associate Director can refer international students to ELP on a case-by-case basis based on TOEFL scores and/or advising sessions. In some instances, it will be recommended that students complete an Oral Proficiency Interview (ACTFL OPI) administered by ELP staff and, based on the results, take English courses at the appropriate level. Students will be responsible of covering the cost associated with courses and testing.

Office of the University Ombudsman

The Office of the Ombudsman assists individuals in finding solutions to problems that they may not be able to resolve through normal channels. The office is concerned with safeguarding individual rights and promoting better channels of communication throughout the University. It is independent of all administrative offices. The Ombudsman is not an advocate for any one individual or group. He or she is an advocate for fairness, adherence to University regulations, due process, and personal responsibility. The Office supplements, but does not replace, any existing grievance mechanisms or modes of redress. It can and does recommend changes in the existing rules and practices when necessary. The Office of the Ombudsman may be reached at 215-898-8261.

Code of Academic Integrity

Inasmuch as the standing of an educational institution and the value of a degree from that institution are dependent upon the integrity of study and research carried on at that institution, the Code of Academic Integrity is drawn to make clear the policy of the University concerning academic honesty. Each student attending the University must abide by this code, the text of which appears in the Pennbook.

Confidentiality of Student Records

Pursuant to the Family Educational Rights and Privacy Act of 1974 (FERPA), as amended, in general, personally identifiable information can be disclosed to people outside the University only with the written consent of the student or alumnus/na involved. A statement setting forth specific University policy concerning: (1) disclosure of information to people outside the University, (2) disclosure of information to people within the University, (3) permitting students to inspect and review records, and (4) providing students with the opportunity to seek the correction of their records appears in the Pennbook.

Nondiscriminatory Policy

The University of Pennsylvania values diversity and seeks talented students, faculty and staff from diverse backgrounds. The University does not discriminate on the basis of race, color, sex, sexual orientation, religion, national or ethnic origin, age, disability or status as a disabled or Vietnam Era veteran in the administration of its educational policies, programs, or activities, admissions policies and procedures, scholarship and loan programs, employment, recreational athletic or other University administered programs. Questions or concerns regarding the University’s equal opportunity and affirmative action programs and activities or accommodations for people with disabilities should be directed to the Office of Affirmative Action and Equal Opportunity Programs, located at 3600 Chestnut Street, Sansom Place West, Suite 228 or call 215-898-6993 or 215-898-7803 (TDD).
Student Responsibility

While advisors, faculty, and staff will assist the student in every aspect of their graduate study, it is the responsibility of the student to ensure that all steps and necessary paperwork have been completed and submitted to the Program Director and/or LPS as appropriate. Grant proposals, awards, accepted publications and other records of achievement should also be submitted to the Director of the MCS program.
Appendix A

MCS COURSE LIST

NOTE: This is a comprehensive list of courses offered in the Department of Chemistry that may be taken to fulfill requirements of the MCS curriculum. The parentheses indicate which area(s) of concentration the course fulfills and when the course is typically offered. Not all courses are offered every year. Check current course listings for which courses are offered each semester.

Concentrations:
- Biological (B)
- Inorganic (I)
- Organic (O)
- Physical (P)
- Material (M)

441. Advanced Organic Chemistry: Reactions, Mechanisms, and Stereoelectronic Effects. (O, Fall)
Prerequisite(s): CHEM 242.
Study of important types of reactions and functional groups, with emphasis on synthetic usefulness, mechanisms, and stereoelectronic principles.

443. Modern Organic Synthesis. (O, Fall) Prerequisite(s): CHEM 241 and 242.
Introduction to advanced organic synthesis. Study of important synthetic reactions including: oxidations, reductions, and methods for the formation of carbon-carbon bonds, with an emphasis in chemoselectivity, stereoselectivity and asymmetric synthesis. Survey of modern methods for the synthesis of small, medium and large ring systems. Analysis of modern synthetic strategies, with illustrative examples from total synthesis of natural and unnatural products.

451. Biological Chemistry I. (B, O, Fall) Prerequisite(s): CHEM 242, 221 (may be concurrent), and 251 or permission of instructor. Structure, dynamics, and function of biological macromolecules. Properties of macromolecular assemblies, membranes and their compartments. (Formerly, CHEM 450-I).

452. Biological Chemistry II. (B, Fall) Prerequisite(s): CHEM 242, 221, and 251 or permission of instructor.
Physical and chemical description of macromolecular information transfer. Gene organization, replication, recombination, regulation and expression. (Formerly, CHEM 450-II).

