CH341 Fall 2018
Advanced Inorganic Chemistry
Course Syllabus
Fairfield University
College of Arts and Sciences

Welcome to CH341, Advanced Inorganic Chemistry. This is a one-semester course intended for chemistry and biochemistry majors and chemistry minors. This lecture course will introduce students to the interdependence of chemical bonding, spectroscopic characteristics, and reactivity properties of coordination compounds and complexes using the fundamental concept of symmetry. Please read and keep this syllabus throughout the semester.

Instructor: Professor John R. Miecznikowski
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Office Hours: Monday, 8:30 a.m. to 9:15 a.m.
Tuesday, 10:00 a.m. to 11:00 a.m.
Wednesday, 10:00 a.m. to 11:30 a.m.
Thursday, 8:30 a.m. to 9:15 a.m.
or by appointment.

Please come to me for help as soon as you need it. I prefer to answer chemistry questions and discussing problems in person, with a pen and paper handy. A lot of thinking, and especially working through problems are needed to become familiar with all the material.

Class Meetings: Lecture: Monday & Thursday, 11:00 a.m. to 12:15 p.m., BNW 254A. You are expected to attend all the lectures. Cell phones must be turned off (not on vibrate) and put away in class. I will let you know when you should bring your model kits with you to class. I will ask you to bring your lap top computer to class on several occasions.

Laboratory Section: Wednesday (CH341L) 1:00 p.m. to 4:55 p.m. BNW 363

Class Format: Lectures, classroom demonstrations, example problems, class discussion, problem solving. **ATTENDANCE IS EXPECTED.**

For those who are taking the laboratory course, we will meet in BNW 363 for a lab report writing workshop on September 5th. We will meet for a lab lecture followed by check in on September 12th. We will begin Laboratory Experiments on September 19, 2018.

I will send announcements to the class via e-mail. All students are responsible for maintaining their e-mail accounts and should check their e-mail daily.

If you are playing Division I athletics for Fairfield University, I would appreciate it if you would let me know, during the first two weeks of the semester, what days you will be missing class because you will have athletic obligations. Also, please let me know, during the first two weeks of the semester, if you will be missing class for religious reasons. If you will be missing class for any reason, it is your responsibility to meet with me to discuss what was missed when you were absent.

All compounds and chemicals used and prepared in the laboratory must remain in the laboratory! All compounds, glassware, reagents, and equipment must be returned to the laboratory instructor at the end of the laboratory period or at checkout!

Blackboard:

The course syllabus, problem sets, and other handouts will be posted onto Blackboard. The URL for this website is **http://www.fairfield.edu/blackboard**

Texts and Tools (available at Bookstore):

"Inorganic Chemistry" 5th ed, Miessler, G.L.; Fischer, P. J.; Tarr, D.A. Pearson Prentice Hall, New York, **2014**. (required)

One required model kit:

- Inorganic Chemistry Coordination Compounds and Complex Ions Model Kit, Mega Molecules LLC (required) or

- HGS 006 Researcher Inorganic Chemistry D-Set (required).

"Advanced Inorganic Chemistry Laboratory Manual." Miecznikowski, J.R. **2018** (required). This will be distributed in the laboratory during the first meeting on September 5, 2018.

Please purchase a binder where you can store all handouts and weekly syllabi. Please bring this binder with you to class.

In addition, for the laboratory, you will need a laboratory notebook (duplicate copy, bound), safety goggles, and a lab coat (strongly suggested). The lab coat could be purchased from Fisher Scientific on-line or at the Fairfield University Bookstore. The safety goggles (splash proof) can be purchased from the Fairfield University Bookstore or Amazon.com.

Safety goggles are mandatory in the laboratory. No contact lenses are to be worn in the laboratory.

In the laboratory, all students must wear appropriate clothing: long pants, long sleeves, and closed shoes (no sandals or flip-flops). If you are not dressed appropriately for lab, you'll have to go home and change. No eating, drinking or smoking is allowed in lab. Long hair should be tied back.

You are also required to have your own calculator for the course. It should display scientific (exponential) notation and have logarithm functions. Be sure to bring it to exams (although you will probably not need a calculator), and laboratory sessions.

