Course Readiness

CHEM 350 Course Outlines Spring 2023

Course code	CHEM 350A	**Course Title**	Coordination Chemistry
Semester	Spring 2023	**Credit Hours**	04 (3+1)
Section	A	**Instructor**	Dr. M. Nadeem Asghar
Office Hours & Virtual Office Hours	09:30-11:00 Hrs (TR) Cell/WhatsApp, Zoom cloud meeting (on request)	**Instructor's Email & Cell #**	nadeemasghar@fccollege.edu.pk 0332-4522509

1. COORDINATION CHEMISTRY (CHEM 350)

Pre-requisite: *This course is open for students who have studied or are currently enrolled in CHEM 150 or CHEM 250*

Topics include historical background of coordination compounds, nomenclature and stability, geometry of complexes having coordination number 2 to 9, explanation of optical and magnetic properties of coordination compounds, Jahn-Teller effect, isomerism and stereochemistry, stabilities of coordination compounds, characterization and applications of coordination compounds, metal-based drugs, organic reagents used in inorganic analyses.

2. LEARNING OBJECTIVES

At the end of this course students should be able to:

- appreciate metal ions chemistry in aqueous solution by reference to Lewis acid/base concept.
- identify the important historical developments of theories of coordination chemistry like Chain theory and Werner's theory.
- write formulas and nomenclate coordination complexes in accordance with IUPAC naming system;
- identify the ligands and their donor atoms; determine coordination number and oxidation state of the metal, and the charge on any complex ion;
- describe and explain the bonding in coordination compounds using Effective Atomic Number Rule (18-electron rule), Valence Bond Theory, Crystal Field Theory and Molecular Orbital Theory; compare the bonding theories.
- determine the electronic structure of square planar, tetrahedral, and octahedral metal complexes by applying crystal field theory.
- explain Jahn Teller theorem for octahedral and tetrahedral complexes
- construct molecular orbital energy level diagrams for octahedral metal complexes in the absence of pi-bonding
- predict location of ligands in the spectrochemical series by determining the crystal field splitting energy spectrophotometrically
- recognize types of isomerism in coordination compounds and to be able to draw possible stereoisomers (geometric and optical) for square planar and octahedral complexes
- describe the difference between Thermodynamic stability and Kinetic stability
- differentiate between inert and labile complexes in terms of reaction kinetics.

Course Readiness

- synthesize simple mononuclear complexes in the laboratory, determine their percentage yield and structure using instrumental techniques, like magnetic susceptibility balance, UV-Visible spectrophotometer, TGA etc.
- appreciate the role of various complexes in analytical determination of different metal ions and drugs in aqueous medium.

3. TEXTBOOKS

- *Essentials of Coordination Chemistry* by Vasishta Bhatt, 2016, Elsevier Inc.
- *Inorganic Chemistry* by Gary L. Miessler, Paul J. Fischer, Donald A. Tarr, 2014, Prentice Hall.
- *Coordination Chemistry* by Fred Basolo and Ronald C. Johnson, 1986, Science Reviews.
- *Principles of Inorganic Chemistry by* Pfennig, Brian William, 5th Ed. 2015, John Wiley & Sons.

4. GRADING SYSTEM AND COURSE EVALUATION CRITERION

a) Grading system

The grading system followed by the university is as follows:

Letter grade	Point average	Numerical value %	Meaning
A	4.00	93-100	Excellent
A-	3.70	90-92	
B+	3.30	87-89	
B	3.00	83-86	Good
B-	2.70	80-82	
C+	2.30	77-79	
C	2.00	73-76	Satisfactory
C-	1.70	70-72	
D+	1.30	67-69	
D	1.00	60-66	Pass
F	0.00	59 or below	Fail

b) Course Evaluation/Assessment Criteria and Activity Schedule

- Course assessment/evaluations will be made through different timed-quizzes and exams, and/or viva voce examination using online Learning Management System (Moodle) and other resources like Zoom, WhatsApp etc., if needed.
- For evaluation purpose, whole course is divided into six parts to be evaluated through four quizzes, a mid-term and a final term exam.
- Four quizzes and mid-/final-term exams are designed to evaluate theory component of the course. Though each theory-based quiz will partly cover practical component, yet a dedicated lab exam and/or *viva-voce* exam will also be taken to assess lab skills/activities.
- Final grade will be cumulative of the score earned in all the quizzes and exams as per the grading system described above.
- The distribution of marks of quizzes and assignment is as follows:

Course Readiness

Wk	Topic and Resource	Evaluation Criteria	Points Allocated	Due Date of Assignment/Quiz/Exam
1-3 (13th Feb-03 March)	Historical background and nomenclature of coordination compounds, Chain Theory, 18-electron Rule	Quiz 1	5	4th Week
4-7 (Mar 06-31)	Werner Theory, VBT, Crystal Field Theory	Quiz 2	5	8th Week
8-10 (Apr 03-21)	Calculation of Crystal Field Splitting Energy, CFSE, Magnetic Properties, Spectrochemical Series	Mid-term Exam	25	10th Week
11-14 (Apr 24-May 19)	Molecular orbital theory	Quiz 3	5	15th Week
15-17 (May 22-Jun 09)	John-Teller Distortion in tetrahedral and octahedral complexes, Stereoisomerism in square planar and octahedral compounds, Synthesis and characterization of complexes	Quiz 4	5	17th Week
	Lab skills/activities	Final Lab Exam	25	17th Week
(June 10 onwards)		Final Term Exam	30	June 12 onward (TBD)
Total			**100**	

5. OTHER RULES

- This course is open for students who are either currently enrolled in or have qualified CHEM 150 or CHEM 250.
- All assignments will be submitted and graded through Moodle (Online Learning Management System).
- No retake of quiz/assignment is allowed except under special circumstances
- The instructor may lower or improve the weightage of any activity depending upon the overall performance of the student and difficulty level of that activity.

