

### CHEM 191: SENIOR THESIS

**Coordinating Instructor**

Prof. Jane M. Liu (SN-216; jane.liu@pomona.edu)

**Meeting Times**

Tuesdays and Thursdays, 11 am

**Credit**

Half course, each semester

Letter grade given at end of second semester

**Prerequisite**

Permission of department chair

The senior capstone exercise for all chemistry majors is the Senior Thesis (CHEM 191 PO) with two options: an experimental thesis based on original research in collaboration with a faculty member or a thesis in grant proposal format based on literature research.

Throughout your studies of chemistry, you have been developing not only your content knowledge, but also skills relevant to professional chemists. The Senior Thesis experience focuses primarily on further developing these skills by asking you to undertake a yearlong project in the field of chemistry. The **overarching learning goals** of the Senior Thesis fall under four broad categories:

1. **Be able to interact with data and scientific literature and use critical analysis of this information to guide your own research.** This year, we will further develop your abilities to:
  - a. Thoroughly and properly analyze scientific data
  - b. Find and use primary literature relevant to your project
  - c. Relate your own work to previous work in the field
2. **Be able to effectively communicate with a broader community of chemists.** This year, we will further develop your abilities to:
  - a. Write with a level of sophistication, using accurate terminology, appropriate for a sub-field of chemistry
  - b. Present, orally, your project to effectively engage both a non-expert and an expert audience
3. **Be able to take ownership of your project.** This year, we will further develop your abilities to:
  - a. Manage a long-term research project, including the use of scientific reasoning to realistically plan out next steps in the research process
  - b. Conduct research in an organized, safe, and productive manner
  - c. Achieve independence and direct your own research agenda
4. **Be able to conduct yourself in a professional manner.** This year, we will further develop your abilities to actively engage with other scientists in the field, in part by:
  - a. Attending research seminars
  - b. Behaving professionally during these seminars
  - c. Asking seminar speakers questions about their research

**SUMMARY OF REQUIREMENTS:**

First semester	Second semester
<ul style="list-style-type: none"> <li>• Orientation meeting</li> <li>• Thesis Proposal or Annotated Bibliographies</li> <li>• Introductory presentation</li> <li>• Attending and participating in workshop(s)</li> <li>• Seminar attendance / seminar journal</li> <li>• Time devoted to research</li> <li>• Thesis Introduction / Background and Significance</li> <li>• Mid-year evaluation</li> </ul>	<ul style="list-style-type: none"> <li>• Attending and participating in workshop(s)</li> <li>• Thesis symposium presentation abstract</li> <li>• Presentation / participation at departmental symposium</li> <li>• Seminar attendance / seminar journal</li> <li>• Time devoted to research</li> <li>• First submission of thesis to readers</li> <li>• Final submission of thesis to department</li> <li>• End-of-year evaluation</li> </ul>

## GENERAL INFORMATION

### *Seminar attendance / seminar journal*

Students are required to attend at least 6 chemistry seminars in the fall and 4 in the spring (in addition to ALL Robbins lectures). The purpose of these exercises is to develop your abilities to engage chemistry at a professional level. This includes: Behaving professionally during these seminars and asking scientific questions of the seminar speakers.

Students should chronicle their seminar attendance and keep an electronic journal in a single MS-word file. For each seminar, list the speaker's name, their title, date of presentation, a brief (4-5 sentences) summary of the talk and 1-2 questions that you still have regarding the information presented. This document will be used as part of your mid-year evaluation.

The 5C chemistry seminar schedule can be accessed at

<http://www.pomona.edu/academics/departments/chemistry/events/seminars.aspx>

Due dates (electronic copy, placed in drop box on Sakai):

Fall: 5 pm, Wednesday, December 3, 2014

Spring: 5 pm, Wednesday, April 22, 2015

### *Time devoted to research*

All thesis authors need to spend sufficient time engaged in research and thesis activities during each semester. Experimental thesis students may require a greater time commitment for research and credit for this requirement is formally given via CHEM 199 after consultation with the student's research advisor (usually half credit for one afternoon per week, full credit for two afternoons per week).

## TIMELINE AND GUIDELINES (subject to change; also see attached calendars)

### First Semester, Fall 2014

#### *1) Orientation meeting*

Thesis requirements and deadlines are discussed. Students share their research projects\* with their peers.