462. Inorganic Chemistry II. (I, M, Spring) Prerequisite(s): CHEM 261 or its equivalent and permission of instructor.
A detailed treatment of the theory and application of modern physical methods for the elucidation of structure and mechanism in inorganic and organometallic chemistry. An introduction to symmetry and group theory is followed by the application of these concepts to vibrational and electronic spectroscopy of inorganic complexes. Magnetic resonance is discussed in detail, including topics such as EPR, fourier transform methods, dynamic systems, and 2-dimensional NMR.

521. Statistical Mechanics I. (P, Fall) Prerequisite(s): CHEM 222.
Principles of statistical mechanics with applications to systems of chemical interest.
522. Statistical Mechanics II. (P, Spring) Prerequisite(s): CHEM 521.
A continuation of CHEM 521. The course will emphasize the statistical mechanical description of systems in condensed phases.

523. Quantum Chemistry I. (P, Fall) Prerequisite(s): CHEM 222.
The principles of quantum theory and applications to atomic systems.

524. Quantum Chemistry II. (P, Spring) Prerequisite(s): CHEM 523.
Approximate methods in quantum theory and applications to molecular systems.

525. Molecular Spectroscopy. (P, Fall)
A modern introduction to the theory of the interaction of radiation and matter and the practice of molecular spectroscopy. Conventional microwave, magnetic resonance, optical, photoelectron, double-resonance, and laser spectroscopic techniques will be included.

526. Chemical Dynamics. (P, Spring)
Theoretical and experimental aspects of important rate processes in chemistry.

525. (BMB 554) Macromolecular Crystallography: Methods and Applications. (B, M)
The first half of the course covers the principles and techniques of macro- molecular structure determination using X-ray crystallography. The second half of the course covers extracting biological information from X-ray crystal structures with special emphasis on using structures reported in the recent literature and presented by the students.

557. Mechanisms of Biological Catalysis. (B) Prerequisite(s): One year of organic chemistry and a biochemistry course, or permission of instructor.
Reaction mechanisms in biological (enzymes, abzymes, ribozymes) and biomimetic systems with emphasis on principles of catalysis, role of coenzymes, kinetics, and allosteric control.

559. (BMB 559) Biomolecular Imaging. (B, M)
This course considers the noninvasive, quantitative, and repetitive imaging of targeted macromolecules and biological processes in living cells and organisms. Imaging advances have arisen from new technologies, probe chemistry, molecular biology, and genomic information. This course covers the physical principles underlying many of the latest techniques, and defines experimental parameters such as spatial and temporal resolution, gain, noise, and contrast. Applications to cellular and in vivo imaging are highlighted for confocal, two-photon, and force microscopies; single-molecule, CARS, and fluorescence correlation spectroscopy; FRET and fluorescence bleaching; mass spectroscopy; MRI, PET and SPECT. The role of molecular imaging agents comprised of proteins, organic or inorganic materials is widely discussed.

564. Organometallics. (O, I)
This course is focused on molecular species that contain metal-carbon bonds, and the role of these compounds in catalytic processes and organic synthesis. Aspects of the synthesis, structure and reactivity of important classes of organometallic compounds such as metallo- alkyl, aryl, alkene, alkylidene and alkylidyne complexes are surveyed for the d and f block metals. Emphasis is placed on general patterns of reactivity and recurring themes for reaction mechanisms.
565. Main Group Chemistry. (I, M)
This course encompasses a comprehensive survey of the chemistry and properties of the p-block elements of the periodic table. Topics include syntheses, structures and reactivities of important compounds. In addition, alternative bonding theories which have been used to explain the unique properties of these compounds are critically examined.

567. (BMB 567) Bio-inorganic Chemistry. (B, I, M)
The course covers selected topics in bioinorganic chemistry; special emphasis is placed on dioxygen chemistry and electron transfer processes. Course topics include: (i) oxygen uptake and utilization; (ii) diatomic oxygen trans port; (iii) diatomic and monoatomic oxygen incorporation into substrates; (iv) metalloenzyme-catalyzed C-C bond formation; (v) the metallobiochemistry of DNA; (vi) metal-sulfide proteins; (vii) manganese-containing metalloproteins; (viii) Photosystem II: light-driven electron transfer and the biological water-splitting reaction; (ix) biological electron transfer; (x) electron transfer theory; (xi) mechanisms of energy storage and release; and (xii) long-distance electron transfer reactions.

580. (PHYS 580) Biological Physics. (B) Prerequisite(s): Physics 150-151 or 170-171, Math 104-114 or Math 104-115. Recommended: concurrent Physics 230 or prior Physics 250, basic background in chemistry and biology.

MCS 599. Pro-seminar. (ALL, Fall) Required course during 1st year will review the scientific method, research design, and professional scientific communication. Current opinions in the study of the chemistry and presentations by guest lecturers will add content to areas of concentration.


