UNIVERSITY OF CALGARY
FACULTY OF SCIENCE

Department of Chemistry
Science B 605
403 220-5385
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COURSE OUTLINE

1. **Course:** CHEM 433, Inorganic Chemistry: Transition Metals - Winter 2022

   Lecture 01 : TR 11:00 - 12:15 in SA 106

Instructor	Email	Phone	Office	Hours
Dr Farideh Jalilehvand	faridehj@ucalgary.ca	403 220-3855	SB 213	By Appointment

Course Description

Lectures: Bonding models for metals and for transition metal compounds; interpretation of redox and thermodynamic properties based on ligand field theory; coordination and organometallic compounds of the transition metals; metal complexes as catalysts in industry and biology.

Laboratory: Synthesis, analysis, and physical investigations of transition metal compounds which illustrate their important properties.

To account for any necessary transition to remote learning in the winter 2022 semester, courses with in-person lectures, labs, or tutorials may be shifted to remote delivery for a certain period of time. In addition, adjustments may be made to the modality and format of assessments and deadlines, as well as to other course components and/or requirements, so that all coursework tasks are in line with the necessary and evolving health precautions for all involved (students and staff).

In Person Delivery Details:

Lectures will be delivered online (Zoom - Synchronous delivery) until**February 28, 2022**. To accommodate students who are living in different time zones, the lectures will be recorded and automatically posted on D2L.

To help ensure Zoom sessions are private, do not share the Zoom link or password with others, or on any social media platforms. Zoom links and passwords are only intended for students registered in the course. Zoom recordings and materials presented in Zoom, including any teaching materials, must not be shared, distributed or published without the instructor's permission.

In-person lectures will not be recorded - annotated lecture handouts, however, will be posted on Class Notebook (OneNote) after class.

Under extenuating circumstances (e.g. instructor self-isolating after close contact), or in the case of changes to University regulations related to COVID restrictions, in-person lecture delivery may be temporarily switched online (Zoom - Synchronous delivery). In this case, notification will be posted on course D2L.

Term Test I will be held synchronously (live) on the scheduled time/ date (see Section 5).

Laboratory activities will begin in the week of**January 31st, 2022**; the first session will also include check-in.

Five wet labs will be completed in person at the scheduled time and location (EEEL 253).

Until **March 31st**, all laboratory groups will be split into two groups of ~10 students attending the wet labs in alternating weeks. T**he complete laboratory schedule will be available on D2L by Friday, January 21st, 2022**. Students will need to contact the instructor as soon as possible if unable to attend any in-person component (wet lab).

Re-Entry Protocol for Labs and Classrooms:

To limit the spread of COVID-19 on campus, the University of Calgary has implemented safety measures to ensure the campus is a safe and welcoming space for students, faculty and staff. The most current safety information for campus can be found here.

Course Site:

D2L: CHEM 433 L01-(Winter 2022)-Inorganic Chemistry: Transition Metals

(To access lecture handouts and practice problems)

Microsoft Teams: CHEM 433_Winter 2022 (For communications and access to Class Notebook)

Please activate Multi-Factor Authentication (MFA) in your U of C account.

OneNote: You will receive an access link via D2L for Class Notebook (for annotated lecture notes)

Note: Students must use their U of C account for all course correspondence.

Equity Diversity & Inclusion:

The University of Calgary is committed to creating an equitable, diverse and inclusive campus, and condemns harm and discrimination of any form. We value all persons regardless of their race, gender, ethnicity, age, LGBTQIA2S+ identity and expression, disability, religion, spirituality, and socioeconomic status. The Faculty of Science strives to extend these values in every aspect of our courses, research, and teachings to better promote academic excellence and foster belonging for all.

The Chemistry EDI Committee acknowledges there are persistent barriers that prevent such accessibility and hinder our progress towards EDI. Our representatives (faculty, postdocs, graduate and undergraduate students) are committed to addressing any concerns and work towards proactive solutions that enact necessary change within the department. To submit anonymous questions, comments or concerns regarding EDI related issues, please reach out to our Associate Head EDI, Belinda Heyne (bjmheyne@ucalgary.ca)

2. **Requisites:**

See section 3.5.C in the Faculty of Science section of the online Calendar.

