DEPARTMENT OF

CHEMISTRY

CHEM UG Courses

UG Courses offered in Fall Term 2025-2026 but the courses outlines are not time-specific

Course Code	Course Title
CHEM 1008	Introductory Chemistry
CHEM 1011	General Chemistry A: Reactions, Thermodynamics, and Kinetics
CHEM 1012	General Chemistry B: Atomic Structure, Molecules, and Bonding Theories
CHEM 1051	Laboratory for General Chemistry A
CHEM 2110	Organic Chemistry I
CHEM 2111	Fundamentals of Organic Chemistry
CHEM 2210	Inorganic Chemistry I
CHEM 2310	Fundamentals of Analytical Chemistry
CHEM 2409	Mathematical Methods for Physical Chemistry
CHEM 2410	Physical Chemistry I: Equilibrium Thermodynamics and Statistical Mechanics
CHEM 2550	Synthetic Chemistry Laboratory I
CHEM 2555	Molecular Characterization Chemistry Laboratory I
CHEM 3010	Great Ideas in Chemistry
CHEM 4110	Structural Elucidation in Organic Chemistry
CHEM 4120	Biomolecular Chemistry
CHEM 4140	Intermediate Organic Chemistry
CHEM 4150	Biomolecular Synthesis Laboratory
CHEM 4155	Biomolecular Characterization Laboratory

The Hong Kong University of Science and Technology
Department of Chemistry

CHEM 1008 – Introductory Chemistry (3-credits) **Fall 2025 - 2026**

Instructors:

Prof. Jinqing HUANG	**Prof. Emily M.W. TSANG**
Office: Rm 4544 (lift 25/26)	Office: Rm 4536 (lift 25/26)
E-mail*: jqhuang@ust.hk	E-mail*: chetsang@ust.hk

**Instructor office hour by email appointment*

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

Class Schedule and Venue:

L1	Mon 3:00 - 4:20 pm Fri 10:30 - 11:50 am	Rm 2464 (Lift 25/26)
L2	Tues, Thurs 4:30 - 5:50 pm	

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 %

The Hong Kong University of Science and Techonology

UG Course Syllabus

General Chemistry A: Reactions, Thermodynamics, and Reaction Kinetics
CHEM 1011

3 Credits

Instructor:
Name: Dr. Frederick Fu Kit SHEONG (1st half of the course)
Email: chemfksheong@ust.hk

Name: Prof. Zhenyang LIN (2nd half of the course)
Email: chzlin@ust.hk

Instructional Assistant:
Name: Dr. Long Yiu TSANG
Email: lytsangchem@ust.hk

Office Hours: Every Thursday, 12:30pm – 3:00pm, at Room 4507

Course Description

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.

Intended Learning Outcomes (ILOs)

By the end of this 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.

Course Topics

Chapter 10:	Properties of Solutions
Chapter 12:	Chemical Equilibrium
Chapter 13:	Acids and Bases
Chapter 14:	Acid-Base Equilibria
Midterm Exam (Chapters 10, 12-14)	
Chapter 15:	Solubility and Complex Ion Equilibria
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, 15-18, 21)	

Assessment and Grading

Assessment	Contribution	Due date
Assignment 1	4%	Week7
Mid-term exam	36%	Week8 6:30pm – 8:30pm October 19 (Sun)
Assignment 2	6%	Week14
Final exam	54%	Week15 8:30am – 11:30am December 10 (Wed)

Mapping of Course ILOs to Assessment Tasks

Assessment	Course ILOs	Explanation
Assignment 1	1, 2	Assignment is designed to assess students' foundational understanding of the properties of solutions (ILO 1) and definitions of acids and bases theories (ILO 2)
Midterm exam	1, 2, 6	This midterm assesses students' ability to analyze properties of solutions, determine stoichiometry of chemical transformations (ILO 1), determine acid-base equilibrium (ILO 2), and recognize the impact of chemistry to society (ILO 6).
Assignment 2	3, 4, 5	Assignment is designed to

		assess students' foundational understanding of thermodynamics in chemical reaction (ILO 3), electrochemistry (ILO 4), and chemical properties of organic and biological molecules (ILO 5)
Final exam	3, 4, 5, 6	This final exam assesses students' ability to apply the laws of thermodynamics to determine spontaneous physical and chemical changes. (ILO 3), describe redox reactions and comprehend the structures of electrochemical cells (ILO 4), determine chemical properties of organic, biological molecules, and polymers (ILO 5), and recognize the impact of chemistry to society (ILO 6).
Participation	1, 2, 3, 4, 5, 6	Students can achieve all ILOs via participation.

Communication and Feedback
Assessment marks for individual assessed tasks will be communicated via Canvas within one week of submission. Paper checking sessions are provided for midterm and final exams.

Required Texts and Materials

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

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Academic Integrity | HKUST - Academic Registry for the University's definition of plagiarism and ways to avoid cheating and plagiarism.

The Hong Kong University of Science and Technology
Department of Chemistry

Fall 2025 -2026

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

Instructors:

Prof. Guocheng JIA	**Prof. Emily M.W. TSANG**
Office: CYT-6009	Office: Rm 4536 (lift 25/26)
E-mail*: chjiag@ust.hk	E-mail*: chetsang@ust.hk

**Instructor office hour by email appointment*

Course Description:
This course targets 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, and organic molecules will be briefly reviewed.

Pre-requsites: *Level 3 or above in HKDSE 1/2x Chemistry OR Level 3 or above in HKDSE 1x Chemistry*

CHEM 1004 or CHEM 1008

Exclusions: *CHEM 1010*

Class Schedule and Venue:

L1	Tues, Thurs 10:30 - 11:50 am	LT-C
L2	Tues, Thurs 3:00 - 4:20 pm	LT-E

Textbook: *Chemistry: An Atoms First Approach*, 3rd Asian Ed. S.S. Zumdahl; S. A. Zumdahl; D. DeCoste © Cengage Learning. ISBN: 9789814896993

Course Content/Topics:

- ☐ Chapter 1: Chemical Foundations
- ☐ Chapter 2: Atomic Structure and Periodicity
- ☐ Chapter 3: Bonding: General Concepts
- ☐ Chapter 4: Molecular Structure and Orbitals
- ☐ Chapter 8: Gases
- ☐ Chapter 9: Liquids and Solids
- ☐ Chapter 19: The Representative Elements
- ☐ Chapter 20: Transition Metals and Coordination Chemistry (Guest Lecturer)

Intended Learning Outcomes:

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

1. Describe and apply fundamental principles and terminologies of chemistry.
2. Develop a microscopic view of the world in terms of atoms and molecules and their change
3. Describe and apply concepts of mass conservation and energy conversation in chemical changes.
4. Describe the atoms and ions in terms of atomic structure, atomic orbitals, electron configuration, and periodicity of chemical properties
5. Describe molecules in terms of bonding theory, energy, molecular geometry and interactions.
6. Describe the physical states of matters: gases, liquids and solids.
7. Recognize and appreciate the impact 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 1051 Laboratory for General Chemistry A

2025–26 Fall

Course Outline

Instructor

Dr. CHEUNG Man Sing (sing@ust.hk)

Instructional Assistants (IAs)

Ms. CHENG Cathy H. Y. (cathychy@ust.hk)

Mr. MAN Tim T. P. (takpm@ust.hk)

Technical Officer

Dr. KONG Jacky L. C. (lckongchem@ust.hk)

Class Schedule

Section	Date	Time	Venue
LA1	Tuesday	10:30AM – 01:20PM	UG001, CYT Building
LA2		01:30PM – 04:20PM	
LA3	Wednesday	10:30AM – 01:20PM	
LA4		01:30PM – 04:20PM	
LA5	Thursday	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)

On successful completion of the course, students will 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 chemical substances 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

CHEM 2110 ORGANIC CHEMISTRY I
Syllabus- Fall 2025

1. **Instructor**

Name: Hugh NAKAMURA, Ph.D.
Contact Details: Room 6143, 6th floor, (Lift 22)
Email: hnakamura@ust.hk
Tel: 3469-2552

2. **TAs**

LIN, Jie (jlincv@connect.ust.hk)
OGAWA, Hiroshige (hogawa@connect.ust.hk)
ZHANG, Jie (jzhangin@connect.ust.hk)

3. **Lecture Time and Venue**

Date/Time: Monday (15:00-16:20) and Friday (10:30-11:50)
Venue: 2502 (Lift 25/26)

4. **Course description**

This is the Part I of a two-semester, introductory level organic chemistry course designed for chemistry/biochemistry major undergraduates. Topics covered include: Structure and bonding; regio-, geometric, and stereoisomerism; polar and radical reactions of alkenes and alkynes; substitution and elimination reactions; synthesis and reactions of alcohols and epoxides.

5. **Intended Learning Outcomes**

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

No.	ILOs
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 relevance to social and daily life.
4	Formulate and analyze mechanisms and products of organic transformations by applying organic chemistry principles.

6. **Assessment Scheme**

40% Midterm exam (mid of Oct)
60% Final exam (mid of Dec)

7. **Student Learning Resources**

Recommended Reading:

Text(s): John E. McMurry, "Organic Chemistry, 8th edition, international edition", Brooks/Cole, Cengage Learning

Francis A. Carey, Robert M. Giuliano, "Organic Chemistry, 9th edition, international edition", McGraw-Hill.

William H. Brown, Brent L. Iverson, Eric V. Anslyn, Christopher S. Foote, " Organic Chemistry, 7th edition, international edition" Brooks/Cole, Cengage Learning.

8. Course Schedule

Keyword Syllabus:

- Structure and bonding
- Polar covalent bonds and acids and bases
- Organic compounds: alkanes and their stereochemistry
- Organic compounds: cycloalkanes and their stereochemistry
- Stereochemistry at tetrahedral centers
- An overview of organic reactions
- Alkenes: structure and reactivity
- Alkenes: reactions and synthesis
- Alkynes: Organic synthesis
- Organohalides
- Reactions of alkyl halides: nucleophilic substitution and eliminations
- Alcohols and phenols
- Ethers and Epoxides: Thiols and Sulf

9. Schedule[a]

1 Sep	LT-1: Introduction to Organic Chemistry, Structure
5 Sep	LT-2: Atomic Bonding
8 Sep	LT-3: Polar Covalent Bonds, Lewis Acids and bases
12 Sep	LT-4: Polar Covalent Bonds, Lewis Acids and bases
15 Sep	LT-5: Alkanes and their stereochemistry
19 Sep	LT-6: Cycloalkanes and their stereochemistry
22 Sep	LT-7: Stereochemistry at tetrahedral centers
26 Sep	LT-8: Stereochemistry at tetrahedral centers
29 Sep	LT-9: Overview of organic reaction
3 Oct	LT-10: Alkenes—structure and reactivity
6 Oct	Tutorial (1) by TAs (Explanation of the past exam)
10 Oct	Tutorial (2) ORQ (Open Round Questions)[b]
13 Oct	**Mid-Term Exam, 15:00 – 16:20 am (2502), closed book**
17 Oct	LT-11: Alkenes—structure and reactivity
20 Oct	LT-12: Alkenes—reaction and synthesis

24 Oct	LT-13: Alkenes—reaction and synthesis
27 Oct	LT-14: Alkyne—Introduction to Organic Synthesis
31 Oct	LT-15: Alkyne—Introduction to Organic Synthesis
3 Nov	LT-16: Organic Halides
7 Nov	LT-17: Reactions of Alkyl halides
10 Nov	LT-18: Reactions of Alkyl halides
14 Nov	LT-19: Alcohol and Phenols
17 Nov	LT-20: Ethers and Epoxide, Thiol and sulfides
21 Nov	Tutorial (3) by TAs (Explanation of the past exam)
24 Nov	Tutorial (4) ORQ (Open Round Questions)[b]
xx Dec	**Final Exam, 16:30-19:30 (3 hours), closed book**

[a]The lecture schedule may change depending on the progress of the lecture, the typhoon, and other circumstances. Please pay attention to announcements during the lecture.

[b]ORQ may be cancelled or postponed depending on the progress of the course.

CHEM 2111 Fundamental of Organic Chemistry

Fall Semester 2025 (Sept 1 – Nov 29)

Venue: LTL, CYT Bldg
Lecture hours: Tuesday and Thursday, 9:00 – 10:20 PM

Credits: 3
Pre-requisite: CHEM 1010 or CHEM 1012
Exclusion: CHEM 2110

INSTRUCTOR

Prof. Kenward VONG
Office: 4521 (lifts 25/26)
E-mail: kvong@ust.hk

COURSE DESCRIPTION

Various classes of organic compounds, emphasizing organic chemical reactions and mechanisms of major functionalities and their importance in the area of biological chemistry. For engineering students under the four-year degrees who prefer to learn organic chemistry in a single term.

The course will treat selected topics from a mechanistic viewpoint and illustrate their usefulness in the wider body of organic chemistry. Examples of concepts in organic synthesis will be given. The course does not aim to provide a comprehensive coverage of organic reactions, rather it will seek to encourage students to think about organic chemical reactions, and to apply key concepts to other reactions not covered in the course.

INTENDED LEARNING OUTCOMES

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

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

ASSESSMENT SCHEME

Midterm 1 (open book): 20%
Midterm 2 (open book): 30%
Final Exam (one A4 size cheat sheet allowed): 50%

SCHEDULE

Week 1	Sept 2	Chemical Bonding (*chap 1*)
	Sept 4	Break
Week 2	Sept 9	Chemical Bonding (*chap 1*)
	Sept 11	Chemical Bonding/Reactions (*chap 1+2*)
Week 3	Sept 16	Chemical Reactions (*chap 2*)
	Sept 18	Stereochemistry (*chap 3*)
Week 4	Sept 23	Alkanes and Cycloalkanes (*chap 4*)
	Sept 25	Alkanes and Cycloalkanes (*chap 4*)
Week 5	Sept 30	Alkenes and Alkynes I (*chap 5*)
	Oct 2	Review session
Week 6	Oct 7	Holiday
	Oct 9	Break or Q&A section
	Midterm I (open book) – Date TBD	
Week 7	Oct 14	Alkenes + Alkynes II (*chap 6*)
	Oct 16	Aromatics (*chap 7*)
Week 8	Oct 21	Alkyl halides (*chap 8*)
	Oct 23	Nucleophilic substitution (*chap 9*)
Week 9	Oct 28	Alcohols (*chap 10*) and Amines (*chap 14*)
	Oct 30	Aldehydes and Ketones (*chap 11*)
Week 10	Nov 4	Carboxylic Acids (*chap 12*)
	Nov 6	Carboxylic Acid Derivatives (*chap 13*)
Week 11	Nov 11	Review session
	Nov 13	Break or Q&A section
	Midterm II (open book) – Date TBD	
Week 12	Nov 18	Retrosynthesis
	Nov 20	Retrosynthesis
Week 13	Nov 25	Q&A section
	Nov 27	Q&A section
Exam period	Dec 8 – Dec 19	**Final Exam (*1-page A4 sized cheat sheet*)**

STUDENT LEARNING RESOURCES

Textbook:

"Organic Chemistry, A Brief Course" by Robert C. Atkins, Francis A. Carey, and Chi Wi Ong, McGraw-Hill Education (Asia), 2013

or

"Organic Chemistry, A Brief Course, 3rd Edition" by Robert C. Atkins and Francis A. Carey, McGraw-Hill Education, International Edition, 2007

Solutions Manual:

"Student Solutions Manual to accompany Organic Chemistry, A Brief Course, 3rd Edition" by Robert C. Atkins and Francis A. Carey, McGraw-Hill Education, International Edition, 2007

RESERVE ITEMS IN LIBRARY

CALL NUMBER	QD253.2 .A74 2002
AUTHOR	Atkins, Robert C. (Robert Charles)
TITLE	Organic chemistry, a brief course
EDITION	3rd ed.
IMPRINT	Boston : McGraw-Hill, c2002.
# Copies:	3 copies

CALL NUMBER	QD251.2 .A82 2002
AUTHOR	Atkins, Robert C. (Robert Charles)
TITLE	Organic chemistry, a brief course: student solutions manual
EDITION	3rd ed.
IMPRINT	Boston : McGraw-Hill, c2002.
# Copies:	2 copies

The Hong Kong University of Science and Technology
UG Course Syllabus

Inorganic Chemistry I
CHEM 2210
3 Credits
Prerequisites: CHEM 1012

Name: Prof. Wa-Hung Leung
Email: chleung@ust.hk, Rm 4538, ext.7360

Course Description

This course is designed for students who have taken CHEM 1011 under the four-year degree. Key topics include atomic structure, molecular structure and bonding, structures of simple solids, physical techniques in inorganic chemistry, molecular symmetry, acids and bases, introduction to coordination chemistry, electronic structures and spectra of coordination compounds. For students in the program under the four-year degree that designate the course as required course/specified elective, or students with approval from the instructor.

