DEPARTMENT OF

CHEMISTRY

CHEM UG Courses

UG Courses offered in Fall Term 2021-2022 but the courses outlines are not time-specific

Course Code	Course Title
CHEM 1004	Chemistry in Everyday Life
CHEM 1010	General Chemistry 1A
CHEM 1020	General Chemistry 1B
CHEM 1030	General Chemistry II
CHEM 1050	Laboratory for General Chemistry I
CHEM 2110	Organic Chemistry I
CHEM 2210	Inorganic Chemistry I
CHEM 2310	Fundamentals of Analytical Chemistry
CHEM 2350	Analytical Chemistry Laboratory
CHEM 2409	Mathematical Methods for Physical Chemistry
CHEM 2410	Physical Chemistry I: Equilibrium Thermodynamics and Statistical Mechanics
CHEM 2450	Physical Chemistry Laboratory
CHEM 2550	Synthetic Chemistry Laboratory I
CHEM 3010	Great Ideas in Chemistry
CHEM 4120	Biomolecular Chemistry
CHEM 4140	Intermediate Organic Chemistry
CHEM 4150	Biomolecular Synthesis Laboratory
CHEM 4155	Biomolecular Characterization Laboratory

Course Code	Course Title
CHEM 4220	Materials Chemistry
CHEM 4250	Materials Preparation Laboratory
CHEM 4255	Materials Characterization Laboratory
CHEM 4340	Bioanalytical Techniques
CHEM 4350	Environmental Chemistry Laboratory
CHEM 4355	Instrumental Analytical Chemistry Laboratory
CHEM 4550	Advanced Synthetic Laboratory
CHEM 4555	Advanced Molecular Characterization Laboratory
CHEM 4640	Chemistry for Advanced Solar Cell Technologies
CHEM 4680	Undergraduate Research
CHEM 4689	Capstone Project
CHEM 4691	Capstone Research I
CHEM 4692	Capstone Research II

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

CHEM1004 (L1) Chemistry in Everyday Life

Fall Semester 2021-22

3 credits

Lectures:	Tuesdays and Thursdays 10:30 am – 11:50 am **LT-L (CYT building)**
Mixed mode:	Visit Canvas for Zoom meeting links (pw: **chem1004**)
	No lecture on 14 Oct (Th) (public holiday)
Course Instructors:	**Prof. Jason K. K. CHAN** Assistant Professor of Science Education, Department of Chemistry Email: **kkjchan@ust.hk** Office: Rm 4543, between Lifts 25/26 and 27/28
	Prof. Emily M. W. TSANG Assistant Professor of Science Education, Department of Chemistry Email: **chetsang@ust.hk** Office: Rm 4536, between Lifts 25/26 and 27/28
Teaching Assistants:	Mr Steevanson BAYER email: sbayer@connect.ust.hk Miss Cho Ying CHAN email: cychanbz@connect.ust.hk Miss Mengting CHEN email: mchenbl@connect.ust.hk Miss Wing Sze CHOW email: wschow@connect.ust.hk Mr Siu Ho LI email: shliak@connect.ust.hk
Course website:	**https://canvas.ust.hk**

Course Description

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

Course objectives are as follows:

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

The course is divided into six Chapters:

Chapters	Topic	Taught by
1	What is everything made of?	Prof. Chan
2	The Air.	Prof. Tsang
3	The air and our environment.	Prof. Tsang
4	The metals in our daily life.	Prof. Tsang
5	Metals in the industry.	Prof. Chan
6	Fire and fuels.	Prof. Chan

Lectures

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

Course Contents

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

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

The **power point slides** will be mostly pictures or graphics. These will also be released on Canvas after the end of each lecture. Please note that they are mostly released after the lectures, you are advised to take notes on the lecture notes instead.

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

Textbooks/Reading Lists

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

End of Chapter Exercises and Tutorials

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

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

Tutorial videos with detailed solutions to the exercises will be released by chapter. In the videos, the instructor will go through the answers to the exercises. If you have questions on these exercises please feel free to contact the instructor in-charge or the TAs to ask.