Prerequisite(s):
Chemistry 201 or 211, and 203 or 213, and 331 or 431. Also known as: (formerly Chemistry 333)

3. **Grading:**

The University policy on grading and related matters is described in F.1 and F.2 of the online University Calendar.

In determining the overall grade in the course the following weights will be used:

Course Component	Weight	Due Date (duration for exams)	Modality for exams	Location for exams
Laboratory (5)	25%	Ongoing		
Term Test I[1]	10%	Feb 11 2022 at 07:00 pm (1.5 Hours)	online	Online (synchronous)
Term Test II	25%	Mar 18 2022 at 07:00 pm (2 Hours)	in-person	ICT 102
Registrar Scheduled Final Exam	40%	Will be available when the final exam schedule is released by the Registrar	in person	Will be available when the final exam schedule is released by the Registrar

[1] 60 min Writing time + 30 min buffer time. See Section 7 for available accommodations for students facing a significant barrier to writing this online assessment during the scheduled time.

Each piece of work (reports, assignments, quizzes, midterm exam(s) or final examination) submitted by the student will be assigned a grade. The student's grade for each component listed above will be combined with the indicated weights to produce an overall percentage for the course, which will be used to determine the course letter grade.

The conversion between a percentage grade and letter grade is as follows.

	A+	A	A-	B+	B	B-	C+	C	C-	D+	D
Minimum % Required	95 %	85 %	80 %	75%	70%	65 %	60 %	55%	50%	45 %	40 %

This course will have a Registrar Scheduled Final exam that will be delivered in-person and on campus. The Final Examination Schedule will be published by the Registrar's Office approximately one month after the start of the term. The final exam for this course will be designed to be completed within 2 hours.

Notes

3.1. Students will be expected to understand at every stage the material covered in all components of the course. In order to achieve the prerequisite requirements (i.e., C-) for further Chemistry courses, a student must

meet the following requirements:

(1) achieve a minimum 50% in the laboratory grading, and

(2) achieve a minimum 50% weighted average on the examinations (Term Tests and Final).

This means that if a student scores below 50% in either the laboratory component or the examinations, then the maximum course letter grade they can obtain in CHEM 433 is a D+.

3.2. All exams are cumulative. There will be no deferred Term Tests for this course. See also Section 4.

The University of Calgary offers a flexible grade option, Credit Granted (CG) to support student's breadth of learning and student wellness. Faculty units may have additional requirements or restrictions for the use of the CG grade at the faculty, degree or program level. To see the full list of Faculty of Science courses where CG is not eligible, please visit the following website: https://science.ucalgary.ca/current-students/undergraduate/program-advising/flexible-grading-option-cg-grade

4. **Missed Components Of Term Work:**

The university has suspended the requirement for students to provide evidence for absences. Please do not attend medical clinics for medical notes or Commissioners for Oaths for statutory declarations.

In the event that a student legitimately fails to submit any online assessment on time (e.g. due to illness etc...), please contact the course coordinator, or the course instructor if this course does not have a coordinator to arrange for a re-adjustment of a submission date. Absences not reported within 48 hours will not be accommodated. If an excused absence is approved, one possible arrangement is that the percentage weight of the legitimately missed assignment could also be pro-rated among the components of the course. This option is at the discretion of the coordinator and may not be a viable option based on the design of this course.

There will be no deferred Term Test for this course

Excused absence may be considered for only ONE of the two Term Tests. The missed Term Test weight will be shifted to the Final Exam for students with a legitimate reason for absence.

If a student missed a Term Test, or did not perform an experiment, for non-legitimate reasons (e.g. vacation or incomplete pre-lab assignment), the contribution of that Term Test or experiment in the final course grade will be zero.

5. **Scheduled Out-of-Class Activities:**

The following out of class activities are scheduled for this course.

