DEPARTMENT OF

CHEMISTRY

CHEM UG Courses

UG Courses offered in Spring Term 2024-2025 but the courses outlines are not time-specific

Course Code	Course Title
CHEM 1004	Chemistry in Everyday Life
CHEM 1008	Introductory Chemistry
CHEM 1011	General Chemistry A: Reactions, Thermodynamics, and Reactions Kinetics
CHEM 1012	General Chemistry B: Atomic Structure, Molecules, and Bonding Theories
CHEM 1051	Laboratory for General Chemistry A
CHEM 1052	Laboratory for General Chemistry B
CHEM 2155	Fundamentals Organic Chemistry Laboratory
CHEM 2311	Analytical Chemistry
CHEM 2355	Fundamental Analytical Chemistry Laboratory
CHEM 3120	Organic Chemistry II
CHEM 3220	Inorganic Chemistry II
CHEM 3320	Instrumental Analysis
CHEM 3420	Physical Chemistry II
CHEM 3550	Synthetic Chemistry Laboratory
CHEM 3555	Molecular Characterization Chemistry Laboratory
CHEM 4110	Structural Elucidation in Organic Chemistry
CHEM 4240	Intermediate Inorganic Chemistry
CHEM 4310	Environmental Chemistry

CHEM 4420	Statistical Machine Learning Methods for Chemical Data Analysis
CHEM 4430	Symmetry in Chemistry and Spectroscopy
CHEM 4680	Undergraduate Research
CHEM 4689	Capstone Project
CHEM 4691	Capstone Research I
CHEM 4692	Capstone Research II

香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

CHEM 1004 – Chemistry in Everyday Life

Spring Semester 2024-25

3 credits

Lectures:	G009A (CYT Building) Wednesday and Friday 15:00 – 16:20 No lectures on Apr 4, 18
Course Instructor:	**Prof. Emily M.W. TSANG** Assistant Professor of Science Education Department of Chemistry, HKUST Email: **chetsang@ust.hk** Office: Rm 4536 (4/F, between Lifts 25/26 and 27/28)
Course website:	**https://canvas.ust.hk**

Course Description

CHEM 1004 is an introductory course provided for students who have never taken a Chemistry course, but would like to learn what chemistry is and how it may affect the world we live in.

Course objectives are as follows:
1. Introduce basic concepts of Chemistry.
2. Connect Chemistry with everyday life and modern technology.
3. Explain the importance of Chemistry in the environment, medicine, and daily life.

Course Outline

The course is divided into six Chapters:

Chapter 1:	What is everything made of?
Chapter 2:	The Air.
Chapter 3:	The air and our environment.
Chapter 4:	The metals in our daily life.
Chapter 5:	Metals in the industry.
Chapter 6:	Fire and fuels.

Lectures

The lectures are critical to your understanding of course materials. You should try to attend all the lectures. We will show some interesting experiments during some of the classes and they are best viewed in person. Lecture recordings will be provided on Canvas after **each class**, so please catch up promptly when you missed a class.

Course Contents

Comprehensive **lecture notes** will be provided for this course. These notes should be very helpful to you as they provide more details of the lecture materials than power point slides. However, the version of the notes you receive is incomplete. You will need to fill in some important details or draw diagrams to complete the notes during the lectures.

You should print out hard copies of the lecture notes and bring them to the class. You can staple each chapter's notes into a booklet.
It would be advisable to print them single sided, so that you can use the blank page to jot down extra notes that the lecturer mentions but are not in the notes, or to write some references you obtained from other sources or your revision notes.

The **power point slides** will be mostly pictures or graphics. The slides will be released on Canvas.

The lecture notes will be released by chapter. New chapters will be released on Canvas towards the end of the current chapter. You can read through the notes before the lecture to familiarise yourself with the materials.

Textbooks/Reading List

You don't need a textbook for this course, and since we draw examples from many different areas of chemistry in everyday life, no one textbook is a perfect fit for the course. Therefore for each chapter, some reading materials will be suggested to you for optional reference.

End of Chapter Exercises and Tutorial Sessions

To help you prepare for the examination, each chapter will finish with a short **exercise**. These exercises will require you to work through a set of problems, using some knowledge from the lectures and also to teach you some new knowledge through the exercise.

These exercises will not be formally graded, but they will be examinable.

Office Hours of the Instructor

Please feel free to approach the instructor, Prof. Emily Tsang to ask questions or to discuss any chemistry or course-related issues. You may approach her after the lectures, or you may email her to arrange an appointment. There is no fixed office hour schedule: if you need one, feel free to email and book a time.

Online Graded Quizzes (15 % of the course)

There will be two online graded quizzes in addition to the end-of-chapter exercises, the first quiz is **after Chapter 4** (covering Chapters 1 – 4), and the second quiz is at the end of the course (covering mainly Chapters 5 – 6). You should complete them within the given time (typically 2 – 3 days). The accumulated points from the online quizzes will carry 15 % to the course grade, but the main purpose

is to help you further understand the course materials and have a chance to practice and receive answers immediately after submission. When these quizzes are available, you will receive email notification as well as instructions during the lectures.

Individual Study-Project (30 % of the course)

This course will have a study project component for you to learn more about a particular area of everyday chemistry that interests you. The project period will commence about 3 weeks into the course. In view of the time needed for this project, **there will be no mid-term examination** for this course.

Every student will undertake an *individual* written study project. At the end of the project, each student should submit a piece of written original research. You will choose a topic yourself that is about any chemistry phenomenon or chemicals that is in your everyday life. Be creative and explore interesting topics!

You are expected to read widely, using resources available to you, not limited to the internet – you also have access to books, journal articles and other multimedia resources. You may report also real experiences yourself and report them. Photographs would be needed to demonstrate that your topic is truly something you can connect to in the real world.

The article should bring together many ideas to draw up an original story. Originality checks will be performed so you must do the writing yourself.

More information will be announced during a lecture around week 3.

Final Examination (55 %)

On-campus proctored examination during the final exam period: This course will end with a *closed-book* final examination (2 hours). This will cover all the lecture materials and exercises that were taught in the course. You will mainly be tested on your understanding and ability to solve problems rather than solely on the memorisation of facts, but you should also be familiar with some key chemical details – some of these will inevitably require some memorisation.

Grades

The final grade for the course will be consisted of:
15% from the Online Quizzes
30% from the Study Project
55% from the Final Examination
The course is graded from A+ to F. An F grade will not earn you credits for the course.

Intended Learning Outcomes (ILOs)

At the end of the course, the students will have:

1. An ability to recognize physical/chemical properties, physical/chemical changes.
2. An ability to apply knowledge of chemical reactions, stoichiometry, atomic structure, chemical bonding, molecular structure, states of matter, acid-base chemistry, and redox reactions.
3. A basic knowledge of organic chemistry, polymer chemistry, biochemistry, and food chemistry.
4. An ability to link chemistry to modern technology, environment, and daily life.

Assessment Scheme

Weight	Assessment	Course ILOs	CHEM Program ILOs
15%	Online Revision Quiz	1, 2, 3, 4	1, 2, 3
30%	Study Project	1, 2, 3, 4	3, 6, 11, 12, 13
55%	Final Exam	1, 2, 3, 4	1, 2, 3

Teaching and Learning Activities (Non-assessed)

Activities	Course ILOs	CHEM Program ILOs
Lecture	1, 2, 3, 4	1, 2, 3
End of chapter exercises and Tutorials	1, 2, 3, 4	1, 2, 3

Topics by Chapter

Chapter 1: What is everything made of?	**~2 Lectures**	Introduction of the course Discovery of the atomic structure Elements; relative atomic mass relative molecular mass The mole Chemical calculations Relationship between mole and mass, mole and concentration, mole and gas volume Calculations, Common elements
Chapter 2: The Air	**~3 Lectures**	Gases in the Air, Electronic configuration Forming covalent bonds States of matter, separation of gases in air, Intermolecular forces: London dispersion force Electronegativity, Polar and non-polar molecules, Intermolecular forces: dipole-dipole interactions
Chapter 3: The air and our environment	**~5 Lectures**	Electromagnetic waves Greenhouse gases, Greenhouse effect, Global Warming, Carbon cycle, Reducing CO_2 emission Acids and Bases Air Pollution: Acid Rain and other air pollutants Reading organic chemical structures Air Pollution: VOCs, smog, PMs Controlling air pollution

		Ozone and ozone depletion
Chapter 4: The metals in our daily life	**~5 Lectures**	Different groups of metals in the periodic table: Alkali metals, Alkaline earth metals, Transition metals, Lanthanides, metals in Group 13-15, Radioactivity and the Actinide elements Structure of Metals, Metallic bonding Metal lattice systems Physical properties of typical metals; Alloys Alloys: types and applications Compounds of metals: Ionic bonding Name and Formula of ionic compounds Structure of complex ions Solid structure of ionic compounds Ionic lattice systems Physical properties of ionic compounds Reaction of metals with oxygen Reaction of metals with water Reaction of metals with acids
Chapter 5: Metals in the industry	**~6 Lectures**	Metal extraction industry Calculate %mass of metal in a compound Redox Oxidation number Metal displacement reactions Metal displacement reactions Extraction of Metals by heating with carbon: Copper, Iron (Blast Furnace, Basic Oxygen Converter) Electrolysis of molten ionic compounds: Extraction of sodium Electrolysis of molten ionic compounds: Extraction of aluminium Electrolysis of aqueous solution The chloroalkali industry

		The refining of copper metal Electroplating Anodising aluminium Half cells and standard electrode potentials Electrochemical cells Fruit batteries, zinc-carbon batteries Alkaline batteries Silver oxide cells Rechargeable batteries: Ni-MH batteries Lithium metal batteries Lithium-ion batteries
Chapter 6: Fire and fuels	**~4 Lectures**	Fire and combustion, Fire triangle How to fight a fire Fire extinguishers Introduction to fossil fuels: coal, natural gas and crude oil Alkanes: naming and isomers Fractional distillation of crude oil Fractions from crude oil Cracking Alkenes Polymers Calculating energy from combustion reactions Starting a fire Fireworks Explosives

The Hong Kong University of Science and Technology
Department of Chemistry

Instructor: Prof. Emily M. W. Tsang
Office: Rm 4536 (Lift 25/26)
E-mail: chetsang@ust.hk

CHEM 1008 – Introductory Chemistry (3-credits) Spring 2024 -2025

Course Description:
This course targets science or engineering students with very little to no chemistry background. It provides a general introduction to basic principles of chemistry. Key topics include state of matters, atoms and elements, molecules and compounds, atomic structures and periodicity, molecular structures, quantities in chemical reactions, bonding theories, acids and bases, and solution chemistry.

Exclusions: Level 3 or above in HKDSE 1/2x Chemistry OR HKDSE 1x Chemistry, a passing grade in AL/AS Chemistry, any CHEM courses at or above 1004-level

Lecture: Wed, Fri, 16:30 – 17:50

Venue: LT-L (CYT Building)

Instructor Office Hours: By email appointment

Course Content/Topics:

Chapter 1: Matter and Energy	Chapter 7: Electrons in Atom and the Periodic Table
Chapter 2: Atoms and Elements	Chapter 8: Chemical Bonding
Chapter 3: Molecules and Compounds	Chapter 9: Solids, Liquids, and Intermolecular Forces
Chapter 4: Chemical Composition	Chapter 10: Properties of Solutions
Chapter 5: Chemical Reactions	Chapter 11: Acids and Bases
Chapter 6: Reaction Stoichiometry	Chapter 12: Chemical Equilibrium

Intended Learning Outcomes:
Upon successful completion of this course, students are expected to be able to:

1. Develop a microscopic view of the worlds in terms of atoms and molecules
2. Recognize physical/chemical properties, physical/chemical changes
3. Apply knowledge of states of matter, chemical reactions, stoichiometry, atomic structure, chemical bonding, molecular structure, and intermolecular interactions.
4. Obtain a basic knowledge of solution chemistry, acid-base chemistry, chemical equilibrium.
5. Recognize and appreciate the impact and significance of chemistry to our society.

Course Grading Scheme

Online Quizzes (2 x 10% each)	20%
In-class Midterm Exam	40 %
In-class Final Exam	40 %

CHEM 1011 General Chemistry A: Reactions, Thermodynamics, and Reaction Kinetics (3:3-0-0)

Pre-requisite: Level 3 or above in HKDSE 1/2x OR level 3 or above in HKDSE 1x Chemistry
OR CHEM 1004 OR CHEM 1008

This course targets at students who have acquired prior knowledge in fundamental Chemistry in high school. Key topics include stoichiometry, chemical energy, properties of aqueous solutions, acids and bases, thermodynamics and equilibrium, reaction kinetics, and electrochemistry.