Prof. Jane Liu

Date: 11 am, Thursday, September 4, 2014, SN 202

*\*If a student does not yet have a topic for their thesis, they should develop one in this first week of the semester.* In the first week of the semester, sit down with 2-3 faculty members in the department and bounce around ideas for your thesis. Good places to start would include topics that you have seen in your previous chemistry classes that you would be interested in exploring in more depth.

#### *2) Planning meeting with thesis advisor*

Research is unpredictable. But that does not mean it is disorganized. In fact, a thoughtful and organized approach to research is the key to managing long-term projects.

Early in the semester – within the first two weeks – the student and thesis advisor should meet to develop and agree upon a yearlong calendar. In addition to the major deadlines listed below, the student and thesis advisor may want to set goals for incremental progress (e.g. annotated bibliographies, outline of introduction, outline of results section, etc.) throughout the year. The student and thesis advisor should also make plans to revisit the agreed upon plan regularly and amend the plan as necessary.

#### *3) Workshop 1: How to write a grant proposal – Mandatory for literature thesis students*

Prof. Liu

Date: 11 am, Thursday, September 11, 2014, SN 202

#### *4) Workshop 2: Searching the literature and creating an electronic bibliographic database*

Prof. Taylor

Date: 11 am, Thursday, September 18, 2014, Cowart 113 (ITS classroom)

**5) (Experimental) – Submit a Thesis Proposal**

The purpose of this document is to provide the student an early opportunity to communicate, in writing, an overview of their experimental thesis project – what is the major question being asked and how will the question be addressed. The target audience for this proposal is any faculty member in the Chemistry Department – so someone who has a degree in chemistry, but is not necessarily an expert in your particular field.

The proposal should be written in 12 point, Times New Roman font and must be limited to one page (excluding references). The proposal should include a title and cite at least three references, but no more than 10. These guidelines are meant to encourage a thorough, but concise, proposal. The department uses this document to provide students with feedback regarding their thesis topic/scope, and to assign faculty as first and second readers. (See *Experimental Thesis Proposal Guidelines* – on Sakai – for a template)

Due date: 5 pm, Thursday, September 25, 2014 (electronic copy, placed in drop box on Sakai)

*Faculty:* proposals will be discussed and readers assigned at noon faculty meeting on Thursday, October 2, 2014.

**6) (Literature) – Submit Annotated Bibliography I**

Present 5 annotated references (primary or secondary scientific papers) that provide background on the overall topic that you are tackling. Remember – this is a chemistry thesis project, so your overall project must involve some sort of molecular interaction and/or address some fundamental issue of chemistry. While some of your references may provide more general background information, at least 1-2 should make it *clear that chemistry is relevant to your project*. The department uses this document to provide students with feedback regarding their thesis topic/scope, and to assign faculty as readers.

See Sakai for more information on how to prepare an annotated bibliography.

*Note: Use JACS citation style for the annotated bibliography*

Due date: 5 pm, Thursday, September 25, 2014 (electronic copy, placed in drop box on Sakai)

*Faculty:* proposals will be discussed and thesis advisor/and another reader assigned at noon faculty meeting on Thursday, October 2, 2014.

**7) Introductory presentation (see Thesis Presentation Rubrics for general guidelines)**

The purpose of this exercise is to provide the student an early opportunity to communicate orally an overview of their thesis project – what is the major question being asked and how will the question be addressed. The target audience for this presentation is any faculty member in the Chemistry Department – so someone who has a degree in chemistry, but is not necessarily an expert in your particular field.

Students will give a brief (~6-8 minutes and *no more than 6 PowerPoint slides!*) introduction to their project. This is also an opportunity to share with your peers the project that you are undertaking for the year. Your attendance and participation in all the presentations is expected.

Dates: Thursdays, October 9 and 16, 2014, 11 am - 1 pm, Location TBA

**8) Workshop 3: Writing the Introduction / Background and Significance**

Prof. Liu

Date: 11 am, Thursday, October 30, 2014, SN 202

**9) (Literature) – Submit Annotated Bibliography II**

Present 8-10 more annotated references (primary or secondary scientific papers) that are relevant to your proposal. You will need references that:

- Provide context for your question and your proposed experiments.
- Provide support for any claims you make

- Provide support that the question you are asking is an important and unanswered one
- Help you develop your experimental approach (perhaps a similar study was done?)