Activity	Location	Date and Time	Duration
Term Test I	Online (synchronous)	Friday, February 11, 2022 at 7:00 pm	1.5 Hours
Term Test II	ICT 102	Friday, March 18, 2022 at 7:00 pm	2 Hours

REGULARLY SCHEDULED CLASSES HAVE PRECEDENCE OVER ANY OUT-OF-CLASS-TIME-ACTIVITY. If you have a conflict with the out-of-class-time-activity, please contact your course coordinator/instructor no later than **14 days prior** to the date of the out-of-class activity so that alternative arrangements may be made.

Note that Term test 1 (1.5 hours) includes both 60 min Writing time + 30 min buffer time for technical issues. See Section 7 for available accommodations for students facing a significant barrier to writing this online assessment during the scheduled time.

6. **Course Materials:**

Recommended Textbook(s):

Missler, G. L.; Fischer, P. J., and Tarr, D. A.,*Inorganic Chemistry (5th Ed)*: Pearson.
Housecroft, C.E. and Sharpe, A.G.,*Inorganic Chemistry (4th or 5th Edition)*: Pearson.
Huheey, J. and Keither, E.A.,*Inorganic Chemistry (4th Ed)*: Harper Collins College Publishers.
Szafran, Z., Pike, R.M. and Singh, M.M.,*Microscale Inorganic Chemistry: A Comprehensive Laboratory Experience*: John Wiley & Sons.
Vogel A.,*Qualitative Inorganic Analysis (7th Ed)*: Longman.
Nakamoto, K.,*Infrared & Raman Spectra of Inorganic & Coordination Compounds (Parts A & B), 6th Ed* Wiley (available at U of C library - Online).
Lippard, S.J.,*Principles of Bioinorganic Chemistry*: University Science Books.

Other Course Materials:

Lab coat & safety glasses (required)
Molecular Model Kit (Molymod recommended)
A non-programmable scientific calculator (Casio FX 260 or equivalent)

In order to successfully engage in their learning experiences at the University of Calgary, students taking online, remote and blended courses are required to have reliable access to the following technology:

- A computer with a supported operating system, as well as the latest security, and malware updates;
- A current and updated web browser;
- Webcam/Camera (built-in or external);
- Microphone and speaker (built-in or external), or headset with microphone;
- Current antivirus and/or firewall software enabled;
- Stable internet connection.

For more information please refer to the UofC ELearning online website.

7. **Examination Policy:**

All exams will be **cumulative** in **closed book** format, and written **individually**. Both Term Test II and the Final exam (in-person) are designed to take 120 minutes for students to complete.

The Term Test I (*online, synchronous*) is designed to take 60 minutes for students to complete, but students will be given additional 30 minutes to account for any technical issues (e.g. internet interruption, D2L time out, etc.). Any form of communication (other than with the Prof) during the writing constitutes academic misconduct. The exam may consist of any combination of an online D2L quiz or long answer worksheet - to be submitted (as a scanned image, doc or pdf file) through D2L Dropbox for grading.

All students must start writing the Term Tests and Final exams within 30 min of the exam's start time.

Students who require accommodation must be registered with Student Accessibility Services (see section 12 (e.) below), and must identify themselves to their instructor as soon as possible. For any synchronous assessment, time will be adjusted for SAS students if needed. As well, accommodations for students facing a significant barrier to writing the assessment during the scheduled time will be done on a case-by-case basis. Students who need accommodation for the Term Tests or Final exam must contact the instructor at least **7 days** in advance of the scheduled assessment. Note that there will be no deferred Term Test for this course.

Since all exams are in **closed book** format, you may not access your lecture notes or course materials on One Note/ D2L, or any other resources during exams. No other aids are allowed on exams, including your mobile devices, or accessing internet resources such as search engines (Google, etc.), other websites, shared documents (Google docs etc.) or chat servers (Discord, WhatsApp, etc.), etc., and you are specifically prohibited from working with or contacting any other individuals while you complete the exam. For **in-person** examinations, students are allowed to have only pencils, pens, erasers, their ID card, and non-programmable calculators. Violation of these rules is considered academic misconduct (see also Item 12(d), below). Students will receive a **Periodic Table** as part of their exam package.