Homework, Quizzes, Exams, and Grading:

Homework: Problem sets will be assigned weekly. The assignments will be due the following week in lecture. Late homework will not be accepted and the grade of zero will be given for that assignment. Please see me if you have extenuating circumstances that may prevent you to turn in the assignment on-time. **Do not wait until the night before to do the problem sets. Do some problems every night. Come and see me if you have questions on the problem set before the due date. Some of the problem set questions may be based on literature articles.**

Quizzes: Three or four short quizzes (5-10 minutes) will be given at various times during the semester. The quizzes will be announced in advance. The quizzes may not all count equally and no quiz scores will be dropped. **There are no makeup quizzes. Please see me if you have extenuating circumstances that will prevent you to take a quiz.**

Exams: There will be two lecture exams and one final (comprehensive) exam. The exams will take place in the lecture room and will take place of lecture. **There are no makeup exams. The final exam will not be given at any other time** and failure to take the exam will result in an I (incomplete) grade for the course so please make end-of-semester travel plans accordingly. If you have a legitimate reason for missing a lecture exam, (severe illness, family crisis, etc.) the weight of that exam score will be added to the final exam. Thus, if a student misses an exam due to a medical or a verifiable emergency the value of his/her final exam increase in weight from 30 % to (30 % + 15 % = 45 %).

You **must** understand the logic of chemistry, to do well on the homework, and exams. On the quizzes and exams during the semester, you will not have access to your notes or the textbook.

You **must** learn the position of the d-block elements in the periodic table. You **must** also know the number of valence electrons for each transition element.
You **must** know the position and group number of the first thirty-six elements and the transition metals!

Tentative Lecture Exams: Monday, October 22, 2018
Monday, November 19, 2018

Final Exam: **Monday, December 17, 2018**
8:00 a.m. to 11:00 a.m. (Room BNW 254A)

Grading: The course grade will be based on the following weights:

Quizzes	10 %
Homework	30 %
Lecture exams (15 % each)	30 %
Final Exam	30 %

You will receive a separate grade for the laboratory portion of Advanced Inorganic Chemistry.

Weekly Syllabi: Weekly syllabi will be posted onto Blackboard and distributed in class each week. The weekly syllabi will contain the week's specific lecture topics, associated reading assignments, literature articles, exam dates, handouts, notes, announcements and problem set assignments. **The student is responsible for checking Blackboard and their Fairfield University e-mail account on a daily basis and is held accountable for all posted assignments, assignment due dates, exam dates, and schedule changes.**

Academic Conduct: (Read this Section At Least Twice!)

All work and conduct regarding this class (lecture and lab) are governed by the Rules and Regulations as described in the Fairfield University Academic Conduct Code (Academic Honesty and Academic Dishonesty). All students are responsible for understanding and following this Code. The Academic Conduct Code is detailed in the Fairfield University Undergraduate Catalog for 2018-2019.

Specifically, all work that you submit in this class must be your own work. **While you are encouraged to work in groups on homework assignments and laboratory reports to discuss**

strategies and concepts, each student must submit papers that represent their own work and is written in their own words. Any cheating on exams is forbidden and will result in a failing grade (F) for the course. Students suspected of committing academic misconduct will be brought before the appropriate committee.

Fairfield University expects students to be honest in their academic work. The University reserves the right to penalize any student whose academic conduct at any time, in its judgment, detrimental to the University. As specified in the University Catalog and Student Handbook, examples of dishonest conduct include, but are not limited to:

- Cheating, such as copying examination answers from materials such as crib notes or another student's paper.
- Collusion, such as working with another person or persons when independent work is prescribed.
- Inappropriate use of notes.
- Falsification or fabrication of an assigned project, data, results, or sources.
- Giving, receiving, offering, or soliciting information in examinations.
- Using previously prepared materials in examinations, tests, or quizzes.
- Destruction or alteration of another student's work.
- Submitting the same paper or report for assignments in more than one course without the prior written permission of each instructor.
- Appropriating information, ideas, or the language of other people or writers and submitting it as one's own to satisfy the requirements of a course – commonly known as plagiarism. Plagiarism constitutes theft and deceit. Assignments (compositions, term papers, computer programs, etc.) acquired either in part or in whole from commercial sources, publications, students, or other sources and submitted as one's own original work will be considered plagiarism.
- Falsification of academic records or grades, including but not limited to, any act of falsifying information on an official academic document, grade report, class registration document, or transcript.
- Unauthorized recording, sale, or use of lectures and other instructional materials.

