**Advanced Inorganic Chemistry - Chem 471/571**
**Fall 2021**

M & Th / 11:00 am – 12:20 pm
CCB - 1209

***Professor Mark Lipke***

Office: CCB 2202
Office Hours: Tuesday 3 – 4 pm
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**Prerequisites (for undergraduates enrolled in 471)**: Chem 371 *Inorganic Chemistry*

**Tex**t: *Inorganic Chemistry* (5th Ed.) by Miesslar, Fischer, and Tarr.

**Other suggested texts**: "Orbital Interactions in Chemistry" by Albright, Burdett, and Whangbo; "Chemical Structure and Bonding" by DeKock and Gray; "Atkins' Physical Chemistry" by Atkins and De Paula.

Sections of these textbooks are useful for providing a better/deeper understanding of some course material and will be used as references for material covered in lecture.

**Other Resources**: Lecture slides will be posted on the Canvas site, usually shortly before the start of each lecture. Lectures will partially follow the content of the text by Miesslar and Tarr, but will include a significant amount of material that draws from other texts or the primary literature.

**Grading**: A total of 475 points are possible. Points are distributed as follows:

Quizzes 1 – 5: 125 pts (~25 pts each)
Exams 1 – 3: 300 pts (100 pts each)
Final Presentation: 50 pts
Total: 475 pts

**Course Description**:

The >100 known elements exhibit significant variation in their individual properties and the types of bonds/structures they form with each other. Understanding the rich chemistry of the elements is an enticing intellectual challenge with practical benefits that arise from the useful properties of many elements and compounds. This course will build upon previous courses in inorganic and physical chemistry to deepen students' understanding of the concepts of electronic structure and chemical bonding that underlie the diverse behavior of the elements. The physical and mathematical foundations of atomic orbitals and their use in constructing molecular orbitals will be examined, including the use of group theory to predict the form of molecular orbitals in various molecular symmetries. These concepts will be illustrated with classic examples of inorganic compounds along with recent examples drawn from the primary literature. Thus, students will develop a strong intuitive understanding of molecular orbital theory as it applies in many common areas of research.

**Specific Objectives**

1) Reinforce students' understanding of material from undergraduate courses in inorganic chemistry and chemical bonding (e.g. atomic structure, molecular orbital theory, acid/base chemistry, spectroscopy, coordination chemistry of transition metals, solid state chemistry, etc.)

2) Develop a stronger understanding of the mathematical and physical foundations of atomic structure and quantum mechanical theories of chemical bonding

3) Develop a stronger understanding of molecular orbital theory as it applies to a wide range of elements, especially those in the d-block of the periodic table (i.e. transition metals).

4) Demonstrate mastery of the course material by using knowledge gained in this course to analyze the primary chemical literature.

## Course Policies

**Grades, Presentations, and Examinations:** There will be three "exams" each worth 100 pts. The exams can be completed on your own time, with a specific due date listed below. You must work alone on the exams, though you may use any text or online resources as long as they are not interactive (e.g., no seeking help in online forums). Exams will be released at least one week before the due date.

There will be five quizzes, each worth about 25 pts. These will be given in class. Quizzes will be announced about one week before they are given. You may use any textbooks, notes, or other printed resources, but not phones or computers during the quizzes.

Each student will also be required to give a final presentation of a paper from the recent or classic literature, worth 50 pts. These presentations should provide a brief overview of the paper, and then a discussion of a specific aspect of the work that is relevant to topics covered in this course. A selection of papers will be announced as the semester progresses.

**Cheating, plagiarism and academic dishonesty:** Cheating will not be tolerated. Reporting infractions of the honor code is both your responsibility and the instructor's. You may be required to show your Rutgers ID when you turn in your exam to compare your picture and signature. Students caught cheating will fail the assignment (gets 0 point on the specific assignment), or if the infraction is deemed to be particularly serious or deliberate, the students involved will receive an "F" grade in Chem 471/571. University policy on academic dishonesty will be followed and the student(s) will be referred to the appropriate university office for disciplinary action. A letter will be sent explaining the punishment to the Associate Dean of Undergraduate Affairs or to the Chair of your graduate program. If you have further complaints regarding the failed assignment/class and the letter, you must contact the Associate Dean for Undergraduate Affairs or the Chair of Graduate Studies directly. Each student has to turn in his or her own exams. Copying is considered cheating and will be treated as stated above, with 0 points given for the exam and a letter to the Dean's offices. If you let someone copy your quiz from you, you will lose full credit and a letter sent to the Associate Dean of Undergraduate Affairs or the Chair of Graduate Studies.