Office Hours of the Instructors and TAs

Please feel free to approach the instructors to ask questions or to discuss any chemistry or course-related issues. You may approach them after the lectures, or you may email to arrange an appointment. There is no fixed office hour schedule: if you need one, feel free to email and book a time. Both in-person or zoom office hour meetings can be arranged.

In addition, our TAs are all postgraduate research students working in the forefront of chemistry research. They are here to help you also if you want to ask any questions or if you want to find out more about their research. You should email them directly to arrange an appointment.

Online Graded Quizzes (10 % of the course)

There will be two online graded quizzes in addition to the end-of-chapter exercises, the first quiz is **after Chapter 4** (covering chapters 1 – 4), and the second quiz is at the end of the course (covering mainly Chapters 4-6). You should complete them within the given time (around 1 week). The accumulated points from the online quizzes will carry 10 % to the course grade, but the main purpose is to help you further understand the course materials and have a chance to practice and receive answers immediately after submission. When these quizzes are available, you will receive email notification as well as instructions during the lectures. The quizzes are *open-book*, which means you are free to consult your notes or other resources, but the work should be your own (no collaboration with others).

You may expect these dates for the release of online graded quizzes:

Graded quiz 1	Ch. 1- 4	Estimated release date: **2 – 5 Nov** Deadline: 1 week post release
Graded quiz 2	Ch. 1- 6 (with focus on 5&6)	Estimated release date: **30 Nov – 2 Dec** Deadline: 1 week post release

Study Project (35 % of the course)

This course will have a study project component for you to learn more about a particular area of everyday chemistry that interests you. The project period will commence about 2 weeks into the course.

On **16 September** (5th Lecture), the class will be devoted to introduce the requirements and details of the study projects. This lecture is very important, please ensure you attend this class.

In view of the time needed for this project, **there will be no mid-term examination** for this course.

There will be three types of study projects, and you are free to choose one or the other.

- Individual written study report
- Group Experimental study project
- Group Video study project

Unfortunately for those students who are not able to come to Hong Kong this semester, it is not feasible to arrange group projects for you, therefore you may only choose the option of individual study project.

The study project is a **compulsory component** of the course, those students who fail to submit their study project will receive an 'F' grade to the course, no matter how they performed in the final exam. Late submissions will be accepted until the date of the final exam, with appropriate mark deductions.

Individual projects

Individual projects will be a piece of written original research. You will choose a topic yourself that is about any chemistry phenomenon or chemicals that is in your everyday life. Be creative and explore interesting topics!

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

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

More information will be announced on the 5th lecture before the start of the project.

Group projects

There will be two types of group projects: experimental group project or video group project. We plan to group students into groups of 5 to 8 for the experimental project, and into groups of 6 to 10 for the video project. You may form groups among yourselves and other students not already belonging to a group who wished to carry out the experimental projects will be randomly formed into groups. For the video projects, you are advised to form into your own group, gathering a group of classmates with different expertise of video production.

About the Experimental Project (5-8 people):
Several research topics will be listed and you will decide to carry out one of these or you may discuss with your groupmates and come up with an original topic. Students-led experiment ideas are very encouraged but they must be experiments that can be safely performed at a 'kitchen' or 'home' setting – meaning that it should not involve highly hazardous chemicals or unsafe procedures. Use of any flames would be forbidden. The experiments should have an everyday chemistry theme.

After deciding on the topic, there will be a meeting with one the instructors, who will listen to the ideas and give some guidance on the projects. In particular, together with the instructor, your group will identify the experiments to carry out based on your topic. It is a requirement that these experiments will be simple and safe to conduct at home. The Department of Chemistry can provide some simple apparatus (such as test tubes, beakers, droppers, etc.) and other small items or specific chemicals. In rare and worthwhile cases, we may make arrangements for specific experiments to be conducted in a laboratory, but due to limited resources, this may not be available to everyone.

Each project group should identify a leader who will coordinate the group work. A Canvas group website will be created where the members can share files, hold discussions, arrange meetings, etc.

