# San José State University
# Department of Chemistry
# Inorganic Chemistry, CHEM 145, Fall, 2022

## Course and Contact Information

| | |
|---|---|
| Instructor: | Prof. Madalyn Radlauer (*she/her*) |
| Office Location: | DH 517 |
| Telephone: | (408) 924-5482 |
| Email: | madalyn.radlauer@sjsu.edu |
| Office Hours: | Mondays 2:30 pm – 3:30 pm<br>Fridays 10:00 am – 11:00 am<br>Or by request |
| Class Days/Time: | MWF 9:00 am – 9:50 am |
| Classroom: | DH 351 |
| Prerequisite: | CHEM 112B (with grades of "C" or better; "C-" not accepted) |
| Co-requisite: | CHEM 113A |
| | *Note: Concepts and topics covered in General Chemistry (i.e. CHEM 1A & CHEM 1B) are essential for success in this class. We will review the relevant information, but we will do so rather quickly, so we will also have review sessions for anyone interested* |
| Learning Assistant: | Jenalyn Halog-Calimquim (s*he/her*)<br>jenalyn.halog-calimquim@sjsu.edu |

## Course Website

Course materials such as the syllabus, handouts, notes, assignment instructions, etc. can be found on Canvas (https://sjsu.instructure.com/). Even though our class periods will be in person, videos, notes, and assignments will all be posted on Canvas, so you will likely be using it several times per week.

**Course Description** (from the University Catalog: http://info.sjsu.edu/web-dbgen/splash/catalog.html)

Development of unifying principles to understand the chemistry of the elements. An introduction to the chemistry, bonding theories, and applications of coordination compounds.

## Course Format

### Partially Flipped Course

I wanted to use class time for discussion and problem solving in addition to more traditional lecture, so some of the lecture material has been made into edited videos that are available through the Canvas modules. As described in detail in the "Start Here" module on Canvas, the course will have a repeating pattern each week that includes lecture (both the videos and in person), discussions, group work, and short assignments. During class, you will work with me, our Learning Assistant, Jenalyn Halog-Calimquim, and your classmates to engage with the material through lectures, discussions, group quizzes, and worksheets.

## Course Goals and Learning Objectives

The goal of this course is to provide an introduction to inorganic chemistry, specifically regarding periodic trends, bonding theory, molecular symmetry, atomic and molecular orbitals, and coordination compounds.

**Program Learning Outcome (PLO)**

Upon successful completion of this program,

PLO 1.1: Students will be able to identify, formulate, and solve a range of chemistry problems (fundamental to complex) through application of mathematical, scientific, and chemical principles.

PLO 1.2: Students will be able to recognize, relate, and/or apply chemistry terms and concepts to propose and solve interdisciplinary and multidisciplinary real world problems.

PLO 3.1: Students will be able to explore, critique, and reflect on how chemistry relates to society, culture, and issues of equity and ethics that shape their scientific beliefs and identities.

PLO 3.2: Students will be able to identify as scientists within the scientific community through constructing peer reviews, engaging in collaborations, and participating in mentorship.

**Course Learning Outcomes (CLO)**

Upon successful completion of this course, students will be able to:

CLO 1: Predict and classify the structures of various inorganic complexes.

CLO 2: Predict the properties of various inorganic complexes and use this prediction to distinguish between molecules.

CLO 3: Discuss and employ atomic structure and bonding models, including molecular orbitals, to interpret experimental and spectroscopic evidence.

CLO 4: Apply concepts and models of symmetry, structure, and bonding to other areas in chemistry such as organic and biochemistry, and to use these concepts to more deeply examine many aspects of biology, forensic science, materials science, and environmental science.

## Texts/Readings

**Textbook** (recommended, available via the SJSU campus bookstore and on reserve at the MLK Library)

*Inorganic Chemistry* by Gary L. Miessler, Paul J. Fischer, and Donald A. Tarr (5th edition, 2014) ISBN: 9780321811059.

Because this text is expensive, I am in the process of transitioning to a free textbook option. The site is still under construction so it's not a complete text, but you can find some useful readings at the following website: https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Map%3A_Inorganic_Chemistry_(Miessler_Fischer_Tarr).

**Other References** (not required, on reserve at the MLK Library)

*Inorganic Chemistry* by Catherine E. Housecroft and Alan G. Sharpe

*Chemical Applications of Group Theory* by F. Albert Cotton

*Symmetry and Spectroscopy* by Daniel C. Harris and Michael D. Bertolucci

**Model Kit** (highly recommended)

A model kit can be a great help in this course, especially early on. Look for one with atoms that can bind to 1-6 other atoms or groups. I have some small kits I can loan out for the semester if you do not have one.