Include a statement of **the question and/or hypothesis you want to propose in your grant application**. Try to be very specific here – your question or hypothesis should be addressed / testable with 1-2 well-designed experiments. Once again, how your proposal involves *chemistry* should be made very clear. (~ 1 paragraph)

See Sakai for more information on how to prepare an annotated bibliography. *Note: Ask your thesis advisor for what citation style to use for this bibliography and for your entire thesis.*

Due date: 5 pm, Friday, October 31, 2014 (electronic copy, placed in drop box on Sakai)

### **10) Optional Workshop on creating figures using Adobe Illustrator**

Prof. Muzikar

Date: 7 pm, Thursday, November 6, 2014, location TBA

### **11) Peer review of Thesis Introduction / Background and Significance**

The purpose of this exercise is to provide the student an opportunity to receive feedback on their introduction before submitting the document to their primary and secondary readers.

Due date: 5 pm, Thursday, November 13, 2014 (electronic copy, placed in drop box on Sakai)

Drafts will available for peer readers by Friday, November 14, 2014 at 5 pm. Readers should return comments to the student promptly, such that they can incorporate suggested changes in time for the November 25 deadline.

### **12) Thesis Introduction / Background and Significance**

Experimental thesis students: At the end of your first semester, a draft of the introduction to your thesis is due. The purpose of this introduction is to present the motivation and context of your project. Most of the introduction will be devoted to presenting a review of relevant literature and introducing the goal(s) and question(s) of your thesis project. The target audience for this section is any faculty member in the Chemistry Department – so someone who has a degree in chemistry, but is not necessarily an expert in your particular field. Students should refer to the “Introduction” section of the *Experimental Thesis Rubric* for more details on what should be included in the introduction.

Literature thesis students: At the end of your first semester, a draft of the background and significance section of your proposal is due. The purpose of this section is to present a review of the relevant literature that convinces your reader that your grant proposal addresses an important scientific need that will fill in a current gap in knowledge. The chemistry of your proposal needs to be made explicit. (Your proposal must involve some sort of molecular interaction and/or address some fundamental issue of chemistry.) Students should refer to the “Background and Significance” part of the *Literature Thesis Rubric* for more details on what should be included in this section.

The purpose of this draft is to provide a checkpoint for both the student and the thesis advisor(s) regarding the progress of the student in developing an understanding of their thesis project. Along these lines, the thesis advisor may request additional materials to be turned in addition to the introduction/background and significance.

Due Date: 5 pm, Tuesday, November 25, 2014 (electronic copy, placed in drop box on Sakai)

Faculty: student work will be discussed and evaluated at the faculty meeting on Thursday, December 4, 2014.

### **13) Mid-year evaluation**

Students are expected to meet with their thesis advisor no later than Wednesday, December 10, 2014. The purpose of this meeting is to discuss the student's mid-year evaluation (a template is included at the end of this syllabus), review the second-semester syllabus, and make plans for a successful completion of the thesis in the second semester!

### **Second Semester, Spring 2015**

#### **1) Planning meeting(s) with thesis advisor**

Early in the semester – within the first two weeks – the student and thesis advisor should meet to revisit the schedule set up at the start of the year. The original plan should be amended as necessary. Sometime in the first half of the semester, the student and thesis advisor should also meet to agree upon the appropriate format/organization of the final thesis manuscript.

#### **2) Workshop 4: The departmental symposium and your oral presentation**

Prof. Muzikar

Date: 11 am, Thursday, January 29, 2015, Location TBA

#### **3) Thesis symposium presentation abstract and discussant assignment**

Students are expected to submit an electronic copy of the abstract of their oral presentation to their thesis advisor and to Prof. Liu in advance of the symposium. The document should be no longer than one page in length and can contain a representative figure and 2-3 key references. The format should be in Times New Roman, 12-point font, single-spaced, 1-inch margins. The abstract will be published in the Chemistry Senior Thesis Symposium proceedings. With their abstract submission, students should also indicate who would serve as the discussant for their talk -- eligible candidates are sophomore, junior or senior chemistry majors. (We encourage 2<sup>nd</sup> and 3<sup>rd</sup> year discussants!)

Due Date: 5pm, Thursday, February 12, 2015 (electronic copy, placed in drop box on Sakai, AND emailed to Lauri Bell)

#### **4) Presentation and participation in the chemistry thesis symposium (see Thesis Presentation Rubrics for general guidelines)**

Thesis presentations are scheduled for **Thursday, February 26** and **Friday February 27, 2015**. Students should plan to give a 25-minute presentation. An additional five minutes will be allocated for questions and discussion. Students must submit a copy of their PowerPoint presentation to Sakai (drop box) the day before their presentation so that all presentation files will be readily accessible throughout the symposium.