Spring 2025

Instructor:

Dr. Frederick Fu Kit SHEONG (1st half of the course)
(Room 4543; Tel. 3469 2098; Email: chemfksheong@ust.hk)

Prof. Zhenyang LIN (2nd half of the course)
(Room 4518; Tel. 2358 7379; Email: chzlin@ust.hk)

Instructional Assistant:

Dr. Tsz Kin NG (Room 4506; Tel. 2358 7404; Email: ngken@ust.hk)
Dr. Long Yiu TSANG (Email: lytsangchem@ust.hk)

Textbook: Chemistry – an atoms first approach (3e)
Authors: Steven S. Zumdahl, Susan A. Zumdahl and Donald J. Decoste

Chapter 10: Properties of Solutions
Chapter 12: Chemical Equilibrium
Chapter 13: Acids and Bases
Chapter 14: Acid-Base Equilibria
Chapter 15: Solubility and Complex Ion Equilibria
Midterm Exam (Chapters 10, 12-15) 10am – 12nn March 29 (Sat)
Chapter 16: Spontaneity, Entropy, and Free Energy
Chapter 17: Electrochemistry
Chapter 11: Chemical Kinetics
Chapter 18: The Nucleus: A Chemist's View
Chapter 21: Organic and Biological Molecules
Final Exam (Chapters 11, 16-18, 21)

Learning Outcomes

On completion of the course, students will be able to

1. Analyze properties of solutions and determine stoichiometry of chemical transformations.
2. Describe different definitions of acids and bases theories and understand acid-base equilibrium.
3. Apply the laws of thermodynamics and account for the factors that lead to spontaneous physical and chemical changes.
4. Describe redox reactions, use electrochemical data to predict the spontaneity of redox reactions, and comprehend the structures of electrochemical cells.
5. Understand the fundamental chemical properties of organic and biological molecules at a molecular level, differentiate between synthetic and natural polymers while appreciating the diverse roles played by biological molecules such as starch, cellulose, proteins, DNA, and RNA in living systems.
6. Recognize the impact of chemistry to society.

Lecture Hours: Section L1: 1:30 pm – 2:50 pm; Tuesday, Thursday at LT-D
Section L2: 4:30 pm – 5:50 pm; Tuesday, Thursday at LT-D

Office Hours:
Monday 3:30pm – 6:00pm: At Room 4507, or other time upon email request

Assessment:

Mid-term exam	45%
Final exam	45%
Assignments 1 & 2	5% x 2

Assessment Scheme:

Weight	Assessment	Course ILOs
5%	Assignment 1	1, 2
5%	Assignment 2	3, 4, 5
45%	Midterm exam	1, 2, 6
45%	Final exam	3, 4, 5, 6
	Participation	1, 2, 3, 4, 5, 6

Ungraded Problem Set will be given on Canvas for each chapter.

CHEM 1012 General Chemistry B: Atomic Structure, Molecules, and Bonding Theories (3:3-0-0)

Pre-requisite: Level 3 or above in HKDSE 1/2x OR level 3 or above in HKDSE 1x Chemistry OR CHEM 1004 OR CHEM 1008
Exclusion(s): CHEM 1010
This course targets at students who have acquired prior knowledge in fundamental Chemistry in high school. Key topics include atomic structure and periodicity, molecules, bonding theories, and properties of gases, liquids and solids. Other topics such as transition metals and coordination compounds will be briefly reviewed.

Spring 2025

Instructor:

Prof. Guochen JIA (1st half of the course)
(Room CYT 6009; Tel. 2358 7361; Email: chjiag@ust.hk)

Prof. Haipeng Lu (2nd half of the course)
(Room 4533; Tel. 3469 2097; Email: haipenglu@ust.hk)

Instructional Assistant:

Dr. Tsz Kin NG (Room 4506; Tel. 2358 7404; Email: ngken@ust.hk)
Dr. Long Yiu TSANG (Email: lytsangchem@ust.hk)

Textbook: Chemistry – an atoms first approach (3e)
Authors: Steven S. Zumdahl, Susan A. Zumdahl and Donald J. Decoste

Chapter 1. Chemical Foundations
Chapter 2. Atomic Structure and Periodicity
Chapter 3. Bonding: General Concepts
Chapter 4A. Molecular structure and valence bond model
(Textbook section 4.1 – 4.3)
Midterm Exam (Chapters 1 – 4A) 7th April (Mon) 7:30 pm – 9:30 pm
Chapter 4B. Molecular orbital model
(Textbook section 4.4 – 4.7)
Chapter 8. Gases
Chapter 9. Liquids and solids
Chapter 20: Transition Metals and Coordination Chemistry
Final Exam (Chapters 4B, 8, 9, 20)

Learning Outcomes

At the end of the course, students are expected to be able to:

1. Describe and apply elementary concepts and terminologies of chemistry
2. Describe the structure of atoms and periodicity, and determine electron configurations.
3. Describe and apply the concepts of bonding theory.
4. Describe properties of gases, liquids and solids.
5. Describe properties of transition metals, and coordination compounds.

Lecture Hours: Section L1: 4:30 pm – 5:50 pm; Wednesday, Friday at LT-D
Section L2: 4:30 pm – 5:50 pm; Tuesday, Thursday at LT-J

Office Hours:
Monday 3:30pm – 6:00pm: At Room 4507, or other time upon email request

Assessment:		
	Mid-term exam	**40%**
	Final exam	**40%**
	Online Quizzes 1 & 2	**10% × 2**

Assessment Scheme:

Weight	Assessment	Course ILOs
10%	Online Quizzes 1	1, 2
10%	Online Quizzes 2	3, 4
40%	Midterm exam	1, 2, 3
40%	Final exam	3, 4, 5
	Participation	1, 2, 3, 4, 5

Ungraded Problem Set will be given on Canvas for each chapter.

CHEM 1051 Laboratory for General Chemistry A

2024–25 Spring

Course Outline

Instructor

Dr. CHEUNG Man Sing (Rm4535; Tel: 2358 7401; Email: sing@ust.hk)

Instructional Assistant (IA)

Ms. MAK Angela P. Y. (Rm4501C; Tel: 2358 8450; Email: makpy@ust.hk)

Class Schedule

Section	Date	Time	Venue
LA1	Monday	10:30AM – 01:20PM	1004, CYT Building
LA2		01:30PM – 04:20PM	
LA3	Tuesday	10:30AM – 01:20PM	
LA4		01:30PM – 04:20PM	
LA5	Wednesday	10:30AM – 01:20PM	
LA6		01:30PM – 04:20PM	

Course Information

Credit Units: 1

Pre-requisite: Nil

Co-requisite: CHEM 1011

Exclusion: Nil

Grade: P/F

Description:

This course is the laboratory class designed for students who are enrolled in CHEM 1011. With laboratory experience acquired in this course, students will be able to relate the physical and chemical principles and theories learned in the corresponding lecture course, perform basic chemical laboratory techniques, and develop their data analyzing skills.

Intended Learning Outcomes (ILOs)

Upon successful completion of this course, students should be able to:

Knowledge/Content Related:

1. recognize various kinds of equipment in chemistry laboratory
2. conduct standard laboratory procedures involved in basic chemistry experiments

Academic Skills/Competencies Related:

3. conduct risk assessments concerning the use of chemicals in basic chemistry experiments
4. keep records of experimental work in basic chemistry experiments
5. interpret experimental results for physical and chemical phenomena in basic chemistry experiments

Assessment Scheme

Assessment	Assessing Course ILOs
Pre-course Tests	1, 2, 3
Lab Attendance and Performance	1, 2, 3, 4, 5
Lab Reports	4, 5

To pass the course, students have to get satisfactory performances in all abovementioned assessment tasks/activities.

Student Learning Resources

- Reference Book: James Hall, *Experimental Chemistry: An Atoms First Approach*, Brooks/Cole, Cengage Learning, **2012**.
- Reference Book: J. A. Beran and Mark Lassiter, *Laboratory Manual for Principles of General Chemistry* (*11th edition*), Wiley, **2022**.
- Other learning resources can be accessed through Canvas.

Teaching and Learning Activities

Laboratory: focus on experiments related to co-requisite course

Course Schedule

Keyword Syllabus:

- Laboratory safety
- Common laboratory apparatus
- Basic techniques for measurements in chemistry laboratory
- Solution stoichiometry and volumetric titration
- Acids and bases
- Acid-base equilibria
- Solubility and complex ion equilibria
- Spontaneity, entropy, and free energy
- Electrochemistry

CHEM1052 Laboratory for General Chemistry B

2025 Spring

Course Outline

LA1 to LA6

1. Instructor

Name: Dr TSE, W.P. Veronica (email:chvaipui@ust.hk)

Office Room 4537; Tel: 2358-7364

2. Technical support staff & Teaching Assistant:

Technical support staff:

Name: Mr. TSE, Man Lung (email:mltse@ust.hk)

Name: Mr. Man, T.P. Tim (email:takpm@ust.hk)

Teaching Assistants:

Name: [to be provided on a separate file on Canvas]

3. Class Schedule

Section	Date	Time	Venue
LA1	**Tuesday**	**10:30 – 13:20**	**CYT Building UG001**
LA2		**13:30 – 16:20**	
LA3	**Wednesday**	**10:30 – 13:20**	
LA4		**13:30 – 16:20**	
LA5	**Thursday**	**10:30 – 13:20**	
LA6		**13:30 – 16:20**	

4. Course Information

Credit Units: 1

Co-requisite: CHEM 1012 'General Chemistry B'

Grade: **P or F**

Description:

This course is the laboratory class designed for students who are enrolled in CHEM 1012. With laboratory experience acquired in this course, students will be able to relate the physical and chemical principles and theories learned in the corresponding lecture courses, perform basic chemical laboratory techniques, and develop their data analyzing skills.

5. Intended Learning Outcomes

Upon successful completion of this course, students should be able to:

Knowledge/Content Related:

1. Recognize various kinds of equipment in chemistry laboratory
2. Conduct standard laboratory procedures involved in basic chemistry experiments

Academic Skills/Competencies:

3. Conduct risk assessments concerning the use of chemicals in basic chemistry experiments
4. Keep record of experimental work in basic chemistry experiments
5. Interpret experimental results for physical and chemical phenomena in basic chemistry Experiments
6. Work independently and collaborate in teamwork.

6. Assessment Scheme

Assessment	Assessing Course ILOs
Lab Attendance and Performance	1,2,3,4,5,6
Lab Reports	3,4,5

To pass the course, students must get satisfactory performances in all above-mentioned assessments/tasks/activities.

- *Lab attendance and performance*

  Students are required to complete the experiments according to this course. Various laboratory techniques are included in the experiments. Explanation of theory and demonstrations will be given for each experiment. The students will then complete the experiment under our supervision.

- *Lab report*

  A laboratory report is required for each experiment based on the experimental data. Students should follow the format given in the guidelines provided. Two points per day will be deducted for late submission of any lab reports.

7. Student Learning Resources

- Reference books:
  - James Hall, *Experimental Chemistry an Atoms First Approach*, Brooks/Cole: Cengage Learning, **2012**.
  - Jo A. Beran, *Laboratory Manual for Principles of General Chemistry 11th edition*, Wiley, **2022**.
- Other learning resources can be accessed through Canvas.

8. Teaching and Learning Activities

Laboratory Demonstration: focus on experiments related to its co-requisite course

9. Course Schedule

To be provided on a separate file on Canvas

10. Keyword Syllabus:

- Chemical Foundations
- Periodicity
- Gases
- Liquids and Solids
- Intermolecular Forces
- Complexometric Titration
- Transition Metals

CHEM 2155 Fundamental Organic Chemistry Laboratory

2025 spring

Course Outline

1. Instructor

Prof. CHAN, Ho Wai Dennis (email: chanhw@ust.hk)
Office Room 4528; Tel: 3469-2099

2. Technical support staff / Teaching Assistant:

Technicial support staff:

LAU, Chun Tak Disney (email: disney@ust.hk)
CHAN, Ka Lok Kelvin (email: chkelvin@ust.hk)
CHOI, Chai Yu Edwin (email: edwinchoi@ust.hk)
WONG, Yuet Yan Claire (email: chclaire@ust.hk)
Contact Details: CYT-1003 and CYT-1004; Tel: 3469-2611 or 3469-2612

Teaching Assistant:

Name: [to be provided on a separate file on Canvas]

3. Meeting Time and Venue:

Date/Time:	Tue	LA1 10:30 – 13:20
	Tue	LA2 13:30 – 16:20
	Tue	LA3 10:30 – 13:20
Venue:	CYT-1003 and CYT-1004 (1/F, CYT buidling)	

4. Course Description

Credit Points: 1
Pre-requisites: (CHEM 1010 or CHEM 1012) & CHEM 1052
Co-requisites: CHEM 2110 or CHEM 2111
Exclusions: CHEM 2150, CHEM 2550
Brief Information/synopsis:

This is the laboratory course designed for non-CHEM students who enrolled in CHEM 2110 or CHEM 2111. Students will perform a series of organic experiments related to the theories learnt in the related lecture courses. Students will be trained to practice a wide range of fundamental organic laboratory techniques, operate chemical instruments, relate the physical and chemical principles and theory in practice, and develop their data interpretation and analytical skills. For non-CHEM students in programs that designate this course as required course/specified elective.

