

Transition Metal Chemistry

CHEM 312/ENCH 312

Fall 2023

Course Description

This course focuses on understanding the chemical and physical behavior of transition metal (and related) compounds through quantum chemistry theories such as the molecular orbital (MO) theory and the electronic structure theory.

General Course Information

Lectures

From 2025-09-02 to 2025-12-02

All lectures are held in-person in [REDACTED]

Instructor: Dr. Peng Wang

My main research interest focuses on crystalline materials and crystal growth. Trained as a solid-state chemist in McMaster University, I have a background in synthesizing and studying the physical properties of crystalline materials. I then worked as a postdoctoral scholar in Northwestern University focusing on the exploration, crystal growth and characterization of semiconducting radiation detectors. Subsequently, I served as a scientist in the semiconducting material industry. In 2018, I started my position at Queen's University, here I am focusing on the exploration and development of new crystalline compounds for optical and optoelectronic applications.

Contact Information:

Office: CHE303

Email: wang.peng@queensu.ca

Office hours: by email appointment.

Tutorial information is available *via* SOLUS

Tutorials

From 2025-09-09 to 2025-12-02

Teaching Assistant:

TBA

onQ site

Students registered in the course can access the course onQ site at <https://onq.queensu.ca/d2l/home>. The site includes the assignments, your grades, and other materials.

Course Outline

1. Introduction to *d*- and *f*-element chemistry
2. Coordination complexes
3. Crystal Structures and *X*-ray Diffraction
4. Crystal field (CF) theory
5. Molecular orbital (MO) theory for transition metal complexes

- Electronic structures of solid materials
- spectroscopy and magnetism of transition metal complexes
- Metal-metal bonding and transition metal cluster compounds
- Introduction to Organometallic Chemistry

Course Materials

- Inorganic Chemistry (4th or 5th edition) by Housecroft & Sharpe
- Organic Chemistry (2nd edition) by Clayden, Greeves & Warren

Intended Student Learning Outcomes

- Name transition metal complexes and draw structures based on the formulae, including determining the oxidation state of the metal, given a set of common coordinated ligands.
- Describe the space group symmetry of crystalline compounds and diffraction techniques used in the study of transition metal compounds.
- Interpret electronic spectra of transition metal complexes in terms of the relationships between energy and intensities of the transitions present in the spectrum and the nature of the metal and the coordinated ligands.
- Predict the electronic and spin configurations, magnetic properties and reactivity of transition metal ions and their complexes based on the type of metal, its oxidation state and the nature of the coordinated ligands.
- Explain the causes of differences in structure and reactivity of compounds of different transition elements
- Describe the electronic structures of solid transition metal compounds and how they impact the properties of functional material.
- Describe the basic roles of transition metal ions and their complexes in biological systems.

Suggested Time Commitment

In this course, you should expect to invest on average 8 to 10 hours per week. This will include the time you spend studying course material, practicing course objectives, and participating in course activities and assessments. You are encouraged to adhere to a pre-determined study schedule as you will be more likely to complete the course on time successfully.

Assessment

Assignment 1:	15%	Date TBA
Assignment 2:	15%	Date TBA
Midterm:	25%	Date TBA
Final Exam (in person):	45%	Date TBA
Total	100% ^a	

Grading Method

All components of this course will receive numerical percentage marks. The final grade you receive for the course will be derived by converting your numerical course average to a letter grade according to Queen's Official Grade Conversion Scale:

Queen's Official Grade Conversion Scale

Grade	Numerical Course Average (Range)
A+	90-100
A	85-89
A-	80-84
B+	77-79

B	73-76
B-	70-72
C+	67-69
C	63-66
C-	60-62
D+	57-59
D	53-56
D-	50-52
F	49 and below

Course Announcements and communications

Throughout the course, we will routinely post course news in the Announcements section of the course homepage. I encourage you to actively check the course onQ main page for course announcements throughout the semester for reminders and additional course information or learning opportunities.

Equity, Diversity and Inclusivity Statement

Queen's University recognizes that the values of equity and diversity are vital to and in harmony with its educational mission and standards of excellence. It acknowledges that direct, indirect, and systemic discrimination exists within our institutional structures, policies, and practices and in our community. These take many forms and work to differentially advantage and disadvantage persons across social identities such as race, ethnicity, disability, gender identity, sexual orientation, faith, and socioeconomic status, among other examples. In this class I will work to promote an anti-discriminatory, anti-racist and accountable environment where everyone feels welcome. Every member of this class is asked to show respect for every other member.

Land Acknowledgement

The territory that Queen's University occupies is included in the Dish with One Spoon Wampum Belt Covenant, an agreement between the Iroquois Confederacy and the Confederacy of the Ojibwe and Allied Nations to peaceably share and care for the resources around the Great Lakes. The Kingston Indigenous community continues to reflect the area's Anishinaabek and Haudenosaunee roots. There is also a significant Métis community as well as First Peoples from other Nations across Turtle Island present here today.