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1. Demonstrate a comprehensive and well-founded knowledge of structure and bonding theories that are relevant to inorganic molecular compounds.
2. Rationalize the stability of inorganic compounds using concepts of acids and bases.
3. Describe and rationalize structures of simple solids.
4. Appreciate the importance of molecular symmetry in the field of chemistry and assign molecular point groups.
5. Understand structures of coordination compounds.

Teaching Assistant(s)

Miss JIANG, Xinxin	email: xjiangbd@connect.ust.hk
Mr. HO, Chun Yin	email: cyhobj@connect.ust.hk
Mr. YAN, Xuyang	email: xyanbc@connect.ust.hk

Meeting Time and Venue

Lectures:

Date/Time: Wednesday, Friday (16:30-17:50)

Venue: LT-K

Tutorials:

Date/Time: N.A.

Venue: N.A.

Assessment Scheme

a. Examination duration: 2 hours
b. Percentage of coursework, examination, etc.:

Assessment	Assessing Course ILOs
6% by assignment	1, 2, 3, 4
10% by quizzes	1, 2, 3, 4
38% by mid-term test	1, 2, 3, 4, 5
46% by final exam	1, 2, 3, 4, 5

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

Student Learning Resources

Recommended Reading:

Text(s):

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

Teaching and Learning Activities

Scheduled activities: 3 hrs (lecture)

7. Course Schedule

Keyword Syllabus:

- Molecular orbital theory: bonding and antibonding molecular orbitals, bond order and energy, homo- and heteronuclear diatomic molecules, polynuclear molecules, ligand group orbitals, Walsh diagram.
- Acids and bases: definition and examples of Lewis acids, relative Lewis acidity, acid-base reactions hard-soft acid-base theory and its application.
- Structures of simple solids: unit cell and crystal structure description, close packing of spheres and holes, characteristic structures of ionic solids and their rationalization, energetics of ionic bonding and consequences of lattice enthalpies, electronic structures of solids, band formation, semiconductors
- Molecular symmetry: symmetry elements and operations, classification of point groups, applications of molecular symmetry
- Coordination chemistry: coordination geometry of metal complexes, classification of ligands, isomerism and chirality

The Hong Kong University of Science and Technology

UG Course Syllabus

Fundamentals of Analytical Chemistry

CHEM 2310

3 Credits

Pre-requisite(s): CHEM 1012

Exclusion(s): CHEM 2311

Name: Xioajiang Xie

Email: xiexj@ust.hk, Rm4520

Office Hours: by appointment

Course Description

Fundamental and practical aspects of chemical analysis, including titrimetric, electrochemical and spectroscopic methods, analytical separations by GLC and HPLC.

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1. Recognize fundamentals of analytical chemistry including various concentration units, statistics for analytical chemistry, acid-base titrations, complexometric titrations, redox titrations, basics of spectroscopy, basics of chromatography and mass spectrometry.
2. Explain the essential facts, principles and theories for analytical chemistry.
3. 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.

Teaching Assistant(s)

Ms. Kaiting Xiao <kxiaoac@connect.ust.hk>

Mr. Hei Tak Tse <httseaa@connect.ust.hk>

Mr. King He Chengi <khchengaq@connect.ust.hk>

Lecture Time and Venue

Date/Time: Tues & Thurs (16:30 – 17:50) Venue: LG3009

Assessment Scheme

Class attendance (10%), 3 x Assignment (30% total), 1x Final closed-book exam (60%)

Student Learning Resources

Textbook: Exploring Chemical Analysis (5th Edition), Daniel Harris, Freeman, 2013

Reference: Quantity Chemical Analysis, Daniel C. Harris, Freeman

Teaching and Learning Activities

Scheduled activities: 3 hrs (lecture)

Course Schedule

Keyword Syllabus:

Measurements and tools of analytical chemist	Acids and Bases
Math Tool-kit, significant figures and errors	Buffers and Indicators
Statistics	Acid-Base Titrations & N-Analysis
Titrations	Polyprotic Acids and Bases
Gravimetry	EDTA Titrations
Introduction to Electrochemistry	UV-Vis absorption spectroscopy
Potentials and Potentiometry: Electrode Measurements	FT-IR
Redox Titrations	Fluorescence
Introduction to Optical Spectroscopy	Atomic Spectroscopy
Chromatography	Mass Spectrometry

CHEM 2409
Mathematical Methods in Physical Chemistry
Fall 2025

Instructor:

Dr. Haibin Su (Professor)
Room: 4540, Lift 25/26
Tel: 2358-7388
E-mail: haibinsu@ust.hk

Teaching Crew:

Chi Ming KAN	Rm 4207
Shan Qi YAP	Rm 4207
Imanual RAVA	Rm 4207
Wentao XU	Rm 4207
Yingtong ZHU	Rm 4207
Jingyuan ZHU	Rm 4207
Japhert CHANG	Rm 4207
Ka Hei CHOY	PG Hub (level 1)

Lectures:

Monday	1:30 pm – 2:50 pm	2407 (Lift 17/18)
Friday	9 am – 10:20 am	2407 (Lift 17/18)

Tutorials:

Wednesday	9 am – 10:20 am	2464 (Lift 25/26)

Course Website:

https://canvas.ust.hk/courses/64772

COURSE DESCRIPTION

Chem2409: Mathematical Methods in Physical Chemistry covers numerical and mathematical methods for solving undergraduate-level problems in physical chemistry. The purpose of the course is to supplement the mathematical and computational background of chemistry students and build on skills learned in year-1 calculus courses by teaching them methods for quickly solving typical complex problems found in upper level chemistry courses. This course is a prerequisite to the *Physical Chemistry I and II* courses.

LEARNING OUTCOMES

Upon the study of this course, students are expected to understand how to interpret and classify integral/ordinary differential equations, to acquire basic skills to solve partial

differential equations in quantum mechanics using computational, numeric and analytical methods, to have a skill set needed to learn theory of physical chemistry at a high level, and to be able to quickly and efficiently classify problems in physical chemistry and solve by any means.

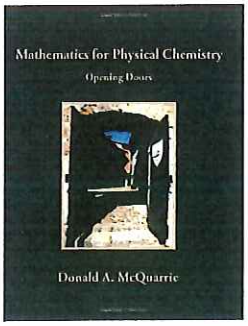
Upon successful completion of this course, students will be able to:

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

(2) Communicate effectively both orally and in writing to a professional and/or lay audience.

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

TEXTBOOK



"Mathematics for Physical Chemistry – Opening Doors", by Donald A. McQuarrie, University Science Books

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/courses/38900) 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 made 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	40%
Assignments	20%

Notes:

- Midterm Exam and Final Exam are in the mixed mode closed-book examinations.
- Assignments: There will be four sets of homework assignments in total.

COURSE SCHEDULE

wk 1	Mon. 01 Sep	Lecture 1	Introduction & Functions of a Single Variable: Differentiation *Textbook: Chapters 1*
	Fri. 05 Sep	Lecture 2	Functions of a Single Variable: Integration *(cont'd.)* *Textbook: Chapters 2*
wk 2	Mon. 8 Sep	Lecture 3	Functions of a Single Variable: Integration *(cont'd.)* *Textbook: Chapters 2*
	Fri. 12 Sept	Lecture 4	Functions of a Single Variable: Integration *(cont'd.)* *Textbook: Chapters 2*
wk 3	Mon. 15 Sep	Lecture 5	Ordinary Differential Equations *Textbook: Chapters 6*
	Fri. 19 Sep	Lecture 6	Ordinary Differential Equations (cont'd.) *Textbook: Chapters 6*
wk 4	Mon. 22 Sep	Lecture 7	Ordinary Differential Equations (cont'd.) *Textbook: Chapters 6*
	Fri. 26 Sep	Lecture 8	Ordinary Differential Equations (cont'd.) *Textbook: Chapter 6*
wk 5	Mon. 29 Sep	Lecture 9	Ordinary Differential Equations (cont'd.) *Textbook: Chapter 6*
	Fri. 03 Oct	Lecture 10	Series *Textbook: Chapter 3*
wk 6	Mon. 06 Oct	Lecture 11	Series (cont'd) + Review for Midterm Exam *Textbook: Chapter 3*

	Fri. 10 Oct		Midterm review
wk 7	Mon. 13 Oct	**Exam**	**Midterm Exam** (covering Lecture 1 to 11) Time: 1:30pm – 2:50pm **Location: To be announced**
	Fri. 17 Oct	Lecture 11	Functions of Several Variables *Textbook: Chapter 12*
wk 8	Mon. 20 Oct	Lecture 12	Functions of Several Variables (cont'd) *Textbook: Chapter 12*
	Fri. 24 Oct	Lecture 13	Functions of Several Variables (cont'd) *Textbook: Chapter 12*
wk 9	Mon. 27 Oct	Lecture 14	Operators/Vectors *Textbook: Chapter 11 & 13*
	Fri. 31 Oct	Lecture 15.	Operators/Vectors (cont'd) *Textbook: Chapter 11 & 13*
wk 10	Mon. 03 Nov	Lecture 16	Plane Polar & Spherical Coordinates *Textbook: Chapter 14*
	Fri. 07 Nov	Lecture 17	Plane Polar & Spherical Coordinates (cont'd) *Textbook: Chapter 14*
wk 11	Mon. 10 Nov	Lecture 18	Plane Polar & Spherical Coordinates (cont'd) *Textbook: Chapter 14*
	Fri. 14 Nov	Lecture 19	Matrix *Textbook: Chapter 18*
wk 12	Mon. 17 Nov	Lecture 20	Matrix (cont'd) *Textbook: Chapter 18*
	Fri. 21 Nov	Lecture 21	Matrix (cont'd) *Textbook: Chapter 18*
wk 13	Mon. 24 Nov	Lecture 22	Matrix (cont'd) *Textbook: Chapter 18*
	Fri. 28 Nov		Review for Final Exam
Final Exam			(covering Lecture 11 to 21) Arranged by the university

Updated in August 2025

Instructor: *Prof. Jonathan HALPERT* Fall, 2025

Chem2410: Physical Chemistry I
(home: https://canvas.ust.hk/courses/64777)

Description:
This 3-credit course is the Part-I of "Physical Chemistry" sub-curriculum for students majoring in chemistry. It covers:
(a) The basic principles and applications of equilibrium thermodynamics; and
(b) The equilibrium statistical thermodynamics

Textbook: "*Physical Chemistry*", P. Atkins, J. de Paula & J. Keeler **11th Edition** (Oxford, 2018)
https://www.amazon.com/Atkins-Physical-Chemistry-Revised-Paperback/dp/B00RWU5W1I/ref=sr_1_fkmr0_1?
Coverage: Fundamentals and Part I: Equilibrium (Chap 1R, 2 – 6, 12) ***(11th Ed. Chap 12 = 9th Ed. Chap 15/16)***

Prerequisites:
CHEM1030 and CHEM2409

Schedule/Venue:
(a) Lectures: Wednesday (3:00 – 4:20 pm), Rm 5404 &
Friday (3:00 – 4:20 pm), Rm 5404
(b) Instructors' Office Hours: Friday: 11:00 am – 12:00 pm (on Zoom, by appointment only)
(c) TAs' Tutorial: **Wednesday 7:30 pm (evening, 1 hour)**

(d) Examinations:
Midterm Exam: **TBD,** near October 31, tentatively
Final Exam: **TBD**, Dec 8-19 (during exam period)

Teaching Assistants and Assignments [# L's]:

KUMAR, Nitish	(nkumaraa@connect.ust.hk)	Chap. 4, 5, 6
DING, Pengbo	(pdingab@connect.ust.hk)	Chap. 1R, 2, 3
MA, Tai Ho Gideon	(thgma@connect.ust.hk)	Chap. 12

Credit/Grading :

Midterm:	50 % (Chapters 2, 3, 4)
Homework:	10 % (*avg of the best 3 out of 4*)
Final Exam:	40 % (Chapters 5, 6, 12)

The HW questions must be handed in and this will contribute directly to your final grade!

(i) HWs (provided on CANVAS) will be completed and handed in to TA **via the CANVAS portal.**
(ii) Questions will be marked by the TAs: 50 % completeness, 50 % correctness
(iii) **Exam** questions: ~20% of Q's are directly from HW or in-class Q's
(iv) Tutorials are **about the HW**: the TAs will present model answers and answer questions
(v) ***Don't wait until exam time!*** By then it is too late to learn everything.

MAIN REFERENCES:

Atkins, P.; de Paula, J. "*Physical Chemistry*" 9th Ed., Oxford University Press, 2011. **[previous main text]**

Atkins, P.; de Paula, J. "*Physical Chemistry*" 10th Ed., Oxford University Press, 2014. **[previous main text]**

Atkins, P.; de Paula, J.; Keeler, J *"Physical Chemistry*" 12th Ed., Oxford University Press, 2023. **[next main text]**

Adamson, A.W. *"A Textbook of Physical Chemistry*" 3rd Ed., Academic Press, 1986. (QD453.2.A3 1986)

Klotz, I. M. and Rosenberg, R. M. *"Chemical Thermodynamics: basic theory and methods"* 6th Ed, John Wiley, 2000. (QD 504.K55 2000)

DeVoe, H. *"Thermodynamics and Chemistry"* Prentice Hall, 2001. (QD504.D48 2001)

Ott, J.B. *"Chemical Thermodynamics"* Academic Press, 2000. (QD504.O87, 2000)

Smith, J.M. "*Introduction to Chemical Engineering Thermodynamics"* 6th Ed, McGraw-Hill, 2001. (TP155.T45.S58, 2001)

Chang, R. *"Physical Chemistry for the Chemical and Biological Sciences"* 3rd Ed., Univ. Sci. Press, 2000. (with Solutions Manual by Leung, H.O. and Marchall, M.D.) (QD453.2.C48 2000)

Alberty, R.A. (2003) *"Thermodynamics of Biological Reactions"* Wiley 2003.

MATHEMATICAL TOOLS:

McQuarrie, D. A. "*Mathematics for Physical Chemistry*", 2008, Univ. Science Books

Yates, P. "*Chemical Calculations – Mathematics for Chemistry*", 2007, CRC Press.

Mortimer, R.G. *"Mathematics for Physical Chemistry*" 2nd Ed., Academic Press, 1999. (QD455.3.M3.M67.1999)

Hecht, H.G. *"Mathematics in Chemistry"* Prentice Hall, 1990.(QD39.3.M3.H43.1990)

Starzak, M.E. *"Mathematical Methods in Chemistry and Physics*" Plenum,1989. (QD39.3.M3.S73.1989)

PHYSICS :

G. A. D. Ritchie and D. S. Sivia, "*Foundations of Physics for Chemists*", 2000, Oxford

HOMEWORK ASSIGNMENTS

(from < *Atkins' Physical Chemistry* > ***10th Ed., 2014*** by P. W. Atkins and J. de Paula)

There will be four homework assignments corresponding to Chapters 1R+2, 3+4, 5+6, 12.

Assignments will be transcribed and released on CANVAS a few days or so before the start of the chapter lectures. Students who have the 10th Edition will be able to find them in that book, but it is not necessary to acquire it, we will provide all HW questions and answers.

Model solutions to the homework will be released a few days AFTER they are due. Due dates will be announced but are subject to change, depending on our progress. HW is due by 11:59 pm HKT on the due date and will be submitted in the CANVAS portal. If you have trouble with the CANVAS portal, just email it, on time, to the TA (and cc me) so there is a timestamp showing you did it on time.

Late HW will be accepted without penalty up to 2 days late. *It is officially due, usually, on Friday.*

Assignments will be handed in via CANVAS and will be marked by the TAs for:

50%: completeness, attempted all parts of all problems (must be a serious attempt)
50%: correctness, answered all parts of all problems correctly (partial credit does apply)

You can then check your own answers online against the model solutions 2 days after the assignment. The TAs will also answer questions in tutorial.

Moreover, some portion of the test and exam questions WILL be drawn (almost) directly from the homework. The reason for this is that is necessary to solve the problems in order to understand the course fully. There are no shortcuts to doing well in this course. *Revising old exams will not be enough preparation to succeed.*

Here's the HW schedule (*tentative*). Check the ASSIGNMENTS page on CANVAS for due dates.

HW	**Chapters**	**Due** (+2 days w/o penalty)
#1	2+1R	**Sep 26**
#2	3+4	**Oct 17**
#3	5+6	**Nov 14**
#4	12	**Nov 28**

Extra Credit:
Extra credit will be awarded for:

1. correctly solving problems in class
2. participating in class discussion
3. attending class regularly

This may add up to +2 pts to your final grade.