700. Selected Topics in Chemistry. (B, O, I, P, M)
May be repeated for credit and may be taken for multiple course unit credit if more than one topic is offered in a term.
0.5 CU topics in fall: Materials Chemistry (I, M), Crystallography (I), Inorganic Materials (I, M)
0.5 CU topics in spring: Heterocycles (P), Medicinal Chemistry (B), Organic Materials (O, M)

MCS 910. Independent Studies. (ALL) May be taken for multiple course unit credit (1) Advanced study and research in various branches of chemistry. (2) Seminar in current chemical research. (3) Individual tutorial in advanced selected topics.

MCS 990. Master's Continuation. (ALL)
Appendix B

CAPSTONE HANDBOOK
Master of Chemical Sciences

Capstone Handbook

University of Pennsylvania

College of Liberal and Professional Studies
# Table of Contents

I. Capstone Overview ............................................................................................................. 29

II. Choosing a Topic ................................................................................................................ 29

III. Identifying your Capstone Mentors ................................................................................. 29

IV. Timeline ............................................................................................................................ 30

V. Developing your Proposal .................................................................................................. 31

VI. Writing your Final Report and Creating your Poster ....................................................... 32

VII. Appendix A. Guidelines for Capstone Proposals ........................................................... 33

VIII. Appendix B. Guidelines for Capstone Final Reports .................................................... 35

IX. Appendix C. Guidelines for Oral Presentation Submissions .......................................... 40

X. Appendix D. Guidelines for Poster Submissions ............................................................ 43

XI. Appendix E. Capstone Evaluation Tools .......................................................................... 44
**Capstone Overview**

This guide will provide you with information vital to the successful completion of the capstone project for the Master in Chemical Sciences (MCS) program. You will find procedures, timelines, and resources relevant to your project. You should discuss your ideas with your faculty advisor and project supervisor when you first begin to develop your capstone project. The MCS Associate Director is also available to guide you with respect to project requirements.

**Choosing a Topic**

The capstone project should last a minimum of 6 months and represents the culmination of your MCS graduate study. The capstone may consist of a Penn laboratory research project, an off-campus laboratory research project, or a literature review or educational project. Under no circumstances will previous work experience exclude you from the capstone requirement. If you are currently working part-time in the chemical industry, you might be able to complete your capstone project you’re your employer; however, you must clearly demonstrate what new skills you will acquire through the experience. Your research project should focus on a topic that you decide upon in consultation with your academic advisor and project supervisor. You will need to demonstrate a grasp of the theoretical underpinnings of the research you undertake, be able to justify the reasons for the research, and identify key learning outcomes you plan to achieve through the work.

Your capstone topic should be directly related to your area of concentration and professional goals. Topic ideas may come from:
- A guest speaker in the Department of Chemistry
- An article you read
- Chemistry faculty research
- Your academic advisor
- Professional experience you would like to develop further

Your capstone project should help you develop new skills that will help you advance in your career.

**Identifying your Capstone Mentors**

Regardless of your project’s design, you will need to secure two advisors or “readers” who will help you develop your project proposal (Appendix A) and/or help you organize and edit your final report. Readers can include the following individuals:
- Your academic advisor
- Another Penn faculty member
- Your off-campus project supervisor
- A professor from a local university, an adjunct faculty member, or a lecturer academically engaged in your capstone topic

Your primary reader or project supervisor must be an expert in the research field; the secondary reader need not be. You should attempt to identify your faculty advisor and readers as soon as possible. If you are having difficulty identifying these individuals, the MCS Associate
Director can recommend likely prospects from among the Department of Chemistry faculty. However, it is your responsibility to contact these individuals and discuss your project ideas in depth.

- *If you are planning to conduct research on the Penn campus*, your academic advisor is expected to serve as your project supervisor. If you would like to work with another faculty member instead, they can serve as your project supervisor (and your academic advisor can serve as the secondary reader).

- *If you are planning to work off-campus*, your project supervisor should be on-site and work in collaboration with your academic advisor to ensure your goals are met.

- *If you plan to complete a literature review or educational project on campus*, your academic advisor is expected to provide guidance for your project.