5. Intended Learning Outcomes (ILOs)

Upon completion of the course, students should be able to:

1	Conduct analysis and interpretation of experimental data related to organic experiments.
2	Assess and manage the risk of chemical substances and laboratory procedures, and to evaluate their potential impact on the environment.
3	Conduct standard laboratory procedures involved in synthetic and instrumental work related to organic experiments.
4	Equip with hands on experiences in the operation of chemical instrumentation.
5	Demonstrate self-awareness, to interact with other people in teamwork, and to work independently.

6. Assessment Scheme

Graded A+ to F. In lab. reports, you are allowed to use generative artificial intelligence (AI) to aid you in any manner. However, you must give proper credit for any use of generative AI.

Assessment items	Weight	ILOs to be assessed
Chem lab safety assignment	5%	2
Performance on purification of solids	6%	2, 3, 4, 5
Performance on purification of liquids	6%	2, 3, 4, 5
Performance on separation techniques	6%	2, 3, 4, 5
Performance on organic synthesis	6%	2, 3, 4, 5
Performance on characterizations	6%	2, 3, 4, 5
Lab report on purification of solids	6%	1, 2
Lab report on purification of liquids	6%	1, 2
Lab report on separation techniques	6%	1, 2
Lab report on organic synthesis	6%	1, 2
Lab report on characterizations	6%	1, 2
Examination	35%	1, 2

* *Overall score for getting a Pass (i.e. Grade C- or above): 50%*

7. Student Learning Resources

Reference books:

[1] Kenneth L. Williamson, Kathrine M. Masters, "*Macroscale and Microscale Organic Experiments*" 7th edition, Australia: Cengage ©2017; or

[2] Kenneth L. Williamson, Kathrine M. Masters, "*Macroscale and Microscale Organic Experiments*" 6th edition, Australia: Cengage ©2011.

** Other course materials can be obtained from Canvas (https://canvas.ust.hk). Please log in using your ITSC username and password.*

8. Teaching and Learning Activities

Scheduled activities: 2 hr 50 min (Tutorial + Laboratory work)

9. Keyword syllabus:

- Recrystallization of Organic Solids
- Distillation of Organic Liquids
- Separation of Organic Components from a Mixture
- Isolation of Organic Components
- Organic Synthesis
- Nucleophilic Substitution
- Melting Point Measurements
- Infra-Red Spectroscopy for Organic Solids
- Infra-Red Spectroscopy for Organic Liquids

CHEM 2311 Analytical Chemistry [3-0-0:3]

Spring 2025

Instructor: **Prof. Ian D. Williams Rm CYT 6005 chwill@ust.hk**

Time: **Mon 15:00 , Fri 10:30 LT C**

Curriculum:

according to academic calendar
"Fundamental and practical aspects of chemical analysis, including titrimetric, electrical and spectroscopic methods, analytical separations by GLC and HPLC"

Course text:

Much of the material covered and lecture notes will be based on the following

"Exploring Chemical Analysis" 4th Edition
Daniel C. Harris, WH Freeman 2009
available in bookstore w discount ca HK$271 (ca 80 copies); there is not much difference with older 3rd edition
a slightly more thorough text covering same and additional material is:

"Quantitative Chemical Analysis" 8th Edition
Daniel C. Harris, WH Freeman 2010

There should be several copies of these texts (maybe as older editions) on reserve in HKUST library. Most other Analytical Chemistry text books eg **Skoog et al 'Fundamentals of Analytical Chemistry' 8th Ed**. will cover much of the same UG curriculum but are useful to gain different perspective. They will also offer alternative worked problems. Topics that are proving difficult to you in class are often the most useful to seek new insight through reading an alternative source.

Lecture notes will be made available in pdf format before the class on the lmes2.ust.hk website. A more detailed curriculum guide follows so that background reading of relevant chapters of the course text (or equivalent) can be made in preparation. The lectures will be video-taped to enable replay, catch-up or for revision.

Teaching Assistants for CHEM 2311 Spring 2025

- Miss WANG, Cengan
- Mr. ZENG, Xianghao
- Mr. ZHAO, Chaoyue

- We will schedule TA hours and Prof Williams Office hours once everyone's timetables are finalized.

Course Grading Scheme 2025:

The grading will be calculated as follows

Attendance/ PRS Quiz	10%
Homework/ Assignments	15%
Mid-term (1hr 20min)	30%
Final exam (2hr)	45%

Problem sets will be assigned as homework most weeks and two of these (7.5% each) will be graded. Another 5% will be based on responses to questions given in class, via the iPRS system!

Homework submission will be through web via the LMES2 server. The homework answers will be Multi-choice or require your numerical input; much of the Mid Term and Final exam questions will be based on the style and type of problem set in homeworks, so these should be studied independently

Curriculum Details and suggested Background Reading:

Background reading Chapters from Exploring Chemical Analysis (ECA) Harris

- I plan to update this compared to previous years to make it more contemporary and relevant for engineers & bio scientists.

Weeks 1-2 **Introduction**

- Analytical Process; Chemical Measurements & Methods; Errors & Sig Figs; Basic statistics

Weeks 3-4 **Classical Methods**

Calibrations, (Validation of results, standard additions, internal standards) Titrations, (acid-base, indicators, EDTA) Gravimetry & Combustion analysis.

Weeks 5-6 **Electrochemical and Optical Methods**

REDOX chemistry; Ion selective electrodes; Amperometry; Voltammetry; Biosensors; Absorption/emission of light; Fluorescence; Spectrophotometry

Week 7 **Revision & Mid-term exam**

The second half is organized to cover the main elemental and molecular analysis methods used today

Weeks 8-10 **Elemental Analysis**

Atomic spectroscopies (absorption, emission); ICP-MS & SIMS; Isotope ratios; X-ray methods (XRF, EDX, XPS); Food, drug, environmental analysis, material identification (metal alloys).

Weeks 10-12 **Molecular Analysis**

Chromatography & Separation methods; GC, HPLC; Molecular spectroscopies; NMR; Mass spectra; X-ray methods – P-XRD & S-XRD structure determination; Analysis of chirality

Week 13 **Review & Revision for Final exam**

Final Examination (2hr) schedule will be determined by ARR

Course Intended Learning Outcomes (ILOs)

Upon successful completion of this course, students should be able to:

No.	**ILOs**
1	Able to recognize fundamentals of analytical chemistry including various concentration units, statistics for analytical chemistry, acid-base titrations, complexometric titrations, redox titrations, basics of optical spectroscopy, basics of chromatography and mass spectrometry.
2	Able to explain the essential facts, principles and theories for analytical chemistry.
3	Able to demonstrate awareness of topics of analytical chemistry relevant to social and daily life, such as environmental issues.
4	Formulate and analyze a wide range of analytical chemical problems by applying chemical principles.
5	Show appreciation of analytical chemistry and its interface with social and daily life such as environmental issues, and arouse audience's interest in chemistry.

CHEM 2355 Fundamental Analytical Chemistry Laboratory
Course Outline – Spring 2025

1. Instructor
Name: Dr Joanne W T Tung <*jwttung@ust.hk*>
Contact: Office: Rm 4541 (Lift 25/26); Tel: 2358 7395

2. Technical Officers/ Instructional Assistant/ Teaching Assistants
Technical Officers*:*
Name: Rowena LEUNG <*chlsy@ust.hk*>; Alice WONG <*wongtingin@ust.hk*>
Contact: Lab: CYT-3007 (Lift 35/36); Tel: 2358 7244; 2358 7402

Instructional Assistant: *Anson WONG <wchwong@ust.hk>*
Contact: Lab: CYT-3007 (Lift 35/36); Tel: 2358 7402;

Teaching Assistants: *Separate file*

3. Meeting Time and Venue
LA1: Tuesdays 10.30 - 13.20
LA2: Tuesdays 13.30 - 16.20

Venue: CYT-3007

4. Course Description
Credit Points: 1
Pre-requisites: CHEM1010 General Chemistry IA or CHEM1020 General Chemistry IB, or CHEM1050 Laboratory for General Chemistry I
Co-requisites: CHEM2311 Analytical Chemistry, or CHEM2310 Fundamentals of Analytical Chemistry

Course Description: Practical aspects of fundamental chemical analysis.

Course Objective: With the use of analytical instruments and lab equipment, the course applies what the students learned in lectures in practical term.

5. Intended Learning Outcomes (ILOs)

On completion, students should be able to:

1	Explain the essential facts, principles and theories in the area of analytical chemistry.
2	Formulate and analyze a wide range of chemical problems by applying relevant chemical principles.
3	Analyze and interpret experimental data and extract useful data from it
4	Conduct standard laboratory procedures involved in instrumental work.
5	Operate a range of chemical instrumentation with adequate hands-on experiences.
6	Assess and manage the risks of chemical substances and laboratory procedures by evaluating their potential impact on the environment
7	Demonstrate self-awareness, work independently and collaborate effectively with other people in a team.

6. Assessment Scheme

Course Grading

Weight	Assessment	Course ILOs
60%	Report	1 - 4, 7
30%	Lab Quiz	1 - 4
10%	Lab Performance	4 - 7

7. Syllabus

Expt No.	Title of Experiment
1	Calibration of Volumetric Glassware
2	Quantitative Analysis of Xylene Isomers (meta-Xylene and para-Xylene) Using Fourier Transform- Infrared Spectrometer (FT-IR)
3	Determiantion of *n*-Heptane, *n*-Octane and *n*-Decane in unknown sample using Gas Chromatograph - Flame Ionization Detector (GC-FID)

8. Student Learning Resources

- Harris D. C., Charles A. Lucy, ***Quantitative Chemical Analysis***, 10th Ed., Macmillian Learning, 2020.
- Skoog D A, West D M, Holler F J, ***Fundamentals of Analytical Chemistry***, 9th Ed, Brooks/Cole, 2013.

(A few copies of each of the above textbooks have been reserved at the Course Reserve in HKUST library.)

9. Teaching and Learning Activities

Students can gain their hands-on experience from bench-top work and sample preparation to equipment/instrument operations in the practicals. There will have tutorials for experiments conducted by the Instructor.

CHEM 3120 Organic Chemistry II

Spring Semester, 2025

INSTRUCTOR: Dr. Jianwei Sun
Office: CYT6010
Telephone: 2358 7351
E-mail: sunjw@ust.hk

TEACHING ASSISTANTS:

WANG, Xinyuan
CHEN, Yuyang
FAN, Shuaixin
LI, Chong

LECTURE TIME: Tuesday, 16:30 - 17:50
Thursday, 16:30 - 17:50

VENUE: Rm 6591 (Lift 31/32)

COURSE DESCRIPTION:

CHEM3120 is the second half of a two-semester, introductory level organic chemistry course designed for chemistry and biochemistry majors. The complete course will prepare students for further studies in organic chemistry and/or biochemistry. Topics to be covered include IR, MS, and NMR spectroscopy; dienes, resonance and aromaticity; electrophilic aromatic substitution and nucleophilic aromatic substitution; benzylic and allylic reactivity; the chemistry of carbonyl compounds and carboxylic acid derivatives; the chemistry of amines; pericyclic reactions.

TEXTBOOK:

"*Organic Chemistry*" 8th edition by J. McMurry; Brooks/Cole, Thomson Learning, Inc. 2012
"*Study Guide and Student Solutions Manual for McMury's Organic Chemistry, 8th Edition*" by Susan McMurry, Brooks/Cole, Thomson Learning, Inc.

COURSE OBJECTIVES AND INTENDED LEARNING OUTCOMES:

This is the Part II of a two-semester, introductory level organic chemistry course designed for chemistry/biochemistry major undergraduates. The complete two-semester course will prepare students for further studies in organic chemistry and/or biochemistry. Upon the end of the course, students should be able to:

1 Recognize fundamentals of organic chemistry including structures, reaction mechanisms, and transformations of carbon-derived compounds.
2 Explain the essential facts, principles, and theories of organic chemistry.
3 Demonstrate awareness of organic chemistry topics relevant to social and daily life.
4 Formulate and analyze mechanisms and products of organic transformations by applying organic chemistry principles.