In the event of such dishonesty, professors are to award a grade of zero for the project, paper, or examination in question, and may record an F for the course itself. When appropriate, expulsion maybe recommended. A notation of the event is made in the student's file in the academic dean's office. The student will receive a copy. Students should refer to the Undergraduate Catalog for a complete and controlling statement on all academic policies, including academic dishonesty.

Course Content:

This lecture course will introduce students to the interdependence of chemical bonding, spectroscopic characteristics, and reactivity properties of coordination compounds and

complexes using the fundamental concept of symmetry. After reviewing atomic structure, the chemical bond, and molecular structure, the principles of coordination chemistry will be introduced. A basic familiarity with symmetry will be formalized by an introduction to the elements of symmetry and group theory. The students will use symmetry and group theory approaches to understand central atom hybridization, ligand group orbitals, and the construction of qualitative molecular orbital (MO) energy diagrams including both σ- and π- bonding contributions. The students will continue to utilize their understanding of group theory during an introduction of electronic spectroscopy and the use of correlation and Tanabe-Sugano diagrams. MO diagrams will then used as a starting point for understanding the reactivity properties of coordination complexes.

Essential Course Objectives from IDEA Center Learning Objectives:

- Gaining factual knowledge (terminology, classifications, methods, trends)
- Learning fundamental principles, generalizations, or theories
- Learning to apply course material (to improve thinking, problem solving, and decisions)

Course Goals:

1. Be able to draw complete Lewis Structures for molecular compounds and metal complexes. Be able to predict molecular geometry about the central atom and polarity of a molecule or complex.
2. Be able to predict acid/base behavior of compounds, ligand, and metal complexes.
3. Be able to draw out and name metal complexes. Be able to draw all possible isomers of a metal complex.
4. Be able to assign the symmetry elements and point groups for molecules and objects.
5. Be able to draw out molecular orbital diagrams for diatomic molecules and metal complexes. Be able to draw out the linear combination of atomic orbitals to form molecular orbitals.
6. Be able to predict if Jahn-Teller distortions will happen in a metal complex.
7. Be able to assign the transitions in ultra-violet visible spectroscopy using Tanabe-Sugano diagrams and molecular orbital diagrams.
8. Be able to predict the reactivity of square planar and octahedral metal complexes.
9. Be able to understand the properties of a metal complex using the following data: magnetic susceptibility, polarimetry, infrared spectroscopy, NMR spectrometry, and ultra-violet visible spectroscopy.
10. Learn the basic ideas in inorganic chemistry to keep on learning inorganic chemistry after the course is over.
11. Be able to use chemistry journal articles and reference texts and articles to understand and explain their data.

Lectures:

You are responsible for material covered in **class and in the textbook and all handouts**. Attendance at lectures is expected. This course meets twice a week.
Out of respect for me and your classmates, please observe the following rules:

- Arrive on time. If an emergency causes you to arrive late, please enter quietly.
- Do not begin to pack up your books etc. before the end of lecture.
- Do not have conversations with your neighbor during lecture.
- Turn off (not on vibrate) your cell phone, pager, iPOD, iPAD, Blackberry, smart phone or iPhone and put it away during class. Because these electronic devices will be off and put away, you can't send text messages, surf the Internet, or play with your phone during class.
- Do not wear headphones during lecture.
- Electronic recording of class, either audio or video, is strictly forbidden.
- Bring your lap top computer and model kit when I ask you to do so.
- Be an active learner in class. Participate, ask questions, and build chemical models that the instructor asks you to build.
- Do not take photos of items the Professor has written and drawn on the board.

Required Text Readings:

Every week, you will receive a detailed syllabus outlining the material covered that week in lecture. This syllabus will also include the problem set for the week. I will also distribute handouts each week. **It is expected that assigned reading will be completed prior to class. You are responsible for all of the material presented on the handouts!**

Laboratory:

The laboratory portion of CH 341 is designed as a synthetic inorganic lab with emphasis placed on characterization. You will synthesize and characterize some of the fundamental compounds first studied by the foremost figures in coordination chemistry; A. Werner, S.M. Jørgensen and F.A. Cotton, to name just a few. The characterization of these compounds by UV-Visible spectroscopy (UV-Vis), infrared spectroscopy (IR), polarimetry, magnetic susceptibility measurements and nuclear magnetic resonance (^{1}H NMR) spectroscopy will allow you to gain insight into the basic theories that underlie the study of inorganic chemistry. The hands-on learning will help you take the theories you are concurrently learning in the lecture portion of CH 341 and realize how they can be physically applied.