### Capstone Mentors

<table>
<thead>
<tr>
<th>Title</th>
<th>Possible Roles</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Academic advisor</strong></td>
<td>Project supervisor</td>
<td>Help guide development of and approve proposal; supervise throughout the project; edit and evaluate final report; assign grade for MCS 699</td>
</tr>
<tr>
<td></td>
<td>Secondary reader</td>
<td>Help guide development of and approve proposal; advise throughout the project; edit and evaluate final report; assign grade for MCS 699 with feedback from supervisor</td>
</tr>
<tr>
<td><strong>Penn faculty member</strong></td>
<td>Project supervisor</td>
<td>Help guide development of and approve proposal; supervise throughout the project; edit final report; provide feedback to academic advisor regarding performance</td>
</tr>
<tr>
<td></td>
<td>Secondary reader</td>
<td>If possible, help guide development of and approve proposal; edit final report</td>
</tr>
<tr>
<td><strong>Off-campus researcher</strong></td>
<td>Project supervisor</td>
<td>Help guide development of and approve proposal; supervise throughout the project; edit final report; provide feedback to academic advisor regarding performance</td>
</tr>
<tr>
<td><strong>Local professor or lecturer</strong></td>
<td>Secondary reader</td>
<td>If possible, help guide development of and approve proposal; edit final report</td>
</tr>
</tbody>
</table>

### Timeline

You are expected to start your project during the summer following completion of your first academic year of study. Depending on the capstone option selected, you may begin work on your project as early as spring semester during your first year in the program. *Regardless of when you start, remember that*
you need to have your proposal approved \textit{PRIOR} to starting your work in order to receive credit for your capstone experience.

The final product of your capstone research will be a scientific report (Appendix B). You should work closely with your academic advisor and project supervisor (for off-campus projects) or secondary reader when you write your report. In addition to the scientific report, you will be expected to present your work via and oral presentation (Appendix C) and create a poster detailing your work (Appendix D). These posters will be displayed at the end of the academic year for faculty and students to view during a special event prior to graduation.

The course grade for capstone credit (MCS 699) will be assigned by your academic advisor, taking into consideration feedback received from the project supervisor (for off-campus projects) and secondary reader, as well as your final report and poster. You should register for MCS 699 during the semester you expect to receive a grade for completing your capstone project and report.

<table>
<thead>
<tr>
<th>Semester</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late fall – year 1</td>
<td>Start developing ideas for capstone project; discuss with academic advisor</td>
</tr>
<tr>
<td>Spring – year 1</td>
<td>Draft and receive approval of proposal \textit{PRIOR} to initiating research</td>
</tr>
<tr>
<td>Summer – fall</td>
<td>Work on capstone project</td>
</tr>
<tr>
<td>Spring – year 2</td>
<td>Finish writing capstone report; register for MCS 699; create poster</td>
</tr>
<tr>
<td>Late spring – year 2</td>
<td>Present poster; graduate*</td>
</tr>
</tbody>
</table>

* If you are unable to finish your capstone report and receive a grade for MCS 699 prior to graduation, but you expect to complete these requirements prior to the start of fall semester, you can still participate in the graduation ceremony, although you will not receive your diploma at this time.

If you have completed all course work for the degree but have not completed your capstone report, you will be automatically enrolled in the Capstone Continuation course (MCS 990) for one additional semester or until the report is complete and a grade has been assigned. This will ensure that you will continue to have access to the library and your Penn e-mail accounts. Should you wish to extend this registration beyond two semesters, you must first receive permission from the MCS Associate Director.

\textit{Developing your Proposal}

As stated earlier, your capstone may consist of Penn laboratory research, off-campus laboratory research, or a literature review or educational project. Your capstone proposal should be developed in collaboration with your academic advisor and project supervisor (for off-campus projects). You must submit a proposal for approval by your academic advisor, a project supervisor (for off-campus projects), and the MCS Associate Director \textit{at least 3 weeks prior to} the anticipated start date of your capstone project. Appendix A provides a template and guidelines for writing an effective proposal. If your project will be conducted in a research laboratory located off-campus, you may be required to sign a non-disclosure agreement, and this should be included as an appendix to your capstone proposal.

Funding to conduct your capstone research is not provided by the MCS program; it is your responsibility to ensure that adequate resources are available for the work proposed. You should work with your project supervisor to make sure research costs will be covered.
One-third of the way through your project, you should check-in with your academic advisor to ensure that your research is on-track as outlined in your proposal. If any revisions need to be made because of unexpected events affecting progress, they should be made as soon as possible.

**Writing your Final Report and Creating your Oral Presentation and Poster**

Work with your project supervisor and academic advisor to develop an outline for your final report, based on the guidelines provided in Appendix B. The Weingarten Learning Resources Center, located at 3702 Spruce Street, Suite 300, provides professional consultation services in skills such as academic reading and writing through a variety of services and programs including the very popular series of study skills workshops offered at the beginning of each fall and spring term for LPS students. A special workshop series is also offered for international students. For more information about the Weingarten Learning Resources Center, visit their web site or call 215-573-9235.