CHEM 2410 Syllabus

WEEK (roughly)	CONTENTS (Textbook Sections)	ASSIGNMENT
	Chap. 1 : Review of Gas Laws (Chapter 1)	**Homework-1**
1	(a) State variables and the gas laws ➢ Pressure, volume, moles, R constant ➢ The Gas Law and changes in variable of state ➢ Temperature in thermodynamics ➢ Solving problems in pchem ➢ Real Gases	
2-4	**Chap. 2 :** The First Law (§2.1 - §2.9)	**Homework-1**
	(a) The Basic Concepts and Terminology in Thermodynamics ➢ System and Its Surroundings ➢ Open, Closed, and Isolated Systems ➢ State and Process ➢ Work, Heat, Internal Energy (U) and Its Change (ΔU)	
	(b) The First Law: The basic statement(s)	
	(c) More on Work: Expansion Work and Reversibility	
	(d) More on Heat ➢ Heat Capacity (C_v) ➢ Heat Capacity (C_p) and Enthalpy (H)	
	(e) Thermochemistry ➢ Standard Enthalpy Changes($\Delta H^{\emptyset}$) ➢ Standard Enthalpy of Formation($\Delta_f H^{\emptyset}$) ➢ *T*-dependence of ΔH (Kirchhoff's law)	
	(f) Mathematics and Machinery for Thermodynamics (§2.10 –§2.12) ➢ Math Background: Two-variable Calculus ➢ State Functions and Exact Differentials vs. and Non-State variables / Inexact Differentials ➢ The Change of State Functions : dU and dH ➢ The Relationship between Cv and Cp ➢ Expansion coefficient α and isothermal compressibility	

4-6 **Chap. 3 :** The Second Law (§3.1 –§3.6) **Homework-2**

(a) The Basic Concepts
- The Direction of Spontaneous Change
- The Second Law: Clausius Statement and Kelvin Statement
- Reversible and Irreversible Processes

(b) The Second Law: The Formal Statement
- The Change of the System Entropy (ΔS) and that of the Environment (ΔS_{surr})
- The Clausius Inequality

(c) The Entropy (S)
- Physical Meaning
- Thermodynamic Definition
- Statistical View of Entropy (Boltzmann Formula)

(c) Evaluate ΔS and/or ΔS_{surr} for Some Specific Processes

(d) The Third Law : The Standard Entropy ($S^{\emptyset}$)

(e) Helmholtz Energy (A) and Gibbs Energy (G) and Remarks
- Evaluate ΔG and/or ΔA for Some Specific Processes
- Standard Molar Gibbs Energy ($\Delta_r G^{\emptyset}$).

6-7 **Chap. 4 :** Physical Transformations of Pure Substances (§4.1 –§4.6) **Homework-2**

(a) Phase Diagrams: Phases and Their Stability;
(b) Phase Diagrams: Phase Boundary and The Phase Transition Temperature;
(c) Phase Transition: Thermodynamic Criterion for Phase Equilibrium;
(d) Phase Transition: The Dependence of Phase Stability on the Conditions;
(e) Phase Transition: The Location of Phase Boundaries;

MIDTERM (week 8 or 9)

7-9 **Chap. 5:** Simple Mixtures (§5.1-§5.13) **Homework-3**

(a) Thermodynamic description of mixture and mixing process
(b) The properties of solutions: Chemical Potentials of Ideal Solutions
(c) The properties of dilute solutions: Colligative Properties
(d) Phase diagrams of binary systems
(e) The Raoult's Law versus the Henry's Law
(e) The Activities (α): solvent, solute, molecule versus ions

9-10 **Chap. 6 :** Chemical Equilibrium (§6.1 –§6.9) **Homework-3**

(a) The Direction of Spontaneous Chemical Reactions: The Criterion;
(b) Reaction Quotient (Q) and Equilibrium Constant (K);
(c) The Response of Equilibrium to P and T ;
(d) Several Examples of Applications of Chemical Equilibrium.

(e) Equilibrium Electrochemistry (§6.5 –§6.9)
- Ions in Solution: ΔG, ΔS, and activity α
- Electrochemical Cells : Half-reactions and Electrodes
- Electrochemical Cells : Cell Reactions and Cell Potentials
- The Nernst Equation and Standard Potentials
- The Electrochemical Series
- Measurement of pH and pK and Standard Thermodynamics Functions

11-13 **Chap. 12 :** Statistical Thermodynamics

- Statistical Thermodynamics 1 (formerly Ch 15) : **Homework-4**
  The concepts, the Boltzmann distribution
  The microcanonical ensemble and the canonical ensemble
  The partition functions and the thermodynamics relations
- Statistical Thermodynamics 2 (formerly Ch 16):
  Boltzmann statistics and molecular partition functions
  Applications to thermodynamic properties of non-interacting molecular systems

Dec **FINAL EXAM**
Exam period (December)

GENERAL ADVICE:

(a) NEVER ACCUMULATE PROBLEMS TO THE END OF SEMESTER! Should you have any confusion/questions/problems about the lectures/text/assignments, do not hesitate to ask for help from the TAs or instructor. The accumulation of problems would only create more trouble for you to follow the new lectures.

(b) TEAM-WORK IS STRONGLY ENCOURAGED! Do homework in groups! Discuss with each other (after the class)! Teamwork has proven to be highly efficient means to enhance the understanding of difficult concepts in this course.

(c) NEVER ACCUMULATE DIFFICULTIES TO THE END OF SEMESTER
Should you have any confusions/questions/problems about the lectures/text/assignments, do not hesitate to ask for help from the instructor or TAs. The accumulation of problems would only create more trouble for you to follow the new lectures. Reading textbook and notes before and after lectures/tutorials.

(d) TEAM-WORK IS STRONGLY ENCOURAGED
Discuss the course materials and homework problems with your peers after the class! The team-study has been proven to be highly efficient means to enhance the understanding of difficult concepts and mathematical skills in this course.

(e) Math and science are not spectator sports…the **only** way to learn the material is to solve problems.

CHEM 2410: Physical Chemistry I

"Equilibrium Thermodynamics and Statistical Mechanics"

The Intended Learning Outcomes

Upon the study of this course, students are expected to establish a recognition of the fundamentally important role of *Physical Chemistry* in molecular science, to gain a better understanding of the relationship between *Physical Chemistry* and other sub-areas of chemistry (such as Organic, Inorganic, Analytical, Biological, Environmental and Materials Chemistry), to develop an appreciation of the relationship between Chemistry, Physics and Mathematics and other disciplines in science, and to be able to assess and judge some of the pressing societal issues in health, environment, and new technologies from the point of view of Physical Chemistry.

Specifically, students are expected to gain the following knowledge and skills.

A. Basic Knowledge in Science and Basic Skills in Mathematics

1) To grasp the principles of thermodynamics in terms of four basic thermodynamic laws, and be able to use the thermodynamic functions, such as Gibbs energy, enthalpy, entropy, chemical potential, to judge the direction of spontaneous change and to study various physical and chemical equilibrium problems
2) To grasp the basic principles of equilibrium statistical mechanics, the concepts and skills of statistical ensembles and the partition functions and their relations to thermodynamics functions
3) To be able to use the molecular partition functions and Boltzmann statistical mechanics to study the equilibrium thermodynamics properties and fluctuations of noninteracting molecular systems

B. Intellectual Skills in Chemistry

4) To be able to apply the principles of equilibrium thermodynamics to analyze and interpret a wide range of chemical problems from other sub-areas and interdisciplinary areas of chemistry
5) Able to analyze and judge the relevant issues and topics from daily life by employing the principles of thermodynamics and chemical equilibrium

C. Chemistry-Related Practical Skills

6) To gain a qualitative impression of the common physical techniques and experimentally measurables employed in the study of various physical and chemical equilibrium problems

D. Transferable Skills

7) To establish an effective scientific communication skill, in both oral and writing, in terms of equilibrium thermodynamics, chemical equilibria, and equilibrium statistical mechanics
8) To demonstrate information technology skills, especially in the areas of information retrieval, literature searching and library databases relevant to thermodynamics and equilibrium statistical mechanics
9) To enhance self-awareness and the ability of both team work and independent work.

The Hong Kong University of Science and Technology

CHEM 2550 Syllabus, ILOs, Assessments and Grading

Course Title: Synthetic Chemistry Laboratory I

Course Code: CHEM 2550

Number of Credit(s): 2

Pre-requisite: CHEM 1050 or CHEM 1052 (or CHEM 1050 or CHEM 1055)

Co-requisite: CHEM 2110 and CHEM 2210

Exclusion: CHEM 2155, CHEM 2150 and CHEM 2250

Name: Prof. CHAN, Ho Wai Dennis and Dr. TSE, Wai Pui Veronica

Email: chanhw@ust.hk *and* chvaipui@ust.hk

Office Hours: By email appointments

Course Description

This is the laboratory course designed for students who have enrolled in CHEM 2110 Organic Chemistry I and CHEM 2210 Inorganic Chemistry I. It includes a series of organic and inorganic experiments related to the theory learnt in the lecture courses. Students will be trained to perform a wide range of basic synthetic chemistry laboratory techniques, operate chemical instruments in the laboratory, relate the physical and chemical principles and theory in practice, and develop their data interpretation and analysis skills. For CHEM students only.

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1. Describe the fundamentals of organic and inorganic chemistry. [ILO1]
2. Assess and manage the risks of organic and inorganic chemical substances and laboratory procedures. [ILO2]
3. Conduct analysis and interpretation of experimental data of synthetic chemistry. [ILO3]
4. Conduct standard laboratory procedures involved in fundamental chemical synthesis and instrumental work. [ILO4]
5. Operate a range of chemical instrumentation. [ILO5]
6. Work independently and collaborate in teamwork. [ILO6]

Assessment and Grading

Summary:

Assessment Task	Contribution to Overall Course grade (%)	Due date
Risk Assessment	5%	Week 2, 4, 7, 10 and 12 *
Lab Quizzes	25%	Week 2, 4, 7, 10 and 12 *
Laboratory Performance	20%	Week 2, 4, 7, 10 and 12 *
Product /Results	10%	Week 2, 4, 7, 10 and 12 *
Lab Report 1	8%	Week 3 *
Lab Report 2	8%	Week 5, 6 *
Lab Report 3	8%	Week 8 *
Lab Report 4	8%	Week 11 *
Lab Report 5	8%	Week 13 *

* Assessment marks for individual assessed tasks will be released within two weeks of the due date.

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Risk Assessment	ILO2	These tasks assess students' ability to manage the risks of organic and inorganic chemical substances and laboratory procedures (ILO 2).
Lab Quizzes	ILO1, ILO2	These tasks assess students' comprehension of fundamental concepts in both organic and inorganic chemistry (ILO1), as well as their awareness of the potential hazards associated with these chemical substances (ILO2).
Laboratory Performance	ILO2, ILO3, ILO4, ILO5, ILO6	These tasks enable students to safely handle chemicals (ILO2) and apply the knowledge learned in lecture courses to analyze data (ILO3). They assess students' proficiency in conducting laboratory techniques (ILO4) and handling equipment (ILO5), while also emphasizing the importance of working both independently and as part of a team (ILO6).
Product /Results	ILO4	These tasks demonstrate our students' capacity to grasp laboratory techniques and effectively utilize equipment. (ILO4).
Lab Reports	ILO1, ILO3, ILO5	These tasks evaluate students' capacity to grasp the lecture and laboratory materials encompassing the essentials of organic and inorganic chemistry (ILO1), including data interpretation (ILO3), and handling the equipment (ILO5).

Grading Rubrics

Criteria	Excellent (9-10/10)	Good (7-8/10)	Satisfactory (5-6/10)	Marginal (3-4/10)	Fail (0-2/10)	Mapping to course ILO(s)
Risk assessment	Demonstrates exceptional understanding of the importance of risk assessment. Shows meticulous attention to accuracy in assessing chemical hazards.	Provides a clear understanding of the importance of risk assessment. Shows a solid grasp of accuracy in assessing chemical hazards.	Offers some understanding of the importance of risk assessment. Shows some degree of accuracy in assessing chemical hazards.	Lacks in-depth understanding of the importance of risk assessment. Shows very limited accuracy in assessing chemical hazards.	Fails to meet minimum expectations for understanding of the importance of risk assessment. Lacks accuracy in assessing chemical hazards.	ILO3
Lab quiz	Demonstrates thorough understanding of the essential facts, principles and theories across organic and inorganic chemistry related to solid state materials. Connects these elements to relevant course concepts and theories, showcasing a strong understanding of the material.	Provides a clear and detailed understanding of the essential facts, principles and theories across organic and inorganic chemistry related to solid state materials. Makes connections to course material.	Offers some understanding of the essential facts, principles and theories across organic and inorganic chemistry related to solid state materials. Connections to course material may be limited.	Lacks in-depth understanding of the essential facts, principles and theories across organic and inorganic chemistry related to solid state materials. Shows very limited connections to course material.	Fails to meet minimum expectations for understanding of the essential facts, principles and theories across organic and inorganic chemistry related to solid state materials. Shows almost no connection to any course material.	ILO1, ILO2
Laboratory Performance	Demonstrates thorough understanding of the skills for (i) managing the risk of chemical substances and laboratory procedures (ILO3), (ii) conducting standard laboratory procedures in synthetic and instrumental work related to organic polymers and solid-state materials, and (iii) conducting analysis and interpretation of experimental data related to solid state materials. Demonstrates strong ability to work independently and collaborate effectively in teamwork	Demonstrates a clear and detailed understanding of the skills for (i) managing the risk of chemical substances and laboratory procedures (ILO3), (ii) conducting standard laboratory procedures in synthetic and instrumental work related to organic polymers and solid-state materials, and (iii) conducting analysis and interpretation of experimental data related to solid state materials. Demonstrates ability to work independently and collaborate effectively in teamwork	Demonstrates some understanding of the skills for (i) managing the risk of chemical substances and laboratory procedures (ILO3), (ii) conducting standard laboratory procedures in synthetic and instrumental work related to organic polymers and solid-state materials, and (iii) conducting analysis and interpretation of experimental data related to solid state materials. Demonstrates some level of ability to work independently and collaborate effectively in teamwork	Lacks in-depth understanding of the skills for (i) managing the risk of chemical substances and laboratory procedures (ILO3), (ii) conducting standard laboratory procedures in synthetic and instrumental work related to organic polymers and solid-state materials, and (iii) conducting analysis and interpretation of experimental data related to solid state materials. Shows very limited ability to work independently and collaborate effectively in teamwork	Fails to meet minimum expectations for understanding of the skills for (i) managing the risk of chemical substances and laboratory procedures (ILO3), (ii) conducting standard laboratory procedures in synthetic and instrumental work related to organic polymers and solid-state materials, and (iii) conducting analysis and interpretation of experimental data related to solid state materials. Shows almost no ability to work independently and collaborate effectively in teamwork	ILO3, ILO4, ILO5, ILO6
Product	Demonstrates thorough understanding of the skills in conducting standard laboratory procedures in synthetic and instrumental work related to organic polymers and solid-state materials.	Demonstrates a clear and detailed understanding of the skills in conducting standard laboratory procedures in synthetic and instrumental work related to organic polymers and solid-state materials	Demonstrates some understanding of the skills in conducting standard laboratory procedures in synthetic and instrumental work related to organic polymers and solid-state materials.	Lacks in-depth understanding of the skills in conducting standard laboratory procedures in synthetic and instrumental work related to organic polymers and solid-state materials.	Fails to meet minimal expectations for understanding of the skills in conducting standard laboratory procedures in synthetic and instrumental work related to organic polymers and solid-state materials.	ILO4

Laboratory Reports	Demonstrates thorough understanding of the essential facts, principles and theories across organic and inorganic chemistry related to solid state materials. Connects these elements to relevant course concepts and theories, showcasing a strong understanding of the material.	Provides a clear and detailed understanding of the essential facts, principles and theories across organic and inorganic chemistry related to solid state materials. Makes connections to course material.	Demonstrate some understanding of the essential facts, principles and theories across organic and inorganic chemistry related to solid state materials. Connections to course material may be limited.	Lacks in-depth understanding of the essential facts, principles and theories across organic and inorganic chemistry related to solid state materials. Shows very limited connections to course material.	Fails to meet minimum expectations for understanding of the essential facts, principles and theories across organic and inorganic chemistry related to solid state materials. Shows almost no connection to any course material.	ILO1, ILO2

Final Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates exceptional understanding of laboratory procedures and concepts. Shows meticulous attention to detail in experimental work, analysis, and reporting. Consistently produces high-quality results and exhibits advanced problem-solving skills.
B	Good Performance	Displays a solid grasp of laboratory techniques and concepts. Completes experiments accurately and effectively, with well-organized data collection and analysis. Shows proficiency in applying theoretical knowledge to practical situations.
C	Satisfactory Performance	Shows a satisfactory understanding of laboratory procedures and concepts. Conducts experiments with some degree of accuracy and efficiency, though improvements could be made in data interpretation and analysis. Meets basic requirements but lacks depth in experimentation.
D	Marginal Pass	Demonstrates limited understanding and application of laboratory techniques and concepts. Shows inconsistencies in experimental procedures and data handling. Requires significant enhancement in accuracy, precision, and adherence to safety protocols.
F	Fail	Fails to meet minimum expectations for laboratory work. Exhibits significant deficiencies in understanding, execution of experiments, and safety practices. Lacks basic skills in data collection, analysis, and reporting.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Feedback on assignments will include explanations of why the answer is incorrect. Students who have further questions about the feedback, including marks, should consult the corresponding TA within seven days after the feedback is received.