Building a Classroom Community

University is a place to share, question, and challenge ideas. Each student brings a different set of lived experiences. You can help to create a safer, more respectful classroom community for learners by following these guidelines:

- Make a personal commitment to learn about, understand, and support your peers.
- Assume the best of others and expect the best of them.
- Recognize and value the experiences, abilities, and knowledge each person brings to the course.
- Acknowledge the impact of oppression on other people's lives and make sure your words and tone are respectful and inclusive.
- Encourage others to develop and share their ideas.
- Pay close attention to what your peers say/write before you respond. Think through and re-read what you have written before you post online or send your comments to others.
- Be open to having your ideas challenged and challenge others with the intent of facilitating growth.
- Look for opportunities to agree with one another, building on and intentionally referencing peers' thoughts and ideas; disagree with ideas without making personal attacks, demeaning, or embarrassing others.

Fostering Accessibility

All of us have a shared responsibility for reducing barriers to learning and fostering accessibility and promoting meaningful inclusion of those with disabilities. The [Accessibility Hub](#) at Queen's University's Human Rights & Equity Office offer a host of [tutorials](#) that provide us all with practical tips for:

- creating accessible documents, e.g., to submit to your teaching team or share with peers in peer feedback activities/in a presentation,
- emails, e.g., while communicating with group members or your teaching team, and
- meeting practices (e.g., in tutorials/labs/seminars or virtual meetings).

Late Policy

If you require additional time to complete an assignment, please contact me as soon as possible. See below for the Chemistry Department policy on *missed* quizzes, tests, midterms, presentations, and assignments.

Department of Chemistry Policy on Missed Quizzes, Tests, Midterms, Presentations, and Assignments

The Chemistry Department requires that students submit a 'declaration of extenuating circumstances' form before being considered for accommodation. The form, and related information, is available at <http://www.chem.queensu.ca/undergraduate/undergraduate-resources/missed-exam-policy>. Note that this departmental policy does NOT apply to final exams.

Department of Chemistry Policy on Missed Labs

Laboratory work is an integral part of this course. All labs must be completed to pass the course. It is the responsibility of the student to notify the lab coordinator when a lab cannot be completed at the scheduled time. In exceptional circumstances, the following considerations will be given if a scheduled lab cannot be completed at the assigned time: Whenever possible, provisions will be made for a make-up lab preferably shortly before or after the missed experiment; the lab may be completed during the following academic year and a course mark of IN will be assigned until the missing work is completed; In rare circumstances, other accommodations may be made. For further information consult the course instructor and/or the lab coordinator.

Academic Consideration for Students in Extenuating Circumstances

Academic Consideration is a process for the University community to provide a compassionate response to assist students experiencing unforeseen, short-term extenuating circumstances that may impact or impede a student's ability to complete their academics. This may include but is not limited to any extenuating circumstance (illness, bereavement, traumatic event, injury, family emergency, etc.) which is short-lived, begins within the term, and will not last longer than 12 weeks - see Academic Consideration webpage for details (<https://www.queensu.ca/artsci/undergraduate/student-services/academic-consideration>)

Each Faculty has developed a protocol to provide a consistent and equitable approach in dealing with requests for academic consideration for students facing extenuating circumstances. For more information, undergraduate students in the Faculty of Arts and Sciences should consult the Faculty's webpage on Academic Consideration in Extenuating Circumstances and submit a request via the Academic Consideration Request Portal. Students in other Faculties and Schools who are enrolled in this course should refer to the protocol for their home Faculty.

Students are encouraged to submit requests as soon as the need becomes apparent and to contact their instructor and/or course coordinator as soon as possible once academic consideration has been granted. Any delay in contact may limit the options available for academic consideration. While we encourage instructors to accommodate, each instructor has discretion in deciding whether or how to apply the Academic Consideration. For more information on the Academic Consideration process, what is and is not an

extenuating circumstance, and to submit an Academic Consideration request, please see the Faculty of Arts and Science's Academic Consideration website. ASO courses include links to information on Academic Consideration on your Course Homepage in onQ.

Please see the Teaching Team page for contact information for your instructor and TA(s), where relevant.

For more information, please see the Senate Policy on Academic Consideration for Students in Extenuating Circumstances.

Accommodations for Disabilities

Queen's University is committed to achieving full accessibility for people with disabilities. Part of this commitment includes arranging academic accommodations for students with disabilities to ensure they have an equitable opportunity to participate in all their academic activities. The Senate Policy for Accommodations for Students with Disabilities was approved at [Senate in November 2016](#). If you are a student with a disability and think you may need academic accommodations, you are strongly encouraged to contact the **Queen's Student Accessibility Services (QSAS)** and register as early as possible. For more information, including important deadlines, please visit the [QSAS website](#).

