SULTAN QABOOS UNIVERSITY

COURSE OUTLINE

PROGRAM: CHEMISTRY

1. Course Code	CHEM6615	
2. Course Title	Advanced Inorganic Chemistry	
3. Credits	3	
4. Pre-requisite Course(s)	CHEM4411	
5. Co-requisite Course(s)	none	
6. Equivalent Course(s)	none	
7. Incompatible Course(s)	none	
8. Course Category	☐ University Requirement	☐ University Elective
	☐ College Requirement	☐ College Elective
	☒ Department Requirement	☐ Department Elective
	☐ Specialization Requirement	☐ Specialization Elective
	☐ Other (specify):	
9. Course Owner	College: Science	Department: Chemistry
10. Course Type	☒ Lecture	☐ Lecture/Lab
	☐ Lecture/Seminar	☐ Lecture/Studio
	☐ Lecture/Tutorial	☐ Lecture/Lab/Tutorial or Seminar
	☐ Tutorial	☐ Laboratory (Practical)
	☐ Field or Work Placement	☐ Studio
	☐ Seminar	☐ Internship
	☐ Workshop	☐ Project
11. Language of Instruction	English	

12. Course Description

This is a two-part advanced inorganic chemistry course. The first part is aimed at exposing students to the principles and chemical applications of molecular symmetry. The major topics include basic concepts of symmetry elements and symmetry operations, point groups of molecules, representations of groups and selected applications of symmetry to chemistry. The second part of the course gives an indepth coverage of advanced physical coordination chemistry of d-block metals. A wide spectrum of an array of coordination spheres as revealed by crystallographic analyses is correlated with the pertinent d-orbital eneryy-level diagrams, which ultimately influence the physicochemical properties of the complexes. Principles of symmetry are applied to X-ray structures of d-block metal complexes. Students are introduced to advanced molecular magnetism, particularly variable-temperature magnetic susceptibility measurements. An overview of physical techniques of characterisation is given with at least one new inorganic spectroscopic technique introduced. Subsequently, students are familiarised with original research in d-block coordination chemistry. They are required to acquire and develop skills in reading and analysing a journal article critically as well as writing a coherent journal manuscript from provided data.

13. Teaching/Learning Strategies

Lectures, class discussions, demonstrations, models, literature survey and Moodle

14. Assessment Components and Weight [%]

☒ Quizzes 10	☐ Practical	☐ Other (specify):
☒ Homework assignments 10	☐ Project	
☒ In-term examination(s) 30	☒ Final examination 50	

15. Grading Method

☒ A-F Scale ☐ Pass/Not passed

16. Textbook(s) and Supplemental Material

Part 1: R. L. Carter, Molecular Symmetry & Group Theory, 4th Ed., John Wiley & Sons, Chichester, 1998; A. Vincent, Molecular Symmetry & Group Theory, John Wiley & Sons, Chichester, K. C. Molloy, Group Theory for Chemists, Harwood Publishing Co., 2007, S. F. A. Kettle, Symmetry & Structure, 2nd Ed., John Wiley & Sons, Chichester, 1998; F. A. Cotton, Chemical Applications of Group Theory, 3rd Ed., Wiley, 1990; relevant articles from J. Chem. Edu.

Part 2: F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochman, Advanced Inorganic Chemistry, 6th Ed., John Wiley & Sons, Chichester, 1999; M. Weller, T. Overton, J. Rourke, and F. Armstrong, Inorganic Chemistry, 7th Ed., Oxford University Press, 2018; relevant handouts from other inorganic and physical chemistry books, and journal articles

17. Matching Course Objectives with Program Outcomes and SQU Graduate Attributes

SQU Graduate Attributes

A. SQU graduates should be able to:	**B. SQU graduates possess**	**C. SQU graduates should**
1. apply the knowledge and skills relevant to the specialization 2. communicate effectively and use information and communication technologies 3. critically analyze complex information and present it in simple clear manner	1. interpersonal communication skills and alignment with culture of international labour market to assist them in practical life and in living successfully 2. skills and motivation for independent learning and engagement in lifelong learning and research 3. work ethics and positive values, and intellectual independence and autonomy 4. teamwork skills and display potential leadership qualities	relish good citizenship qualities, be conscious of their national identity and be socially responsible, engage in community affairs and be mindful of contemporary issues.