During the project, each group will be assigned with a TA to guide your project. You will find your TA can usually offer a lot of insight and support to you, so do meet with him/her often and invite him/her along to your experiment gatherings. You will need to research by looking up books in the library, scientific journals and using the internet. You can also approach the instructor to discuss your projects. You will also gather some results from the experiment observations. Finally you will sum these up into a group report and produce a poster. These will be graded for all members of the group and individual performances will also be a grading factor. We hope to be able to share the findings of your projects during a later lecture after reading and marking all the reports.

About the Video Project (6-10 people):
In the Video project, the group will design and produce a **short video clip (around 5 mins)** that is related to a Chemistry topic. The video can be expressed in any appropriate forms, including drama, animated graphic, etc. Students with expertise or passion in video making, should try to form into a group that should have a well balanced membership (e.g. actors, script writers, video editors, sound editors, graphic artists, camera-men, etc.)

- Your group should discuss and agree on the video theme. Dr Jason himself will usually be the TA to assist video project groups. Support in terms of experiments and chemical equipment can be discussed with the instructor. Limited audio-visual facilities/assistance may be available through the *Creative Media Zone* in the library (https://cmz.ust.hk/), but generally it is expected that the students should use their own equipment to undertake the project.

Each project group should identify a leader who will coordinate the group work. A Canvas group website will be created where the members can share files, hold discussions, arrange meetings, etc.

Final Examination (55 %)

On-campus proctored examination: This course will end with a *close-book* final examination (2.5 hours). This will cover all the lecture materials and exercises that were taught in the course. You will mainly be tested on your understanding and ability to solve problems rather than on the memorisation of facts, but you should also be familiar with some key chemical details – some of these will inevitably require some memorisation.

The date, time and venue for the final exam will be announced later.

Online mode assessment: For those who are unable to return to Hong Kong, it can be assumed that your final exam will be offered in an online mode. This will be a *closed-book* final examination on Canvas and it will be proctored through Zoom Meeting (webcam monitoring) by an invigilator.

Grades

The final grade for the course will be consisted of:
10 % from the Online Graded Quizzes
35 % from the Study Project*
55 % from the Final Examination
The course is graded from A+ to F. An F grade will not earn you credits for the course.
**Note that failure to complete the study project would result in an F grade.*

Intended Learning Outcomes (ILOs)

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

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

Assessment Scheme

Weight	Assessment	Course ILOs	CHEM Program ILOs
10%	Online Revision Quiz	1, 2, 3, 4	1, 2, 3
35%	Study Project	1, 2, 3, 4	3, 6, 11, 12, 13
55%	Final Exam	1, 2, 3, 4	1, 2, 3

Teaching and Learning Activities (Non-assessed)

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

The Hong Kong University of Science and Technology
Department of Chemistry

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

CHEM 1010 – General Chemistry IA (3-credits) Fall 2021 -2022

Course Description:
This course targets students who have learnt the basic knowledge of Chemistry in high school, and is the Part I of a two-semester course 'General Chemistry'. Key topics covered include atoms, atomic structures, chemical bonds, molecules, molecular structures, substances, chemical kinetics, and energy.

Pre-requsites: *Level 3 or above in HKDSE 1/2x Chemistry OR CHEM 1004*

Exclusions: *Level 3 or above in HKDSE 1x Chemistry, CHEM 1008, CHEM 1020*

Lecture: Tuesday and Thursday, 15:00 – 16:20, Rm 2464 (Lift 25-26)

Instructor Office Hours: By email.