Students should also read the Calendar, Section G, on Examinations.

8. **Approved Mandatory And Optional Course Supplemental Fees:**

   Laboratory Breakage Fees

   The Department of Chemistry has a laboratory glassware breakage fee. At the start of the course, each student is assigned a locker and checks-in to establish that they have a complete set of usable glassware. By signing for check-in, a student agrees that they are now responsible for the glassware until check out. Any equipment that is missing, unusable or has been replaced during the semester will be charged to the student. All students, even those who withdraw early from the course must check out of the laboratory before the last day of lectures (April 12, 2022). Any student who fails to check out before the last day of lectures for the term will be assessed a charge of $30.00. If this fee is not paid by the posted deadline, university services (registration, transcripts, etc.) may be withheld.

9. **Writing Across The Curriculum Statement:**

   For all components of the course, in any written work, the quality of the student's writing (language, spelling, grammar, presentation etc.) can be a factor in the evaluation of the work. See also Section E.2 of the University Calendar.

10. **Human Studies Statement:**

    Students will not participate as subjects or researchers in human studies.

    See also Section E.5 of the University Calendar.

11. **Reappraisal Of Grades:**

    A student wishing a reappraisal, should first attempt to review the graded work with the Course coordinator/instructor or department offering the course. Students with sufficient academic grounds may request a reappraisal. Non-academic grounds are not relevant for grade reappraisals. Students should be aware that the grade being reappraised may be raised, lowered or remain the same. See Section I.3 of the University Calendar.

    a. **Term Work:** The student should present their rationale as effectively and as fully as possible to the Course coordinator/instructor within **ten business days** of either being notified about the mark, or of the item's return to the class. If the student is not satisfied with the outcome, the student shall submit the Reappraisal of Graded Term work form to the department in which the course is offered within 2 business days of receiving the decision from the instructor. The Department will arrange for a reappraisal of the work within the next ten business days. The reappraisal will only be considered if the student provides a detailed rationale that outlines where and for what reason an error is suspected. See sections I.1 and I.2 of the University Calendar

    b. **Final Exam:**The student shall submit the request to Enrolment Services. See Section I.3 of the University Calendar.

12. **Other Important Information For Students:**

    a. **Mental Health** The University of Calgary recognizes the pivotal role that student mental health plays in physical health, social connectedness and academic success, and aspires to create a caring and supportive campus community where individuals can freely talk about mental health and receive supports when needed. We encourage you to explore the mental health resources available throughout the university community, such as counselling, self-help resources, peer support or skills-building available through the SU Wellness Centre (Room 370, MacEwan Student Centre, Mental Health Services Website) and the Campus Mental Health Strategy website (Mental Health).

    b. **SU Wellness Services:** For more information, see www.ucalgary.ca/wellnesscentre or call 403-210-9355.

    c. **Sexual Violence:** The Sexual Violence Support Advocate, Carla Bertsch, can provide confidential support and information regarding sexual violence to all members of the university community. Carla can be reached by email (svsa@ucalgary.ca) or phone at 403-220-2208. The complete University of Calgary policy on sexual violence can be viewed at (https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Sexual-and-Gender-Based-Violence-Policy.pdf)

    d. **Misconduct:** Academic integrity is the foundation of the development and acquisition of knowledge and is based on values of honesty, trust, responsibility, and respect. We expect members of our community to act with integrity. Research integrity, ethics, and principles of conduct are key to academic integrity. Members of our campus community are required to abide by our institutional Code of Conduct and promote academic integrity in upholding the University of Calgary's reputation of excellence. Some examples of academic misconduct include but are not limited to: posting course material to online platforms or file sharing without the course instructor's consent; submitting or presenting work as if it were the student's own work; submitting or presenting work in one course which has also been submitted in another course without the

instructor's permission; borrowing experimental values from others without the instructor's approval; falsification/fabrication of experimental values in a report. Please read the following to inform yourself more on academic integrity:

Student Handbook on Academic Integrity
Student Academic Misconduct Policy and Procedure
Research Integrity Policy

Additional information is available on the Student Success Centre Academic Integrity page

e. **Academic Accommodation Policy:**

It is the student's responsibility to request academic accommodations according to the University policies and procedures listed below. The student accommodation policy can be found at: https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Student-Accommodation-Policy.pdf

Students needing an accommodation because of a disability or medical condition should communicate this need to Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities: https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Accommodation-for-Students-with-Disabilities-Procedure.pdf.

Students needing an accommodation in relation to their coursework or to fulfil requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, by filling out the Request for Academic Accommodation Form and sending it to Dr. Yuen-Ying Carpenter by email yyscarpe@ucalgary.ca preferably 10 business days before the due date of an assessment or scheduled absence.

f. **Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). Students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information, see Legal Services website.

g. **Student Union Information:** VP Academic, Phone: 403-220-3911 Email: suvpaca@ucalgary.ca. SU Faculty Rep., Phone: 403-220-3913 Email: sciencerep@su.ucalgary.ca. Student Ombudsman, Email: ombuds@ucalgary.ca.

h. **Surveys:** At the University of Calgary, feedback through the Universal Student Ratings of Instruction (USRI) survey and the Faculty of Science Teaching Feedback form provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses. Your responses make a difference - please participate in these surveys.

i. **Copyright of Course Materials:** All course materials (including those posted on the course D2L site, a course website, or used in any teaching activity such as (but not limited to) examinations, quizzes, assignments, laboratory manuals, lecture slides or lecture materials and other course notes) are protected by law. These materials are for the sole use of students registered in this course and must not be redistributed. Sharing these materials with anyone else would be a breach of the terms and conditions governing student access to D2L, as well as a violation of the copyright in these materials, and may be pursued as a case of student academic or non-academic misconduct, in addition to any other remedies available at law.

13. Laboratory Information:

Laboratory activities will begin in the week of **January 31st, 2022**; the first session will also include check-in. It is mandatory that students wear a lab coat and safety glasses at all times when working in the lab. Students wearing inappropriate laboratory attire will not be permitted to conduct experiments for safety reasons. The manual can be found online through course D2L site. You must consult the online laboratory manual prior to attending any of your scheduled lab periods and printout the required portion of the manual that outlines the procedures you will be doing.

14. Laboratory Safety Training:

All undergraduate students taking chemistry laboratories are required to complete an online training (approx. 50 minutes) on laboratory safety. Students who have previously completed the Chemistry Online Safety Training at the University of Calgary in the past five years are NOT required to repeat it. The Safety Training must be completed before the first laboratory experiment (before **January 31st, 2022**). Details about how to enroll in this online training is available on course D2L. The material is considered to be part of the course and is therefore appropriate for inclusion into laboratory pre-labs and exams.

15. Laboratory Exemption:

Students repeating the course within the last two years can be exempted from the Laboratory Component of the course if a grade of 75% or higher was obtained. Students choosing to exempt from the lab should be aware that,

- the material covered in labs may be integrated into non-lab-based course assessments; and,
- the lab grade achieved on the previous attempt will be carried forward.

Prior to applying for an exemption, students are encouraged to connect with their course instructor or coordinator to better understand the *risks* and *benefits* in their specific course, particularly if these labs are not in the same format (online or in-person) this semester. Instructors can tell you what access you will have (or not have) to lab materials as an exempt student, and how the lab materials may be integrated.

Applications for lab exemptions must be emailed to the Undergraduate Science Center (science.advising@ucalgary.ca) as soon as possible, but no later than the drop date.