There is also a wealth of information and resources available through the University of Pennsylvania libraries, Van Pelt Library, the main University library, is located at 3420 Walnut Street (the entrance is on the College Green across from College Hall). The Weigle Information Commons, which is located in the Van Pelt Library, offers training in various applications, like Excel, students can use the Digital Media Lab to print posters.

Your project mentors and the MCS Associate Director can provide feedback on your final report and poster prior to final submission. Once approved, you should submit your report to Penn’s online repository, the Scholarly Commons, for publication.
Appendix A. Guidelines for Capstone Proposals

The following items must be included in the capstone proposal:

1. Project cover sheet (next page)

2. Proposal
   
   a) Work Site: Include a brief summary describing the company and their goals, complete work address, phone and e-mail contact details for supervisor(s), and any compensation/reimbursement provided. If working at Penn, please include campus address and details.

   b) Position Title and Overview: Include a 1-2 sentence description of your key responsibilities.

   c) Timeline: List specific start and end dates, number of work hours/week, and total number of months you will spend on this project.

   d) Project Description: Describe in detail what you will be doing and how you will be doing it. If you will be conducting research, details about the overall project (including a description of the problem, project rationale, objectives, methodology, outcomes, and references) should be attached in the appendices. The body of the Project Description should focus on your activities.

   e) Learning Outcomes: Explain what new skills and/or knowledge you will be acquiring through this experience and how it will move you forward along your career path. (Overall expected project outcomes should be included in the appendices.)

   f) Evaluation Criteria: How will your project supervisor evaluate your performance? Identify project-specific parameters to be assessed in addition to those listed in the project evaluation form (Appendix B).

3. References: This is an alphabetical listing of all references used. Page numbers in the bibliography continue the pagination of the text; do not number the bibliography separately. MCS projects follow ACS style citation.

4. Appendices (including current resume or CV, references and additional overall project details)

A copy of the capstone proposal, its appendices, and signed cover sheet should be submitted to your academic advisor, your project supervisor, and the MCS Associate Director for approval at least 3 weeks before the start of the project.
Master of Chemical Sciences Capstone Project Proposal Cover Sheet

Name: Penn ID:

Phone: Email:

Date Submitted:

Project Period: ☐ summer 20__ ☐ fall 20__ ☐ spring 20__

Area of Concentration:

Number of CUs Completed:

Project Title:

Project Type: ☐ on-campus research ☐ off-campus research ☐ review paper

Project Supervisor:

Academic Advisor:

Off-Campus Location (if applicable):

Project Start and End Dates:

Site Supervisor Phone: Email:

__________________________________________________________

I have read the Capstone Proposal and agree to serve as a mentor for this project.

Project Supervisor/Academic Advisor (circle): _____________________________

Printed name

Signature: _____________________________ Date: ______________

Academic Advisor/Secondary Reader (circle): _____________________________

Printed name

Signature: _____________________________ Date: ______________

MCS Associate Director:

Signature: _____________________________ Date: ______________
Appendix B. Guidelines for Capstone Final Reports

The Capstone Report should be written using these general guidelines. Bound as well as electronic copies of your report should be submitted to your academic advisor and the MSC Associate Director.

Sections should be organized as listed below:

1. Pretext Pages
   a) Abstract Page
   b) Title Page
   c) Approval Page
   d) Acknowledgements (optional)
   e) Table of Contents
   f) List of Figures
   g) List of Tables
   h) List of Appendices

2. Scientific Report
   a) Introduction
   b) Materials and Methods
   c) Results
   d) Discussion
   e) Summary or Conclusion

3. References

4. Appendices

5. Fly Leaf (blank page)

Number of Copies
Submit one digital copy and one bound official copy of your Capstone Report to the MCS Associate Director as well as your academic advisor.

Paper, Font and Spacing
The Capstone Report must be printed on standard size, white, 8½ x 11 inch paper. Use single line spacing throughout and print on only one side of the paper. Use regular, unadorned print (e.g., New Times Roman or Arial) 10-12 point size for text. Scientific names of genera and species should be underlined or printed in true italics.

Margins
Every page of the internship report must be kept within a minimum margin of 1½ inches (for binding purposes) on the left side of the page; 1 inch at the right side, top and bottom of the page.

Pagination
All pages except the title page should be numbered. This includes full-page photographs, charts and graphs, the bibliography, and appendices. For the pretext pages, use small Roman numerals (ii, iii, etc.). Page i is the abstract page, but the page number is not printed on this page. The first item on the Table of Contents list should be the Abstract. This will be followed by the title page, the approval page and any dedication or acknowledgment section you may wish to include. This is numbered in the small Roman series, with the page numbers displayed. The remainder of the Capstone Report is numbered with Arabic numerals (1, 2, etc.).
The page numbers that are displayed must be centered at the bottom of each page.