Required Texts and Materials

- No specific textbook
- Course materials (lab manuals, tutorial videos, etc.) can be downloaded/viewed by logging in to the CANVAS website using your ITSC username and password (https://canvas.ust.hk).

Additional Resources

Reference books:

[1] Kenneth L. Williamson, Katherine M. Masters, Macroscale and Microscale Organic Experiments 7th edition, Australia: Cengage ©2017. (or the 6th edition ©2011)

[2] Dana W. Mayo; Ronald M. Pike; David C. Forbes, "Microscale Organic Laboratory: with Multistep and Multiscale Syntheses" 6th Edition, Wiley Global Education, ©2013. (or the 5th edition ©2011)

[3] Addison Ault, "Techniques and Experiments for Organic Chemistry" 6th Edition, Sausalito, CA: University Science Books ©1998.

[4] Catherine E. Housecroft and Alan G. Sharpe, Inorganic Chemistry 5th edition, Harlow: Pearson Education ©2018. (or the 3rd edition ©2008 [QD151.2 .H68 2008])

[5] James E. House, Inorganic Chemistry 2nd edition, Amsterdam: Academic Press/Elsevier ©2013. [QD151.5 .H68 2013eb]

[6] J. Derek Woollins, Inorganic Experiments 3rd edition, Weinheim: Wiley © 2010. [QD155.I54 2010]

Course AI Policy

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

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance for academic misconduct. Please refer to Academic Integrity | HKUST – Academic Registry for the University's definition of plagiarism and ways to avoid cheating and plagiarism.

Keyword syllabus

- Planar Chromatography & TLC
- Recrystallization of Organic and Simple Inorganic Compounds
- Liquid-Liquid Extraction of Organic Components from a Mixture
- Organic Synthesis
- Nucleophilic Substitution
- Melting Point Measurement
- Infrared Spectroscopy of Organic Compounds
- Synthesis of Transition Metal Complexes with Multi-dentate Ligands
- Spectrochemical Series
- UV-visible Spectroscopy of Inorganic Compounds

CHEM 2550 Synthetic Chemistry Laboratory I

2025 Fall Semester Timetable (LA1 and LA2); Time: 12:30 - 4:20 pm

Week	Date (Tue)	LA1 Activity / Expt. no	Date (Wed)	LA2 Activity / Expt. no
1	2/9	• Mandatory Chem lab safety training (2nd level) by HSEO[%] • Course introduction (by Prof. Chan and Dr. Tse)	3/9	• Mandatory Chem lab safety training (2nd level) by HSEO[%] • Course introduction (by Prof. Chan and Dr. Tse)
2	9/9	Expt. 1 (W)	10/9	Expt. 1 (W)
3	16/9	Expt. 1 (R)	17/9	Expt. 1 (R)
4	23/9	Expt. 2 (W)	24/9	Expt. 2 (W)
5	30/9	Expt. 2 (R)	1/10	Public Holiday
6	7/10	Public Holiday	8/10	Expt. 2 (R)
7	14/10	Expt. 3 (W)	15/10	Expt. 3 (W)
8	21/10	Expt. 3 (R)	22/10	Expt. 3 (R)
9	28/10	No Class	29/10	Public Holiday
10	4/11	Expt. 4 (W)	5/11	Expt. 4 (W)
11	11/11	Expt. 4 (R)	12/11	Expt. 4 (R)
12	18/11	Expt. 5 (W)	19/11	Expt. 5 (W)
13	25/11	Expt. 5 (R) [Make-up & enquiry session]	26/11	Expt. 5 (R) [Make-up & enquiry session]

[%] HSEO = Health Safety and Environment Office (HKUST)

Ex #	Experiment title
1	Planar Chromatography (PC)
2	Recrystallization for Chemical Components and Melting Point Measurement
3	Separation of Chemical Components from a Mixture
4	Organic synthesis (Williamson ether synthesis) and IR Spectroscopy
5	Synthesis of metal chelate complexes and UV-Vis Spectroscopy

CHEM 2550 Synthetic Chemistry Laboratory I

2025 Fall

Course Outline

1. Instructor

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

Name: Dr. TSE, Wai Pui Veronica (email: chvaipui@ust.hk)
Contact Details: Room 4537 (office); Tel: 2358-7364 (office)

2. Technical support staff / Teaching Assistant:

Technical support staff:

Name: LAU, Chun Tak Disney (email: disney@ust.hk)
CHAN, Ka Lok Kelvin (email: chkelvin@ust.hk)
Dr. WONG Yuet Yan Claire (email: chlaire@ust.hk)
CHOI Chai Yu, Edwin (email: edwinchoi@ust.hk)
Contact Details: CYT-1003 & CYT-1004; Tel: 34692611 & 34692612

Teaching Assistant:

Name: [to be provided in a separate file]

3. Meeting Time and Venue:

Date/Time:	LA1 Tuesday	/	12:30 – 16:20
	LA2 Wednesday	/	12:30 – 16:20
Venue:	CYT-1003 and CYT-1004 (Cheng Yu Tung building)		

4. Course Description

Credit Points: 2
Pre-requisite: CHEM 1050 or CHEM 1052
Corequisite: CHEM 2110 and CHEM 2210
Exclusion: CHEM 2155, CHEM 2150 and CHEM 2250
Brief Information/synopsis:

This is the laboratory course designed for students who have enrolled in CHEM 2110 Organic Chemistry I and CHEM 2210 Inorganic Chemistry I. It includes a series of organic and inorganic experiments related to the theory learnt in the lecture courses. Students will be trained to perform a wide range of basic synthetic chemistry laboratory techniques, operate chemical instruments in laboratory, relate the physical and chemical principles and theory in practice and develop their data interpretation and analyzing skills. For CHEM students only.

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.

#	Assessment items	Weighting	ILO(s) to be assessed
1	Risk Assessment	5%	2
2	Lab Quizzes†	25%	1, 2
3	Performance in laboratory	20%	2, 3, 4, 5, 6
4	Product /Results	10%	4
5	Lab Reports	40%	1, 3, 5

† *There will be a short lab quiz 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 the *6th edition* ©2011)

(b) Dana W. Mayo; Ronald M. Pike; David C. Forbes, "*Microscale Organic Laboratory: with Multistep and Multiscale Syntheses*" *6th Edition*, Wiley Global Education, ©2013. (or the *5th edition* ©2011)

(c) Addison Ault, "*Techniques and Experiments for Organic Chemistry*" *6th Edition,* Sausalito, CA: University Science Books, ©1998.

(d) Catherine E. Housecroft and Alan G. Sharpe, *Inorganic Chemistry 5th edition,* Harlow: Pearson Education ©2018. (or the *3rd edition* ©2008 [QD151.2 .H68 2008])

(e) James E. House, *Inorganic Chemistry 2nd edition*, Amsterdam: Academic Press/Elsevier ©2013. [QD151.5 .H68 2013eb]

(f) J. Derek Woollins, *Inorganic Experiments 3rd edition*, Weinheim: Wiley © 2010. [QD155.I54 2010]

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

8. Teaching and Learning Activities

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

9. Course Schedule

Keyword syllabus:

- Thin Layer Chromatography (TLC)
- Recrystallization of Organic and Simple Inorganic Compounds
- Liquid-Liquid Extraction of Organic Components from a Mixture
- Organic Synthesis
- Nucleophilic Substitution
- Melting Point Measurement
- Infrared Spectroscopy of Organic Compounds
- Synthesis of Transition Metal Complexes with Multi-dentate Ligands
- Spectrochemical Series
- UV-visible Spectroscopy of Inorganic Compounds

10. **Regarding score assignment**: *TAs and Technical Supports would discuss before deciding the final score (such as lab performance score)*

CHEM 2555 Molecular Characterisation Chemistry Laboratory I
Course Outline – Fall 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: Alice WONG <tinginwong@ust.hk>; Rowena LEUNG <chlsy@ust.hk>;
Contact: Lab: CYT-3007; Tel: 2358 7402 or 2358 7244

Instructional Assistant:

Name: Anson WONG <wchwong@ust.hk>
Contact: Lab: CYT-3007; Tel: 2358 7402

Teaching Assistants: *Separate file*

3. Meeting Time and Venue

Date & Time:
LA1: Tuesdays 10.30 - 14.20
LA2: Wednesdays 10.30 - 14.20

Venue: CYT-3007

4. Course Description

Credit Points: 2

Pre-requisites: CHEM 1050 Laboratory for General Chemistry I, and [CHEM 2409 Mathematical Methods for Physical Chemistry, or MATH 2351 Introduction to Differential Equations]

Corequisite: CHEM 2410 Physical Chemistry I: Equilibrium Thermodynamics and Statistical Mechanics, and CHEM2310 Fundamentals of Analytical Chemistry

Course Description:
This is a practical course designed for students who are taking the lectures of Physical Chemistry I and Fundamentals of Analytical Chemistry, in which it provides students some hands-on experience, with the use of analytical instruments or physical equipment, to apply what they learned in lectures in practical term. The main topics include electrochemical equilibrium, GC-FID analysis, etc.

Course Objective: With the use of lab equipment and instruments, 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 across the areas of chemistry, i.e. analytical and physical.
2	Formulate and analyze a wide range of chemical problems by applying relevant chemical principles.
3	Analyze and interpret experimental data, critically assess and extract useful data from it.
4	Conduct standard laboratory procedures involved in instrumental and experimental 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	Determination of *n*-Heptane, *n*-Octane and *n*-Decane in Unknown Samples using Gas Chromatograph-Flame Ionisation Detector (GC-FID)
2	Second Law of Thermodynamics: Entropy Variation with Temperature
3	Quantitative Analysis of *p*-Xylene using Fourier Transform-Infrared Spectrometry (FT-IR)
4	Electrochemical Equilibrium: Measurement of the Standard Electrode Potential and Gibbs Energy in an Electrochemical System
5	Calibration of Volumetric Glassware

8. Student Learning Resources

- Peter Atkins, Julio de Paula, James Keeler, *Atkins' Physical Chemistry*, 11th Ed, Oxford University Press, 2018.
- Daniel C. Harris, Charles A. Lucy, *Quantitative Chemical Analysis*, 10th Ed, Macmillan Learning, 2020

9. Teaching and Learning Activities

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

The Hong Kong University of Science and Technology

UG Course Syllabus

Great Ideas in Chemistry

CHEM 3010

3 Credits

Prerequisite(s): Any CHEM course at or above 1000-level or CORE 1120

Mode of Study: [BLD] Blended Learning

Name: Prof. Ian WILLIAMS

Email: chwill@ust.hk

Teaching Assistant:LI Jiawen (Email: jliki@connect.ust.hk**)**

Course Description

This course is intended for Chemistry and other Science majors with some high school background in Chemistry. It covers many major advances, **historical developments** and **contemporary applications** of critical concepts in Chemistry. These may range from atomic theory and identification and arrangement of the elements to modern problems such as CO_2 and global warming; pollution and environmental clean-up. Unlike other Chemistry courses it will focus on the **background** to our knowledge, on what **experimental evidence** our **current theories** are based, and how old ones were **overturned** or **modified**. In addition to course assessment by assignment, in-class quizzes and discussion there will be a short mid-term test, and a short end of term 10-min presentation (groups of 2-3).

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1. Develop a sounder knowledge based on examples from chemistry, physics and other disciplines.
2. Have a better understanding of scientific method and knowledge of history of science and chemistry.
3. More aware in revolution and evolution of scientific theories and the relationship of science, technology and society.

4. Review the ethical behavior of scientists in both collaboration and competition.
5. Develop critical reasoning.
6. Communicate more effectively in speaking and writing and presentation skills.
7. Demonstrate self-awareness, work independently and collaborate effectively with other people in a team.

Assessment and Grading

This may be modified based on final enrolment but following is suggested:

On-line Work and Quizzes	25%
In-class Discussion and Quizzes	25%
Mid-term test (1 hr)	25%
Term Presentations	25%

There will be 16 Lecture modules most of which have been video-taped. You will access the video clips through this Canvas web-site.

Proposed Dates for in-class group activities

Generally on Wed afternoons

3 Sept (Wed) Class Intro

17 Sept (Wed)

3 Oct (Fri)

15 Oct (Wed)

24 Oct (Fri)

5 Nov (Wed)

12 Nov (Wed) Revision class

19 Nov (Wed) 1hr Exam (Open book)

26 Nov (Wed) Presentation preparation

5 Dec (Fri) (Study break) - **Small Group Presentations** by Zoom

Please attend the classes on the above days. Attendance will be taken.

Aims of the Course:

Knowledge development: based on examples from Chemistry, Physics and other disciplines

Understanding of Scientific Method

Knowledge of History of Science and Chemistry

Revolution and Evolution of Scientific Theories

Relationship of Science, Technology and Society

Skill Development:

Critical reasoning

Discussion and presentation skills

Working as part of a team

Part 1. Atoms: the Foundation of Chemistry

Lectures 1 & 2. We are Stardust and Origin of the Elements

1. A brief history of everything; Concept and proof of atoms; Composition of Matter; Size scales - time and space; Expanding Universe; Big-bangs and big crunches; Cosmic abundance of the elements.

2. How the elements were formed; Big bang; Stellar Nucleosynthesis; Supernova Explosions; Spallation; Mass = Energy; Fission and Fusion; Nuclear power; Thorium versus Uranium.

Lectures 3 & 4 . A Brief History of Science and Alchemy back to Atoms

3. What is Science and what is Chemistry ? History of Science and the Scientific Method; Galileo, the first scientist ?; Overview of History of Chemistry; Materials, Metals and Ancient man; The seven ancient metals; the Egyptians; the Greeks and Romans; the Middle-east; early Chinese science;

4. Alchemy; Paracelsus; Hennig Brand & Phosphorus; Phlogiston theory; The Fathers of Modern Chemistry; Robert Boyle - the End of Alchemy; Lavoisier Law of Conservation of Mass; Proust - Law of Definite Proportions; Dalton and 'modern' atomic theory;

Lectures 5 & 6. Discovering the Elements and The Periodic Table

5. The gases - Black, Priestley, Cavendish, Rutherford; Scheele; The metals - Davy; Klaproth; Berzelius; Bunsen; Ramsey - Noble gases; The Radioactive elements - Becquerel; Marie Curie; Seaborg - nuclear reactions; Lise Meitner- Nuclear power and weapons; Modern alchemy - making new Super-heavy elements;

6. Dobereiner- triads; Gmelin; Newlands- Octaves; Meyer - the first Periodic Table; Odling's table; Mendeleev - the predictor; Modern and Exotic Periodic tables.