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 Review: Measurement and Calculations in Chemistry
- ☐ Chapter 1: Chemical Foundations
- ☐ Chapter 2: Atomic Structure and Periodicity
- ☐ Chapter 3: Bonding - General Concepts
- ☐ Chapter 4: Molecular Structure and Orbitals
- ☐ Chapter 5: Stoichiometry
- ☐ Chapter 6: Types of Chemical Reactions and Solution Stoichiometry
- ☐ Chapter 7: Chemical Energy
- ☐ Chapter 8: Gases

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

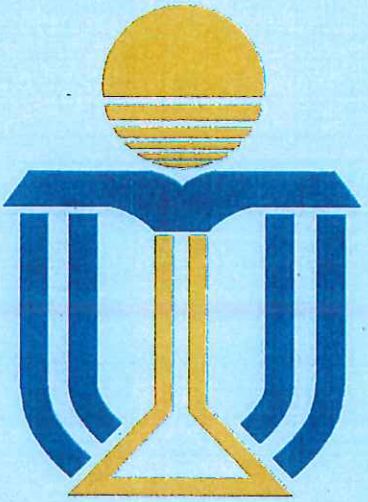
1. Describe and apply fundamental principles and terminologies of chemistry.
2. Develop a microscopic view of the world in terms of atoms and molecules and their change
3. Describe and apply concepts of mass conservation and energy conversation in chemical changes.

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 a chemical reaction from an equilibrium, thermodynamic and kinetics point of views.
7. Describe the physical states of matters: gases, liquids and solids.
8. Recognize and appreciate the impact of chemistry to our society.

Course Grading Scheme

Midterm Exam	50 %
Final Exam	50 %

Welcome to HKUST!



Welcome to Chem1020!

CHEM 1020 General Chemistry IB (Fall 2021)

Instructor (1):

Name:	**Guochen JIA**
Office:	**CYT 6009**
Email:	**chjiag@ust.hk**
Phone #:	**2358 7361**
Office hour:	**Friday, 14:00 – 15:00**

CHEM 1020 General Chemistry IB
(Fall 2021)

Instructor (2):

Name: Jinqing HUANG

Office: RM 4544

Email: jqhuang@ust.hk

Phone #: 3469 2627

CHEM 1020 General Chemistry IB
(Fall 2021)

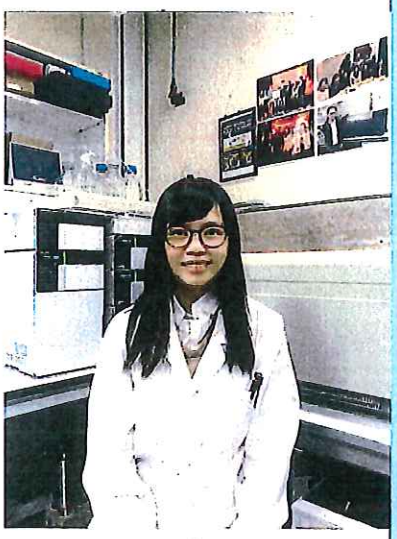
Instructional Assistant (The I.A.):

Name: Miss Elaine, WONG Yee Lam

Office: RM 4524

Email: wylelaine@ust.hk;

