

## Course Syllabus

**offered by Department of Chemistry  
with effect from Semester B 2023/24**

This form is for the completion by the Course Leader. The information provided on this form is the official record of the course. It will be used for the City University's database, various City University publications (including websites) and documentation for students and others as required.

Please refer to the Explanatory Notes on the various items of information required.

**Prepared / Last Updated by:**

|              |   |                |                                |
|--------------|---|----------------|--------------------------------|
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**City University of Hong Kong  
Course Syllabus**

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**Part I Course Overview**

|   |   |
|---|---|
| <b>Course Title:</b>                                  | Inorganic Chemistry   |
| <b>Course Code:</b>                                   | CHEM3014 (and CHEM3014A)  |
| <b>Course Duration:</b>                               | 1 semester  |
| <b>Credit Units:</b>                                  | 4 (3) credits   |
| <b>Level:</b>   | B3  |
| <b>Proposed Area:</b><br>(for GE courses only)        | <input type="checkbox"/> Arts and Humanities<br><input type="checkbox"/> Study of Societies, Social and Business Organisations<br><input type="checkbox"/> Science and Technology |
| <b>Medium of Instruction:</b>                         | English   |
| <b>Medium of Assessment:</b>                          | English   |
| <b>Prerequisites:</b><br>(Course Code and Title)      | Nil   |
| <b>Precursors:</b><br>(Course Code and Title)         | CHEM2006/BCH2006 Principles of Inorganic Chemistry  |
| <b>Equivalent Courses:</b><br>(Course Code and Title) | BCH3014 (and BCH3014A) Inorganic Chemistry  |
| <b>Exclusive Courses:</b><br>(Course Code and Title)  | Nil   |

**Note: CHEM3014A does not contain any practical component, and has a credit unit value of three (3).**

## Part II Course Details

### 1. Abstract

(A 150-word description about the course)

This course aims to provide students with knowledge of the various principles of inorganic chemistry as well as practical experience in the synthesis, analysis and characterization of inorganic compounds.

### 2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

For CHEM3014:

| No. | CILOs <sup>#</sup>  | Weighting*<br>(if applicable) | Discovery-enriched curriculum related learning outcomes (please tick where appropriate) |    |    |
|-----|---|-------------------------------|---|----|----|
|     |   |                               | A1  | A2 | A3 |
| 1.  | Determine the symmetry elements, the symmetry operations and the point group of a molecule; and predict the infrared and Raman active vibrational modes of that molecule. | 15%                           | ✓   | ✓  |    |
| 2.  | Explain the bonding and properties of a molecule using molecular orbital theory.  | 10%                           | ✓   | ✓  |    |
| 3.  | Explain the spectroscopic and magnetic properties of transition metal complexes using ligand field theory.  | 10%                           | ✓   | ✓  |    |
| 4.  | Describe the bonding, structures, properties and reactivity of organometallic compounds containing carbon monoxide, alkene, alkyne, arene and cyclopentadienyl ligands.   | 35%                           | ✓   | ✓  |    |
| 5.  | Design and implement the synthesis, purification and characterization of inorganic compounds in the laboratory.   | 30%                           |   | ✓  | ✓  |
|     |   | 100%                          |   |    |    |

\* If weighting is assigned to CILOs, they should add up to 100%.

For CHEM3014A:

| No. | CILOs <sup>#</sup>  | Weighting*<br>(if applicable) | Discovery-enriched curriculum related learning outcomes (please tick where appropriate) |    |    |
|-----|---|-------------------------------|---|----|----|
|     |   |                               | A1  | A2 | A3 |
| 1.  | Determine the symmetry elements, the symmetry operations and the point group of a molecule; and predict the infrared and Raman active vibrational modes of that molecule. | 20%                           | ✓   | ✓  |    |
| 2.  | Explain the bonding and properties of a molecule using molecular orbital theory.  | 15%                           | ✓   | ✓  |    |
| 3.  | Explain the spectroscopic and magnetic properties of transition metal complexes using ligand field theory.  | 15%                           | ✓   | ✓  |    |
| 4.  | Describe the bonding, structures, properties and reactivity of organometallic compounds containing carbon monoxide, alkene, alkyne, arene and cyclopentadienyl ligands.   | 50%                           | ✓   | ✓  |    |
|     |   | 100%                          |   |    |    |

\* If weighting is assigned to CILOs, they should add up to 100%.