Part 2. **Molecules: Bonding, Structures, Reactions**

Lectures 7 & 8: **Models of the Atom and History of the Chemical Bond**

7. Berzelius - atomic masses; Prout's Hypothesis; Modern Theories: Thompson, van den Broek; Rutherford, Atomic numbers - Moseley; Bohr; Neutrons and Isotopes; Periodicity and Periodic properties; Quantum numbers; Atomic structure; Aufbau Principle; Electronic configurations;

8. Lewis - electron pair theory; Kossel -ionic bonds; Pauling -electronegativity and polar bonds; Hydrogen bonds; Modern DFT theory; Bond energies; Multiple bonds; FA Cotton; M-M quadruple bond; Ce=O double bond; Three center bonding; 2013 Nobel Prize; Computation and the Future

Lectures 9 & 10: **Molecular Shapes and X-ray Crystallography**

9. Avagadro - Cannizarro; Concept of molecules; Frankland - Valence; Organic molecules -Michael Faraday; Lines as Bonds - Scott-Coupar and Crum Brown; Ring Structure of Benzene - Kekule & Lohschmidt;Great Ideas - Tetrahedral Carbon Van't Hoff and LeBel; Conformers, enantiomers and diastereomers; Fischer - Sugars; Werner - Coordination isomers;

10. X-rays; Rontgen; von Laue; Bragg's; X-ray diffraction; Simple structures - NaCl, ZnS, diamond; SiO_2; Benzene; graphite; Kathleen Lonsdale; Bijvoet - absolute structure; Dorothy Hodgkin; Rosalind Franklin; Lawrence Bragg at Cambridge; Perutz and Kendrew - Hemoglobin; Crick and Watson; Philips - Structural Biology; Bragg Centenary; IYCr2014

Lectures 11 & 12: Chemical Reactions and Chemical Synthesis

11. Combustion and corrosion; REDOX, Acid-base and Bond-forming reactions; Boltzmann-physical meaning of Temperature; Van't Hoff: Kinetics and Equilibria; Arrhenius - Rate Law; Ostwald - Catalysis; Enzymes; Gibbs - Chemical thermodynamics;

12. Named reactions - the greats of Organic chemistry; von Baeyer; Fischer; Chemical toolkit - making something new; R.B. Woodward - Total synthesis - quinine; E.J. Corey - Retrosynthesis; Inorganic and Organometallic Chemistry;

Week 10: **Mid Term Review and Discussion.** **Exam (on Parts 1 and 2)**

Part 3. **Chemistry in the Modern World**

Lectures 13-15 **Chemical Analysis: Elements and Separations**

13. Qualitative and Quantitative analysis; Accuracy and Precision; Methods of Elemental analysis; Atomic spectroscopies; Mass spectra – Aston: Discovery of Isotopes; ICP-MS; Isotope analysis; Methods of Dating; Past Climate Reconstruction; X-ray methods

14. Great ideas – Chromatography history and types; gc and lc applications; Food; Forensics; Melamine; MS-MS; Biological MS Spectroscopy: absorption/ emission of light; Great Ideas - NMR spectroscopy; Electronic spectroscopy: Ozone; Ozone hole; Rowland ban on CFCs; Vibrational spectroscopy: CO2 and Global Warming; Keeling curve; Carbon capture.

Lecture 16 Life - A Chemical Evolution

16. Early Ideas of Biochemistry; Developments in the 1800's; Composition of Biomolecules; Proteins and DNA; Sugars and Fats; After the Double Helix; Crick – the Genetic Code; Saenger – two Nobels; Modern Biotechnology – Drug Design; Kary Mullis – CPR; Human genome project; Definition of Life; where Chemistry meets Biology; In the beginning – primordial swamp; Urey – biomolecules; My name is LUCA; the tree of life; RNA world; Man versus virus; Biosensors; Life on other worlds; Review: from the beginning to the end of time.

Lectures 11 & 12: Chemical Reactions and Chemical Synthesis

11. Combustion and corrosion; REDOX, Acid-base and Bond-forming reactions; Boltzmann-physical meaning of Temperature; Van't Hoff: Kinetics and Equilibria; Arrhenius - Rate Law; Ostwald - Catalysis; Enzymes; Gibbs - Chemical thermodynamics;

12. Named reactions - the greats of Organic chemistry; von Baeyer; Fischer; Chemical toolkit - making something new; R.B. Woodward - Total synthesis - quinine; E.J. Corey - Retrosynthesis; Inorganic and Organometallic Chemistry;

Week 10: Mid Term Review and Discussion. Exam (on Parts 1 and 2)

Part 3. Chemistry in the Modern World

Lectures 13-15 Chemical Analysis: Elements and Separations

13. Qualitative and Quantitative analysis; Accuracy and Precision; Methods of Elemental analysis; Atomic spectroscopies; Mass spectra – Aston: Discovery of Isotopes; ICP-MS; Isotope analysis; Methods of Dating; Past Climate Reconstruction; X-ray methods

14. Great ideas – Chromatography history and types; gc and lc applications; Food; Forensics; Melamine; MS-MS; Biological MS Spectroscopy: absorption/ emission of light; Great Ideas - NMR spectroscopy; Electronic spectroscopy: Ozone; Ozone hole; Rowland ban on CFCs; Vibrational spectroscopy: CO2 and Global Warming; Keeling curve; Carbon capture.

Lecture 16 Life - A Chemical Evolution

16. Early Ideas of Biochemistry; Developments in the 1800's; Composition of Biomolecules; Proteins and DNA; Sugars and Fats; After the Double Helix; Crick – the Genetic Code; Saenger – two Nobels; Modern Biotechnology – Drug Design; Kary Mullis – CPR; Human genome project; Definition of Life; where Chemistry meets Biology; In the beginning – primordial swamp; Urey – biomolecules; My name is LUCA; the tree of life; RNA world; Man versus virus; Biosensors; Life on other worlds; Review: from the beginning to the end of time.

CHEM 4110 Structural Elucidation in Organic Chemistry — Fall Term 2025

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

Teaching Assistant: Hongping Chu

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 5402 from 9:00-10:20 on every Tuesday and Thursday.

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 4120 Biomolecular Chemistry

Fall semester, 2025

INSTRUCTOR:

Zhihong Guo
Rm. 4519, Tel. 2358-7352
Email: chguo@ust.hk
Office hour: By appointment

TEACHING ASSISTANT:

Lingfeng Zhang
Rm. 6123
Email: lzhangdl@connect.ust.hk

COURSE SUMMARY:

This course will introduce the fundamental chemical principles underlying the structure, properties, and functions of biologically important molecules. Using the chemical concepts of bonding, structure, and structure-reactivity relationships developed in organic chemistry, this course will cover topics on the stereochemistry, structural diversity, physicochemical properties, and reactivity of amino acids, peptides, proteins, nucleic acids, carbohydrates, and lipids to understand the molecular basis of their biological functions. Another major topic of this course is the preparation of these important biological molecules for understanding of their functions and exploitation of their biotechnological and medicinal values, using available organic chemistry methods. *Prerequisite*: CHEM3120, Organic Chemistry II.

Lecture Time: Monday 15:00-16:20 pm; and Friday 10:30-11:50am

Venue: Rm. 1527.

Course Website: http://canvas.ust.hk/, use ITSC user name and password.

Course Materials: From selective textbooks, research reviews, and research papers.

1. "*Organic Chemistry*" 8th edition by J. McMurry; Brooks/Cole, Cengage Learning. 7th edition, QD251.3 .M364 2008, 4 copies.
2. "*Peptide chemistry: a practical textbook*" 2nd edition, Miklos Bodanszky, Springer-Verlag, c1988. Call number: QP552.P4 B629 1988.
3. "Introducing Proteomics" Josip Lovrić, Wiley-Blackwell, 2011. Call number: QP551.L68 2011.
4. *"Biochemistry of Lipids, Lipoproteins and Membranes"* 4th and 5th editions, D.E. Vance and J.E. Vance (Eds.), Elsevier 2002 and 2008. 4th Ed: QP 751.B55.2002; 5th Ed: QP751.B55.2008eb, online access: http://catalog.ust.hk/catalog/archives/769210.

5. "*Carbohydrates: synthesis, mechanisms, and stereoelectronic effects*" by Momčilo Miljković , Springer c2009. Call number: QD321 .M55 2009eb. Online access through SpringerLink: http://www.springerlink.com/content/gm7201/?MUD=MP.
6. "*Carbohydrates: the sweet molecules of life*" by Robert V. Stick, Academic Press, c2001. Call number: QD321 .S84 2001.
7. "*Nucleic acids in chemistry and biology*" 3rd ed. / edited by G. Michael Blackburn et al., RSC Pub., c2006. Call number: QD433.N83 2006.
8. "*Principles of nucleic acid structure*" by Stephen Neidle, 1st ed. Elsevier: Academic Press, 2008. Call number: QD433 .N43 2008. Online access through Elsevier: http://www.sciencedirect.com/science/book/9780123695079.

EXAMS AND GRADING SCHEME:

1. Midterm exam: 50%.
2. Final exam: 50%

COURSE OBJECTIVES AND INTENDED LEARNING OUTCOMES:

This course is dedicated to fundamental principles governing the structure, properties, and functions of biologically important molecules. It is designed to better prepare chemistry majors and other students for careers related to biologically important molecules in industry, government agencies, or academic institutions. Upon the end of the course, students should be able to:

1 To understand and recognize the fundamental chemical principles underlying the structure, properties, and functions of biologically important molecules.

2 To explain the essential facts, principles, and theories of the behaviours and properties of molecules in biological processes.

3 To understand the favourable and unfavourable interactions of living organisms with nature and environment to better appreciate the significance of regulation of food safety and environmental pollution.

4 To use the biologically important molecules in elucidation of their biological functions.

5 To formulate synthetic strategy for preparation of biological molecules for biotechnological and medicinal purposes.

Syllabus

	Dates	Subjects
Week 1	Sept. 1	Introduction
	Sept. 5	Amino acids, peptides and proteins
Week 2	Sept. 8	Synthesis of amino acids and peptides
	Sept. 12	Solid-state synthesis of peptides
Week 3	Sept. 15	Synthesis of proteins
	Sept. 19	Analysis of amino acids and proteins: Mass spectroscopy
Week 4	Sept. 22	Peptide fingerprinting of proteins
	Sept. 26	Proteomics
Week 5	Sept. 29	Lipids—Fatty acids, wax, and triacylglycerols
	Oct. 3	Lipids—Components and structure of cell membranes (1)
Week 6	Oct. 6	Lipids—Components and structure of cell membranes (2)
	Oct. 10	***No Class, Chung Yeung Festival***
Week 7	Oct. 13	Biosynthesis of lipids and drug development
	Oct. 17	Carbohydrates—Stereochemistry and hemiacetal forms
Week 8	Oct. 20	**Mid-term exam, in class.**
	Oct. 24	Carbohydrates—Reactions of monosaccharides
Week 9	Oct. 27	Carbohydrates—Di-, oligo- and polysaccharides
	Oct. 31	Carbohydrates—Synthesis of oligosaccharides
Week 10	Nov. 3	DNA structure, properties, and reactivity (1)
	Nov. 7	DNA structure, properties, and reactivity (2)
Week 11	Nov. 10	DNA replication and amplification
	Nov. 14	DNA chemical synthesis
Week 12	Nov. 17	DNA sequencing (1)
	Nov. 21	DNA sequencing (2)
Week 13	Nov. 24	RNA structure and properties
	Nov. 28	RNA functions
Week 14	Dec. 1-6	**Study Break**
Final exam	**Dec.8-19**	**To be announced**

CHEM 4140 Intermediate Organic Chemistry: Fall Semester (1 Sept – 29 Nov 2025)

INSTRUCTOR	Prof. HUANG, Yong
	Office: 4530
	Telephone: 3469 2625
	E-mail: yonghuang@ust.hk
TEACHING ASSISTANTS	ZHAO, Yicheng; yzhaoeq@connect.ust.hk

LECTURE TIME	Mon. 9:00 – 10:20 AM
	Wed. 9:00 – 10:20 AM
CLASS VENUE	Rm 5560, Lift 27/28

COURSE DESCRIPTION:

Provides further training in the multistep organic synthesis of natural and unnatural products and will focus on retrosynthetic analysis, control of stereochemistry, carbonyl group chemistry, and pericyclic reactions with a brief coverage of new synthetic methodologies for the efficient synthesis of compound libraries. A prerequisite for students wishing to take CHEM 5110/5120 as part of their undergraduate programme. Prerequisite(s): CHEM 3120.

REFERENCE BOOKS:

1. "Advanced Organic Chemistry, Part A & Part B; 5th Ed", by Francis A. Carey and Richard J. Sundberg, New York: Springer, 2007.
2. "Organic Chemistry: an intermediate text; 2nd Ed", by Robert V. Hoffman; Hoboken, N.J.: Wiley-Interscience, 2004.
3. "Organic Synthesis; 4th Ed", by Michael B. Smith; Irvine, CA: Academic Press, 2017.
4. "Organic Synthesis: strategy and control", by Paul Wyatt and Stuart Warren; Chichester, England: John Wiley, 2007.
5. "Organic Synthesis: the disconnection approach; 2nd Ed", by Stuart Warren and Paul Wyatt; Chichester, UK: John Wiley & Sons Ltd., 2008.
6. "Molecules That Changed The World," by K. C. Nicolaou, T., Montagnon, and Weinheim: Wiley-VCH 2008.

COURSE OBJECTIVES AND INTENDED LEARNING OUTCOMES:

This course will treat selected topics in synthetic organic chemistry from a mechanistic viewpoint and illustrate their usefulness in the synthesis of designed organic molecules and

natural products. This course aims to provide an introduction to multistep organic synthesis and new developments in synthetic methodologies essential for pharmaceutical research and application. It also seeks to encourage students to raise their interest in a career in chemical research and development, either within a university or in industry.

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

1. Recognize and explain essential facts, principles, and theories of organic chemistry, including structures, stereochemistry, reaction mechanisms, and main transformations of carbon-derived compounds.
2. Demonstrate awareness and appreciation of synthetic organic chemistry topics relevant to advancements in social and daily life.
3. Formulate and analyze synthetic planning and products of multistep organic transformations by applying the principles of retrosynthetic analysis.
4. Communicate effectively in the community of synthetic organic chemistry, both orally and in writing.

SYLLABUS

Module 1: Introduction to Organic Chemistry

- Brief revision of atomic theory and the periodic table

- The impact of organic molecules on life

- Importance of chemical synthesis, including total synthesis of natural products

Module 2: Stereochemistry Part I

- Molecular chirality and stereoisomerism

- Fischer convention and CIP convention

- Chiral centers and axes

- Chirality, symmetry, and optical activity

- Physical properties of enantiomers

- Prochiral relationship, stereochemical drawing techniques, and analysis

- Conformations of acyclic alkanes, alkenes, aldehydes, and ketones

- Conformations of cyclohexanes, cyclohexenes, and cyclohexanones

- A values, 1,3-allylic strain, stereoelectronic effect, and anomeric effect

Module 3: Stereochemistry Part II: Stereochemistry of Reactions

- Chemoselectivity, regioselectivity, and stereoselectivity in reactions

- Heterogeneous and homogeneous catalytic hydrogenation
- Polar group directing effects
- Hydride reduction of acyclic ketones and cyclohexanones
- Nucleophilic addition to acyclic carbonyl groups
- Cram's rule and Felkin-Ahn model
- 1,3-asymmetric induction on reduction of β-hydroxyketones
- Chelation control in reduction and Grignard addition
- Houk conformation for reactions of alkenes
- Sharpless asymmetric epoxidation (AE) and asymmetric dihydroxylation (AD)

Module 4: Retrosynthetic Analysis & Synthetic Strategy

- Bond disconnection and retrosynthetic steps
- Convergent synthesis
- Normal and umpolung synthons
- Functional group interconversion (FGI) and functional group addition (FGA)
- Selected strategies for reaction control

Module 5: Functional Group Interconversion

- Mitsunobu reaction
- Conversion of alcohols
- Formation of esters from alcohols
- Formation of amides
- Cleavage of ethers and esters using TMSI
- Reduction of carbonyl compounds
- Reductive amination
- CBS reduction
- Swern oxidation
- Dess–Martin periodinane reagents

Module 6: Carbonyl Group Chemistry I

- Grignard and organolithium reagents
- Addition reactions with carbonyls
- Wittig olefination and its variations
- Horner-Wadsworth-Emmons (HWE)
- Schlosser modifications
- Peterson olefination
- Julia olefination

Module 7: Carbonyl Group Chemistry II

- Chemo- and regio-selectivity in enol and enolate formation
- Regio-, stereoselective aldol reactions
- The Zimmermann–Traxler transition state
- Open transition state
- Controlling selectivity in aldol reactions
- Mukaiyama aldol reactions
- Chiral enolates of Evans auxiliaries
- Proline-catalyzed asymmetric aldol
- Robinson annulation

Module 8: Pericyclic Reactions

- Diels-Alder reactions
- Stereoselectivity in DA reactions
- Catalyzed DA reactions

Module 9: Case Study - Total synthesis of amphidinolides

- Olefin Metathesis
- Fürstner's total synthesis of T1, T3 and T4
- Ghosh's total synthesis of T1
- Jamison's total synthesis of T1
- Dai's total synthesis of T2

Module 10: Cross-Coupling Reactions

- Introduction to cross-coupling reactions

- The catalytic cycle of Pd-catalyzed coupling

- Various Palladium-catalyzed cross-coupling reactions (Suzuki, Stille, Negishi, Sonogashira, Heck)

Module 11: Diversity-Oriented Synthesis and Multicomponent Reactions

- Principles of diversity-oriented synthesis

- Multicomponent reactions

- Passerini reaction (P-3CR)

- Ugi reaction (U-4CR)