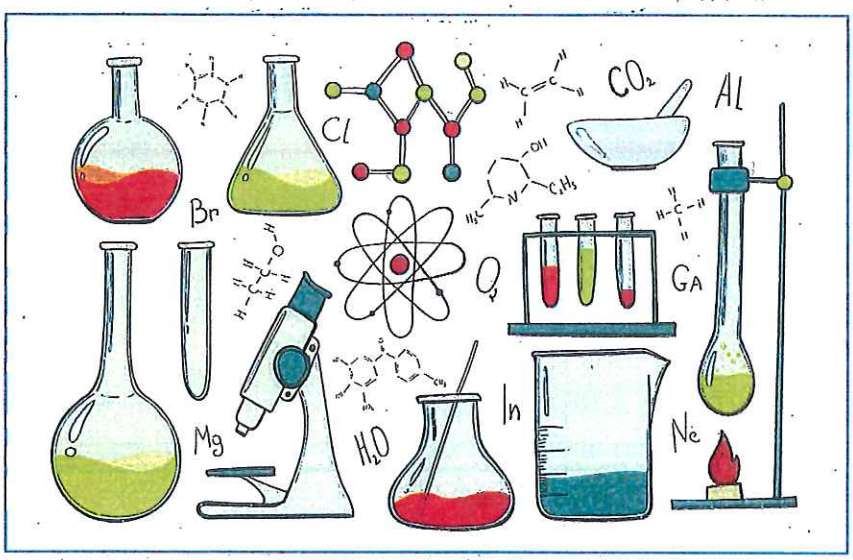
Phone #: 2358 7243



Office hour: Wednesday, 14:30 – 15:30

Course Objectives

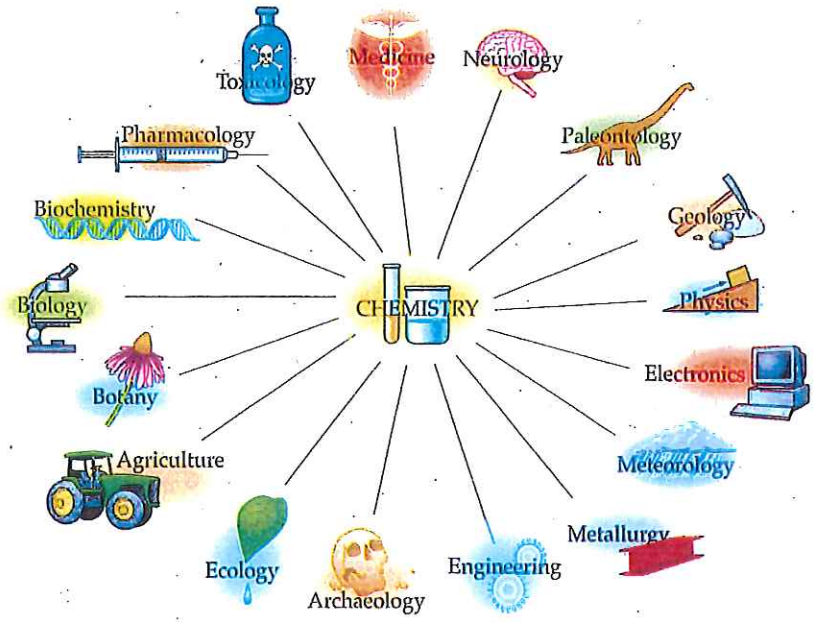
- **Chemistry** is a science that studies **composition**, **structure**, **properties**, and **changes (reactions)** of matter.



Chemistry and Life

We encounter and use chemicals every days.

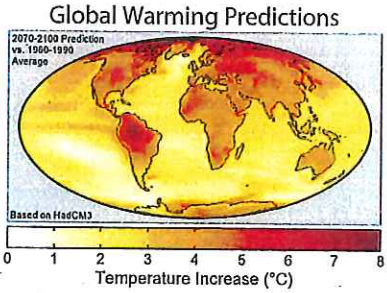
Chemistry: Its Central Role

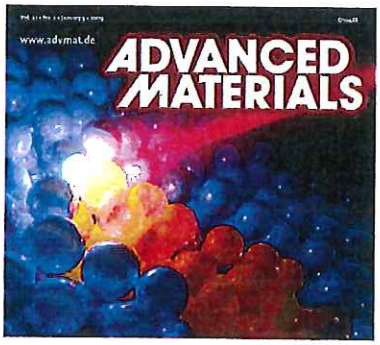


Chemistry is a central science. It is related to many modern technologies and industries.

Chemistry and Future

Many problems require chemistry knowledge to resolve, e.g.





New medicines

Course Objectives

- To introduce fundamental concepts and principles of chemistry.
- To prepare you for further study in other chemistry-related subjects in Science and Engineering.
- Key topics: atomic structures, bonding theories, thermochemistry, solution chemistry, properties of gas, liquid and solid.