EXAMS AND GRADING SCHEME:

1. Midterm examination, 40%
2. Final examination, 60%

SYLLABUS

Week 1	Feb. 4	*Chapter 12. Mass Spectrometry & Infrared Spectroscopy (1)*
	Feb. 6	*No class (swap with mid-term exam)*
Week 2	Feb. 11	*Chapter 12. Mass Spectrometry & Infrared Spectroscopy (2)*
	Feb. 13	*Chapter 13. Nuclear Magnetic Resonance Spectroscopy (1)*
Week 3	Feb. 18	*Chapter 13. Nuclear Magnetic Resonance Spectroscopy (2)*
	Feb. 20	*Chapter 14. Conjugated Dienes and UV Spectroscopy (1)*
Week 4	Feb. 25	*Chapter 14. Conjugated Dienes and UV Spectroscopy (2)*
	Feb. 27	*Chapter 15. Benzene and Aromaticity*
Week 5	Mar. 4	*Chapter 16. Electrophilic Aromatic Substitution (1)*
	Mar. 6	*Chapter 16. Electrophilic Aromatic Substitution (2)*
Week 6	Mar. 11	*A Preview of Carbonyl Compounds*
		Chapter 19. Aldehydes/Ketones: Nucleophilic Addition Reaction (1)
	Mar. 13	*Chapter 19. Aldehydes/Ketones: Nucleophilic Addition Reaction (2)*
Week 7	Mar. 18	*Tutorial (1)*
	Mar. 20	*Chapter 20. Carboxylic Acids and Nitriles*
	Mar. 22	**(Sat.) Mid-Term Exam, 16:00 – 18:00**
		Covering Chapters 12-16 and 19, inclusive; Venue: **CYT G009A + G010**
Week 8	Mar. 25	*Chapter 21. Carboxylic Acid Derivatives: Nucleophilic Acyl Substitution Reactions (1)*
	Mar. 27	*Chapter 21. Carboxylic Acid Derivatives: Nucleophilic Acyl Substitution Reactions (2)*
Week 9	Apr. 8	*Chapter 22. Carbonyl Alpha-Substitution Reactions (1)*
	Apr. 10	*Chapter 22. Carbonyl Alpha-Substitution Reactions (2)*
Week 10	Apr. 15	*Chapter 23. Carbonyl Condensation Reactions (1)*
	Apr. 17	*Chapter 23. Carbonyl Condensation Reactions (2)*

Week 11	Apr. 22	*No class (swap with mid-term exam)*
	Apr. 24	*Chapter 24. Amines and Heterocycles (1)*
Week 12	Apr. 29	*Chapter 24. Amines and Heterocycles (2)*
Week 13	May 6	*Chapter 30. Orbitals and Organic Chemistry: Pericyclic reactions (1)*
	May 8	*Chapter 30. Orbitals and Organic Chemistry: Pericyclic reactions (2)*

Final Exam, to be announced

SUPPORTING READING MATERIALS AND SOLUTION MANNUAL:

Call Number	QD251.3 .M364 2008 c.1-3
AUTHOR	McMurry, John.
TITLE	Organic chemistry / John McMurry.
EDITION	7th ed.
IMPRINT	Belmont, CA : Thomson Brooks/Cole, c2008.
# Copies:	3 copies

Call Number	QD251.3 .M3642 2008 c.1-3
AUTHOR	McMurry, Susan
TITLE	Study guide and student solutions manual for McMurry's Organic chemistry
EDITION	7th ed.
IMPRINT	Australia : Thomson Brooks/Cole, c2008.
# Copies:	3 copies

Call Number	QD251.3 .M364 2004 c.1-4
AUTHOR	McMurry, John.
TITLE	Organic chemistry / John McMurry.
EDITION	6th ed.
IMPRINT	Pacific Grove, CA : Brooks/Cole, c2004.
# Copies:	4 copies

Call Number	QD251.3 .M3642 2004 c.1-4
AUTHOR	McMurry, Susan.
TITLE	Study guide and solutions manual for McMurry's Organic chemistry
EDITION	6th ed.
IMPRINT	Pacific Grove, CA : Brooks/Cole, c2004.
# Copies:	5 copies

Call Number	QD251.2 .M43 2000
AUTHOR	McMurry, John.
TITLE	Organic chemistry / John McMurry.
EDITION	5th ed.
IMPRINT	Pacific Grove, CA : Brooks/Cole, c2000.
# Copies:	4 copies

Call Number	QD251.2 .M432 2000
AUTHOR	McMurry, Susan.
TITLE	Study guide and solutions manual for McMurry's Organic chemistry,
EDITION	5th ed.
IMPRINT	Pacific Grove, Calif. : Brooks/Cole, c2000.
# Copies	4 copies

Call Number	QD251.2 M43 1996
AUTHOR	McMurry, John
TITLE	Organic Chemistry / John McMurry
EDITION	4th ed.
IMPRINT	Pacific Grove: Brooks/Cole Pub. Co., c1996.
# Copies:	4 copies

Call Number	QD251.2 M432 1996
AUTHOR	McMurry, Susan
TITLE	Study guide and solution manual for organic chemistry, fourth edition / Susan McMurry
IMPRINT	Pacific Grove, CA: Brooks/Cole Pub. Co., c1996.
# Copies:	4 copies

CHEM 3220 Inorganic Chemistry II Spring 2024

Course instructor: Prof. Yangjian Quan (office: Rm 4532; phone: 34692550; e-mail: chyjquan@ust.hk)

Class schedule
Lecture: Tuesday (9:00-10:20 am), Thurday (9:00-10:20 am), Rm LG3008

Course website: http://canvas.ust.hk/

Textbook:
Inorganic Chemistry, International edition, by M. Weller et al., OUP (2018)

Reference book:
"*Inorganic Chemistry*", 4th ed., by C. E. Housecroft and A. G. Sharpe, Pearson (2012) [online access to the 3rd edition]

Assessment scheme (to be announced)
Quizzes
Assignments
Midterm exam
Final exam
Others (e.g. PRS, participation in class and tutorials)

Course Contents
(1) Coordination Chemistry
- Classification of ligands, naming of inorganic complexes
- Crystal field theory: d-orbital splitting for octahedral, tetrahedral, tetragonal and square planar complexes
- Factors that affect the size of crystal field splitting, spectrochemical series
- High-spin and low-spin electron configurations, ligand field stabilization energies
- Geometry of d^8 complexes: square planar versus tetrahedral geometry
- Spectral properties of metal ions: d-d and charge-transfer transitions
- Magnetic properties of transition metal ions
- Correlation of enthalpies of hydration of metal ions and lattice enthalpies of metal oxides with ligand field stabilization energies
- Coordination equilibria, stepwise and overall formation constants, Irving-Williams series
- Chelate and macrocyclic effects, applications of chelate ligands
- Jahn-Teller distortion of Cu(II) compounds
- Molecular orbital energy level diagrams of metal complexes, comparison of MO theory with crystal field theory

(2) Organometallic chemistry of transition elements
- The 18-electron rule: rationale, examples, and exceptions
- Electron count: ionic and covalent models

- Carbonyl compounds: bonding and structures, factors affecting IR C-O stretching frequencies of metal carbonyls, synthesis and reactions of metal carbonyls, acidity of metal carbonyl hydride compounds
- Ligands that are isoelectronic with CO (NO^+, CN^-, N_2)
- Alkene and alkyne compounds
- Organometallic reactions: oxidative addition, reductive elimination, and migratory insertion
- Homogeneous catalysis: catalytic cycles for Rh-catalyzed alkene hydrogenation, Co-catalyzed alkene hydroformylation, metal-catalyzed polymerization of alkenes, Pd-catalyzed cross-coupling reactions
- Selectivity of catalytic reactions, Tolman cone angles of phosphines

(3) Main group hydride compounds

- Classification of hydride compounds: saline, covalent, and metallic hydrides
- Electron-deficient, electron-precise and electron-rich hydrides: bonding, structures, and stability, acid-base properties
- Synthesis and reactions of hydride compounds

(4) Main group alkyl/aryl compounds

- Thermodynamic and kinetic stabilities of metal alkyl compounds
- Trends of M-C bond energies for transition and main group alkyl compounds
- Bonding and structures of main group alkyl compounds
- Inert pair effects
- Synthesis and reactions of main group alkyl compounds

(5) Element-element multiple bonds

- Trends of element-element sigma and pi bonds
- N_2 vs. P_4, O_2 vs. S_8
- Multiple bonds between heavier elements, bonding and structure of Sn_2R_4
- $d\pi$-$p\pi$ interactions in R_3Si-O-SiR_3 and $R_3P{=}O$

(6) Inorganic rings and cages

- Inorganic rings: borazine, polysiloxane, phosphazenes
- Inorganic cages
- Boranes and carboranes: *closo*, *nido* and *arachno* polyhedra, Wades rules

Intended Learning Outcomes

Upon successful completion of this course, students should be able to:

No.	ILOs
1	Recognize fundamentals of chemistry, including structures, reactivity and properties of inorganic compounds and states of matters.
2	Explain essential facts, principles and theories of inorganic chemistry such as crystal field theory and the 18-electron rule
3	Demonstrate awareness of chemical topics relevant to social and daily life

CHEM3320
Instrumental Analysis

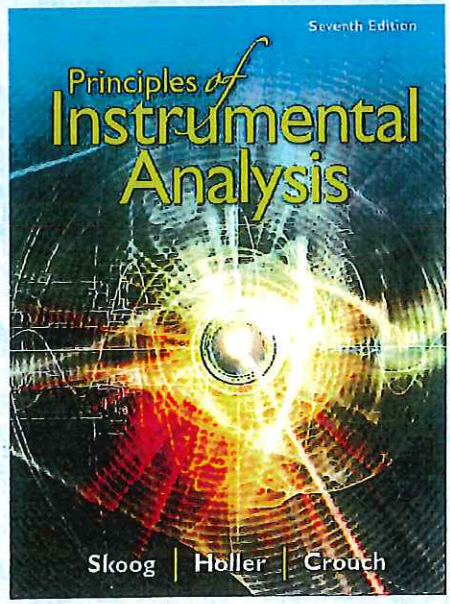
Lecture venue: Rm 2503, Lift 25-26
Lecture time: Mondays &Wednesdays (9:00-10:20 am)

Instructors:
Prof. YU, Jianzhen
Rm 4534, Tel: 2358-7389, chjianyu@ust.hk

Prof. Wu, Hongkai
Rm 4515, Tel: 2358-7246, chhkwu@ust.hk

Teaching Assistants
CUI, Binbin | bcuiaa@connect.ust.hk
HUANG, Yiwen|yhuanghr@connect.ust.hk
JIANG, Xuwei| xjiangbl@connect.ust.hk

Textbook:
Principles of Instrumental Analysis



CHEM3320 Course Outline (Spring 2025)

- Introduction to Instrumental Method: Chapter 1
- Introduction to Instrument Method: Statistical data evaluation: Appendix 1
- Introduction to Optical Spectrometric Methods: Chapters 6&7
- Introduction to Optical Atomic Spectrometry: Chapter 8
- Atomic Absorption and Emission Spectrometry (Chpt 9&10)
- Atomic Mass Spectrometry (Chpt 11)
- Molecular Mass Spectrometry (Chpt 20)

Prof. Yu, Jianzhen

Exam-1 (40%)

Final (60%)

- Atomic X-Ray Spectrometry: Chapter 12
- Ultraviolet/Visible Molecular Absorption Spectrometry: Chapters 13&14
- Molecular Luminescence Spectrometry: Chapter 15
- Infrared Spectrometry: Chapters 16&17
- Raman Spectrometry: Chapter 18
- Nuclear Magnetic Resonance Spectroscopy: Chapter 19
- Electroanalytical Chemistry-An Introduction: Chapter 22
- Potentiometry: Chapter 23
- Coulometry: Chapter 24
- Voltammetry: Chapter 25
- Surface Characterization by Spectroscopy and Microscopy: Chapter 21

Prof. Wu, Hongkai

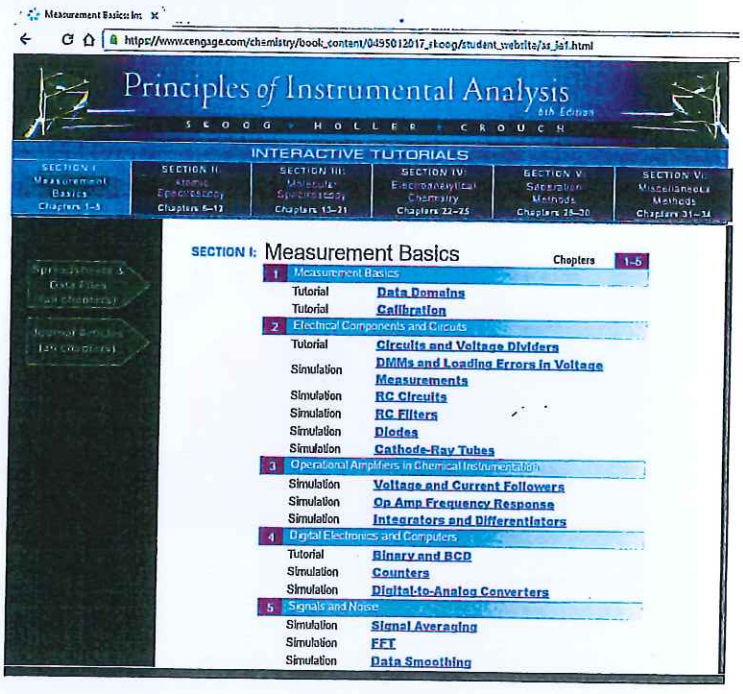
Tutorial materials provided by textbook publisher

Throughout the book, this logo indicates an opportunity for online self-study. Visit the book's companion website at www.tinyurl.com/skoogpia7 to view interactive tutorials, guided simulations, and exercises.

www.tinyurl.com/skoogpia7

You may need an older version of browser to enable adobe flash player

https://www.cengage.com/chemistry/book_content/0495012017_skoog/student_website/as_ie1.html



CHEM 3320: Instrumental Analysis

Course Description

This course builds upon CHEM 2310, where students learn the fundamental and practical aspects of chemical analysis, including titrimetric, electrical, and spectroscopic methods, as well as analytical separations via GLC and HPLC. CHEM 3320 focuses on modern instrument-based chemical analytical methods. Key topics include electrochemical analysis, mass spectrometry, surface analysis, and optical spectroscopic techniques. The course aims to impart a comprehensive understanding of the principles underlying contemporary chemical analyses, which are essential tools in chemistry and related fields today.