#	Intended Student Learning Outcome /Course Learning Objective	Relevant Program Outcome(s)	Applicable Attribute(s)
1.	Identify symmetry elements and recognise symmetry operations generated by each symmetry element for a given molecule/object, construct the multiplication table by combining the symmetry operations of a point group, recognize the common point groups and their principal operations, determine the point group of a molecule/object by the systematic method.	PLO: 1-3	A1
2.	Determine the effect of symmetry operations of a group on linear & rotational vectors and relate to irreducible representation, define reducible and irreducible representations, reducce a reducible representation to its component irreducible representations by inspection, describe the symmetry of a given irreducible representation on the basis of Mulliken symbols, construct real-number representations by combining complex-conjugate irreducible representations.	PLO: 1-3	A1
3.	Reduce a given reducible representation to the component irreducible representations by the systematic method, reduce representations with imaginary characters, identify group-subgroup relationships and construct correlation tables and correlation diagrams, reduce representation of an infinite-order group.	PLO: 1-3	A1
4.	Determine the point group of atomic orbitals (AOs), take linear combination of AOs to form molecular orbitals (MOs), distinguish among sigma, pi & delta MOs on the basis of symmetry, using symmetry criteria predict polarity and chirality of given molecules.	PLO: 1-3	A1
5.	Define basis set, draw basis set for a given molecule, generate reducible representation for a given molecule and reduce it to the componet irreducible	PLO: 1-3	A1

	representations, classify the irreducible representations into translational, rotational and vibrational modes, determine the number of infra-red and Raman-active vibrations, determine vibrational modes of a selected functional group in a given geometrical isomer.		
6.	Distinguish coordination chemistry from other fields of inorganic chemistry and be conversant with the pertinent terminology	PLO: 1-3	A1
7.	Correlate an array of coordination geometries of transition and Group 12 metal complexes with d-electron configurations and predict 3-D structures considering the ligand stereochemistries	PLO: 1-3	A1
8.	Draw d-orbital energy-level diagrams in accordance with the coordination spheres and magnetic properties of the complexes	PLO: 1-3	A1
9.	Discuss a d-block metal complex based on its X-ray structure, electronic structure and other relevant physical properties	PLO: 1-3	A1-A3, B2
10.	Apply molecular symmetry to describe and explain X-ray structures of mononuclear and polynuclear d-block metal complexes	PLO: 1-3	A1
11.	Determine oxidation and spin states of d-block metal centres in various coordination spheres and nuclearities	PLO: 1-3	A1
12.	Plot VT magnetic susceptibility data and identify the Curie and Curie-Weiss laws	PLO: 1-3	A1
13.	Characterise interactions of paramagnetic centres in dinuclear and multinuclear systems and ascertain their extent with coupling constants	PLO: 1-3	A1
14.	Apply a diverse range of physical techniques to characterise a d-block metal complex and be familiar with at least one new inorganic physical technique of characterisation	PLO: 1-3	A1-A3
15.	Explain reaction mechanisms in the syntheses of ligands and corresponding d-block metal complexes within a given research topic	PLO: 1-3	A1-A3
16.	Analyse and criticise a published research paper in coordination chemistry by pointing out its strengths and weaknesses	PLO: 1-3,5,11	A1-A3, B2
17.	Integrate knowledge and comprehension of advanced principles of coordination chemistry to write a coherent journal-style manuscript on a system of d-block metal complexes using provided physicochemical data	PLO: 1-3,4,8,9,11	A1-A3, B2
18.	Give a seminar presentation with lucid and eloquent explanations of the salient points of a research paper in d-block coordination chemistry	PLO: 1-3,4,8,9,11	A1-A3, B2
19.			
20.			

16. Student Responsibilities

It is the student's responsibility to know and comply with all University Academic Regulations relevant to participation in this course. These regulations specifically include attendance requirement and students` academic code of conduct.

For attendance, it is the student's responsibility to be punctual and to attend all classes.