Your laboratory will consist of eight experiments, which have been scheduled as nearly as possible with supporting discussions in regular lectures.

During each laboratory session, there will be a short lecture on next week's laboratory.

The laboratory manual contains a detailed schedule of the laboratory experiments and information on how to prepare laboratory reports.

Academic & Disability Support Services:

Fairfield University complies with the American's with Disability Act and Section 504 of the Rehabilitation Act. Any student who may require an accommodation under such provision should contact Academic & Disability Support Services (203) 254-4000 x 2615.
e-mail: dss@fairfield.edu
If you have a documented disability, please contact Academic Disability Support Services and notify me within the first two weeks of the semester. You will only be permitted accommodations with a signed letter from Academic and Disability Support Services.

Fairfield University Writing Center

The Fairfield University Writing Center is a free resource available to all Fairfield University students. At the Writing Center, a writing tutor will work with you at any point in the writing process, from brainstorming to editing. The tutoring conference is collaborative; please come prepared to be an active participant in the session, and review the website for suggestions to help you prepare for your appointment. For more information or to make an appointment, visit the Writing Center website at www.fairfield.edu/writingcenter, email us at writingcenter@fairfield.edu or stop by the DiMenna-Nyselius Library, Lower Level.

Course Reserves:

The following texts are on closed reserve in the library:

Bertini, I. ed. *Biological Inorganic Chemistry: Structure and Reactivity*. University Science Books, Sausalito, CA, **2007**.

Cotton, F.A. Wilkinson, G. *Advanced Inorganic Chemistry*, 5th ed. Wiley, New York, **1988**.

Greenwood, N.N. *Chemistry of the Elements*, 1st ed. Pergamon Press, New York, **1984**.

Huheey, J.E. *Inorganic Chemistry: Principles of Structure and Reactivity*. Harper and Row, New York, **1972**.

Müller, U. *Inorganic Structural Chemistry*. Wiley, New York, **2007**.

Nakamoto, K. *Infrared and Raman Spectra of Inorganic and Coordination Compounds*, 4th ed. Wiley, New York, **1986.**

Shriver, D.A.; Atkins, P. *Inorganic Chemistry 5th ed.*, Freeman, New York, **2010**.

Hegedus, L. *Transition Metals in the Synthesis of Complex Organic Molecules, 3rd ed.*. University Science Books, Sausilito, CA, **2009**.

Crabtree, R.H. *The Organometallic Chemistry of the Transition Metals*. Wiley, New York, **2011**.

The following articles are posted on Blackboard:

Bjerrum, J.P.; McReynolds, J.P. *Inorganic Synthesis*, **1946**, pp.216-219.

Broomhead, J.A.; Dwyer, F.P. *Inorganic Synthesis*, **1960**, p. 183.

Hallman, P.S.; Stephenson, T.A.; Wilkinson, G. *Inorganic Synthesis*, **1970**, pp. 238-240.

Rowe, R.A.; Jones, M.M. *Inorganic Synthesis*, **1957**, p. 114.

Wang, G-Z.; Bäckvall, J.-E. *J. Chem. Soc. Chem. Commun*, **1992**, 337-339.

LaPlaca, S.J.; Ibers, J.A. *Inorg. Chem*, **1965**, *4*, 778-783.

Schrauzer, G. N. *Accounts of Chemical Research*, **1968**, *1*, No. 4, 97.

Penland, R.B.; Lane, T.J.; Quagliano, J.V. *J. Am. Chem. Soc.* **1956**, *78*, 887.

Ophardt, C.; Stupgia, S. *J. Chem. Ed*. **1984**, *61*, 1102.

Selbin, J. *Chem. Rev*. **1965**, *65*, 155.

Wrobleski, J.T.; Thompson, M.R. *Inorg. Chim. Acta*, **1988**, *150*, 269.

Ligtenbarg, A G.J.; Hage, R.; Feringa, B. *Coord. Chem. Rev*., **2003**, *237*, 89.

Hallman, P.S.; Stephenson, T.A.; Wilkinson, G. *Inorg Synth*, **1970**, *12*, 238-240.

Gladiali, S.; Mestroni, G. *Transition Metals for Organic Synthesis*, Beller, M.; Bolm, C. Eds. Wiley-VCH: Weinheim, Germany, **1998**, vol *2*., pp. 97-119.