Intended Learning Outcomes

Upon successful completion of the course, students will be able to:

1. **Understand Principles**: Grasp the fundamentals and working principles of modern instrumental analytical techniques, including electrochemical analysis, mass spectrometry, optical spectroscopic techniques, and surface analytical techniques.
2. **Explain Knowledge**: Articulate the principles and applications of these instrumental analysis tools in college-level chemistry.
3. **Communicate Effectively**: Convey knowledge related to instrumental analyses in scientific seminars and presentations, tailored to both professional audiences and the general public.
4. **Prepare for Future Research**: Equip themselves with a solid foundation in these analytical techniques for future experiments or research endeavors.

Grade Assessment

- Homework: 0%
  - Submissions not required
- Exam I: 40%
  - Topics examined (see previous slide)
  - Date: 8 March 2025 (Saturday, 10:00 am-12:00 nn)
  - Venue: to be announced
- Final exam: 60%
  - Topics examined (see previous slide)
  - Date and time: To be announced by the university

CHEM 3420
Physical Chemistry II
Spring 2025

(copied from the course canvas)

Instructors:

Prof. Ding Pan

Room: 4476, Lift 25/26

Tel: 2358-8896

E-mail: dingpan@ust.hk

Teaching Assistants:

Mr. CHAN, Hok Tsun (Prof. Lin) htchanbf@connect.ust.hk
Ms. CHEN, Yiwei (Prof. Lin) ychennj@connect.ust.hk
Mr. ZHU, Peiyu (Prof. Chen TT) pzhuae@connect.ust.hk

Lectures (Spring 2025)

L1 (1859)	Mo 03:00PM – 04:20PM	G009A, CYT Bldg (80)
	Fr 10:30AM – 11:50AM	G009A, CYT Bldg (80)

Office Hours:

Monday: 4:20 pm ~ 5:20 pm, outside Rm G009A or Room 4476

Friday: 11:50 am ~ 12:50 pm, outside Rm G009A or Room 4476

COURSE DESCRIPTION

Chem3420: Physical Chemistry II aims to provide the students with a basic knowledge of the concepts, mathematics, and results of quantum mechanics and its application to chemical systems. Specifically, we will cover topics including the principles and mathematics tools in quantum mechanics, one-dimensional problems, particle-in-box, harmonic oscillator, angular momentum theory, spin, and introduction to methods of modern electronic structure theory, with applications in atomic and molecular structures, spectroscopy, and chemical bonding.

INTENDED LEARNING OUTCOMES

On successful completion of this course, students will be able to:

1. Establish a recognition of the fundamentally important role of physical chemistry in molecular science
2. Gain a better understanding of the relationship between physical chemistry and other sub-areas of chemistry
3. Develop an appreciation of the relationship between chemistry and physics, mathematics and other disciplines in science
4. Assess and judge some of the pressing societal issues in health, environment, and new technologies from the point of view of physical chemistry

TEXTBOOK

Physical Chemistry, 10th Edition (or newer), by P. W. Atkins and J. de Paula, Oxford University Press, 2014.

Useful References

https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Physical_Chemistry_(LibreTexts)

Links to an external site.

STUDENT REQUIREMENT

- Students need to be familiar with the syllabus and the class schedule, and be aware of the course requirements and progress.
- Students need to check the course website (https://canvas.ust.hk/) and their UST e-mails on regular basis. All assignments, slides and any other course materials will be posted on the course website. Furthermore, course announcements will also be make on the course website and/or via UST e-mail.
- Students are required to be familiar with HKUST Academic Integrity Policy (http://www.ust.hk/vpaao/integrity/). These policies will be strictly enforced in this course to keep academic honesty.
- Students need to follow proper classroom ethics, so that we can make a comfortable learning environment to each and every student in the class.

GRADING

Midterm Exam	40%
Final Exam	50%
Assignments	10%

*additional bonus for the course participation

Notes:

- Midterm Exam and Final Exam are **in-class closed-book**
- Assignments: There will be four sets of homework assignments in total. **Two** out of **FOUR** with highest scores will each contribute 5% to the final grade.

COURSE SCHEDULE

Prof. Ding Pan

Week 1	Feb 3	Introduction & Topic 1: Introduction to Quantum Theory *Textbook: Chapter 7.*
Week 1	Feb 7	Topic 1: Introduction to Quantum Theory (continued)
Week 2	Feb 10	Topic 1: Introduction to Quantum Theory (continued)
Week 2	Feb 14	Topic 1: Introduction to Quantum Theory (continued)
Week 3	Feb 17	Topic 2: The Quantum Theory of Motion – Translation *Textbook: Chapter 8A.*
Week 3	Feb 21	Topic 2: The Quantum Theory of Motion – Translation (continued)
Week 4	Feb 24	Topic 2: The Quantum Theory of Motion – Vibration *Textbook: Chapter 8B.*
Week 4	Feb 28	Topic 2: The Quantum Theory of Motion – Vibration (continued)
Week 5	Mar 3	Topic 2: The Quantum Theory of Motion – Rotation *Textbook: Chapter 8C*
Week 5	Mar 7	Topic 2: The Quantum Theory of Motion – Rotation (continued)
Week 6	Mar 10	Topic 2: The Quantum Theory of Motion – Rotation (continued)
Week 6	Mar 14	Topic 3: Atoms – Atomic Structure of Hydrogen-like atoms *Textbook: Chapter 9A*
Week 7	Mar 17	Topic 3: Atoms – Atomic Structure of Hydrogen-like atoms (continued)
Week 7	Mar 21	**Midterm Exam** (covers Topic 1 & 2) Time: 10:30 am ~ 11:50 am
Week 8	Mar 24	Topic 3: Atoms – Atomic Structure of Hydrogen-like atoms (continued)
Week 8	Mar 28	Topic 3: Atoms – Atomic Structure of Hydrogen-like atoms (continued)

Week 9	Mar 31	Topic 3: Atoms – Atomic Structure of many electron atoms *Textbook: Chapter 9B*
Week 9	Apr 7	Topic 3: Atoms – Atomic Spectra *Textbook: Chapter 9C*
Week 9	Apr 11	Topic 4: Molecules – Valence Bond theory *Textbook: Chapter 10A*
Week 10	Apr 14	Topic 4: Molecules – Valence Bond theory (continued)
Week 11	Apr 25	Topic 4: Molecules – Valence Bond theory (continued)
Week 12	Apr 28	Topic 4: Molecules – Molecular Orbital theory *Textbook: Chapter 10B-D*
Week 12	May 2	Topic 4: Molecules – Molecular Orbital theory (continued)
Week 13	May 9	Topic 4: Molecules – Hückel theory and review *Textbook: Chapter 10B-D*
May 12-29		**Final Exam** (covers Topic 3 & 4) Arranged by the university

Updated at Feb 1, 2025

CHEM 3550 Synthetic Chemistry Laboratory II

2025 Spring

Course Outline

1. Instructor

Name: Prof. CHAN, Ho-Wai Dennis (email: chanhw@ust.hk)

Contact Details: Office Room 4528; Tel: 3469-2099

2. Technical support staff / Teaching Assistant:

Technical support staff:

Names: LAU, Chun Tak Disney (email: disney@ust.hk)

CHAN, Ka Lok Kelvin (email: chkelvin@ust.hk)

CHOI, Chai Yu Edwin (email: edwinchoi@ust.hk)

WONG, Yuet Yan Claire (email: chclaire@ust.hk)

Contact Details: CYT-1003 & CYT-1004; Tel: 34692611 & 34692612

Teaching Assistant:

Names: [to be provided in a separate file]

3. Meeting Time and Venue:

Date/Time: LA1 Wednesday (12:30 – 16:20);
LA2 Thursday (12:30 – 16:20)

Venue: CYT-1003 and CYT-1004 (CYT buidling)

4. Course Description

Credit Points: 2

Pre-requisite: CHEM 2550

Corequisite: CHEM 3120 and CHEM 3220

Exclusion: NIL

Brief Information/synopsis:

This course was designed and introduced to suit chemistry major students who are enrolling in CHEM 3120 Organic Chemistry II and CHEM 3220 Inorganic Chemistry II, in which it provides students some hands-on experience in organic synthesis and metal complexes formation. Different spectroscopic methods will also be used for characterization of products. The topics of experiments covered in the laboratory course will be related to those taught in the lecture courses.

5. Intended Learning Outcomes (ILOs)

Upon completion of this course, students are expected to be able to:

1	Describe the fundamentals of organic and inorganic chemistry.
2	Assess and manage the risks of organic and inorganic chemical substances and laboratory procedures.
3	Conduct analysis and interpretation of experimental data of synthetic chemistry.
4	Conduct standard laboratory procedures involved in fundamental chemical synthesis and instrumental work.
5	Operate a range of chemical instrumentation.
6	Work independently and collaborate in team work.

6. Assessment Scheme

In lab. reports, you are allowed to use generative artificial intelligence (AI) to aid you in any manner. However, you must give proper credit for any use of generative AI.

#	Items	Weight	ILO(s) to be assessed
1	Risk Assessment	5%	2
2	Lab Quizzes†	25%	1, 2, 3
3	Lab Performance	20%	2, 3, 4, 5, 6
4	Products / Results	10%	4, 5
5	Lab report on liquid chromatography	8%	1, 2, 3, 4, 5
	Lab report on chemical resolution	8%	1, 2, 3, 4, 5
	Lab report on aldol condensation	8%	1, 2, 3, 4, 5
	Lab report on reductive amination and metal complexation	8%	1, 2, 3, 4, 5
	Lab report on synthesis of transition metal complex isomers	8%	1, 2, 3, 4, 5

† *thre will be a short lab quiz (about 8-10 minutes) before each experiment begins.*

7. Student Learning Resources

Reference books:

(a) Kenneth L. Williamson, Katherine M. Masters, *Macroscale and Microscale Organic Experiments 7th edition*, Australia: Cengage ©2017. (or *6th edition*)

(b) A. I. Vogel, (editor), *Vogel's Textbook of Practical Organic Chemistry 5th edition*, London : Longman Scientific & Technical ©1989.

(c) Lutz F. Tietze, Theophil Eicher, Ulf Diederichsen, *Reactions and Syntheses: In the Organic Chemistry Laboratory*, Weinheim: Wiley ©2015. [*available online / UST library*]

(d) J. Derek Woollins, *Inorganic Experiments 3rd edition*, Weinheim: Wiley ©2010.

* *Other course materials can be downloaded from Canvas (https://canvas.ust.hk). Please log in using your ITSC username and password.*

8. Teaching and Learning Activities

Scheduled activities: 3 hr 50 min (tutorial, laboratory work, demonstration, etc.)

9. Course Schedule

Keyword syllabus:

- Separation of an Organic Mixture by Column Chromatography
- Purification of Organic Compounds
- Chemical Resolution of a Racemic Mixture
- Carbon-Carbon Bond Formation by Aldol Condensation
- Reductive Amination
- Synthesis of Schiff Bases
- Synthesis of Transition Metal Complexes
- Characterization of Isomers of Transition Metal Complexes
- Measurement of Magnetic Susceptibility
- Polarimetry of Chiral Organic Compounds
- Measurement of Infrared Spectra
- Measurement of ^{1}H Nuclear Magnetic Resonance Spectra

CHEM 3555 Molecular Characterization Chemistry Laboratory
Course Outline – Spring 2025

1. Instructor
Name: Dr Joanne W T Tung <*jwttung@ust.hk*>
Contact: Office: Rm 4541 (Lift 25/26); Tel: 2358 7395

2. Technical Officers/ Instructional Assistant/ Teaching Assistants
Technical Officers*:*
Name: Kwong K CHAN <*chankk@ust.hk*>; Alice WONG <*wongtingin@ust.hk*>
Contact: Lab: CYT-3007 (Lift 35/36); Tel: 2358 7244; 2358 7402

Instructional Assistant: *Anson WONG <wchwong@ust.hk>*
Contact: Lab: CYT-3007 (Lift 35/36); Tel: 2358 7402;

Teaching Assistants: *Separate file*

3. Meeting Time and Venue
Date & Time:
LA1: 10.30 - 14.20 (Wednesday)
LA2: 10.30 - 14.20 (Thursday)

Venue: CYT-3007

4. Course Description
Credit Points: 2

Pre-requisites: CHEM 2350 Analytical Chemistry Laboratory; CHEM2450 Physical Chemistry Laboratory

Co-requisites: CHEM3320 Analytical Chemistry II; CHEM3420 Physical Chemistry II

Course Objective: With the use of analytical instruments, equipment and computational software, the course applies what the students learned in lectures in practical term.