The purpose of this presentation is to showcase your senior thesis project – the question(s) you asked, the significance of the project, what you did to address the question and potential future directions. Your presentation needs to satisfy both a broad audience (your peers and the chemistry faculty), but also needs to appeal to your primary and secondary readers (experts in the field). Students should refer to the *Thesis Presentation Rubrics* for more details on what should be included in the presentation.

With the exception of academic conflicts, all senior and junior chemistry majors are expected to attend all of the talks. Seniors who elect to attend only a portion of the symposium will not meet this particular thesis requirement, regardless of the quality of their own presentation.

Faculty will meet the following week to evaluate thesis presentations

#### **5) Peer review of thesis**

The purpose of this exercise is to provide the student an opportunity to receive feedback on their thesis before submitting the document to their primary and secondary readers.

Due date: 5 pm, Thursday, March 26, 2015 (electronic copy, placed in drop box on Sakai)

Drafts will be available for peer readers by Friday, March 27, 2014 at 5 pm. Readers should return comments to the student promptly, such that they can incorporate suggested changes in time for the April 6, 2015 deadline.

**6) Submission of full thesis manuscript**

Submit copies of your thesis to your thesis advisor and designated reader. This is not a rough draft. It is as good as done! Your readers will read it and make final corrections/suggestions and give it back to you within a week so that you can print and bind the final version. Students should refer to the *Experimental/Literature Thesis Rubrics* for more details on what should be included in the final manuscript.

Due Date: 5 pm, Monday, April 6, 2015 (electronic copy, placed in drop box on Sakai)

Faculty readers will meet with their students and relay individual comments/suggestions to them no later than Monday, April 13, 2015

**7) Submission of final thesis manuscript**

Use the input of your first and second readers to revise your thesis advisor and submit a final copy to your thesis advisor and designated reader. This is the version that will be discussed to assign final CHEM 191 grades.

Due Date: 5 pm, Friday, April 17, 2015

Faculty readers will meet and assign final CHEM 191 grades on Thursday, April 23, 2015

**8) Submission of bound thesis**

Submit three final bound copies of the thesis to Prof. Liu. You should also submit one final electronic copy to Prof. Liu (via Sakai). To bind your thesis, simply bring your thesis to Pomona's Duplicating Services and provide them your name. Duplicating Services will match your name with a list provided to them of all chemistry majors and will charge the department accordingly.

Due Date: 5 pm, Friday, April 24, 2015

**ACADEMIC ACCOMMODATIONS**

Pomona College is committed to providing equal opportunity for participation in all programs, services and activities. Requests for accommodations may be made by contacting the Dean of Students Office. It is up to the student to contact Professor Liu and his/her thesis advisor to fulfill the accommodations.

**GRADING FOR CHEMISTRY 191**

Your course grade will be primarily based on how well you do in the oral presentation and the bound thesis; rubrics for these assignments will be provided. Your overall grade, however, will be lowered if you fail to meet the other criteria described in this document.

*Distinction in the senior exercise.* The department occasionally awards distinction in the senior exercise to recognize particularly exceptional thesis work that has been recognized with an A or A+ letter grade. Distinction can be awarded for a number of different reasons, including exceptional commitment, creativity, or independence in executing undergraduate research and/or the thesis process, or writing a thesis comprised of text which has served or will serve as the starting point for a peer-reviewed journal article.

A failing grade (F) will be assigned in cases where the bound thesis is deemed unacceptable to members of the department.

**MID-YEAR EVALUATION OF CHEMISTRY SENIOR THESIS PARTICIPANT  
December 2014**

Student Name:

First Reader:

Second Reader:

The feedback listed below is intended to assess whether you are making significant progress towards your senior thesis. If problem areas are identified, you have time until the end of the second semester to improve. The assessment provided below should be taken as an indicator of areas where the expectations of the chemistry senior thesis are being met, as well as areas where the work to date only partially meets or does not currently meet expectations.

Area	Does Not Meet	Partially Meets	Meets
The student has devoted sufficient time and effort on the project			
The student understands the goals, details and concepts/theories relevant to the project			
The student demonstrates engagement and the ability to work independently			
The student has attended the orientation meeting, all workshops and the introductory presentations			
The student has attended the minimum number of 5C chemistry seminars and has completed a seminar journal			
The student has presented an introduction (both written and oral) to their thesis			
The student has written their thesis introduction. Experimental authors have written at least a portion of their experimental section, while library thesis authors have written an outline for the rest of their thesis	<b>Letter grade:</b>		

**Specific comments from readers/department:**

**Interpreting your feedback:**

Meets or Partially Meets will be the most common assessments of your thesis work. An assessment of Partially Meets indicates that there are aspects of your work that require additional attention, time, and work to understand concepts or independent thought. An assessment of Does Not Meet signals significant problems with your work. An assessment of Does Not Meet in more than one area provides the basis for the department to assign a year-end course grade that is significantly below the norm.