Writing Your Pretext Pages

- Abstract, Title and Approval Pages (see format below)
- Abstract
  Describe where your project was conducted (name of company, department, location, type of business). Summarize your research project goals, activities, and accomplishments, highlighting key knowledge or skills gained. How did this Capstone Project benefit you, and how did it benefit the company? The abstract is limited to 350 words in length. It should be 1.0 line-spaced, using only one side of the paper.
- Acknowledgments
  If you wish, you may include a page with a brief note of dedication or acknowledgment of help received from particular individuals.
- Table of Contents
  Capstone Reports are expected to have a Table of Contents for the convenience of the reader. If figures or tables are scattered throughout the text, a separate List of Figures or List of Tables should be included after the Table of Contents.

Writing the Scientific Report

Use Arabic numerals (1, 2, etc.) to number these pages. Start with the first page of the introduction as page 1 and end with the last page of your final report; either References or Appendices.

The format for the scientific report should include:

- **Introduction**
  The introduction is a concise statement of the problem and an outline of the scope, aim, and nature of your project. A review of the literature pertinent to the subject should be included and used to provide context for the Capstone Paper.
- **Materials and Methods**
  The purpose of the Materials and Methods section is to recount, in a concise manner, the materials and methods used to approach the project. It should include sufficient information so that the study could be repeated. Care should be exercised not to include superfluous information. Also, be sure to avoid including results and/or conclusions.
- **Results**
  The results reflect the findings of your investigation only, not the findings of other researchers in the area. This is a summarized form of extensive data that may appear in the figures, tables and/or appendices.
- **Discussion**
  The discussion section provides an analysis of the data acquired. In this section, you may draw comparisons with findings of other researchers in the field or even speculate to some degree and, if appropriate, suggest additional research.
- **Summary or Conclusion**
  The conclusion is a final brief statement, which draws together the objectives and findings of the entire research project.
- **References**
  This is an alphabetical listing of all references used. Page numbers in the bibliography continue the pagination of the text; do not number the bibliography separately. MCS projects follow ACS style citation.
AN ABSTRACT OF THE CAPSTONE REPORT OF

*Student Name* for the degree of Master of Chemical Sciences

Title: *(Underlined Title here)*

Project conducted at: *(Company Name and complete mailing address)*
Supervisor: *(Supervisor’s Name and Title)*
Dates of Project: *(start and end dates)*

Abstract approved:

________________________________________
*Printed Name, Academic Advisor*

Begin text here, using the same spacing, font style and font size as within the body of the text in your document.

*Include academic advisor’s middle initial unless there is none. Do not include his/her title. Co-academic advisors may share the same signature line; put both names below the line.*
Quantum Mechanics and the Electronic Structure of Atoms and Molecules
by
Linus Pauling

A CAPSTONE REPORT

submitted to the

University of Pennsylvania

in partial fulfillment of
the requirements for
the degree of

Masters of Chemical Sciences

Presented \textit{(date)}
Commencement \textit{(date)}
Master of Chemical Sciences Capstone Report of *Linus C. Pauling* presented on *(date)*.

APPROVED:

______________________________

*Academic Advisor, representing Area of Concentration*

I understand that my Capstone Report will become part of the permanent collection of the University of Pennsylvania Master of Chemical Sciences Program. My signature below authorizes release of my final report to any reader upon request.

______________________________

*Linus C. Pauling, Author*
Appendix C. Guidelines for Oral Presentation

All submissions must include an abstract. Student abstracts will be compiled, printed and bound for distribution during the spring research event.

Abstract Guidelines

The abstract should clearly state the purpose and objectives of the internship project. Key statements should include an introduction, methods, results, and discussion points, as well as a few statements describing the employer, project location, timeline, and project application(s). The abstract should demonstrate originality and innovation and should be written clearly and concisely. Research and results should support the conclusion and/or expected results.

Format requirements:
- Use New Times Roman size 12 font throughout unless otherwise noted
- Don’t exceed 500 words maximize for the entire abstract (including the title)
- Species names should be listed in italics and not underlined
- Include a double space after each of the sections described subsequently
- The title should be in all capital letters and bold font
- Authors should be listed in bold italics by first and last name with affiliation indicated by a numerical superscript
- Affiliations should include organization, city, state, and zip code, and be in typed in bold italics
- The word “Abstract” should be bolded
- Paragraphs should not be indented and should be separated with an additional space
- The word “Acknowledgments” should be bolded, capitalized, and in size 10 font

Presentation Guidelines

Students will present their Capstone project design, results, and outcomes during a 20 minutes presentation followed by a 5 minutes discussion. You can inexpensively create an oral presentation using a graphics software package such as PowerPoint. Make sure you convey the rationale and highlight the most salient aspects of your research design and results. Make sure you use a combination of graphics, and a logical order to accurately “tell your story”.