Students are expected to perform their work with honesty and avoid any academic misconduct, which is defined as the use of any dishonest or deceitful means to gain some academic advantage or benefit. This can take many forms, including but not limited to, the following: copying, plagiarism, collusion and forging documents. For full details, please refer to the Undergraduate Academic Regulations and to the Student Academic Misconduct Policy.

Additionally, this course requires that you:

Understand the fundamental concepts of Symmetry and Transition Metal Coordination Chemistry and their applications in chemistry, develop independent learning, critical thinking and problem solving skills and do not resort to rote learning.

Complete the "Practice Questions" for each topic. These are the suggested end of chapter questions.

Attend all Quizzes, Tests, Exams. No make-up exams will be given for any of the interm assessment quizzes/tests. Any student missing an exam for medical/official reasons must submit a medical/official excuse to the instructor.

COURSE INFORMATION			
Course Code	CHEM6615	**Course Title**	Advanced Inorganic Chemistry
Semester/ Year	Fall.2021	**Section(s)**	10
Day, Time, and Place	Sun/Tuesday, 12:00-1:20, A23		

Course Coordinator	Dr. Muna Al-Mandahry		
Office Location	2050	**Office Hours**	Sun/Tuesday, 11:00 - 12:00
Office Tel. Ext.	1493	**Email**	msk@squ.edu.om

Tentative Schedule

Week	Lecture #	Topic/Material to be covered	Assessment
1	1-2	Concepts of symmetry elements and symmetry operations, multiplication table, construction of multiplication table by combining symmetry operations	
2	1-2	Common point groups and their symmetry operations, systematic point group classification, symmetry and optical activity	
3	1-2	Representations of a group, features of a character table, reduction of a reducible representation by trial-and-error method, symmetry of the irreducible representations, complex-conjugate irreducible representations.	
4	1-2	Reduction of reducible representations by systematic method, reducing representations with imaginary characters, group-subgroup relationships, correlation tables and correlation diagrams, representation of infinite-order groups, direct product of irreducible representations	Quiz 1
5	1-2	Symmetry of atomic orbitals (AOs), linear combination of AOs, bonding, anti-bonding & non-bonding molecular orbitals (MOs), sigma, pi & delta MOs	
6	1-2	Basis set for a given molecule, generating reducible representation for a given molecule using basis set, reducing the reducible representation to the component irreducible representations.	
7	1-2	Separating the irreducible representations into translational, rotational and vibrational modes, infra-red and Raman-active vibrations, vibrational modes of a given functional group in a geometrical isomer.	Test 1
8	1-2	Advanced fundamental concepts and principles of coordination chemistry; correlation of a diverse range of coordination geometries of d-block complexes with d-electron configurations; influence of ligand stereochemistries on coordination spheres	
9	1-2	d-Orbital energy-level diagrams for an array of coordination geometries of d-block complexes; descriptions and explanations of X-ray structures; applications of molecular symmetry	
10	1-2	Magnetic features of transition-metal complexes as a function of absolute temperature; Curie/Curie-Weiss laws; correlation of magnetic properties with oxidation states and spin states, spin-state transitions; ferromagnetism and antiferromagnetism in dinuclear and multinuclear systems	
11	1-2	An overview and a review of physical techniques of characterisation in transition-metal coordination chemistry; examples of magneto-structural and spectroscopic data from the literature	
12	1-2	A new spectroscopic technique in a selected research topic: key characteristic features, importance of technique, measurement of spectra, characterisation parameters, applications of the technique in d-block complexes, selected journal articles featuring this technique	
13	1-2	Synthetic strategies: ligand systems and corresponding d-block complexes within a selected research topic, reaction mechanisms, isolation and purification of products, relevant characterisation techniques	
14	1-2	Analysing and criticising journal articles; writing up a coherent manuscript: suitable title, concise abstract, relevant introduction, experimental details,	Test 2

		logical presentation of data and figures, and discussion of results, concluding remarks, references	
15	1-2	Oral presentations of research topics in coordination chemistry of d-block complexes OR submission of research manuscripts based on physicochemical data provided	
16			
17			

APPENDIX A: INSTRUCTORS OF MULTIPLE SECTIONS					
Section	**Instructor**	**Day, Time, and Place**	**Office Location and Extension**	**Email**	**Office Hours**

APPENDIX B: ADDITIONAL INFORMATION