6. LOGISTICS

- Instructor: Dr. Muhammad Nadeem Asghar
    - Email: nadeemasghar@fccollege.edu.pk
    - Cell: 0332-4522509
    - WhatsApp: 0332-4522509
- FCC Online Learning Management System (Moodle)
- Zoom.us free App for online video and audio conferencing

Course Readiness

- Office Hours:09:30-11:00 (TR)
- Zoom online meeting (on request)

7. LESSON PLAN

Following is the topic-wise split up of course objectives. For each objective mentioned there are online methods and resources given. Students are expected to follow the web links and go through the relevant pages of the textbooks for preparation of each quiz/worksheet announced soon after the completion of each topic.

Wk	Learning objectives	Methods and Resources
1-3 (13th Feb-03 March)	a. To familiarize the students with historical background of coordination compounds. b. To appreciate the role of Blomstrand-Jorgensen (Chain) theory, Lewis Acid/Base Theory, Sidgwick Theory, and Werner's theory in understanding the nature of M-L bond c. To be able to write name of a metal complex in accordance with IUPAC nomenclature system.	• *Coordination Chemistry* by Fred Basolo and Ronald C. Johnson (VBT: pg 25-26; CFT: pg 26-37) (soft copy already shared through Moodle)
4-7 (Mar 06-31)	a. To understand the nature of metal-ligand (M-L) bond using Valence Bond Theory (VBT) and Electrostatic Crystal Field Theory (CFT) b. To predict shape of a complex based on spin only magnetic moment c. To learn to calculate Crystal Field Stabilization Energy for different coordination numbers	• *Coordination Chemistry* by Fred Basolo and Ronald C. Johnson (VBT: pg 25-26; CFT: pg 26-37) • Important web-links are: https://www.youtube.com/watch?v=XpqUFP6xpx4 (Played) https://www.youtube.com/watch?v=s0dJHwBVFcI (played) https://www.youtube.com/watch?v=ILdPSLNxDqA https://ocw.mit.edu/courses/chemistry/5-111-principles-of-chemical-science-fall-2008/video-lectures/lecture-28/ https://www.youtube.**com**/watch?v=jhn00jyyUcA
8-10 (Apr 03-21)	a. To correlate spectrochemical series with color/magnetic properties of metal complexes b. To calculate crystal field splitting energy from already taken UV spectra of four complexes	• *Coordination Chemistry* by Fred Basolo and Ronald C. Johnson (pg 24-37) • Important web-links are: https://www.youtube.com/watch?v=ZEPHDaci37I https://ocw.mit.edu/courses/chemistry/5-111-principles-of-chemical-science-fall-2008/readings-and-lecture-notes/lecnotes30.pdf
11-14 (Apr 24-May 19)	a. To understand the nature of M-L bonding using Molecular Orbital Theory (MOT) b. To be able to draw MO diagrams for simple complexes	• *Coordination Chemistry* by Fred Basolo and Ronald C. Johnson (MOT: pg 37-44) • Important web-links are: https://www.youtube.com/watch?v=-xPX3IrIZXE https://www.youtube.com/watch?v=FXH2F4EtE3I (MOT)
15-17 (May 22-Jun 09)	a. To understand and predict the origin and magnitude of distortions in octahedral and tetrahedral complexes in d^1-d^{10} systems (Jahn-Teller distortion) b. To be able to predict and draw geometrical and optical isomers	• *Coordination Chemistry* by Fred Basolo and Ronald C. Johnson (MOT: pg 45-48 and pg 53-58 (soft copy shared through Moodle)) •

Course Readiness

	for a given square planar and octahedral complex	• Important web-links are: https://www.adichemistry.com/inorganic/cochem/jahnteller/jahn-teller-distortion.html https://www.youtube.com/watch?v=1ejUTs7NaZo https://www.youtube.com/watch?v=m19YvcVu37U

8. STUDENTS CONDUCT & OTHER ISSUES

The students are expected to come to class regularly and prepared. Students should conduct and express themselves in a way that is respectful to all individuals. This includes respecting the rights of others to comment and participate fully in class. Classroom misconduct is any behavior which disrupts or interferes with the learning environment.

a) Private conversation, chatting/texting on mobile phones and all other activities which disturb the learning environment are strongly discouraged. The student's behavior should such that classroom interactions remain civil, respectful, and supportive to all.
b) Students are required to keep their mobile phones in silent modes during class and labs.
c) Mobile calculators are strongly discouraged for scientific calculations during class, exams and labs.
d) Students not observing the social distancing SOPs, dress code and displaying their University ID cards would not be allowed to sit in the class.
e) Any sort of plagiarism in assignments etc. or cheating during exam would result in F grade in that assignment/activity/exam.
f) If any student faces any issues or has any concerns regarding the classroom climate and interactions, please feel free to contact VR office gloriacalib@fccollege.edu.pk

9. CHANGES TO THE SYLLABUS

This syllabus is designed to convey course information and requirements as accurately as possible. It is important to note however that it may be subject to change during the course depending on the needs of the class and other situational factors. Such changes would be for your benefit and you will be notified of them as soon as possible.

I expect that you will strictly follow the core values of FCCU and put your entire efforts to learn as per the course requirements, attend classes, read the textbook(s)/other assigned reading material and do the assignments in the stipulated time period