Format requirements and tips:
- Presentations should not last longer than 15 minutes
- Key topics should expand on the key statements made in the abstract (see above)
- Avoid clutter – limit your presentation to the main ideas, emphasizing important points
- Keep the lettering and graphics simple
- Keep the colors simple – too much color can be distracting, while too little color can be boring
- Keep in mind that some colors – e.g. red – do not project well in large rooms
- Proofread – a LOT
- Be prepared to discuss the overall focus of your project, novel methods, results and conclusions; be prepared to repeat your key points succinctly and in a different order and/or degree of completeness to each listener
Evaluation Criteria

Faculty members will be asked to consider the following criteria when evaluating abstracts and oral presentations

- **ORIGINALITY** – How original is the concept presented in the presentation, or how original is the new approach to an old problem? (15 points)
- **SIGNIFICANCE** – How significant or relevant are the presentation’s conclusions in meeting the project’s objectives and/or increasing understanding of a particular problem within a scientific discipline? (15 points)
- **ORGANIZATION** – How logical are the ideas presented in the presentation? How interesting is the manner of presentation? How clearly written and free of significant grammatical problems is the abstract? (20 points)
- **METHODS** – If applicable, how suitable is the design for the stated objectives, and how appropriate are any analysis techniques applied? (15 points)
- **VISUAL IMPACT** – How effective is the presentation visually? How valuable is each figure and graph in furthering viewers’ understanding of the subject? (15 points)
- **DISCUSSION** – How knowledgeable and conversant is the student with the work presented? Did the student present him/herself in a professional manner? (20 points)

A total of 100 points may be awarded, and scores with comments from the judges will be emailed to participants within 1-2 weeks of the end of the event.

Checklist

- Titles, authors, and institutional affiliations are listed
- Key statements required are included in abstract and poster content
- Logical sequence of information flow
- Photographs, graphs, tables and charts are used whenever possible to display data or convey important information
- Each section is concise and clear
- Slides do not appear cluttered
- Text can be read from 3 to 5’ away
- Font is similar throughout (no more than three fonts sizes used for poster title, section title, and text)
- Color, lines, boxes, and arrows are used to emphasize important points
CAPSTONE ORAL PRESENTATION EVALUATION for Masters in Chemical Sciences

Evaluators: Please consider the following criteria when evaluating oral presentations:

- ORIGINALITY – How original is the concept presented in the presentation, or how original is the new approach to an old problem? (15 points)
- SIGNIFICANCE – How significant or relevant are the presentation’s conclusions in meeting the project’s objectives and/or increasing understanding of a particular problem within a scientific discipline? (15 points)
- ORGANIZATION – How logical are the ideas presented in the presentation? How interesting is the manner of presentation? How clearly written and free of significant grammatical problems is the abstract? (20 points)
- METHODS – If applicable, how suitable is the design for the stated objectives, and how appropriate are any analysis techniques applied? (15 points)
- VISUAL IMPACT – How effective is the presentation visually? How valuable is each figure and graph in furthering viewers’ understanding of the subject? (15 points)
- DISCUSSION – How knowledgeable and conversant is the student with the work presented? Did the student present him/herself in a professional manner? (20 points)

<table>
<thead>
<tr>
<th>Student Name:</th>
<th>Title of Presentation:</th>
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<table>
<thead>
<tr>
<th>Criteria</th>
<th>Comments</th>
<th>Points</th>
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<tbody>
<tr>
<td>Originality (15 pts max)</td>
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<td></td>
</tr>
<tr>
<td>Significance (15 pts max)</td>
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<tr>
<td>Organization (20 pts max)</td>
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<tr>
<td>Methods (15 pts max)</td>
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<td></td>
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<tr>
<td>Visual Impact (15 pts max)</td>
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<tr>
<td>Discussion (20 pts max)</td>
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</table>

**TOTAL (100 pts max)**

Name of Evaluator: ____________________________

Signature: ____________________________ Date: ____________________________
Appendix D. Guidelines for Poster Submissions

All submissions must include an abstract and a poster. Student abstracts will be compiled, printed and bound for distribution during the spring research event.

Abstract Guidelines

The abstract should clearly state the purpose and objectives of the internship project. Key statements should include an introduction, methods, results, and discussion points, as well as a few statements describing the employer, project location, timeline, and project application(s). The abstract should demonstrate originality and innovation and should be written clearly and concisely. Research and results should support the conclusion and/or expected results.