Course Description: Computational chemistry and instrumental methods in characterisation of molecular properties.

5. Intended Learning Outcomes (ILOs)
On completion, students should be able to:

1	Explain the essential facts, principles and theories in the area of analytical & physical chemistry.
2	Formulate and analyze a wide range of chemical problems by applying chemical principles.
3	Analyze and interpret experimental data and extract useful data from it
4	Conduct standard laboratory procedures involved in instrumental work.
5	Operate a range of chemical instrumentation with adequate hands-on experiences.
6	Assess and manage the risks of chemical substances and laboratory procedures by evaluating their potential impact on the environment.

7	Demonstrate self-awareness, work independently and collaborate effectively with other people in a team

6. Assessment Scheme

Course Grading

Weight	Assessment	Course ILOs
45%	Report	1 - 4, 7
35%	Lab Quiz	1 - 4
20%	Lab Performance	4 - 7

7. Syllabus

Expt No	Title of Experiment
1	Spectroscopic Evidence of Energy Quantisation from the UV-Visible Spectra of SO_2, I_2 and NH_3 Gases
2	Molecular Emission Method: Spectrofluorimetric Determination of Riboflavin in Vitamin Tablet
3	Illustration of 1-D Particle in a Box: Study of β-Carotene by UV-Visible Spectroscopy
4	Atomic Absorption Method: Lead Content in Hair Dye Sample by Atomic Absorption Spectrophotometry (AAS)
5	Electroanalytical Method: Determination of Chloride Content in Biscuit Samples with Ion-Selective Electrode (ISE)
6	Visualisation of Molecular Orbitals of a Heteronucleus Diatomic Molecule Simulated by a Computational Software - Gaussian

8. Student Learning Resources

Analytical Chemistry

- Harris D. C., Charles A. Lucy, ***Quantitative Chemical Analysis***, 10th Ed., Macmillian Learning, 2020.
- Skoog D. A., Holler F. J., ***Principles of Instrumental Analysis***, 7th Ed., Australia: Cengage Learning, 2007.

Physical Chemistry

- Atkins P. W., Julio de Paula, James Keeler, ***Atkins' Physical Chemistry,*** 11th Ed., Oxford University Press, 2018.

(A few copies of each of the above textbooks have been reserved at the Course Reserve in HKUST library.)

9. Teaching and Learning Activities

Students can gain their hands-on experience from bench-top work, sample preparation to equipment/instrument operations in the practicals. There will have tutorials for experiments conducted by the Instructor.

CHEM 4110 Structural Elucidation in Organic Chemistry — Spring Term 2025

Course Instructors: Prof. Rongbiao Tong, Office: Rm CYT6011. Email: rtong@ust.hk

Teaching Assistant Xinwei Zhang & Huiying Qiu

Text Book: "*Introduction to spectroscopy*", Donald L. Pavia, Gary M. Lampman, George S. Kriz, James A. Vyvyan, 4th Ed. 2009; (Library only has the 3rd Edition: QD 272.S6 P38 2001 and is also available at Bookstore)
"*Spectrometric Identification of Organic Compounds*" 7th edition, Robert M. Silverstein, Francis X. Webster, David J. Kiemle., 2005.

Course Notes: Lecture notes of CHEM4110 are available from the Canvas web (http://canvas.ust.hk), and students can use their your email account and password to get access to them before class.

Course Objectives: The emphasis of this course is on development of problem-solving techniques. After completion of CHEM4110, students will be able to: (i) recognize and comprehend the basic principles of 1D- & 2D-NMR, IR, and mass spectrometric techniques; (ii) analyze spectroscopic data of organic compounds; (iii) apply these spectrometric methods for structural determination of organic molecules.

Course Prerequisite: CHEM 3120.

Venue: Lectures are given at Rm 4579 from 15:00-16:20 on every Wednesday and Friday.

Course Assessments: Midterm exam 35%
Final exam 65%

Course Content

Lecture 1&2: Infrared Spectroscopy 1:
- Mode of Stretching and Bending
- How to Approach the Analysis of IR Spectrum
- Hydrocarbons: Alkanes, Alkenes and Alkynes

Lecture 3: Infrared Spectroscopy 2:
- Alcohols and Amines
- Carbonyl compounds; Effect of ring size
- Nitriles and Nitro Compounds

Lecture 4&5: Mass Spectroscopy:
- Basic principles of MS
- Ionization methods
- Ionization and fragmentation theory
- Determination of Molecular formula
- Isotopic effects

Lecture 6: Mass Spectroscopy:
- Cleavage mechanisms
- Functional group fragments
- MS spectra analysis

Lecture 7: 1D-NMR 1:
- Nuclear Magnetic Moments
- Mechanism of Resonance
- Population Densities of Nuclear Spin States
- Free Induction Decay (FID)

Lecture 8 & 9: 1D-NMR 2:
- NMR Spectrometer: CW vs FT
- How to Approach the Analysis of NMR Spectrum
- Chemical Shift and Shielding
- Anisotropy

Lecture 10: 1D-NMR 3:
- Chemical Equivalence
- Integrals and Integration
- Multiplet Patterns for Common Fragments (CH_3CH_2-, -$CH(CH_3)_2$...)
- Examples of ^{1}H-NMR Spectrum of Different Types of Compounds

Lecture 11: 1D-NMR 4:
- Types of Coupling
- Coupling Constant
- Pascal's Triangle and Splitting Diagram
- Mechanism of Coupling

Lecture 12: 1D-NMR 5:
- One Bond Couplings (^1J)
- Two Bond Couplings (^2J)
- Three Bond Couplings (^3J): Effect of Torsional and Dihedral angle
- Long Range Couplings (^4J-^nJ)

Lecture 13: 1D-NMR 6:
- Magnetic and Chemical Equivalence
- First Order Spectra
- Second Order Spectra
- Spin System Notation AB, AX, AB_2, AX_2...

Lecture 14: 1D-NMR 7:
- Homotopic, Enantiotopic and Diastereotopic System

- Dynamic NMR: Rapid Bond Rotation (C-N), Variable-Temperature NMR
- Protons on Oxygen: Alcohols
- Protons on Nitrogen: Amines

Lecture 15: 1D-NMR 9: - Carbon-13 NMR Spectroscopy
- Carbon-13 Chemical Shifts
- Proton-Decoupled Carbon-13 Spectra
- Nuclear Overhauser Effect

Lecture 16: 1D-NMR 10:- Advanced Carbon-13 NMR Techniques
- Attached Proton Test experiment (APT)
- Distortionless Enhancement by Polarization Transfer (DEPT)

Lecture 17: 2D-NMR 1: - Two dimension NMR theory
- ^{1}H-^{1}H COSY
- Analysis of COSY spectra
- Double Quantum Filtered COSY (DQF-COSY)

Lecture 18 &19: 2D-NMR 2:- Correlation Spectroscopy optimized for Long Rang (COSY-LR)
- Total Correlation Spectroscopy (TOCSY)
- Homonuclear Hartmann-Hann (HOHAHA)
- Nuclear Overhauser Effect
- 2D Nuclear Overhauser Effect Spectroscopy (2-D NOESY)
- 2D Incredible Natural Abundance Double Quantum Transfer Experiment (2D INADEQUATE)

Lecture 20&21: 2D-NMR 3:- Heteronuclear 2-Dimensional NMR Spectroscopy
- Heteronuclear Chemical Shift Correlation Spectroscopy (HETCOR)
- Heteronuclear Single Quantum Coherence (HSQC)
- Heteronuclear Multiple Quantum Coherence (HMQC)
- Correlation Spectroscopy via Long-range Coupling (COLOC)
- Heteronuclear Multiple Bond Correlation (HMBC)

Lecture 22: NMR 4: - Comprehensive NMR Techniques
- Strategies to analyze spectra of unknown compounds
- For examples: ethyl crotonate (H-NMR, C-NMR, DEPT,HMQC, COSY, TOCSY, HMBC, NOESY) & 2-phenyl ethanol (H-NMR, C-NMR, DEPT, HMQC, COSY, TOCSY, HMBC)

Lecture 23: Comprehensive strategies:- Comprehensive Spectral Analysis (NMR, IR & MS)
- Spectral Interpretation of IR, MS and NMR
- Strategies of determination of unknown structure
- For Example: Pinanediol (MS, IR, H-NMR, C-NMR, DEPT, HETCOR, COSY, COLOC, INADEQUATE,

CHEM 4240 Intermediate Inorganic Chemistry

Course Outline- Spring 2025

1. **Instructor**

Name: Wa-Hung Leung

Contact Details: e-mail: chleung@ust.hk, ext. 7360, office: Rm 4538

2. **Teaching Assistant**

Name: Mr. Xuyang YAN

Contact Details: e-mail: xyanbc@connect.ust.hk, ext. 7374

3. **Meeting Time and Venue**

Lectures:

Date/Time: Tuesday & Thursday, 16:30-15:50

Venue: Rm 6602

Tutorials:

Date/Time: To be arranged

Venue: To be arranged

4. **Course Description**

Credit Points: 3

Pre-requisite: CHEM 3220

Exclusion: NIL

Brief Information/synopsis:

Intermediate Inorganic Chemistry is a 3-credit elective course for all Year 3 chemistry undergraduate students. The curriculum is designed to cover a range of topics on bonding, structure and reactivity of inorganic complexes, with intended learning outcomes focusing on developing students' intellectual and generic skills.

5. Intended Learning Outcomes

Upon successful completion of this course, students should be able to:

No.	ILOs
1	Recognize fundamentals of chemistry, bonding, structures, reactivity of inorganic complexes and clusters.
2	Explain essential facts, principles and theories of inorganic chemistry, e.g., spectral properties of inorganic complexes, mechanisms of inorganic reactions, Wades' rules

6. Assessment Scheme

a. Examination duration: 3 hrs

b. Percentage of coursework, examination, etc.:

Assessment	Assessing Course ILOs
6% by assignment	1, 2
2×32% by mid-term tests	1,2
30% by oral presentation and written report	1,2

c. The grading is assigned based on students' performance in assessment tasks/activities.

7. Student Learning Resources

Recommended Reading:

Text(s):

"Inorganic Chemistry", international edition, by M. Weller *et al.*, OUP (2018)

8. Teaching and Learning Activities

Scheduled activities: 3 hrs (lecture)

9. Course Schedule

Keyword Syllabus:

- Inorganic reaction mechanisms: Substitution (square planar and octahedral complexes). Redox reactions (outer-sphere and inner-sphere electron transfer). Intramolecular electron transfer.
- Electronic spectra: Russell-Saunder terms. Hund's rules. Spectral terms. Selection rules for electronic transitions. Tanabe-Sugano diagrams. Nephelauxetic effect. Ligand-field spectra. Charge-transfer spectra. Intervalence charge-transfer.
- Metal-metal multiple bonds: M_2X_8 complexes. Electron configurations. Bond order.
- Metal atom clusters: Lower and higher nuclearity carbonyl clusters. Magic numbers. Wade's rules. Capping Rule.
- Lanthanides chemistry: Electron configurations. Trends of atomic and ionic properties. Oxidation states. Spectral and magnetic properties. Applications.
- Special topics: Metal-ligand multiple bonds, metal-oxo complexes. Photochemistry of inorganic complexes

CHEM4310
Environmental Chemistry

Lecture venue : Rm 6602 (lift 31/32)
Lecture time: Tue (9:00-10:20) | Thu (9:00-10:20 pm)

Instructor:
Prof. Jianzhen YU
Office: Rm 4534, Tel: 2358-7389, chjianyu@ust.hk

Enrollment requirement: CHEM 2310 OR CHEM 2311

Prof. Jianzhen Yu, chjianyu@ust.hk
Chemistry Dept., HKUST
Spring 2025

Contact information

Instructor:
Prof. Jianzhen YU
Rm 4532, Tel: 2358-7389, chjianyu@ust.hk
Office hours: Walk-in or by appointment.

TA: TBD

Course ILO

Upon successful completion of this course, students will be able to:

(1) Explain the essential facts, principles and theories in environmental science

(2) Evaluate and discuss the relevance of chemistry to environmental issues.