CLASS SCHEDULE

Week 1	Sept. 1	*1-brief history and impact of organic chemistry*
	Sept. 3	*2-Molecular chirality, stereoisomers, Fischer and CIP*
Week 2	Sept. 8	*3-chiral centers, axis chirality, symmetry*
	Sept. 10	*4-optical activity, enantiomers, prochirality, drawings*
Week 3	Sept. 15	*5-Conformations, A values, $A^{1,3}$ strain, anomeric effect*
	Sept. 17	*6-Selectivity, hydrogenation, hydride addition*
Week 4	Sept. 22	*7-Nucleophilic addition, Cram and Felkin-Ahn models*
	Sept. 24	*7-Nucleophilic addition, Cram and Felkin-Ahn models, continued*
Week 5	Sept. 29	*8-Chelation control, the Houk conformation*

	Oct. 1	*No Class (The National Day)*
Week 6	Oct. 6	*9-Sharpless epoxidation and dihydroxylation*
	Oct. 8	*10-Retrosynthetic Analysis, synthons, umpolung*
Week 7	Oct. 13	*11-FGI: Mitsunobu, conversion of alcohols*
	Oct. 15	*12-FGI: Interconversion among carboxylic derivatives*
Week 8	Oct. 20	*13-FGI: Reduction and oxidation*
	Oct. 22	*14-Carbonyls I: Grignard, Li-exchange, Nu addition*
Week 9	Oct. 27	*15-Carbonyls I: Olefination: Wittig, HWE, etc.*
	Oct. 29	*No Class (Chung Yeung Festival)*
Week 10	Nov. 3	*16-Carbonyls II: Enolates, Aldol, Zimmermann-Traxler*
	Nov. 5	*17-Carbonyls II: Aldol continued, Mukaiyama aldol, Evans auxiliary*
Week 11	Nov. 10	*18-Carbonyls II: Proline-catalyzed aldol (organocatalysis)*
	Nov. 12	*19-Pericyclic Reactions: Diels-Alder, stereoselectivity*
Week 12	Nov. 17	*20-Cross-Coupling Reactions: mechanisms, variants and applications*

	Nov. 19	*21- Total Synthesis Case Study – Amphidinolide*
Week 13	Nov. 24	*22-DOS: multicomponent reactions, Passerini, Ugi*
	Nov. 26	*23-Tutorial*
	Dec. 2-7	*Study Break*
	Dec. 9-20	*Final Examination (TBD)*
EXAMS AND GRADING SCHEME: Final Examination (100%)		

SUPPORTING READING MATERIALS AND SOLUTION MANUAL

Call Number QD251.2 .C36 2007eb

TITLE: Advanced Organic Chemistry, 5th Ed.

AUTHOR Francis A. Carey and Richard J. Sundberg

IMPRINT New York: Springer, c2007

Online access to the 4th ed. can be found at: https://chemistlibrary.files.wordpress.com/2015/07/advanced-organic-chemistry-4ed-2000-part-a-structure-and-mechanisms-carey-sundberg.pdf

Call Number QD251.2 .H58 2004

TITLE: Organic Chemistry: An Intermediate Text, 2nd ed.

AUTHOR: Hoffman, Robert V

IMPRINT Hoboken, N.J.: Wiley-Interscience, c2004

Call Number QD262 .W284 2008

TITLE: Organic Synthesis: The disconnection approach, 2nd ed.

AUTHOR: Warren, Stuart G

IMPRINT Chichester, UK: John Wiley & Sons Ltd., 2008

Call Number QD262 .W89 2007

TITLE: Organic Synthesis: strategy and control

AUTHOR: Paul Wyatt and Stuart Warren

IMPRINT Chichester, England: John Wiley, c2007

Call Number QD262 .S65 2017

TITLE: Organic Synthesis, 4th Ed.

AUTHOR: Smith, Michael

IMPRINT Amsterdam: Academic Press, c2017

Call Number QD262 .S65 2010

TITLE: Organic Synthesis, 3rd ed.

AUTHOR: Smith, Michael

IMPRINT [Irvine, CA]: Wavefunction, Inc., [2010]

Call Number QD262 .N53 2008

TITLE: Molecules That Changed The World

AUTHOR: Nicolaou, K. C

IMPRINT Weinheim : Wiley-VCH, c2008

CHEM 4150 Biomolecular Synthesis Laboratory

2025 Fall semester

Course Outline

1. Instructors

Name: Dr. TSE. Wai Pui Veronica (chvaipui@ust.hk)
Contact: Office Room 4537; Tel: 2358-7364
Dr. CHAN, Ho-Wai Dennis (chanhw@ust.hk)
Contact: Office Room 4528; Tel: 3469-2099

2. Technician/ Instructional Assistant/ Teaching Assistant:

Technical support:
Name: WONG, Yuet Yan Claire (chclaire@ust.hk)
Contact: Laboratory CYT-1003; Tel: 3469-2611
Teaching Assistants: [names & contact details will be provided in a separate file.]

3. Meeting Time and Venue:

Date/Time: CHEM 4150 Thu (10:30 – 13:20)
Venue: CYT-1004 and CYT-1003

4. Course Description

CHEM 4150 [1 Credit]
Pre-requisite: CHEM 3550
Co-requisite: CHEM 4155
Exclusion: nil
Brief Information/synopsis:
This course provides hands-on experience for students in the biomolecular chemistry option. It focuses on preparation/synthesis of molecules of biological relevance.

5. Intended Learning Outcomes

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

1	Recognize fundamentals of chemistry including structure, reativity and properties of chemical substances, and the states of matter.
2	Explain the essential facts, principles and theories across organic and inorganic chemistry related to biomolecular chemistry.
3	Assess and manage the risk of chemical substances and laboratory procedures, and to evaluate their potential impact on the environment.
4	Conduct standard laboratory procedures involved in synthetic work related to biomolecular chemistry.
5	Conduct analysis and interpretation of experimental data related to biomolecular chemistry.
6	Work independently and collaborate effectively 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.

#	Assessment items	Weighting	ILO(s) to be assessed
1	Risk assessment	5%	3
2	Laboratory Quiz†	25%	1, 2
3	Laboratory Performance	20%	3, 4, 5, 6
4	Product/Result	10%	4
5	Laboratory Reports	40%	1, 2, 5

†*There will be a short lab quiz before each experiment.*

7. Student Learning Resources

Reference books:

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

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

** Course materials can be downloaded by logging in to the CANVAS website using your ITSC username and password (https://canvas.ust.hk).*

8. Teaching and Learning Activities

Tutorial + Laboratory work related to preparative chemistry related to biomolecular chemistry area.

9. Keyword Syllabus

- Synthesis of Platelet Aggregation Inhibitor
- Acylation reactions and Chemoselectivity
- Preparation of Poly-Arcylamide Gel
- Radical Chain-Growth Polymerization
- Extraction of Nucleic Acid from Plant Material
- Extraction of Nucleic Acid from Bacteria Sample
- Protection of Hydroxyl Groups for Carbohydrates
- Regioselective Substitution Reactions
- Diastereoselectivity Control in Substitution Reactions
- Glycosidation Reactions

CHEM 4155 Biomolecular Characterization Laboratory

2025 Fall semester

Course Outline

1. Instructors

Name: Dr. TSE, Wai Pui Veronica (chvaipui@ust.hk)
Contact: Office Room 4537; Tel: 2358-7364
Dr. CHAN, Ho-Wai Dennis (chanhw@ust.hk)
Contact: Office Room 4528; Tel: 3469-2099

2. Technical support / Teaching Assistant:

Name: WONG, Yuet Yan Claire (chclaire@ust.hk)
Contact: Laboratory CYT-1003; Tel: 3469-2611
Teaching Assistants: [names & contact details to be provided in a separate file.]

3. Meeting Time and Venue:

Date/Time: CHEM 4155 Thu (13:30 – 16:20)
Venue: CYT-1004 and CYT-1003

4. Course Description

CHEM 4155 [1 Credit]
Pre-requisite: CHEM 3555
Co-requisite: CHEM 4150
Exclusion: nil
Brief Information/synopsis:
This course provides hands-on experience for students in the biomolecular chemistry option. It focuses on characterization of biologically relevant molecules.

5. Intended Learning Outcomes

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

1	Recognize fundamentals of chemistry including structure, reativity and properties of chemical substances, and the states of matter.
2	Explain the essential facts, principles and theories across organic and inorganic chemistry related to biomolecular chemistry.
3	Assess and manage the risk of chemical substances and laboratory procedures, and to evaluate their potential impact on the environment.
4	Conduct standard laboratory procedures involved in instrumental work related to biomolecular chemistry.
5	Conduct analysis and interpretation of experimental data related to biomolecular chemistry.
6	Work independently and collaborate effectively 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.

#	Assessment items	Weighting	ILO(s) to be assessed
1	Risk assessment	5%	3
2	Laboratory Quiz†	25%	1, 2
3	Laboratory Performance	20%	3, 4, 5, 6
4	Product/Result	10%	4
5	Laboratory Reports	40%	1, 2, 5

†*There will be a short lab quiz before each experiment.*

7. Student Learning Resources

Reference books:

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

(b) "*Principles of Instrumental Analysis*" *7th edition*, by D. A. Skoog, F. J. Holler, S. R. Crouch. Australia: Cengage Learning ©2007 [2018]. E-Book in HKUST Library: https://ebookcentral.proquest.com/lib/hkust-ebooks/detail.action?pq-origsite=primo&docID=6351262

(c) "*Gel electrophoresis of proteins: a practical approach*" *3rd edition*, by B.D. Hames (editor), New York: Oxford University Press, ©1998.

* *Course materials can be downloaded by logging in to the CANVAS website using your ITSC username and password (https://canvas.ust.hk).*

8. Teaching and Learning Activities

Tutorial + Laboratory work related to preparative chemistry and chemical analysis.

9. Keyword Syllabus

- Spectrophotometric Assay for Protein Concentration
- Characterization by FT-IR spectroscopy
- Characterization by ^{1}H-NMR spectroscopy
- Analysis of Protein by Electrophoretic Method - SDS PAGE
- Analysis of Nucleic Acid by Agaorse gel Electrophoresis
- Characterization by MALDI-Tof MS
- Characterization by UV spectroscopy
- Chemical analysis by GC-FID
- Determining Diastereoselectivity by High Resolution ^{1}H-NMR Spectroscopy

The Hong Kong University of Science and Techonology

UG Course Syllabus

Cheminformatics

CHEM 4160

3 Credits

Prerequisites: CHEM 2110 AND (CHEM 2409 OR MATH 2351 OR DASC 2010)

Name: Fu Kit SHEONG
Email: chemfksheong@ust.hk
Office Hours: Thursday 12:30-3:30 pm

Course Description

The course provides a general introduction to the field of cheminformatics, covering the conceptualization, classification and codification of chemical information and data, structures and reactions. Students will learn the terminology, methods and the practical workflow of cheminformatics. Students will then apply these principles working in a project, which involves definition of problem, data mining and analysis, modelling including use of AI, prediction of properties, problem outcomes, and proposing future directions for experimental work.

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able:

1. Recognize the scope, methods and terminology of Cheminformatics.
2. Describe classification and encoding of chemical information, data, structures and reactions.
3. Demonstrate the skills of retrieving and analyzing information relevant to a particular problem through data mining and database searching.
4. Select the correct cheminformatics techniques for a given goal.
5. Assemble various cheminformatics methods to solve a chemical problem as a project.

Assessment and Grading

Written Proposal of a Cheminformatics Project (40%)
- Submission deadline: 9th November, 2025

Proposal Defense OR Completed Project (60%)
- [Defense] 26th November, 2025
- [Project] 7th December, 2025

Course AI Policy

The responsible use of Generative AI in project with proper acknowledgement is permitted and encouraged.

Suggested Reading

- An Introduction to Chemoinformatics – Leach & Gillet, Springer, 2007.
- Chemometrics: Statistics & Computer Application in Analytical Chemistry – Otto, Wiley Online Library, 2016.

Course Schedule

Week 1	1st Sept	Topic 01	Course Intro and the Mindset of Cheminformatics
	3rd Sept	Topic 02	Workflow of Cheminformatics
Week 2	8th Sept	-	*Class cancelled due to typhoon*
	10th Sept	Topic 03	Understanding Representation
Week 3	15th Sept	Topic 04	Representing Molecular Topology
	17th Sept	Topic 05	Representing Molecular Properties
Week 4	22rd Sept	Topic 06	Chemical Data Acquisition
	24th Sept	-	*Class cancelled due to typhoon*
Week 5	29th Sept	Topic 07	Quantifying Dissimilarities
	1th Oct	-	*National Day*
Week 6	6th Oct	Topic 08	Quantifying Similarities
	8th Oct	Topic 09	Visualizing Chemical Data
Week 7	13th Oct	Topic 10	Dimensionality Reduction I
	15th Oct	Topic 11	Dimensionality Reduction II
Week 8	20st Oct	Topic 12	Cluster Analysis in Cheminformatics
	22th Oct	Topic 13	Regression Analysis in Cheminformatics
Week 9	27th Oct	Topic 14	Tree-based Methods in Cheminformatics
	29th Oct	-	*Chung Yeung Festival*
Week 10	3th Nov	Topic 15	Neural Networks in Cheminformatics I
	5th Nov	Topic 16	Neural Networks in Cheminformatics II
Week 11	10th Nov	Topic 17	Model Validation
	12th Nov	Topic 18	Case Studies: Catalyst Design
Week 12	17th Nov	Topic 19	Case Studies: Drug Discovery
	19nd Nov	Topic 20	Case Studies: Energy Functions
Week 13	24th Nov	Topic 21	Case Studies: Material Design
	26th Nov	Assessment + Topic 22	Oral Defense of Project Proposals + Reflections on Cheminformatics

CHEM 4220
Materials Chemistry
Fall 2024

Instructors:

Dr. Haipeng Lu (Assistant Professor)
Room: 4533, Lift 25/26
Tel: 3469-2097
E-mail: haipenglu@ust.hk

Teaching Assistants:

Feng, Jianning (Jack), Email: jfengas@connect.ust.hk

Lectures:

Mon, Wed 12:00-13:20 Rm 1409 (Lift 25/26)

Course Website:

Canvas: https://canvas.ust.hk/courses/64837

COURSE DESCRIPTION

An introductory upper level UG course in materials chemistry for students interested in the fundamental principles governing inorganic and organic materials. Crystalline solids, polymers, nanomaterials, preparative methods, characterization techniques, and properties.

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY
Calendar Dates in the 2025-26 Academic Year

Week	S	M	T	W	T	F	S	Events	General Holidays
	August, 2025								
						1	2		
	3	4	5	6	7	8	(9)	9 Last day of Summer Term, 2024-25	
	10	11	12	13	14	15	16		
	17	18	19	20	21	22	23		
	24	25	26	27	28	29	30	26-27 Class Enrollment starts – All UG students *	
	31							26 Class Enrollment starts – All PG students *	
								[* A validation period for class enrollment will be arranged prior to these dates]	
								31 Last day for submission of final thesis examination results and thesis copies for Summer 2024-25	
	September								
1		(1)	2	3	4	5	6	1 Commencement of the 2025-26 Academic Year	
2	7	8	9	10	11	12	13	1 Fall Term commences	
3	14	15	16	17	18	19	20	1-13 Add/Drop Period	
4	21	22	23	24	25	26	27	15-27 Extended Drop Period – for PG courses only	
5	28	29	30						
	October								
6				1	2	3	4		1 *The National Day*
6	5	6	7	8	9	10	11		7 *The day following the Chinese Mid-Autumn Festival*
7	12	13	14	15	16	17	18		
8	19	20	21	22	23	24	25		
9	26	27	28	29	30	31			29 *Chung Yeung Festival*
	November								
9							1		
10	2	3	4	5	6	7	8		
11	9	10	11	12	13	14	15		
12	16	17	18	19	20	21	22		
13	23	24	25	26	27	28	(29)	29 Last day of Fall Term classes	
	30								
	December								
		1	**2**	**3**	**4**	**5**	**6**	1-6 Study Break	
	7	**8**	**9**	**10**	**11**	**12**	**13**	8-19 Fall Term Examinations	
	14	**15**	**16**	**17**	**18**	**19**	20	19 Last day of Fall Term	
	21	22	23	24	25	26	27		25 *Christmas Day*
	28	29	30	31					26 *The first weekday after Christmas Day*

Public holiday — First/Last day of Term classes

Examination Period/Break — **Boldtype** Important dates for students to note

Objectives:

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

No.	Objectives
1	Obtain key fundamental knowledge about materials chemistry, including structure, synthesis, characterization, properties, and applications of different functional materials.
2	Able to understand the key structural-property relationship of materials from the fundamental chemistry principles (crystal structure, bonding etc).
3	Able to understand the synthetic methods of functional materials from a perspective of chemistry.
4	Able to present key knowledge and principles learned in this course to a broad audience. Intrigue those students who are interested in materials chemistry to pursue further research.