Calculator Policy

Calculators acceptable for use during quizzes, tests and examinations are intended to support the basic calculating functions required by most Arts and Science courses. For this purpose, the use of the **Casio 991** series calculator is permitted and is the **only approved calculator for Arts and Science students**. This calculator sells for around \$25 at the Queen's Campus Bookstore, Staples and other popular suppliers of school and office supplies.

Queen's Policy Statement on Academic Integrity -Mandatory

Queen's University is dedicated to creating a scholarly community free to explore a range of ideas, to build and advance knowledge and to share the ideas and knowledge that emerge from a range of intellectual pursuits. Each core value of academic integrity, as defined in the Senate Academic Integrity Policy, gives rise to and supports the next.

Honesty appears in presenting one's own academic work, whether in the context of an examination, written assignment, laboratory or seminar presentation. It is in researching one's own work for course assignments, acknowledging dependence on the ideas or words of another and in distinguishing one's own ideas and thoughts from other sources. It is also present in faithfully reporting laboratory results even when they do not conform to an original hypothesis. Further, honesty is present in truthfully communicating in

written and/or oral exchanges with instructors, peers and other individuals (e.g. teaching assistants, proctors, university staff and/or university administrators).

Trust exists in an environment in which one's own ideas can be expressed without fear of ridicule or fear that someone else will take credit for them.

Fairness appears in the proper and full acknowledgement of the contributions of collaborators in group projects and in the full participation of partners in collaborative projects.

Respect, in a general sense, is part of an intellectual community that recognizes the participatory nature of the learning process and honours and respects a wide range of opinions and ideas. However, "respect" appears in a very particular sense when students attend class, pay attention, contribute to discussion and submit papers on time; instructors "show respect by taking students' ideas seriously, by recognizing them as individuals, helping them develop their ideas, providing full and honest feedback on their work, and valuing their perspectives and their goals" ("The Fundamental Values of Academic Integrity", 3rd Edition, p. 8).

Ultimately, responsibility is both personal and collective and engages students, administrators, faculty and staff in creating and maintaining a learning environment supported by and supporting academic integrity.

Courage differs from the preceding values by being more a quality or capacity of character – "the capacity to act in accordance with one's values despite fear" ("The Fundamental Values of Academic Integrity", 3rd edition, p. 10). Courage is displayed by students who make choices and integrous decisions that are followed by action, even in the face of peer pressure to cheat, copy another's material, provide their own work to others to facilitate cheating, or otherwise represent themselves dishonestly. Students also display courage by acknowledging prior wrongdoing and taking proactive measures to rectify any associated negative impact.

All of these values are not merely abstract but are expressed in and reinforced by the University's policies and practices.

Syllabus statements for Generative Artificial Intelligence (AI) Tools (select one of the following)

Instructors should include clear guidelines or a statement in the syllabus to advise students on the use of generative AI tools. The below statements were developed by the Faculty of Engineering and Applied Science and shared with permission.

Permitted with citation:

- Students must submit their own work and cite the work that is not theirs. Generative AI writing tools such as ChatGPT are welcome in this class, provided you cite the material that they generate. Any other use constitutes a departure from academic integrity.

Queen's [Student Academic Success Services](#) (SASS) offers a self-directed, online academic integrity module which we encourage all students to take which will help with:

- Understanding the nature of the academic integrity departure
- Understanding the expectations of and role of sources in scholarly writing
- Integrating sources into your writing (paraphrasing, quoting, summarizing)
- Understanding when and how to cite your sources

- Managing your time effectively to avoid the need for shortcuts
- Taking effective notes to ensure accuracy of source material and correct attribution

Turnitin Statement

This course makes use of Turnitin, a third-party application that helps maintain standards of excellence in academic integrity. Normally, students will be required to submit their course assignments through onQ to Turnitin. In doing so, students' work will be included as source documents in the Turnitin reference database, where they will be used solely for the purpose of detecting plagiarized text in this course. Data from submissions is also collected and analyzed by Turnitin for detecting Artificial Intelligence ([AI-generated text](#)). These results are not reported to your instructor at this time but could be in the future.

Turnitin is a suite of tools that provide instructors with information about the authenticity of submitted work and facilitates the process of grading. The similarity report generated after an assignment file is submitted produces a similarity score for each assignment. A similarity score is the percentage of writing that is similar to content found on the internet or the Turnitin extensive database of content. Turnitin does not determine if an instance of plagiarism has occurred. Instead, it gives instructors the information they need to determine the authenticity of work as a part of a larger process.

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