<sup>#</sup> Please specify the alignment of CILOs to the Gateway Education Programme Intended Learning outcomes (PILOs) in Section A of Annex.

- A1: *Attitude*  
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.
- A2: *Ability*  
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to self-life problems.
- A3: *Accomplishments*  
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

### 3. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

| TLA                             | Brief Description   | CILO No. |   |   |   |   | Hours/week<br>(if applicable)  |
|---------------------------------|---|----------|---|---|---|---|--------------------------------|
|                                 |   | 1        | 2 | 3 | 4 | 5 |                                |
| Lectures and tutorials          | Teaching and learning will be based on large and small group activities in which the principles and applications of group theory will be examined and discussed. Small group activities would involve building up of various molecules using models to examine their symmetry.                                  | ✓        |   |   |   |   | 0.5                            |
| Lectures and tutorials          | In large and small group activities the basic concepts of molecular orbital theory will be examined and discussed.  |          | ✓ |   |   |   | 1                              |
| Lectures and tutorials          | In large and small group critical evaluation tasks students will discuss and rationalise the various properties of transitional metal complexes using ligand field theory.  |          |   | ✓ |   |   | 0.5                            |
| Lectures and tutorials          | Teaching and learning will be conducted in large and small groups in which the properties of various organometallic compounds will be examined and discussed.   |          |   |   | ✓ |   | 1                              |
| Experiments and written reports | Students (in groups of two to three) will design and take part in laboratory work in which they will acquire skills in the synthesis, purification and characterization of inorganic compounds. Students will analyse their data and present their results in the form of written reports and oral discussions. |          |   |   |   | ✓ | 2<br>(for<br>CHEM3014<br>only) |

#### 4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

For CHEM3014:

| Assessment Tasks/Activities                         | CILO No. |   |   |   |   | Weighting* | Remarks |
|---|----------|---|---|---|---|------------|---------|
|   | 1        | 2 | 3 | 4 | 5 |            |         |
| Continuous Assessment: <u>30%</u>                   |          |   |   |   |   |            |         |
| Quizzes & Assignments                               | ✓        | ✓ | ✓ | ✓ |   | 20%        |         |
| Laboratory Reports                                  |          |   |   | ✓ | ✓ | 10%        |         |
| Written Examination: <u>50%</u> (duration: 3 hours) |          |   |   |   |   |            |         |
| Practical Examination: 20% (duration: 3 hours)      |          |   |   |   |   |            |         |
| * The weightings should add up to 100%.             |          |   |   |   |   | 100%       |         |

For CHEM3014A:

| Assessment Tasks/Activities                         | CILO No. |   |   |   |   | Weighting* | Remarks |
|---|----------|---|---|---|---|------------|---------|
|   | 1        | 2 | 3 | 4 | 5 |            |         |
| Continuous Assessment: <u>40%</u>                   |          |   |   |   |   |            |         |
| Quizzes & Assignments                               | ✓        | ✓ | ✓ | ✓ |   | 40%        |         |
| Written Examination: <u>60%</u> (duration: 3 hours) |          |   |   |   |   |            |         |
| * The weightings should add up to 100%.             |          |   |   |   |   | 100%       |         |

Starting from Semester A, 2015-16, students must satisfy the following minimum passing requirement for courses offered by CHEM:

**“A minimum of 40% in both coursework and examination components.”**

## 5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

| Assessment Task                              | Criterion  | Excellent<br>(A+, A, A-) | Good<br>(B+, B, B-) | Fair<br>(C+, C, C-) | Marginal<br>(D) | Failure<br>(F)                    |
|--|--|--------------------------|---------------------|---------------------|-----------------|-----------------------------------|
| 1. Short Quizzes                             | ABILITY to develop an understanding of the basic principles of inorganic chemistry                           | High                     | Significant         | Moderate            | Basic           | Not even reaching marginal levels |
| 2. Tutorial Assignments                      | ABILITY to describe, explain and apply concepts of inorganic chemistry and to solve problems                 | High                     | Significant         | Moderate            | Basic           | Not even reaching marginal levels |
| 3. Laboratory Reports<br>(For CHEM3014 only) | ABILITY to conduct inorganic chemistry experiments and to present results and discussions in written reports | High                     | Significant         | Moderate            | Basic           | Not even reaching marginal levels |
| 4. Examination                               | ABILITY to describe, explain and apply concepts of inorganic chemistry and to solve problems                 | High                     | Significant         | Moderate            | Basic           | Not even reaching marginal levels |

### Part III Other Information (more details can be provided separately in the teaching plan)

#### 1. Keyword Syllabus

(An indication of the key topics of the course.)