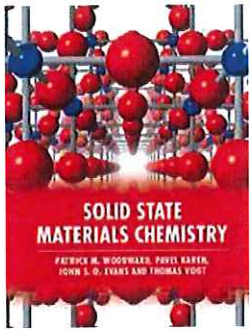
Intended LEARNING OUTCOMES

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

1) Learn the basic knowledge related with materials including organic, inorganic, hybrid, polymer, and nanomaterials
2) Obtain basic crystallographic knowledge and able to understand the structures of complex crystals;
3) Able to understand the chemical bonding from molecular orbitals to extended solids;
4) Learn important synthetic methods for functional inorganic materials and nanomaterials;
5) Obtain basic knowledge of important material characterization methods;
6) Able to understand and predict materials' properties from the fundamental chemistry principles (elemental composition, bonding, and crystal structure) learned in this course;
7) Able to present the most important knowledge and principles learned in this course in a clear and simple presentation.

TEXTBOOK

Solid State Materials Chemistry, 1st Edition, Student Edition
Patrick M. Woodward
ISBN: 9780521873253 May 2021



The instructor will also provide additional notes.

REQUIREMENTS

- 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 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 made 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 student in the class.
- Discussions with fellow students and teaching crew are strongly encouraged, but work which is submitted for grading must be your own understanding, expressed in your own words.
- Student should have taken Inorganic chemistry (CHEM 2210)

GRADING

Assessment

- 20% assignments
- 60% final
- 20% presentation

Notes:

Number of assignments: **3**

Final Presentation: topics will be provided

COURSE SCHEDULE

Week 1	09/01	Lecture 1	Introduction & different materials types
	09/03	Lecture 2	Molecular materials 1
Week 2	09/08	Lecture 3	Coordination materials 1
	09/10	Lecture 4	Coordination materials 2
Week 3	09/15	Lecture 5	Carbon materials
	09/17	Lecture 6	Carbon nanomaterials 1 (Guest lecture)
Week 4	09/22	Lecture 7	Polymer materials 1
	09/24	Lecture 8	Carbon nanomaterials 2 (Guest lecture)
Week 5	09/29	Lecture 9	Polymer materials 2 **Assignment #1**
	10/01	Holiday	
Week 6	10/06	Lecture 10	Crystalline solids 1
	10/08	Lecture 11	Crystalline solids 2
Week 7	10/13	Lecture 12	Battery materials
	10/15	Lecture 13	Nanomaterials 1
Week 8	10/20	Lecture 14	Nanomaterials 2
	10/22	Lecture 15	Synthesis of materials
Week 9	10/27	Lecture 16	Materials characterization: structural characterization **Assignment #2**
	10/29	Holiday	
Week 10	11/03	Lecture 17	Optical materials 1
	11/05	Lecture 18	Optical materials 2
Week 11	11/10	Lecture 19	Light-emitting diodes
	11/12	Lecture 20	Conducting materials
Week 12	11/17	Lecture 21	Different PV techniques **Assignment #3**
	11/19		Final presentation 1
Week 13	11/24		Final presentation 2
	11/26		Final Presentation 3

Date & location of Final Exam will be arranged by ARO.

CHEM 4250 Materials Preparation Laboratory
2025 Fall semester
Course Outline

1. Instructor

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

2. Technical Support / Teaching Assistant:

Name: CHAN, Ka Lok Kelvin (chkelvin@ust.hk)
CHOI, Chai Yu Edwin (edwinchoi@ust.hk)
Contact: Laboratory CYT-1003; Tel: 3469-2611
Teaching Assistants: [names & contact details will be provided in a separate file.]

3. Meeting Time and Venue:

Date/Time: CHEM 4250 Thu (10:30 – 13:20)
Venue: CYT-1003 and CYT-1004

4. Course Description

CHEM 4250 [1 Credit]
Pre-requisite: CHEM 3550
Co-requisite: CHEM 4255 Exclusion: nil
Brief Information/synopsis:
This is a laboratory course for students to gain hands-on experiences in the preparation of modern materials. Students will have the opportunity to practice the synthesis of materials such as organic polymers, nanoparticles and solid materials.

5. Intended Learning Outcomes

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

1	Recognize fundamentals of chemistry including structure, reativity and properties of chemical substances, and the states of matter.
2	Explain the essential facts, principles and theories across organic and inorganic chemistry related to solid state materials
3	Assess and manage the risk of chemical substances and laboratory procedures, and to evaluate their potential impact on the environment.
4	Conduct standard laboratory procedures involved in synthetic work related to organic polymers and solid state materials.
5	Conduct analysis and interpretation of experimental data related to solid state materials
6	Work independently and collaborate effectively 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.

#	**Assessment items**	**Weighting**	**ILO(s) to be assessed**
1	Risk assessment	5%	3
2	Laboratory Quiz†	25%	1, 2
3	Laboratory Performance	20%	3, 4, 5, 6
4	Product/Result	10%	4
5	Laboratory Reports	40%	1, 2, 5

†*There will be a short lab quiz before each experiment.*

7. Student Learning Resources

Reference books:

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

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

* *Course materials can be downloaded by logging in to the CANVAS website using your ITSC username and password (https://canvas.ust.hk).*

8. Teaching and Learning Activities

Tutorial + Laboratory work related to preparative chemistry related to materials chemistry area.

9. Keyword Syllabus

- Preparation of Fluorescent Organic Materials for pH Sensing
- Organic Synthesis by Condensation of Amines with Aldehydes
- Synthesis of Light Emitting Metal Complex with Multidentate Ligands
- Construction of Organic Light-Emitting Device
- Synthesis of Conjugated Aromatics by Suzuki Cross-coupling
- Transition Metal Catalyzed Organic Synthesis
- Synthesis of Mixed-Valence Metal Oxides Solid-State Material by Partial Oxdiation
- Sonochemical Synthesis of Metal Organic Framework

CHEM 4255 Materials Characterization Laboratory
2025 Fall semester
Course Outline

1. Instructor

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

2. Technical support / Teaching Assistant:

Name: CHAN, Kelvin Ka Lok (chkelvin@ust.hk)
CHOI, Chai Yu Edwin (edwinchoi@ust.hk)
Contact: Laboratory CYT-1003; Tel: 3469-2611
Teaching Assistants: [names & contact details to be provided in a separate file.]

3. Meeting Time and Venue:

Date/Time: CHEM 4255 Thu (13:30 – 16:20)
Venue: CYT-1003 and CYT-1004

4. Course Description

CHEM 4255 [1 Credit]
Pre-requisite: CHEM 3555 Co-requisite: CHEM 4250 Exclusion: nil
Brief Information/synopsis: This is a laboratory course for students to gain hands-on experiences in the characterization of modern materials.

5. Intended Learning Outcomes

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

1	Recognize fundamentals of chemistry including structure, reativity and properties of chemical substances, and the states of matter.
2	Explain the essential facts, principles and theories across organic and inorganic chemistry related to solid state materials
3	Assess and manage the risk of chemical substances and laboratory procedures, and to evaluate their potential impact on the environment.
4	Conduct standard laboratory procedures involved in instrumental work related to organic polymers and solid state materials.
5	Conduct analysis and interpretation of experimental data related to solid state materials
6	Work independently and collaborate effectively 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.

#	Assessment items	Weighting	ILO(s) to be assessed
1	Risk assessment	5%	3
2	Laboratory Quiz†	25%	1, 2
3	Laboratory Performance	20%	3, 4, 5, 6
4	Product	10%	4
5	Laboratory Reports	40%	1, 2, 5

†*There will be a short lab quiz before each experiment.*

7. Student Learning Resources

Reference books:

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

(b) *"Principles of Instrumental Analysis" 7th edition*, by D. A. Skoog, F. J. Holler, S. R. Crouch. Australia: Cengage Learning ©2007 [2018]. E-Book in HKUST Library: https://ebookcentral.proquest.com/lib/hkust-ebooks/detail.action?pq-origsite=primo&docID=6351262

* *Course materials can be downloaded by logging in to the CANVAS website using your ITSC username and password (https://canvas.ust.hk).*

8. Teaching and Learning Activities

Tutorial + Laboratory work related to chemical analysis related to materials chemistry area.

9. Keyword Syllabus

- Characterization of Fluorescent Materials - Fluorescence spectroscopy
- Characterization of Fluorescent Materials – Nuclear Overhauser Effect
- Spectrometric Measurement of pH-Dependent Fluorescence
- Materials Characterization by Thermal Analytical Method – DSC
- Materials Characterization by Thermogravimetric Analytical Method – TGA
- Materials Characterization by Transmission FT-IR and ATR FT-IR
- Characterization of Molecular Materials by Fluorescence Spectroscopy
- Characterization of Molecular Materials by UV-Visible Spectroscopy
- Characterization of Solid-state Materials by Powder X-ray Diffraction (pXRD)
- Characterization of Solid-state Materials by Scanning Electron Microscopy (SEM)
- Characterization of Molecular Materials by High-Resolution ^{1}H-NMR Spectroscopy
- Characterization of Molecular Materials by 2D NMR Spectroscopy – Homonuclear Correlation Spectrosopy (COSY)

The Hong Kong University of Science and Technology

UG Course Syllabus

Bioanalytical Techniques

CHEM 4340

3 Credits

Prerequisites: CHEM 2310 OR CHEM 2311

Name: Hongkai Wu

Email: chhkwu@ust.hk

Office Hours: [Specify Office Hours and Location] Rm 4516, walk-in or with appointment

Course Description

This course introduces the principles and applications of modern bioanalytical methods used in chemical and biological research. It is divided into four major sections:

Part 1: Optical Microscopy

Students will learn the fundamentals of optical microscopy, including microscope design, advanced imaging techniques, fluorescence principles, and the use of fluorescence probes. The section also covers image detection and processing for quantitative analysis.

Part 2: Biomolecules and Bioassays

This section explores the structure and function of biomolecules such as proteins and nucleic acids, along with analytical techniques for their characterization. Topics include enzyme immobilization, immunoassays, electrophoresis, DNA-to-protein processes, sequencing methods, and protein-related bioanalysis.

Part 3: Microfluidics

An introduction to microfluidic systems and their role in analytical chemistry is provided. Students will study applications in biosensing, diagnostics, and lab-on-a-chip technologies, emphasizing integration with bioanalytical techniques.

Part 4: Student Oral Presentations

Students will present on selected topics in bioanalytical techniques, fostering critical thinking, communication skills, and the ability to synthesize scientific literature.

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1. Describe the fundamentals of bioanalytical techniques including their work principles, and the interpretation of analytical data and their relations with the chemistry information of the samples.

2. Analyze biomolecules using optical microscopic analyses, modern bioassays and separation techniques.

3. Evaluate and discuss the relevance of the bioanalytical techniques to social and daily life, for example in relations to human health.

4. Analyze a wide range of analytical chemical problems by applying the analytical principles.

5. Apply the bioanalytical technique knowledge in the study of scientific literature, and self-learn the latest, related techniques.

Assessment and Grading

This course will be assessed using criterion-referencing and grades will not be assigned using a curve. Detailed rubrics for each assignment are provided below, outlining the criteria used for evaluation.

Assessments:

Assessment Task	Contribution to Overall Course grade (%)	Due date
Mid-Term	30%	22/10/2025 *
In-course oral presentation	30%	17-26/11/2025 *
Final examination	40%	12/12/2025

* Assessment marks for individual assessed tasks will be released within two weeks of the due date.

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Mid-Term examination	ILO1, ILO2, IL4	This task assesses students' ability to explain and apply optical microscopic concepts (ILO1, ILO2), and design proper optical microscopic bioassays (ILO4).
In-course oral presentation	ILO3, ILO4, ILO5	The presentation and reflection assess students' ability to search literature, critically evaluate useful information, and present well on the related, new bioanalytical techniques (ILO 3-5), demonstrating higher-order thinking skills of analysis and evaluation.
Final examination	ILO1, ILO2, ILO4	This task assesses students' ability to explain and apply modern bioassays and separation techniques (ILO1, ILO2), and get to know the latest development of some important bioanalytical techniques (ILO 4).

Grading Rubrics

[Detailed rubrics for each assignment will be provided. These rubrics clearly outline the criteria used for evaluation. Students can refer to these rubrics to understand how their work will be assessed.]

Final Grade Descriptors:

[As appropriate to the course and aligned with university standards]

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates a comprehensive grasp of subject matter, expertise in problem-solving, and significant creativity in thinking. Exhibits a high capacity for scholarship and collaboration, going beyond core requirements to achieve learning goals.
B	Good Performance	Shows good knowledge and understanding of the main subject matter, competence in problem-solving, and the ability to analyze and evaluate issues. Displays high motivation to learn and the ability to work effectively with others.
C	Satisfactory Performance	Possesses adequate knowledge of core subject matter, competence in dealing with familiar problems, and some capacity for analysis and critical thinking. Shows persistence and effort to achieve broadly defined learning goals.
D	Marginal Pass	Has threshold knowledge of core subject matter, potential to achieve key professional skills, and the ability to make basic judgments. Benefits from the course and has the potential to develop in the discipline.
F	Fail	Demonstrates insufficient understanding of the subject matter and lacks the necessary problem-solving skills. Shows limited ability to think critically or analytically and exhibits minimal effort towards achieving learning goals. Does not meet the threshold requirements for professional practice or development in the discipline.

Course AI Policy

[State the course policy on the use of generative artificial intelligence tools to complete assessment tasks.]

Students are allowed to use generative artificial intelligence tools to assist their homework and the preparation of their oral presentation slides. However, both the midterm and final examinations are close book and no AI tools or any other electronic tools are allowed during the examinations.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Feedback on assignments will include grading, face-to-face discussion, office hour discussion and email exchange. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

Resubmission Policy

[If applicable, explain the policy for resubmitting work or reassessment opportunities, including conditions and deadlines.]

Required Texts and Materials

Various websites and videos including in the teaching slides

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Academic Integrity | HKUST – Academic Registry for the University's definition of plagiarism and ways to avoid cheating and plagiarism.

[Optional] Additional Resources

[List any additional resources, such as online platforms, library resources, etc.]

CHEM4350 Environmental Chemistry Laboratory
Course Outline – Fall 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* >; Rowena Leung <*chlsy@ust.hk*>;
Alice Wong <*tinginwong@ust.hk*>;
Contact: Lab: CYT-3007; Tel: 2358 7244; 2358 7402
Instructional Assistant:
Name: Anson WONG <*wchwong@ust.hk*>
Contact: Lab: CYT-3007; Tel: 2358 7402
***Teaching Assistants:** Separate file*

3. Meeting Time and Venue

Date & Time: Thursdays 10.30 - 13.20
Venue: CYT-3007

4. Course Description

Credit Points: 1
Pre-requisite: [CHEM2310 Fundamentals of Analytical Chemistry or CHEM2311 Analytical Chemistry] AND [CHEM2555 Molecular Characterisation Laboratory I or CHEM2355 Fundamental Analytical Chemistry Laboratory]
Co-requisite: CHEM4355 Instrumental Analytical Chemistry Laboratory

Course Description:
This is a laboratory course for students to gain hands-on experience in collection and handling environmental samples. Analyses particularly for determining analytes in environmental samples using specific instruments and methods will be covered, such as TOC analyser, air collection using DNPH-sorbent cartridge, etc. Experiments covered in this course will be closely connected with the topics covered in the lecture courses of CHEM4310 and CHEM4320, including preparation of environmental samples for analytical analysis.

5. Intended Learning Outcomes (ILOs)

On completion, students should be able to:

1	Explain the essential facts, principles and theories in the area of environmental analytical chemistry.
2	Formulate and analyze a wide range of analytical 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	Work independently, safely and collaborate effectively in team work

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. List of Experiments

Expt No	Title of Experiment
E1	Application of Ion Chromatography (IC) to Determination of Water Soluble Anions on Air Particulate Matter
E2	Volatile Organic Compounds (VOCs) Collected by a Passive Sampler and Analysed by Gas Chromatograph - Mass Spectrometer (GC-MS)
E3	Sampling of Gaseous Carbonyl Compounds Collected by an Active Sampler using On-Sorbent 2,4-Dinitrophenylhydrazine (DNPH) Reaction and Detected by High Performance Liquid Chromatograph – Ultraviolet-Visible Detector
E4	Removal of Organic Matter in Pond Water Sample Using Powdered Activated Carbon Assessed By Total Organic Carbon (TOC) Analyser

8. Student Learning Resources

- Daniel C. Harris, Charles A. Lucy, *Quantitative Chemical Analysis*, 10th Ed., Macmillian Learning, 2020.
- Skoog D. A., Holler F. J. and Crouch S. R., *Principles of Instrumental Analysis*, 6th Ed., Thomson Brooks/Cole, Thomson Corporation, 2007.