Course Outline

Chapter 1. Chemical Foundations

Chapter 2. Atomic Structure and Periodicity

Chapter 3. Bonding: General Concepts

Chapter 4. Molecular structure and orbitals

Chapter 5. Chemical Stoichiometry

Chapter 6. Chemical reactions in aqueous solution

Chapter 7. Thermochemistry: Chemical Energy

Chapter 8. Gases

Chapter 9. Liquids and solids

Knowledge/Content Related Learning Outcomes

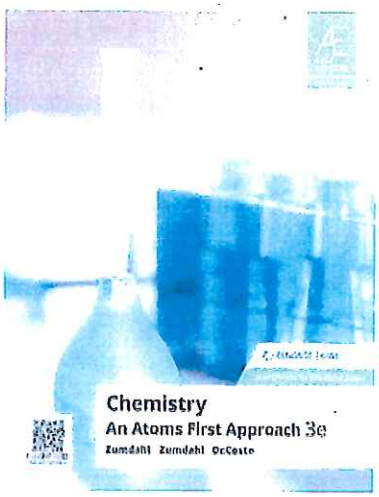
At the end of the course, students are expected to be able to:

1. Describe and apply elementary concepts and terminologies of chemistry
2. Describe the structure of atoms and periodicity, and determine electron configurations.
3. Describe and apply the primary concepts of bonding theory.
4. Perform chemical stoichiometric calculations.
5. Describe common reactions in aqueous solutions.
6. Describe and apply the basic concepts of thermochemistry.
7. Describe properties of gases, liquids and solids

Textbook

Title: "Chemistry: An Atoms First Approach"
3rd Ed (Asia edition); 2021

Authors: Steven S. Zumdahl,
Susan A. Zumdahl &
Donald J. DeCoste



Publisher: Cengage Learning

Note:

✓Both hardcopy and e-book are available for purchasing.

✓Two copies are on-reserve in the HKUST library.

Lecture Notes and Videos

Lecture Notes:

- Lecture-note will be posted on the CANVAS system [https://canvas.ust.hk].
- After-lecture-note will also be posted after finishing each chapter [for my lectures].

Lecture Video:

- All lectures are video tapped.
- Available on Chem-1020 site on the CANVAS system.

Tutorials

- *Two tutorial sessions will be offered.*
- *One* before Mid-Term Exam and one before Final Exam
- Instructed *by instructional assistant.*

Note: The exact date, time and venue for the tutorial class will be announced in due course.

Homework (HW)

- Questions are selected from end-of-chapter exercises in your textbook.
- They will not be graded.
- Model-Answers for HWs will be posted on the CANVAS system.

Assessment and Grading

➢ Midterm Exam	50%
➢ Final Exam	50%

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

CHEM 1030 (L1) General Chemistry II

Fall Semester 2021-2022
3 credits

Lectures:	Wednesdays and Fridays 3:00 – 4:20 PM **Classroom 4620, 4/F, Lift 31/32**	
Mixed-mode:	Visit Canvas for Zoom links (pw: **chem1030**)	
	No Lecture on 22 Sept and 1 Oct (public holidays)	
Instructor:	**Prof. K. K. Jason Chan** Assistant Professor of Science Education Department of Chemistry	
	Email: **kkjchan@ust.hk** Office: Rm 4543, 4/F, Lift 25/26	
Teaching Assistants:	Mr Yuhuang CHENG Mr Xingyang YAN Mr Weijian YE	email: ychengbn@connect.ust.hk email: xyanas@connect.ust.hk email: wyeai@connect.ust.hk
Course website:	Canvas course site	https://canvas.ust.hk

Course Description

This course is for students who have taken or are also taking General Chemistry I. It is a foundational Chemistry course that build up an understanding of Chemistry for more advanced higher level courses.

There will two parts to this course: *Understanding chemical reactions* and *Chemistry of the Elements*. The first part will be consisted of 5 chapters, while the second part will be consisted of 3 chapters.

Part 1: Understanding chemical reactions

Chapter 1	Chemical thermodynamics
Chapter 2	Chemical equilibrium
Chapter 3	Solubility and solution properties
Chapter 4	Acids and bases
Chapter 5	Chemical kinetics

Part 2: Chemistry of the elements

Chapter 6	The main group elements
Chapter 7	Transition metals
Chapter 8	Redox and Electrochemistry

Course materials

(1) Lecture Notes

A set of lecture notes will be provided for each chapter of the course. These notes will be the main teaching materials. The lecture notes for the upcoming Chapter will be uploaded to Canvas towards the end of a chapter. Please download them and either print them out to write notes on them or use them in a digital format that has hand-written note-taking capability.