**Library Liaison**

You should have a student library account with the King Library that allows you access the library electronic databases. If you plan to access the library services from off-campus, you may need to obtain a password and/or proxy to do so. Check the Library website for information. The reference Librarian for Chemistry is Anne Marie Engelsen and her email is annemarie.engelsen@sjsu.edu.

## Course Requirements and Assignments

Graded work will include in-class group quizzes, in-class worksheets, take-home problems, Canvas discussion posts, two midterm exams, and one comprehensive final exam, which all contribute to the course learning outcomes. Dates for the exams are in the Course Schedule below. All relevant dates are also posted to Canvas. Exams and assignments in the course will be weighted as follows:

| **Assignments** | **Points** |
|---|---|
| Start Here Module Assignments | 10 |
| Group Quizzes (10 points each) | 150 |
| Worksheets (9 points each) | 126 |
| Take-home Problems (20 points each) | 260 |
| Canvas Discussions (7 points each) | 98 |
| Midterm Exams (100 points each) | 200 |
| Final Exam | 175 |
| Total | 1019 |
| **Will be graded out of** | **1000** |

Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the course (normally three hours per unit per week) for instruction, preparation/studying, or course related activities, including but not limited to internships, labs, and clinical practica. Other course structures will have equivalent workload expectations as described in the syllabus.

**Weekly Workflow**

| Weekday | Activities |
|---|---|
| before Monday's class | Watch the video and post to the Canvas Discussion |
| Monday | Lecture/discussion, then start Group Quiz (last 15 minutes); submit Take-Home Problem (from last week) by midnight |
| before Wednesday's class | Look through the recommended reading (also a good time to try a few of the recommended problems), continue back-and-forth on Group Quiz |
| Wednesday | In-class Worksheets in groups and as a whole class |
| before Friday's class | Finalize Group Quiz responses and review the Canvas Discussion and respond to at least one other post |
| Friday | Lecture/discussion to take the material to the next level |

## Final Examination or Evaluation

The Final Exam is comprehensive and will be have a range of question styles that will be similar to the other assignments and exams in the course.

## Grading Information

### Determination of Grades

Points will be distributed as described in Course Requirements and Assignments above. I will not curve because I believe that everyone can succeed in this course. I may, at the end of the course, linearly shift the scale. I will only shift it to benefit you. The course grade will be determined from the resulting average of the point total as follows:

| Percentage of Total Points | Final Course Grade |
|---|---|
| 96 and above | A plus |
| 92 to 95.9 | A |
| 88 to 91.9 | A minus |
| 84 to 87.9 | B plus |
| 80 to 83.9 | B |
| 76 to 79.9 | B minus |
| 72 to 75.9 | C plus |
| 68 to 71.9 | C |
| 64 to 67.9 | C minus |
| 60 to 63.9 | D plus |
| 56 to 59.9 | D |
| 52 to 55.9 | D minus |
| less than 52 | F |

### Course Modules

The course is organized into four modules on Canvas, each covering several weeks of material. These modules will lay out the lecture videos and recommended reading, the worksheets, and the assessments for each major course topic. Later modules will rely on the information learning earlier in the course, so numerous checkpoints are built into the course. I hope you'll ask questions early and often. The two midterms would roughly cover Module 1 and Modules 2 and 3, respectively. The final exam is cumulative.

### Group Quizzes

Each Monday during the last ~15 minutes of class, you will do a Group Quiz, but this content will not be graded until after office hours on Friday. These quizzes will be brief and generally cover things from the pre-class video and that day's in-class discussion (though material from the previous week(s) may also be relevant). The format will typically include 1 or 2 multiple choice questions with space to explain your answers. The questions are intended to get you to think about the new material and try to apply it to a question or two. For this assignment, your group will discuss the question(s) and put down your initial ideas and then we will have a bit of back-and-forth in the comment section via Canvas before you submit your "final" answer for grading. It is expected that every student in the group will contribute to the back-and-forth. If this is not the case, then only those who contribute will benefit point-wise from the revision of the answer.

### In-class Worksheets

Worksheets will be posted to the module before class each Wednesday. You will need to access the worksheet for class. It will be formatted so that you can do your work directly on the worksheet. I will have printed copies

for everyone in class (though if you prefer to work on a tablet or similar, let me know and I won't waste the paper printing it). The LA and I will come around to groups to check in and offer assistance. I expect you to use this time to engage with the material and work together. These worksheets will be graded for participation. You do not need to complete the worksheet to get credit, but I recommend that you complete all of the worksheets as these are intended to help you learn the material. Keys for the worksheets will be posted on the page for that week in the Canvas module.

**Canvas Discussions**

The Canvas Discussions will have two parts each week. The first will be due by Monday's class time and the second will be due by Friday's class time. For the first part, the LA and I will devise a topic specific prompt for you to respond to or you can ask one or more specific questions about the week's material. The second part will require that you respond to at least one post from your classmates.