##### Symmetry and Group Theory

Symmetry elements and symmetry operations. Point groups. Character tables. Irreducible and reducible representations.

##### Application of group theory to Infrared and Raman Spectroscopy

Normal modes of vibrations. Symmetry of vibrational modes. Infrared and Raman active vibrational modes.

##### Molecular Orbital Theory

Linear combination of atomic orbitals. Wavefunctions and energies of molecular orbitals. Group Theory approach to molecular orbital theory. Bonding in diatomic molecules. Bonding in polyatomic molecules.

##### Bonding in Transition Metal Complexes

Ligand-field theory. Ligand-field stabilization energy. Spectrochemical series. Spectroscopic and magnetic Properties. Distorted octahedral complexes. Square planar and tetrahedral complexes. Selection rules for electronic transitions.

##### Inorganic Mechanisms

Dissociative, associative, concerted, inner sphere and outer sphere reaction mechanism. Trans effect and trans influence.

##### Main Group Chemistry

Synthetically important lithiated and Grignard reagents. Inert pair effect. Wade's rules.

##### Organometallic Chemistry

Survey of ligands. 18-electron rule. Carbonyl complexes: bonding, synthesis and reactivity. Alkene and alkyne complexes. Complexes containing delocalized carbocyclic ligands. Alkyl complexes.

#### 2. Reading List

##### 2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

|     |  |
|-----|--|
| 1.  |  |
| 2.  |  |
| 3.  |  |
| ... |  |

##### 2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

|    |  |
|----|--|
| 1. | <i>Inorganic Chemistry</i> , Shriver and Atkins, 4th Edition, Oxford University Press, Oxford 2006.              |
| 2. | <i>Chemical Applications of Group Theory</i> , F. Albert Cotton, 3 <sup>rd</sup> Edition, Wiley, New York, 1990. |
| 3. | <i>Inorganic Chemistry</i> , Housecroft and Sharpe, 3 <sup>rd</sup> Edition, Pearson, Essex 2008                 |

- A. Please specify the Gateway Education Programme Intended Learning Outcomes (PILOs) that the course is aligned to and relate them to the CILOs stated in Part II, Section 2 of this form:

| <b>GE PILO</b>  | <b>Please indicate which CILO(s) is/are related to this PILO, if any<br/>(can be more than one CILOs in each PILO)</b> |
|---|--|
| PILO 1: Demonstrate the capacity for self-directed learning   |  |
| PILO 2: Explain the basic methodologies and techniques of inquiry of the arts and humanities, social sciences, business, and science and technology |  |
| PILO 3: Demonstrate critical thinking skills  |  |
| PILO 4: Interpret information and numerical data  |  |
| PILO 5: Produce structured, well-organised and fluent text  |  |
| PILO 6: Demonstrate effective oral communication skills   |  |
| PILO 7: Demonstrate an ability to work effectively in a team  |  |
| PILO 8: Recognise important characteristics of their own culture(s) and at least one other culture, and their impact on global issues               |  |
| PILO 9: Value ethical and socially responsible actions  |  |
| PILO 10: Demonstrate the attitude and/or ability to accomplish discovery and/or innovation  |  |

*GE course leaders should cover the mandatory PILOs for the GE area (Area 1: Arts and Humanities; Area 2: Study of Societies, Social and Business Organisations; Area 3: Science and Technology) for which they have classified their course; for quality assurance purposes, they are advised to carefully consider if it is beneficial to claim any coverage of additional PILOs. General advice would be to restrict PILOs to only the essential ones. (Please refer to the curricular mapping of GE programme: [http://www.cityu.edu.hk/edge/ge/faculty/curricular\\_mapping.htm](http://www.cityu.edu.hk/edge/ge/faculty/curricular_mapping.htm).)*

- B. Please select an assessment task for collecting evidence of student achievement for quality assurance purposes. Please retain at least one sample of student achievement across a period of three years.

| Selected Assessment Task |
|--------------------------|
|                          |