(3) Analyze and interpret experimental data, critically assess data from literature sources and extract and apply useful data from those sources.

(4) Demonstrate self-awareness and the ability to work independently and collaborate effectively with other people in a team.

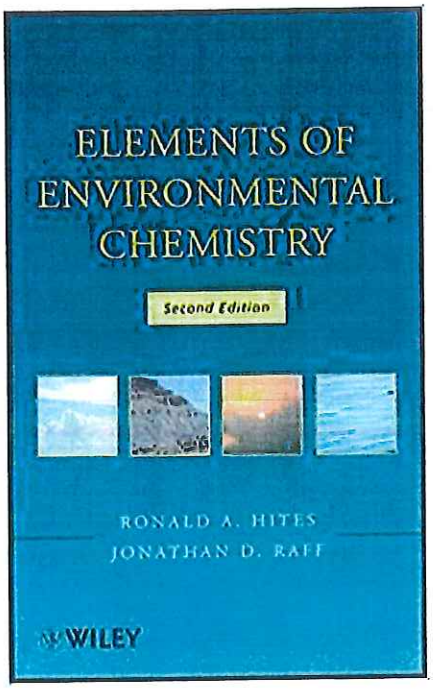
Grade Assessment

- Group project homework: (20%) [Assessing course ILO 1,2,3,4]

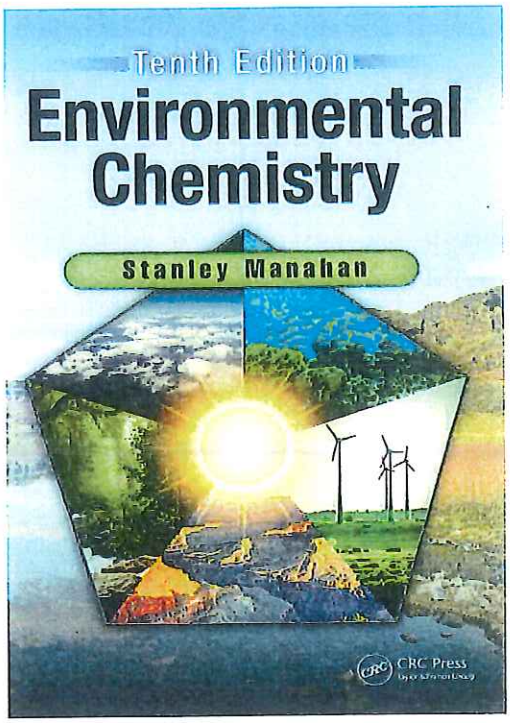
  Group projects

  - 4-5 group projects [3 students per group, formed on a voluntary basis]
  - Group effort
  - Written submission
- Exam I (40%) [Assessing course ILO 1,2,3]
  - Tentatively on 22 March 2025 (Saturday, 10 am-noon)
- Exam II (40%, date TBA) [Assessing course ILO 1,2,3]

Textbook



An e-copy of this book is available through UST library or https://onlinelibrary.wiley.com/doi/epub/10.1002/9781118309926



E-copy of select chapters will be available via Canvas.

CHEM4310 Course Outline

1. Simple Tool Skills
2. Mass Balance and Kinetics
3. Fundamentals of water chemistry
4. Fates of Organic Compounds
5. Persistent Organic Pollutants
6. Heavy metal pollution

Mid-term exam topics

7. Atmospheric Chemistry: Chemical composition
8. Chemical kinetics of atmospheric reactions
9. The killing oxidant: Photochemical smog
10. Stratospheric ozone
11. Greenhouse gases and global warming
12. Particulate matter in the atmosphere
13. Industrial Ecology and Green Chemistry
14. Sustainable Energy
15. Resources and Sustainable Materials

Final exam topics

CHEM4420 Spring Term 2025
Statistical Machine Learning Methods for Chemical Data Analysis

Class Schedules: Tues. & Thurs. 3pm – 4:20pm, Classroom 5619

Instructor: Prof. Haibin SU
Office: Room 4540, 4/F, Lifts 25/26 Email: haibinsu@ust.hk
Office Tel. Number: 2358-7388

TA: Mr. Zhiyan ZOU
Email: zzouaf@connect.ust.hk

GenAI Edu platform https://delulu-rosy.vercel.app/

Subject Code	CHEM4420
Subject Title	Statistical Machine Learning Methods for Chemical Data Analysis
Credit Value	3
Level	4
Description	Design for students would like to learn the basics of machine learning-based data analysis, visualization and to apply these techs to process chemical data.
Pre-requisite/ Co-requisite/ Exclusion	Pre-Requisite: CHEM 2409 AND CHEM 2410 Exclusion: COMP 4211, MATH 4432
Objectives	1. Introduce basic concepts of machine learning and data analysis. 2. Enable chemistry students to create their own analytical model. 3. Connect chemistry knowledge with data science.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: Category A: Professional/academic knowledge and skills 1. Comprehend the fundamentals of statistics and probability. 2. Comprehend key ideas, methods, and techniques of machine learning methods 3. Appreciate typical machine learning methods 4. Implement basic chemical data collection, representation and processing 5. Develop machine learning models for a given problem Category B: Attributes for all-roundedness 6. Present ideas and findings effectively. 7. Think critically. 8. Learn independently.

<table>
<tr><td></td><td colspan="2">9. Work in a team and collaborate effectively with others.</td></tr>
<tr><td rowspan="6">Teaching/Learning Activities</td><td>Class Contact (time-tabled):</td><td></td></tr>
<tr><td>Lecture</td><td>13 * 3= 39 hours</td></tr>
<tr><td>Other Student Study Effort</td><td></td></tr>
<tr><td>preview/review of lecture notes; homework/assignment;</td><td>21 hours</td></tr>
<tr><td>preparation for group project (presentation and report)</td><td>45 hours</td></tr>
<tr><td>Total Student Study Effort</td><td>105 hours</td></tr>
<tr><td>Grading Type</td><td colspan="2">Letter Grades</td></tr>
<tr><td>Assessment Tasks and Grading Policy</td><td colspan="2">Group project (100% of the course)

• Preliminary proposal (no score):
To help students prepare a plan for group project, a preliminary proposal is needed. This proposal should contain: Motivations and objectives, data sets, methodology and expected outcomes.

• Group presentation (50% of the course):
Each group must give a 20-minute presentation at the end of the semester about the project.

• Final report (50% of the course):
A final report should be summited. This report should contain all detailed information about the project and contribution of each member in the group.</td></tr>
<tr><td>Subject Synopsis</td><td colspan="2">Syllabus:
• Chap 1: Math Background
• Chap 2: Regression and Classification
• Chap 3: Supporting Vector Machine
• Chap 4: Neural Network
• Chap 5: Convolution Neural Network
• Chap 6: Chemical/Biological Data Representation
• Chap 7: Recurrent Neural Network
• Chap 8: Graph Neural Network
• Chap 9: Monte Carlo Tree Search Algorithm
• Chap 10: Transformer
• Chap 11: Decision Tree / Random Forest
• Chap 12: Selected applications</td></tr>
</table>

Reading List and References	If you want to learn more about performing data analysis by machine learning, we have a list of suggested books/materials for you: • "Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow", 2nd Edition by Aurélien Géron • "Neural Networks - A Comprehensive Foundation", 3rd Edition by Simon Haykin • "Notes on Statistics and Data Quality for Analytical Chemists", By Michael Thompson and Philip J Lowthian (World Scientific, 2011)

CHEM 4430

Symmetry Principles and Group Theory in Chemistry: *Structure, Bonding, and Spectroscopy*

Teng-Teng Chen (陈藤藤)

Department of Chemistry
The Hong Kong University of Science and Technology

Spring Semester (2024-2025)

Course Description

- This *elective* course is for *the final year UG* or the *first year PG* students majoring in *Chemistry*.
- The first half of the course covers the *fundamentals* of symmetry principles and group theory that are most relevant to common chemistry problems.
  (The symmetries of *molecular structures* are classified and illustrated in this part)
- The second half of the course covers the representative *applications* of group theory and symmetry principles in common chemistry problems such as *bonding* and *spectroscopy*.
- Examples and applications are selected from *inorganic, organic, physical, analytical chemistry,* as well as *from solid state, materials, and biochemistry*.

Course Syllabus

PART – I : Basics of Symmetry Principle and Group Theory.

Chapter 1: Introduction: *Why*

Chapter 2: Classification of *Symmetry Transformations*

Chapter 3: Classification of Figures (i.e., static models of molecular structures): *Chirality*

Chapter 4: Point Groups - *the Basic Concepts*

Chapter 5: Point Groups - *Group Elements, Class Structure and Figure Recognition*

Chapter 6: Representation of Point Groups - *Character Tables*

PART – II : Application of Symmetry Principle and Group Theory in Chemical Problems.

Chapter 7: Symmetry and Physical Properties

Chapter 8: Symmetry Aspect of *MO Theory and Bonding*

Chapter 9: Symmetry Aspect of *Molecular Vibrations*

Chapter 10: Symmetry Aspect of *Electronic and Vibronic Spectroscopy*

Chapter 11: Symmetry Aspect of *Ligand Field Theory* ***

Chapter 12: Symmetry Aspect of *Chemical Reaction* ***

Chapter 13: Non-rigid Symmetry and *Dynamic Stereochemistry* ***

Chapter 14: Special Topics on Symmetry and Group Theory in Chemistry (*solid state, supramolecular,...* **)** ***

List of Useful Websites

Useful web links for Molecular Symmetry and Group Theory :

http://www.phys.ncl.ac.uk/staff/njpg/symmetry/index.html

http://symmetry.jacobs-university.de/

http://www.webqc.org/symmetry.php

http://csi.chemie.tu-darmstadt.de/ak/immel/tutorials

http://symmetry.otterbein.edu/

Intended-Learning-Outcomes (ILOs) :

- Be able to appreciate the *significance* and *limitations* of symmetry principles and group theory in chemistry;
- Be familiar with the *symmetry operations* and their classifications;
- Be familiar with the concepts of *point group theory* and *the structure of point groups*;
- Be familiar with the classification of molecular structures according to their *chirality* and other symmetry properties;
- Be able to correctly *assign a point group* to a molecular structure or a figure according to its symmetry properties;
- Be familiar with the structures, properties and usage of the *character tables of point groups*;

****

- Be able to apply the methods of point group theory to the analysis of the ground state properties of a molecule, such as the electric dipole moment, electric quadrupole moment, and optical activity;
- Be able to apply the methods of point group theory to analyzing the *bonding* from Molecular Orbital Theory (MOT) and Valence Bond Theory (VBT);
- Be able to apply the methods of point group theory to the analysis of *molecular vibrations* and their activities in Raman and IR spectroscopies;
- Be able to apply the methods of point group theory to the analysis of *electronic transitions and vibronic transitions* in UV-Vis and fluorescence spectroscopies;
- Be able to apply the methods of point group theory to the analysis of other *physical and chemical properties* of molecules from their structures and other experimental observables.

Requirements, Course Grade, and Office Hours

Course Requirement:

(i) Attendance of lectures.
(ii) Reading assignments and problem assignments.

Course Grade:

(i) Mid-term Exam (Close book, 50%).
(ii) Final Exam (Independent project, 50%).

Office Hours:

(i) 5:00 – 6:00 pm, Tuesday, Rm 4542
(ii) Review session will be arranged before each Exam.

Off-hour Help :

(i) Email: tengtengchen@ust.hk
(ii) By appointment.

END

The Hong Kong University of Science and Techonology
Department of Chemistry

CHEM 4680 Undergraduate Research
Course Outline

1. Course Description

Credit Points: 3
Pre-requisite: CHEM 2550
Instructor(s): Research Faculties of Chemistry Department

Brief Information/synopsis:

Students conduct original research in accordance with their ability and background, and under the supervision of a research faculty. The final course grade is determined based on an oral presentation and a written report to be submitted to a judging committee, which includes the faculty supervisor plus at least one other faculty. Enrollment in the course requires approval of the faculty supervisor.

2. Intended Learning Outcomes

Upon successful completion of this course, students are expected to be able to:

1	Work independently, to handle and use appropriate instrumentation, interpret data, and complete given tasks in a research setting, and to prepare a written report.
2	Communicate more effectively in speaking and writing, both about their newly acquired knowledge and knowledge in general.
3	Recognize deficiencies in knowledge existing in chemistry, and to plan and mount a research study to address these deficiencies.
4	More critically assess data presented in textbooks, the primary literature or other sources, e.g. electronic data bases, patents.
5	In general, to appreciate the importance of research in relation to science, the definition of problems in research, and how the corpus of scientific knowledge is able to expand through the overall reserach effort for the betterment of humankind.

3. Course Requirements and Grading

At the end of the course, **students are required to give an oral presentation and submit a written report to document their project work**. Course grades will be determined by a faculty panel consisting of their research supervisor and at least one other faculty member. Students will be evaluated based on their research performance, oral presentation (including the Q&A session), and written report.