**Absences and "I" Grade Policy**: The administration of Chem 471/571 will adhere strictly to the academic regulations stipulated in the most recent Schedule of Classes and the RU General Catalog. Withdrawal from the course will follow official RU procedures. Students are required to complete all courses for which

they are registered by the end of the semester. In some rare cases, a student may be unable to complete all of the coursework because of extenuating circumstances, but not due to poor performance, and will receive an incomplete until coursework is completed. The term 'extenuating' circumstances include: (1) incapacitating illness* which prevents a student from attending classes for a minimum period of two weeks, (2) a death in the immediate family, (3) financial responsibilities requiring a student to alter a work schedule to secure employment, (4) change in work schedule as required by an employer, or (5) other emergencies deemed appropriate by the instructor. For Chem 471/571, this policy will apply for students who miss ≥150 pts worth of exams and quizzes for a valid reason. For students who miss <150 pts of course material, a final grade will be assigned based on their grade percent out of the material that was completed.

*See next section for specific COVID policies.

**COVID Absence Policies:** Special policies are in place for this course given the ongoing COVID pandemic. For students who are unable to attend several classes due to quarantining or illness, recorded presentations will be provided from when this course was taught remotely in Fall 2020. For students who must quarantine but are not ill, exams must be turned in remotely. Quizzes given during this time will be dropped from consideration of the student's final grade. If the student must quarantine during a scheduled final presentation, the presentation can be recorded remotely and submitted to the instructor. For students who miss class because of illness, up to one exam will be dropped from consideration of the student's final grade or can be made up when the student recovers. If more than one exam is missed due to illness, at least one of the exams must be made up after the student recovers. Quizzes missed due to illness will be dropped from consideration of the student's final grade. If a final presentation is missed due to illness, the student must record a presentation and submit it remotely once recovered.

**Mask Policy.** In order to protect the health and well-being of all members of the University community, masks must be worn by all persons on campus when in the presence of others (within six feet) and in buildings in non-private enclosed settings (e.g., common workspaces, workstations, meeting rooms, classrooms, etc.). Masks must be worn during class meetings; any student not wearing a mask will be asked to leave.

Masks should conform to CDC guidelines and should completely cover the nose and mouth:
https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/about-face-coverings.html

Each day before you arrive on campus or leave your residence hall, you must complete the brief survey on the My Campus Pass symptom checker self-screening app.

**Students with Disabilities**: The Americans with Disabilities Act mandates that reasonable accommodation will be made for students with disabilities in order to assure equal participation in Chem 471/571.

**Tentative Class Schedule Fall Semester 2021**

| Day | Date | Lecture # | Topic | Chapter (Sections) |
|---|---|---|---|---|
| Th | 9/2 | 1 | Introduction | 2.1 |
| W | 9/8 | 2 | Quantum Mechanics and Atomic Structure | 2.2 |
| Th | 9/9 | 3 | QM/Atomic Structure/Periodic Trends | 2.3 |
| M | 9/13 | 4 | Valence Bond and Molecular Orbital Theory | 5.1, supplement |
| Th | 9/16 | 5 | Molecular Orbital Theory | 5.2 – 5.3 |
| M | 9/20 | 6 | Acidity | 6.3 – 6.4 |
| Th | 9/23 | 7 | Lewis Acids | 6.4 – 6.6 |
| M | 9/27 | 8 | Group Theory | 4.1 – 4.2 |
| Th | 9/30 | 9 | Group Theory | 4.3 – 4.4 |
| M | 10/4 | 10 | Group Theory and Molecular Orbitals | 5.4 |
| Th | 10/7 | 11 | Exam 1 Due / Ligand Field Theory | 10.3 |
| M | 10/11 | 12 | Ligand Field Theory in Other Geometries | 10.3 |
| Th | 10/14 | 13 | Jahn-Teller Distortion | 10.5, supplement |
| M | 10/18 | 14 | Substitution Mechanisms | 12.1 – 12.4 |
| Th | 10/21 | 15 | Mechanisms | 12.6 – 12.7 |
| M | 10/25 | 16 | Electron Transfer Mechanisms | 12.8, (supplement?) |
| Th | 10/28 | 17 | Electronic Spectra | 11.1, 11.2 |
| M | 11/01 | 18 | Electronic Spectra | 11.3 |
| Th | 11/04 | 19 | Characterization of Unpaired $e^-$ | (Supplement?) |
| M | 11/08 | 20 | Solid State Chemistry | 7.1 |
| Th | 11/11 | 21 | Solid State Chemistry | 7.2, 7.3 |
| M | 11/15 | 22 | Exam 2 due/ Solid State Chemistry | |
| Th | 11/18 | 23 | Additional Topics / Student Presentations | TBA |
| M | 11/22 | 24 | Additional Topics / Student Presentations | TBA |
| Th | 11/25 | | No Class | |
| M | 11/29 | | No Class | |
| Th | 12/2 | 25 | Additional Topics / Student Presentations | TBA |
| M | 12/6 | 26 | Additional Topics / Student Presentations | TBA |
| Th | 12/9 | 27 | Additional Topics / Student Presentations | TBA |
| M | 12/13 | 28 | Additional Topics / Student Presentations | TBA |
| W | 12/20 | | Exam 3 Due | |