**Take-home Problems**

Instead of having large problem sets due a few times throughout the semester, we are using a model where there will be one or two questions to work through each week. They will be posted at the same time as the in-class worksheets (by Wednesday at the latest) and will be due by midnight on Monday. Typically, you will both have to provide solutions as well as explain how you went about getting them and why your solution makes sense to you. The Take-home Problems are intended to challenge you, so don't be surprised if they're tough. My goal is that these questions be more difficult than anything you see on the midterms so that if you have a good understand of them, you'll rock the exams. You are welcome to bring questions about the Take-home problems to me (or our LA) at office hours, etc. or to work on them in groups as long as everyone does their own work. I will try to get you feedback within a week and I will post the key right away so that you can use them to study.

**Recommended Reading**

In each module, I will post recommended reading from the book. While this is not required, it offers you another way to learn the material.

**Extra Practice Problems**

In addition to the graded Take-home Problems, I will post ungraded little quizzes in each module. These will typically be multiple choice and will rely on the material covered in Monday's and Wednesday's class periods. They might also be right out of the week's recommended reading and they will be auto-graded by Canvas. I will also post recommended problems from the textbook. These will not be graded, but I have often gotten requests for more practice problems, so here they are! Feel free to pick and choose which exercises you attempt, I list all of the problems that I think are interesting/well-suited to how I teach the course, so they might start to feel repetitive. Solutions to exercises are at the back of the textbook (Appendix A) and solutions to the problems have been posted to Canvas. While all the solutions are provided to you up front, remember that you will learn more effectively by attempting the problems before looking at the answers.

**Missed Exams or Assignments**

The difficult circumstances of the past >2 years have not gone away and I am aware that the havoc in our world has forced us to work and learn under various stressors. This may make it more difficult for you to maintain a steady schedule and you may need to miss class or an assignment at some point in the semester. If this is the case, please contact me ahead of class time and with as much of a heads up as possible and we can discuss the situation. The more heads up you can give me, especially with regards to missing exams or assignment deadlines, the better. Even if you cannot give me a heads up, reach out. I will do my best to be accommodating.

## Classroom Protocols

As a show of respect to your fellow classmates and me, please be on time to class; we will start at 9:00 am sharp.

Please do not come to class if you do not feel well. Email me and the LA, Jenalyn Halog-Calimquim, and we can set up one of two options for you.

1. If you would like to attend class virtually, we can set up a Zoom meeting *as long as you email the LA and myself at least 10 minutes before class starts*.
2. We can get notes sent to you and arrange for you to make up any group work.

I hope that the classroom will serve as an environment that will promote learning and the development of new ideas, as well as be a safe and respectful community. If anything in the classroom makes you feel uncomfortable or disrespected, especially if it is something that I say or do, please bring it to my attention. You all are students, but you are people first and foremost, and the classroom should be a place you feel welcomed and respected.

## Email policy

I receive a lot of emails, so to be sure that I see your email, all CHEM 145 emails should have CHEM 145 in the subject line. I will do my best to respond to class-related emails within 1 business day of receiving them, however, keep in mind that this may not always be possible. You can also message me via Canvas and I will target a similar turnaround time.

## COVID-19 Related Policies

Masks are REQUIRED in the classroom and they must cover both your nose and mouth. I have a toddler who is not yet fully vaccinated, so even if SJSU lifts its mask mandate, I will continue to require masks in the classroom for the entire semester. Anyone not wearing a mask will not be allowed to attend class.

For the time being, SJSU is not requiring social distancing, so that we can do group work in person. If this changes, we may have to go at least partly online in order to do group assignments without having to yell across the room.

All students coming to campus for College of Science classes must go through the College of Science COVID training. This primarily includes watching a video prepared by the Safety Team and reading the SJSU Adapt Plan.

Everyone at SJSU is required to be fully vaccinated and boosted against COVID-19.

If you have COVID symptoms, a positive COVID test, or are exposed to someone who tests positive for COVID, DO NOT COME TO CAMPUS. Email me and I will send you a follow up email with the appropriate protocols to follow. I will do my best to make accommodations so that your progress and grade are not negatively affected should this occur.

## University Policies

Per University Policy S16-9, relevant university policy concerning all courses, such as student responsibilities, academic integrity, accommodations, dropping and adding, consent for recording of class, etc. and available student services (e.g. learning assistance, counseling, and other resources) are listed on Syllabus Information web page (https://www.sjsu.edu/curriculum/courses/syllabus-info.php). Make sure to visit this page to review and be aware of these university policies and resources.