香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

CHEM 4689 Capstone Project
Course Outline (Spring 2024-2025)

1. Course Coordinator:

Prof. Emily M. W. Tsang (chetsang@ust.hk) Rm 4536; Tel: 3469-2100

Faculty Supervisors: (You will be assigned under one supervisor)

Prof. Dennis H.W. CHAN	(chanhw@ust.hk)
Prof. Zhihong GUO	(chguo@ust.hk)
Prof. Jinqing HUANG	(jqhuang@ust.hk)
Prof. Yong HUANG	(yonghuang@ust.hk)
Prof. Wa Hung LEUNG	(chleung@ust.hk)
Prof. Jianwei SUN	(sunjw@ust.hk)
Prof. Emily M.W. TSANG	(chetsang@ust.hk)
Prof. Jianzhen YU	(jian.yu@ust.hk)
Dr. Sai Ho PUN	(punsaiho@ust.hk)
Dr. Frederick F.K. SHEONG	(chemfksheong@ust.hk)
Dr. Liangliang YANG	(yangll@ust.hk)

Library Referencing Advisors: (You will be assigned under one advisor)

Mr. Samson CHOI, Librarian (Learning Support)	(lbsamson@ust.hk)
Mr. Ernest LAM, Librarian (Learning Support)	(lbernest@ust.hk)

2. Class Time and Venue:

Date/Time: 9:30 – 10:20 am, **Fridays** (*please refer to the class schedule*)
Venues: Room 5566 (Lift 27/28) OR Library Computer Barn
(*please refer to class schedule*)

3. Course Description:

Credit Points: 3 Pre-requisite: CHEM 3550 and CHEM3555

Brief Information/synopsis:
Under the supervision of a faculty member or teaching staff, students will complete a capstone project which requires the integration of the chemical knowledge learnt from their previous courses. Students will carry out a literature review on a mutually agreed topic. A written report and an oral presentation are required to document their learning experiences.

4. Intended Learning Outcomes:

1	Demonstrate awareness of chemical topics relevant to social and daily life
2	Analyze and interpret experimental data, critically assess data in literature and extract useful data from it.
3	Carry out directed research by selecting appropriate topics and procedures, and presenting the results
4	Communicate effectively both orally and in writing with professionals and/or lay audience
5	Demonstrate information technology skills, especially in the areas of information retrieval, literature searching and use of library database.
6	Show self awareness, work independently and collaborate effectively with other people in a team

5. Assessment Scheme:

Weight	*Assessment*	*Course ILOs*
10%	Participation	1, 2, 3, 4, 5, 6
20%	Submission of a Scientific Poster and Library Training	2, 4, 5
40%	Literature Research Presentation	1, 4, 5, 6
30%	Literature Research Report	1, 2, 3, 4, 5

6. Student Learning Resources (Reference books):

- Catherine E. Housecroft and Alan G. Sharpe, *Inorganic Chemistry* 3rd edition, Harlow: Pearson Prentice Hall ©2008. [QD151.2 .H68 2008] ♠
- Douglas A. Skoog, F. James Holler, Stanley R. Crouch, *Principles of Instrumental Analysis* 6th edition, Thomson Brooks/Cole, ©2007. [QD79.I5 S58 2007]
- Jonathan Clayden, Nick Greeves and Stuart Warren, *Organic Chemistry* 2nd edition: Oxford University Press ©2012 [QD251.3 .O64 2012]
- T.D.H. Bugg, *Introduction to Enzyme and Coenzyme Chemistry* 3rd edition, Wiley ©2012. [QP601.B955 2012eb] ♠

♠ *Free access online via HKUST Library*

^ *other course materials can be downloaded from Canvas website by logging in using your ITSC username and password (http://canvas.ust.hk).*

7. Teaching and Learning Activities:

Tutorials/Workshops:
1. Literature Search Training
2. SciFinder Workshop
3. Chemical Structure Drawing Training
4. Literature Referencing Training
5. Poster Design Workshop

Consultations: With your faculty supervisor (**at least 3 times**)

Individual Coaching: With your library referencing advisor (**at least once**)

Oral presentation: 10 minutes + 5 minutes Q&A

Poster Mini-Conference: 3 hours session at the end of semester

8. Course Schedule:

Week	Date/Time	Activities [† *denotes follow-up work required*]	Venue/Instructor
1	Feb 7 (Fri) 9:30-10:20 *before Feb 21*	**Course Introduction** [† ***meet your supervisor for topic assignment***] [† ***upload topic to Canvas after assignment***] [† ***submit Weekly Timetable to Canvas for scheduling Oral Presentation Time***]	**Room 5566 (Lift 27/28)** Prof. Emily Tsang
2	Feb 14 (Fri) 9:30-10:20	**Literature Search Training**	**Library LG1 Computer Room B** Mr. Samson Choi/Mr. Ernest Lam
3	Feb 21 (Fri) 9:30-10:20 ***between Feb 24 – Mar 14***	**SciFinder Workshop** **Individual Coaching Session on Literature Search** [***Compulsory***] (with your Referencing Advisor during Weeks 4 – 6)	**Zoom Meeting** SciFinder vendor (based in Singapore) (by appointment with your referencing advisor)
4	Feb 28 (Fri) 9:30-10:20	**Chemical Structure Drawing Training**	**Library LG1 Computer Room B** Prof. Emily Tsang
5	During this week (Mar 3 – 7)	**1st Consultation with supervisor**	(by appointment with your supervisor)
6	Mar 10 – 14 ***before Mar 16***	*Work on your project* [† ***submit Research Plan***]	
7	Mar 21 (Fri) 9:30-10:20	**Referencing Training**	**Library LG1 Computer Room B** Mr. Samson Choi/Mr. Ernest Lam
8	During this week (Mar 24 – 28)	**2nd Consultation with supervisor**	(by appointment with your supervisor)
9	April 11 (Fri)	**Poster Design Workshop**	**Room 5566 (Lift 27/28)** Prof. Emily Tsang
10	April 14 – 18 ***between April 14 – May 2***	*Work on your project* **Individual Coaching Session on Referencing** [***Optional***] (with your Referencing Advisor during Weeks 10 – 12)	(by appointment with your referencing advisor)
11	During this week (Apr 22 – 25)	**3rd Consultation with supervisor**	(by appointment with your supervisor)
12	Apr 28 – May 2	*Work on your project*	
13	May 9 (Fri) ***before May 4 (Sun)***	**Oral Presentations** [† ***submit Poster file to Canvas***]	TBA
Study break	May 12 (Mon) 14:00-17:00	**Poster Mini-Conference**	**Library LG4** **Multi-function Room**
	May 18 (Sun)	† ***Deadline for Literature Research Report***	

9. Supervisor Arrangements:

Student Name	Supervisor
ATWAL, Ryan Josh Singh rjsatwal@connect.ust.hk	Prof. Jianzhen YU jian.yu@ust.hk
CHAN, Yuk Hin Stephen yhchanbm@connect.ust.hk	Prof. Yong HUANG yonghuang@ust.hk
CHENG, Hoi Yan hychengbi@connect.ust.hk	Prof. Dennis H. W. CHAN chanhw@ust.hk
LAI, Ka Chun kclaiag@connect.ust.hk	Prof. Jinqing HUANG jqhuang@ust.hk
LAM, Yeung Lung yllamai@connect.ust.hk	Dr. Liangliang YANG yangll@ust.hk
LAW, Ka Yiu kylawaj@connect.ust.hk	Dr. Sai Ho PUN punsaiho@ust.hk
LEE, Yik Yu yyleeak@connect.ust.hk	Prof. Wa Hung LEUNG chleung@ust.hk
LI, Shing Chit scliab@connect.ust.hk	Prof. Emily M.W. Tsang chetsang@ust.hk
TSANG, Chun Lok cltsangai@connect.ust.hk	Prof. Zhihong GUO chguo@ust.hk
YU, Po Yiu Candice pycyu@connect.ust.hk	~~Prof. Jianwei SUN~~ Dr. Yi CHEN ~~sunjw@ust.hk~~
YUAN, Jiaqi jyuanaq@connect.ust.hk	Prof. Jinqing HUANG jqhuang@ust.hk
SO, Hei Chun hcsoac@connect.ust.hk	Dr. Frederick F. K. SHEONG chemfksheong@ust.hk

10. Library Referencing Advisor Arrangements

Advisor: Mr. Samson Choi Librarian (Learning Support) (lbsamson@ust.hk)	**Advisor: Mr. Ernest Lam** Librarian (Learning Support) (lbernest@ust.hk)
ATWAL, Ryan Josh Singh rjsatwal@connect.ust.hk	LEE, Yik Yu yyleeak@connect.ust.hk
CHAN, Yuk Hin Stephen yhchanbm@connect.ust.hk	LI, Shing Chit scliab@connect.ust.hk
CHENG, Hoi Yan hychengbi@connect.ust.hk	TSANG, Chun Lok cltsangai@connect.ust.hk
LAI, Ka Chun kclaiag@connect.ust.hk	YU, Po Yiu Candice pycyu@connect.ust.hk
LAM, Yeung Lung yllamai@connect.ust.hk	YUAN, Jiaqi jyuanaq@connect.ust.hk
LAW, Ka Yiu kylawaj@connect.ust.hk	SO, Hei Chun hcsoac@connect.ust.hk

CHEM 4691 Capstone Research I

Course Outline (Spring 2024/25)

1. Course Description

Pre-requisite: CHEM 3550 and CHEM 3555

Exclusion: CHEM 4689

Instructor(s)/Project Supervisor(s): Research Faculties of Chemistry Department

Course Coordinator: Prof. Emily M.W. Tsang

Reference Librarians:

Mr. Samson CHOI (lbsamson@ust.hk)

Mr. Ernest LAM (lbernest@ust.hk)

Brief Information/synopsis:

This is a project-based course that provides students an opportunity to integrate and apply their chemical knowledge learnt in regular lecture and lab courses. Students will carry out a research project under the supervision of a faculty member/teaching staff. At the end of the course, students are required to submit a written report and deliver an oral presentation to document their learning experiences. Students should seek instructor's approval prior to enrollment in the course.

2. Intended Learning Outcomes

Upon successful completion of this course, students are expected to be able to:

1	Demonstrate awareness of chemical topics relevant to social and daily life.
2	Analyze and interpret experimental data, critically assess data in literature and extract useful data from it.
3	Carry out directed research by selecting appropriate topics and procedures, and presenting the results.
4	Communicate effectively both orally and in writing with professionals and/or lay audience.
5	Demonstrate information technology skills, especially in the areas of information retrieval, literature searching and use of library database.
6	Show self-awareness, work independently and collaborate effectively with other people in a team.

3. Grading

Weight	Assessment	Course ILOs
50%	Lab Performance and Participation	1,2,3,4,5,6
30%	Written Research Thesis	1,2,3,4,5
20%	Oral Presentation	4,5,6

4. **<u>Mandatory</u> Library Trainings Schedule:**

The following library training workshops are ***mandatory***. Attendances will be taken and counted towards your course participation scores.

Date	Activity	Venue
Feb 14 (Fri), 9:30 – 10:20	**Library Workshop I: Literature Search Training**	Computer Room **B** (Library LG1) (Mr. Samson Choi/Mr. Ernest Lam)
Feb 21 (Fri), 9:30 – 10:20	**SciFinder-n Workshop**	Zoom Meeting (meeting link to be provided)
Feb 28 (Fri), 9:30 – 10:20	**Chemical Structure Drawing Training**	Computer Room **B** (Library LG1) (Prof. Emily Tsang)
Mar 21 (Fri), 9:30 – 10:20	**Library Workshop II - Referencing Training**	Computer Room **B** (Library LG1) (Mr. Samson Choi/Mr. Ernest Lam)

CHEM 4692 Capstone Research II
Course Outline

1. Course Description

Credit Points: 3
Pre-requisite: CHEM 4691
Instructor(s): Research Faculties of Chemistry Department

Brief Information/synopsis:

Continuation of research project started in CHEM 4691 and to be conducted under the supervision of a faculty member/teaching staff. A written report and oral presentation are required to document their learning experiences. Students should seek instructor's approval prior to enrollment in the course.

2. Intended Learning Outcomes

Upon successful completion of this course, students are expected to be able to:

1	Demonstrate awareness of chemical topics relevant to social and daily life
2	Analyze and interpret experimental data, critically assess data in literature and extract useful data from it.
3	Carry out directed research by selecting appropriate topics and procedures, and presenting the results
4	Communicate effectively both orally and in writing with professionals and/or lay audience
5	Demonstrate information technology skills, especially in the areas of information retrieval, literature searching and use of library database.
6	Show self awareness, work independently and collaborate effectively with other people in a team

3. Grading

Weight	Assessment	Course ILOs
50%	Lab Performance and Participation	1,2,3,4,5,6
20%	Oral Presentation	4,5,6
30%	Written Research Thesis	1,2,3,4,5