**YEAR-END EVALUATION OF CHEMISTRY SENIOR THESIS PARTICIPANT**  
**April 2015**

Student Name:

First Reader:

Second Reader:

The feedback listed below is intended to provide you with feedback on the second semester of Chemistry 191 and to provide you with a rationale for your course grade.

Area	Does Not Meet	Partially Meets	Meets
<b>Engagement of Thesis Project, Seminars and Workshops (10%)</b>			
The student has devoted sufficient time and effort on the project			
The student understands the goals, details and concepts / theories relevant to the project			
The student demonstrates engagement and the ability to work independently			
The student has attended all the thesis workshops			
The student has attended the minimum number of 5C chemistry seminars and has completed a seminar journal			
The student has met and adhered to all deadlines set by thesis advisors			
<b>Departmental Thesis Symposium (30%)</b>			
The student has written a clear presentation abstract			
The student has presented their thesis work at the departmental symposium	<b>Letter grade:</b>		
The student participated fully in the departmental thesis symposium			
<b>Thesis Manuscript (60%)</b>			
The student has met the requirements for submitting a graded thesis manuscript ( <u>on time</u> ), has responded collegially to the comments and suggestions by both readers, and has filed a bound thesis manuscript with both readers and the department	<b>Letter grade:</b>		
<b>At the end of the second semester, students are awarded a letter grade for CHEM 191. Your grade is indicated at right.</b>			



**FALL 2014**

SUNDAY	MONDAY	TUESDAY	WEDNES.	THURS.	FRIDAY	SAT.
AUG 24	25	26	27	28	29	30
31	SEPT 1	2 CLASSES START	3	4 ORIENTATION	5	6
7	8	9	10	11 WORKSHOP 1	12	13
14	15	16	17	18 WORKSHOP 2	19	20
21	22	23	24	25 PROPOSAL / ABI DUE	26	27
28	29	30	OCT 1	2	3	4
5	6	7	8	9 INTRO PRESENTATIONS	10	11
12	13	14	15	16 INTRO PRESENTATIONS	17	18
19	20 FALL RECESS	21 FALL RECESS	22	23	24	25
26	27	28	29	30 WORKSHOP 3	31 ABII DUE	NOV 1
2	3	4	5	6 ILLUSTRATOR WORKSHOP	7	8
9	10	11	12	13 DRAFT DUE FOR PEER REVIEW	14	15
16	17	18	19	20	21	22
23	24	25 INTRODUCTION DUE	26	27 THANKSGIVING	28	29
30	DEC 1	2	3 SEMINAR JOURNAL DUE	4 MID-YEAR EVALS	5	6
7	8	9	10 LAST DAY OF CLASSES	11 READING DAY	12 READING DAY	13
14	15 FINALS	16 FINALS	17 FINALS	18 FINALS	19 FINALS	20
21	22	23	24	25	26	27

**SPRING 2015**

SUNDAY	MONDAY	TUESDAY	WEDNES.	THURS.	FRIDAY	SAT.
JAN 18	19	20 CLASSES START!	21	22	23	24
25	26	27	28	29 WORKSHOP 4	30	31
FEB 1	2	3	4	5	6	7
8	9	10	11	12 PRESENTATION ABSTRACT DUE	13	14
15	16	17	18	19	20	21
22	23	24	25	26 THESIS SYMPOSIUM	27 THESIS SYMPOSIUM	28
MAR 1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16 SPRING BREAK	17 SPRING BREAK	18 SPRING BREAK	19 SPRING BREAK	20 SPRING BREAK	21
22	23	24	25	26 DRAFT DUE FOR PEER REVIEW	27 NO CLASSES	28
29	30	31	APR 1	2	3	4
5	6 FULL THESIS DUE	7	8	9	10	11
12	13	14	15	16	17 FINAL THESIS DUE	18
19	20	21	22 SEMINAR JOURNAL DUE	23	24 BOUND THESIS DUE	25
26	27	28	29	30	MAY 1	2
3	4	5	6 LAST DAY OF CLASS!	7	8 <u>SENIOR GRADES DUE</u>	9
10	11	12	13	14	15	16
17 GRADUATION!	18	19	20	21	22	23