9. Teaching and Learning Activities

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

CHEM4355 Instrumental Analytical Chemistry Laboratory
Course Outline – Fall 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*>; Kwong K Chan <*chankk@ust.hk*>
Contact: Lab: CYT-3007; Tel: 2358 7245; 2358 7244

Instructional Assistant:

Name: Anson WONG <*wchwong@ust.hk*>
Contact: Lab: CYT-3007; Tel: 2358 7402

Teaching Assistants: *Separate file*

3. Meeting Time and Venue

Date & Time: Thursdays 13.30 - 16.20
Venue: CYT-3007

4. Course Description

Credit Points: 1
Pre-requisite: [CHEM2310 Fundamentals of Analytical Chemistry or CHEM2311 Analytical Chemistry] AND [CHEM2555 Molecular Characterisation Laboratory I or CHEM2355 Fundamental Analytical Chemistry Laboratory]
Co-requisite: CHEM4350 Environmental Chemistry Laboratory

Course Description
This is a laboratory course for students to gain hands-on experiences in operation of the modern instruments. The instruments include liquid chromatography, gas chromatography, LC-MS/MS, ICP-OES, etc. The experiments covered in this course will be closely connected with the topics covered in CHEM4320 and CHEM4330.

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 analytical chemical problems by applying chemical principles.
3	Analyze and interpret experimental data and extract useful data from it
4	Operate a range of chemical instrumentation with adequate hands-on experiences.
5	Conduct standard laboratory procedures involved in instrumental work.
6	Assess and manage the risks of chemical substances and laboratory procedures by evaluating their potential impact on the environment.
7	Work independently, safely and collaborate effectively in team work

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. List of Experiments

Expt No	Title of Experiment
A1	Analysis of Metals Contents in Pre-packaged Dried Food Products using Inductively Coupled Plasma – Optical Emission Spectrometer (ICP-OES)
A2	Adulteration Detection of White Pepper Samples by Near-Infrared (NIR) Spectrometer with Partial Least Square Regression (PLSR) Model
A3	Determination of Sugars Content in Food Products by High Performance Liquid Chromatography - Evaporative Light Scattering Detector (HPLC-ELSD)
A4	Identification and Quantification of Pesticides in an Unknown Sample using Liquid Chromatography – Tandem Mass Spectrometers (LC-MS/MS)

8. Student Learning Resources

- Daniel C. Harris, Charles A. Lucy, *Quantitative Chemical Analysis*, 10th Ed., Macmillian Learning, 2020.
- Skoog D. A., Holler F. J. and Crouch S. R., *Principles of Instrumental Analysis*, 6th Ed., Thomson Brooks/Cole, Thomson Corporation, 2007.

9. Teaching and Learning Activities

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

CHEM 4550 Advanced Synthetic Laboratory

2025 Fall semester

Course Outline

1. Instructor

Name: Dr. TSE, Wai Pui Veronica (chvaipui@ust.hk)
Contact: Office Room 4537; Tel: 2358-7364
Dr. CHAN, Ho-Wai Dennis (chanhw@ust.hk)
Contact: Office Room 4528; Tel: 3469-2099

2. Technical support / Teaching Assistant:

Name: LAU, Chun Tak Disney (disney@ust.hk)
Contact: Laboratory Room CYT-1003; Tel: 3469-2611
Teaching Assistants: [names & contact details will be provided in a separate file.]

3. Meeting Time and Venue:

Date/Time: CHEM 4550 Thu (10:30 – 13:20)
Venue: CYT-1003 and CYT-1004

4. Course Description

CHEM 4550 [1 Credit]
Pre-requisite: CHEM 3550
Co-requisite: CHEM 4555
Exclusion: nil
Brief Information/synopsis:
This course provides hands-on experience for students in the pure chemistry option. It emphasizes on the advanced lab techniques. Experiment of different areas like metal catalyzed cross coupling, regiospecific synthesis and preparation of a mimic model of natural catalyst will be included.

5. Intended Learning Outcomes

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

1	Recognize fundamentals of chemistry including structure, reativity and properties of chemical substances, and the states of matter.
2	Explain the essential facts, principles and theories across organic and inorganic chemistry.
3	Assess and manage the risk of chemical substances and laboratory procedures, and to evaluate their potential impact on the environment.
4	Conduct standard laboratory procedures involved in synthetic work.
5	Conduct analysis and interpretation of experimental data.
6	Work independently and collaborate effectively 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.

#	Assessment items	Weighting	ILO(s) to be assessed
1	Risk assessment	5%	3
2	Laboratory Quiz†	25%	1, 2
3	Laboratory Performance	20%	3, 4, 5, 6
4	Product/Result	10%	4
5	Laboratory Reports	40%	1, 2, 5

† *There will be a short lab quiz before each experiment.*

7. Student Learning Resources

Reference books:

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

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

* *Course materials can be downloaded by logging in to the CANVAS website using your ITSC username and password (https://canvas.ust.hk).*

8. Teaching and Learning Activities

Tutorial + Laboratory work related to preparative methods in both organic and inorganic chemistry.

9. Key word Syllabus

- Synthesis of Organometallic Compounds and its Light-sensitive Derivatives
- Substitution of Aromatic Ligand in Sandwich Organometallic Compounds
- Synthesis of Metallo-Organic Chelate Complex
- Wittig-Horner Synthesis for Olefins
- Use of Organophosphorus Reagent
- Synthesis of Conjugated Aromatics by Suzuki Cross-Coupling
- Transition Metal Catalyzed Organic Synthesis
- Protection of Hydroxyl Groups for Carbohydrates
- Regioselective Substitution Reaction
- Control of Distereoseletivity in Substitution Reactions
- Glycosidation Reaction

CHEM 4555 Advanced Molecular Characterization Lab
2025 Fall semester
Course Outline

1. Instructor

Name: Dr. TSE, Wai Pui Veronica (chvaipui@ust.hk)
Contact: Office Room 4537; Tel: 2358-7364
Dr. CHAN, Ho-Wai Dennis (chanhw@ust.hk)
Contact: Office Room 4528; Tel: 3469-2099

2. Technical support / Teaching Assistant:

Name: LAU, Chun Tak Disney (disney@ust.hk)
Contact: Laboratory Room CYT-1003; Tel: 3469-2611
Teaching Assistants: [names & contact details will be provided in a separate file.]

3. Meeting Time and Venue:

Date/Time:	CHEM 4555 Thu (13:30 – 16:20)
Venue:	CYT-1003 and CYT-1004

4. Course Description

CHEM 4555 [1 Credit]
Pre-requisite: CHEM 3555
Co-requisite: CHEM 4550
Exclusion: nil
Brief Information/synopsis:
This course is designed for chemistry major students who are enrolling in Pure Chemistry option. It provides students hands-on experience in the operation of different instruments for characterization of organic products.

5. Intended Learning Outcomes

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

1	Recognize fundamentals of chemistry including structure, reativity and properties of chemical substances, and the states of matter.
2	Explain the essential facts, principles and theories across organic and inorganic chemistry.
3	Assess and manage the risk of chemical substances and laboratory procedures, and to evaluate their potential impact on the environment.
4	Conduct standard laboratory procedures involved in instrumental work.
5	Conduct analysis and interpretation of experimental data.
6	Work independently and collaborate effectively 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.

#	Assessment items	Weighting	ILO(s) to be assessed
1	Risk assessment	5%	3
2	Laboratory Quiz†	25%	1, 2
3	Laboratory Performance	20%	3, 4, 5, 6
4	Product/Result	10%	4
5	Laboratory Reports	40%	1, 2, 5

† *There will be a short lab quiz before each experiment.*

7. Student Learning Resources

Reference books:

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

(b) "*Principles of Instrumental Analysis*" *7th edition*, by D. A. Skoog, F. J. Holler, S. R. Crouch. Australia: Cengage Learning ©2007 [2018]. E-Book in HKUST Library: https://ebookcentral.proquest.com/lib/hkust-ebooks/detail.action?pq-origsite=primo&docID=6351262

* *Course materials can be downloaded by logging in to the CANVAS website using your ITSC username and password (https://canvas.ust.hk).*

8. Teaching and Learning Activities

Tutorial + Laboratory work related to chemical analysis and instrumental method of analysis.

9. Key word Syllabus

- Experimental Determination of Rate Constants and Activation Energy of a Reaction
- Estimation of the Force Constant of Covalent Bonds
- Computational Study using MMFF and Time-dependent DFT
- Characterization by 1D NMR Spectroscopies: ^{1}H-NMR, ^{13}C-NMR and DEPT135
- Characterization by 2D NMR Spectroscopies: Homonuclear Correlation Spectroscopy (COSY) and Heteronuclear Multiple Bond Coherence Spectroscopy (HMBC)
- Prediction of Electronic Absorption Maxima using Computational Methods
- Thermogravimetric Analysis of Molecular Materials
- Characterization and Analysis by MALDI-Tof Mass Spectroscopy
- Optical Characterization by UV-vis Spectroscopy
- Optical Characterization by FT-IR Spectroscopy
- Chromatographic Analysis by GC-FID
- Chromatographic Analysis by HPLC-PDA
- Determination of Diastereoselectivity by High-Resolution ^{1}H-NMR Spectroscopy

The Hong Kong University of Science and Technology
UG Course Syllabus

Chemistry for Advanced Solar Cell Technologies
CHEM 4640
3 Credits
Prerequisite(s): *(for Science students) CHEM 2110 AND CHEM 2410;*
(for Engineering Students) CHEM 2111

Name: Prof. He Yan;
Email: hyan@ust.hk, CYT 6003 (Ph# 2358-7366)

Course Description

Solar Cells are considered one of the most promising renewable energy technologies. Conventional solar cells are based inorganic materials such as silicon. In the past decade, however, several new solar cell technologies based organic materials are emerging as promising alternatives to conventional solar cells. This is an exciting and highly interdisciplinary area involving Chemistry, Physics, Materials Science, and Electronic Engineering. The study on organic solar cells provides an excellent platform for Science and Engineering students to learn about how to do research in a multidisciplinary environment. Another key focus of the course is to improve students' communication and interview skills through in-class presentations and group discussion on cutting-edge technologies.

In many of these advanced solar cell technologies, chemistry has been playing an important role. For example, in Polymer Solar Cells and Dye-Sensitized Solar Cells, it is critical to design and synthesize organic and polymer materials with unique photovoltaic and charge-transporting properties. This course will give an overview of several important solar cell technologies including Si cells, polymer solar cells, dye-sensitized cells, and hybrid solar cells. The course will emphasize the chemical principles, design and materials aspects of these advanced solar cell technologies.

Intended learning Outcomes (ILOs)

1. Introduce the general background of organic electronics.
2. Introduce how solar cells work, including both organic and inorganic solar cells.
3. Apply basic chemistry knowledge to several important chemistry/material-based applications.
4. Understand important parameters that influence the performance of organic solar cells.
5. Practice presentation skills and deliver short presentations on general technology topics in a clear and interesting style.
6. Relate basic science knowledge to various emerging applications.

Meeting Time and Venue

Lectures:

Date/Time:	Wednesdays and Fridays (16:30 – 17:50)
Venue:	Classroom 2126D, Lift 19

Grading scheme

Presentation 50%
Final Exam 50%

The Hong Kong University of Science and Techonology
UG Course Syllabus

Undergraduate Research

CHEM 4680
3 Credits
Prerequisite(s): CHEM 2550

Instructor(s): Research Faculties of Chemistry Department

Course Description

Brief Information/synopsis:

Students do 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.

Intended Learning Outcomes (ILOs)

By the end of this course, students should 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 writting, both about students' newly acquired knowledge and knowledge in general.
3. Recognize deficiencies in knowledge existing in chemistry, and 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 databases, patents.
5. Appreciate the importance of research in relation to science, the definition of problems in research, and the corpus of scientific knowledge is able to expand through the overall research effort for the betterment of humankind.

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 (Fall 2025-2026)

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. Tengteng CHEN	tengtengchen@ust.hk
Prof. Zhihong GUO	chguo@ust.hk
Prof. Yong HUANG	yonghuang@ust.hk
Prof. Wa Hung LEUNG	chleung@ust.hk
Prof. Zhenyang LIN	chzlin@ust.hk
Prof. Jianwei SUN	sunjw@ust.hk
Prof. Emily M. W. TSANG	chetsang@ust.hk
Prof. Hongkai WU	chhkwu@ust.hk
Prof. Xiaojiang XIE	xiexj@ust.hk
Prof. Jianzhen YU	jian.yu@ust.hk
Dr. Ryan T. K. KWOK	chryan@ust.hk
Dr. Jacky W.Y. LAM	chjacky@ust.hk
Dr. Sai Ho PUN	punsaiho@ust.hk
Dr. Frederick F.K. SHEONG	chemfksheong@ust.hk
Dr. Liangliang YANG	yangll@ust.hk
Dr. Xiaobin YAO	xiaobinyao@ust.hk
Dr. Chaoshen ZHANG	zhangcs@ust.hk

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

Mr. Samson CHOI, Librarian (Learning Support)	lbsamson@ust.hk
Ms. Jennifer GU, Librarian (Learning Support)	lbjennifer@ust.hk

2. Class Time and Venue:

Date/Time: 9:30 – 10:20 am, **Fridays** (*please refer to the class schedule*)
Venues: Room 5508 (Lift 25/26) 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	Sept 5 (Fri) 9:30-10:20 *before 19 Sept*	**Course Introduction** [† *meet your supervisor for topic assignment*] [† *upload topic to Canvas after assignment*]	**Room 5508 (Lift 25/26)** Prof. Emily Tsang
2	Sept 12 (Fri) 9:30-10:20	**Literature Search Training**	**Library LG1 Computer Room B** Mr. Samson Choi
3	Sept 19 (Fri) 9:30-10:20 *before Sept 19* *between Sept 22 – Oct 10*	**SciFinder Workshop** [† *submit Weekly Timetable to Canvas for scheduling Oral Presentation Time*] **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	Sept 26 (Fri) 9:30-10:20	**Chemical Structure Drawing Training**	**Library LG1 Computer Room B** Prof. Emily Tsang
5	During this week (Sept 29 – Oct 3)	**1st Consultation with supervisor**	(by appointment with your supervisor)
6	Oct 6 – 10 *before Oct 13*	*Work on your project* [† *submit Research Plan*]	
7	Oct 17 (Fri) 9:30-10:20	**Referencing Training**	**Library LG1 Computer Room B** Mr. Samson Choi
8	During this week (Oct 20 – 24)	**2nd Consultation with supervisor**	(by appointment with your supervisor)
9	Oct 31 9:30-10:20	**Poster Design Workshop**	**Room 5508 (Lift 25/26)** Dr. Frederick Sheong
10	Nov 3 – 7 *between Nov 3 – 21*	*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 (Nov 10 – 14)	**3rd Consultation with supervisor**	(by appointment with your supervisor)
12	Nov 17 – 21	*Work on your project*	
13	Nov 28 (Fri) *before Nov 23 (Sun)*	**Oral Presentations** [† *submit Poster file to Canvas*]	TBA
Study break	Dec 1 (Mon) 14:00-16:30	**Poster Mini-Conference**	**Library LG4 Multi-function Room**
	Dec 14 (Sun)	† *Deadline for Literature Research Report*	

CHEM 4691 Capstone Research I

Course Outline (Fall 2025/26)

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)

Ms. Jennifer GU (lbjennifer@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
Sept 12 (Fri), 9:30 – 10:20	**Library Workshop I: Literature Search Training**	Computer Room B (Library LG1) (Mr. Samson Choi)
Sept 19 (Fri), 9:30 – 10:20	**SciFinder-n Workshop**	Zoom Meeting (meeting link to be provided)
Sept 26 (Fri), 9:30 – 10:20	**Chemical Structure Drawing Training**	Computer Room B (Library LG1) (Prof. Emily Tsang)
Oct 17 (Fri), 9:30 – 10:20	**Library Workshop II - Referencing Training**	Computer Room B (Library LG1) (Mr. Samson Choi)

The Hong Kong University of Science and Technology

UG Couse Syllabus

Capstone Research II

CHEM 4692

3 Credits

Prerequisite(s): CHEM 4691

Name: Research Faculty of Chemistry

Course Description

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.

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.

Intended Learning Outcomes (ILOs)

By the end of this course, students should 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.

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