16. Laboratory Experiments (5 weeks, 3 hrs/ week):

1. Coordination Complexes of Cobalt (III) Amine Complexes

Syntheses of $[Co(NH_3)_4(CO_3)]NO_3$ and $[Co(NH_3)_5Cl]Cl_2$, comparing their electrical conductance

2. Coordination Complexes - Geometrical Isomerism in Octahedral Complexes

Syntheses of *cis*- and *trans*- isomers of [Co(en)2Cl2]Cl, comparing their UV-vis. spectra

4. Carbonyl Complexes

Syntheses of two isomers of $Mo(CO)_4(PPh_3)_2$ from $Mo(CO)_6$; their structural characterization using IR spectroscopy

5. The Paramagnetic Complex $Mn(acac)_3$

Synthesis of $Mn(acac)_3$ complex (Hacac = acetylacetone) and finding its spin state (high-spin or low-spin) by measuring its magnetic susceptibility

7. Magnetochemistry & Electronic Spectra of Ni(II) Complexes with Different Coordination Environments

Syntheses of $[NiBr_2(PPh_3)_2]$, $[Ni(NH_3)_6]Cl_2$ and bis(triphenylphosphine)dithiocyanatonickel(II), correlating their magnetic susceptibilities and UV-vis spectra with their coordination geometries; identifying SCN- coordination mode to Ni(II) ion using IR spectroscopy.

Course Outcomes:

- By completing this course, students will be able to:
- 1) write name, formula and charge of coordination compounds; recognize common ligands, their donor atoms and denticity; determine the oxidation state of the metal and its electronic configuration; perform conductivity test in the lab to identify the number of ions constituting a coordination compound (when dissolved in water), making a distinction between inner-sphere and outer-sphere coordination; recognize symmetry elements and operations in a coordination compound, and determine its Point Group.
- 2) distinguish between different types of isomers for coordination compounds; prepare geometrical isomers of an octahedral complex in the lab, recognizing differences in their colors and UV-vis absorption spectra; learn in the lab how to separate two optical isomers (enantiomers) in a racemic solution, and determine the optical purity of the isolated enantiomer by measuring its optical activity using a polarimeter.
- 3) use 18-electron rule, crystal field theory and MO theory to explain bonding in octahedral, tetrahedral, square planar complexes and organometallic compounds, and calculate their crystal field stabilization energies; predict a ligand's field strength (weak vs. strong) and its position in the spectrochemical series based on its ability to be sigma-donor, pi-donor or pi-acceptor, leading to high-spin vs. low-spin electronic state in a complex; generate MO energy level diagrams for different ligand field strengths in an octahedral field; recognize metal ions that gain further stability through tetragonal distortion (Jahn-Teller effect); synthesize metal complexes in the lab, explaining their colors based on the color wheel and absorption bands in their visible spectra, justifying those electronic transitions according to crystal field splitting of d-orbitals, recognizing their spin-state by measuring their magnetic susceptibilities, identifying the nature of isomers formed using IR spectroscopy; explain nature of bonding and orbital overlaps in complexes with metal-metal bonds (delta bonding); describe sigma-donation and pi-back-bonding in metal-carbonyl complexes, preparing such complexes in the lab, using IR spectroscopy to determine their structures.

- 4) recognize thermodynamic stability of a metal complex in solution; distinguish between metal ions that form kinetically inert or labile complexes; describe the mechanisms (Associative, Dissociative, Intermediate) of ligand substitution reactions for octahedral and square planar complexes, and interpret the corresponding rate laws; discuss the electronic and steric factors that influence the reactivity of square planar complexes (such as Trans effect); recognize the mechanism of electron transfer (inner-sphere vs. outer-sphere) in a redox reaction for metal complexes based on supporting evidence (rate constants, presence of bridging ligands, use of radioisotopes, etc), and discuss factors contributing in the “self-exchange” and “cross-exchange” outer-sphere redox reactions.
- 5) use their knowledge about structure, bonding and reactivity of transition metal complexes to describe the mechanism of some fundamental catalytic processes, and the role of transition metal ions and their complexes in selected biological systems.

Electronically Approved - Jan 20 2022 16:49

Department Approval

Electronically Approved - Jan 20 2022 17:16

Associate Dean's Approval