Sheldon, R.A.; Arends, I.W.C.E. *Catalysis by Metal Complexes*, **2003**, *26* (Advances in Catalytic Activation of Dioxygen by Metal Complexes), 123-155.

Useful website for Symmetry and Point Groups: http://symmetry.otterbein.edu/

Lecture Schedule and Required Text Readings:

Date	Topics	Text Readings
Thurs., Sept. 6 and Mon., Sept. 10	What is Inorganic Chemistry? Why study Inorganic Chemistry? Nucleosynthesis and Lewis Dot Structures and VSEPR	Chapter 1 and Chapter 3.1 and 3.2 and handouts
Thurs., Sept. 13	Lewis Dot Structures, VSEPR, Polarity and Acids and Bases	Chapter 3.1 - 3.3 Chapter 6.1 – 6.6
Mon., Sept. 17	Acids & Bases, **Quiz 1,** and Introduction to Coordination Compounds	Chapter 9.1-9.3
Thurs., Sept. 20	d-Block Chemistry: Properties and Isomerism and Coordination Number	Chapter 9.1–9.5
Mon., Sept. 24	d-Block Chemistry: Coordination Complexes, Valence Bond Theory, Crystal Field Theory	Chapter 9.4, 9.5 and 10.1 and 10.2
Thurs., Sept. 27	d-Block Chemistry: Coordination Complexes, Valence Bond Theory, Crystal Field Theory	Chapter 9.4, 9.5 and 10.1 and 10.2
Mon., Oct. 1	Atomic Structure	Chapter 2
Thurs., Oct. 4	Symmetry Operations	Chapter 4.1–4.2
Mon., Oct. 8	**Columbus Day. No Class!**	
Thurs., Oct. 11	Symmetry Operations and Point Groups	Chapter 4.2 – 4.4
Mon. Oct. 15	Point Groups and Chirality	Chapter 4.2 – 4.4
Thurs., Oct. 18	Symmetry and Group Theory, Character Tables	Chapter 4.3–4.4
Mon., Oct. 22	**Lecture Exam 1 (Covering Classes 9/6 – 10/11)**	
Thurs., Oct. 25	Symmetry and Group Theory and Hybridization	Chapter 4 and Chapter 5.1
Mon., Oct. 29	Molecular Orbital Theory, Formation and Homonuclear Diatomic Molecular Orbital Diagrams	Chapter 5.2–5.3
Thurs., Nov. 1	Molecular Orbital Theory, Multiple Bonds, Polyatomics	Chapter 5.4 and handouts
Mon., Nov. 5	Molecular Orbital Theory O_h, T_d, D_{3h}, D_{4h} Complexes	Chapter 10.3 and 10.4, 10.6 and handouts
Thurs., Nov. 8	Molecular Orbital Theory O_h, T_d, D_{3h}, D_{4h} Complexes	Chapter 10.3 and 10.4, 10.6 and handouts
Mon., Nov. 12	Molecular Orbital Theory (complete) and Spectrochemical Series	Chapter 10.3 and 10.4, 10.6 and handouts
Thurs. Nov. 15	Jahn-Teller Distortions	Chapter 10.5 and handouts
Mon., Nov. 19	**Lecture Exam 2**	

	Covering Class (10/4 – 11/12)	
Thurs., Nov. 22	**No Class! Thanksgiving Break!**	
Mon., Nov. 26	Selection Rules for Electronic Spectra	Chapter 11.1 – 11.2 and handouts
Thurs., Nov. 29	Term States and Electronic Spectra	Chapter 11.2 and handouts
Mon., Dec. 3	Interpretation of Electronic Spectra using Tanabe Sugano Diagrams	Chapter 11.3
Thurs., Dec. 6	Interpretation of Electronic Spectra using Tanabe Sugano Diagrams and Interpretation of Charge Transfer Spectra	Chapter 11.3
Mon., Dec. 10	Square Planar Substitution Reaction Mechanisms	Chapter 12.1 – 12.3 and 12.6 and handouts
Monday, Dec. 17	**Final Examination, 8:00 a.m. (Covering Class 9/6 – 12/10)**	

The instructor reserves the right to alter the schedule/organization of topics and laboratories as the course develops depending on class progress and pace. **It is expected that you will read the assigned material prior to class. I will let you know when you should bring your textbook to class.**

Please purchase a binder where you can store all handouts and weekly syllabi. Please bring this binder with you to class.