Format requirements:
• Use New Times Roman size 12 font throughout unless otherwise noted
• Don’t exceed 500 words maximize for the entire abstract (including the title)
• Species names should be listed in italics and not underlined
• Include a double space after each of the sections described subsequently
• The title should be in all capital letters and bold font
• Authors should be listed in bold italics by first and last name with affiliation indicated by a numerical superscript
• Affiliations should include organization, city, state, and zip code, and be in typed in bold italics
• The word “Abstract” should be bolded
• Paragraphs should not be indented and should be separated with an additional space
• The word “Acknowledgments” should be bolded, capitalized, and in size 10 font

Poster Guidelines

You can inexpensively create a poster using a graphics software package such as PowerPoint. Posters can be printed at the Department of Chemistry, Weigle Information Commons located in the Van Pelt Library, and other commercial options. Make your presentation as visual as possible; not only does it make your poster more appealing, but information can be transmitted more efficiently with a picture, figure, or graph.

Format requirements and tips:
• Posters should not be larger than 4’ x 4’ in total size and should be mounted in the morning (push pins provided)
• Key topics should expand on the key statements made in the abstract (see above)
• Avoid clutter – limit your presentation to the main ideas, emphasizing important points
• Keep the lettering simple – use no more than three different font sizes (largest for the title; 2nd largest for section titles; smallest for text (usually 24 font that can be read from a distance of 3-4’)
• Keep the colors simple – too much color can be distracting, while too little color can be boring
• Proofread – a LOT – prior to printing
## Appendix E. Capstone Evaluation Tools

### PROJECT SUPERVISOR EVALUATION FORM (online)

Thank you for providing an educational research opportunity for one of our MCS students. Your completion of this form will allow us to assess the student’s performance during the project, and provide the student with valuable feedback regarding his/her strengths and weaknesses as a prospective professional in this field.

<table>
<thead>
<tr>
<th>Name of Student:</th>
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<table>
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<tr>
<th>Student's Major Advisor:</th>
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<table>
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<tr>
<th>Sponsoring Organization:</th>
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<table>
<thead>
<tr>
<th>Project Start Date:</th>
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<tr>
<th>Project End Date:</th>
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<table>
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<tr>
<th>Student's Research Project Overview:</th>
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</table>

Please comment on the following 5 areas:

1. Overall attitude toward project assignment(s):


2. Effectiveness in executing assignments:

3. Dependability:

Responsible? Uses good judgment? Hesitant to make decisions? Follows through consistently on assignments? Persistent?

4. Relationships with others:


5. Work ethic:


What type of feedback have you provided this student and his/her performance during the project? In what way was work progress reviewed and how?

How has this student responded to your suggestions for carrying out his/her work assignments?
OVERALL EVALUATION of student’s current level of work experience and education:

- Outstanding (performed well beyond expectations)
- Very Good (high quality performance)
- Good (performed all tasks as expected)
- Marginal (performance mostly inadequate - needs improvement)
- Unsatisfactory (please contact the PSM coordinator)

Has the general content of this evaluation been discussed with the student?

- Yes
- No

Would you be willing to consider another student from the University of Pennsylvania MCS Program?

- Yes
- No

Additional comments (optional):

CAPTCHA
This question is for testing whether you are a human visitor and to prevent automated spam submissions.
MCS 699 Capstone Project Evaluation

Student name: ___________________________ Date: ____________

Title of project: ____________________________________________

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Does not meet expectations</th>
<th>Meets expectations</th>
<th>Exemplary performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written work: Clearly articulated project goals, methodology, results, and discussion OR clearly articulated thesis supported by appropriate library research, selected examples and critical analysis</td>
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</tr>
<tr>
<td>Research Skills: Completed project goals, acquired new analytical skills, and analyzed data appropriately OR effectively sourced information, created an appropriate bibliography, and used other relevant research materials</td>
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<tr>
<td>Critical Thinking: Demonstrated capability for independent research and/or work in the area of concentration</td>
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<tr>
<td>Supervisor’s Evaluation: Completed project goals as described in the capstone project proposal</td>
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</tbody>
</table>

Assessment of the overall performance of the student is based on the items above:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Performance Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Must Revise and Resubmit Capstone Project Report</td>
<td>Completed MCS Capstone Project</td>
</tr>
<tr>
<td>Does not meet expectations</td>
<td>Meets expectations (B)</td>
</tr>
</tbody>
</table>

Grade is: ___________________________

Examiner: Please provide written commentary below as needed.

Name of the Academic Advisor: ___________________________

Signature: ___________________________

Date: ___________________________

47