# Inorganic Chemistry, CHEM 145, Fall 2022, Course Schedule

The tentative course calendar below includes weekly course content, exam dates, and the date for the final exam. Dates may be subject to change, but prior to this, fair notice will be given during class and through Canvas. The recommended reading and problems from our primary textbook, *Inorganic Chemistry* by Miessler, Fischer, and Tarr will be listed on the Canvas site along with each module. The related modules are indicated in bold as M1, M2, M3, and M4.

**Tentative Course Schedule**

| Class | Week | Date | Topics, Readings, Assignments, Deadlines |
|---|---|---|---|
| 1 | 1 | F 8/19 | ***First day of classes*** Introduction to course |
| 2 | 2 | M 8/22 | **M1:** Drawing structures and finding symmetry elements |
| 3 | 2 | W 8/24 | **M1:** Symmetry elements worksheet |
| 4 | 2 | F 8/26 | **M1:** Symmetry elements and point groups |
| 5 | 3 | M 8/29 | **M1:** Point groups |
| 6 | 3 | W 8/31 | **M1:** Point groups worksheet |
| 7 | 3 | F 9/2 | **M1**: Character tables |
| | 4 | M 9/5 | ***Labor Day – No class*** |
| 8 | 4 | W 9/7 | **M1**: Character tables worksheet |
| 9 | 4 | F 9/9 | **M1**: How to use character tables |
| 10 | 5 | M 9/12 | **M1**: How to use character tables |
| 11 | 5 | W 9/14 | **M1**: Reducing reducible representations worksheet |
| 12 | 5 | F 9/16 | **M1**: Applications in vibrational spectroscopy |
| 13 | 6 | M 9/18 | **M1**: Applications in vibrational spectroscopy |
| 14 | 6 | W 9/21 | **M1**: Vibrational spectroscopy worksheet |
| 15 | 6 | F 9/23 | **M2:** Diatomic MO diagrams |
| 16 | 7 | M 9/26 | **M2:** Moving to larger molecules |
| 17 | 7 | W 9/28 | **M2:** Diatomic MO diagrams worksheet |
| 18 | 7 | F 9/30 | **Midterm Exam 1 (covering Module 1)** |
| 19 | 8 | M 10/3 | **M2:** SALCs |
| 20 | 8 | W 10/5 | **M2:** SALC The Game |
| 21 | 8 | F 10/7 | **M2:** MO diagrams of more complex molecules |
| 22 | 9 | M 10/10 | **M2:** MO diagrams of more complex molecules |
| 23 | 9 | W 10/12 | **M2:** MO theory worksheet |

| Class | Week | Date | Topics, Readings, Assignments, Deadlines |
|---|---|---|---|
| 24 | 9 | F 10/14 | **M3:** Electron counting and ligand types |
| 25 | 10 | M 10/17 | **M3:** Electronic properties of ligands |
| 26 | 10 | W 10/19 | **M3:** Recognizing ligand types worksheet |
| 27 | 10 | F 10/21 | **M3:** MOs of octahedral complexes and delta octahedral |
| 28 | 11 | M 10/24 | **M3:** d-d splitting and what it can tell us |
| 29 | 11 | W 10/26 | **M3:** MOs of octahedral complexes worksheet |
| 30 | 11 | F 10/28 | **M3:** Delta octahedral trends |
| 31 | 12 | M 10/31 | **M3:** MOs of complexes with other symmetries |
| 32 | 12 | W 11/2 | **M3:** d-d splitting worksheet |
| 33 | 12 | F 11/4 | **M3:** Spectrochemical series and high and low spin complexes and distortions of the ligand field |
| 34 | 13 | M 11/7 | **M3:** Review |
| 35 | 13 | W 11/9 | **Midterm Exam 2 (covering Modules 2 and 3)** |
| | 13 | F 11/11 | *Veteran's Day, no class* |
| 36 | 14 | M 11/14 | **M4:** Magnetism, Electronic spectroscopy |
| 37 | 14 | W 11/16 | **M4:** Electronic spectroscopy worksheet |
| 38 | 14 | F 11/18 | **M4:** Types of charge transfer |
| 39 | 15 | M 11/21 | **M4:** Reactivity |
| | 15 | W 11/24 | ***Thanksgiving Break – No class*** |
| | 15 | F 11/26 | ***Thanksgiving Break – No class*** |
| 40 | 16 | M 11/28 | **M4:** Intro to organometallic and bioinorganic chemistry |
| 41 | 16 | W 11/30 | **M4:** Applications worksheet |
| 42 | 16 | F 12/2 | **M4:** Review |
| 43 | 17 | M 12/5 | ***Last day of classes*** Class wrap-up |
| | | | |
| | **Final Exam** | Tu 12/13 | ***Assigned final exam time is 7:15 – 9:30 am*** |
| | | M 12/19 | ***Grades available*** |