There are blanks to be filled in and exercises to be completed during the lectures within the notes, so please attend the lectures to ensure you can follow the progress and not miss out on important parts.

(2) Presentation Slides

The lectures will be delivered with the use of some ppt slides. The slides contain both the content from the lecture notes and additional information. Slides are used for more visual presentation and the additional information in the slides provide more context or supplementary information to the course. The content of the slides are also examinable, unless the slides are clearly marked as 'not for exam'. A PDF of the slides will be uploaded to Canvas after each lecture and they will contain any hand-written notes of the lecturer from the class.

(3) Textbook

This course is the continuation of General Chemistry I, and the same textbook is adopted as our reference: *Chemistry: An Atoms First Approach* (Steven Zumdahl and Susan Zumdahl). It is optional on whether you purchase the textbook as we will not be using the textbook directly during the course.

The course will not follow the exact contents, or the order of this textbook, but you can find the corresponding chapters in Zumdahl & Zumdahl's on the cover page of each set of lecture notes. This textbook can be useful to supply more practice questions with answers provided at the back, however it is often helpful to consult some other resources that can provide better quality explanation. Recommended books or internet resources will be provided to you on Canvas by Chapter, please make use of these resources to go deeper on the topics.

(4) Practice exercises and on-demand tutorials

At the end of each chapter, a set of practice exercises will be provided. These are not graded and they are meant to be your homework to be completed at your private study time.
Tutorial classes on these exercise questions will be provided by pre-recorded tutorials, given by the instructor. You can watch the tutorial class after completing the exercise to check your answers. To ask further questions, you can contact the instructor or a TA by email or to arrange for an office hour.

Graded Assessments

The course grade will be computed from three assessments carrying different weighting:

- Four graded quizzes 20 %
- Mid-term examination 30 %
- Final examination 50 %

A letter grade (A+ to F) will be given to the course, with reference to the university grades distribution guidelines.

(1) Graded quizzes 20 %
There will be a graded quiz at the end of every two Chapters, i.e. a total of four graded quizzes. Each graded quiz will count towards around 5 % of the course grade, giving a total of 20 % from the 4 quizzes. These quizzes are designed to be a revision or concept check of your understanding and they should be treated as a learning opportunity.

Graded quizzes will be arranged on Canvas in a digital format. There will be a window of around 10 days to complete each quiz. When a quiz becomes available, you will be notified by email with the details, and the lecturer will announce this in the class.

(2) Mid-term examination 30 %
A mid-term examination will take place on **27 Oct (Wed) at 7:00 – 9:00 PM** (after the 15th lecture). The exam will be arranged **online on Canvas** with Zoom proctoring, and will cover the contents of the course up to and including the lecture on 20 Oct (one week before).

The mid-term exam will be in an **open-book format**. Please note the exam time is in the evening, please make prior arrangements to be available at a suitable location at home or in HKUST to take the exam. A special classroom will be provided for those who wish to take the exam in HKUST, but you will need to bring your own laptop (with sufficient battery) with you.

(3) Final examination 50 %
The final exam will take place during the final examination period on a date and time arranged by the Academic Registry. The final exam will be a closed-book proctored exam. For those who cannot be in Hong Kong, an online version will be provided with webcam proctoring.

This final exam will cover all contents for the entire course, including those parts already covered in the mid-term exam. It will include questions that require knowledge across the Chapters to test your understanding. Of course, there will be a heavier focus on the latter parts of the course, but you should be prepared to make use of knowledge learned in the earlier parts too.

Office Hours
The instructor will be available for consultation by appointment. Please email Prof. Chan to request an office hour meeting.

Learning Outcomes
On completion of the course, students will be able to:

1. Analyse 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. Describe and explain the trends and patterns of structures, physical properties and reactivities of selected main group compounds, transition metal compounds.
6. Recognize the impact of chemistry to society.

CHEM 1050 Laboratory for General Chemistry I

2021–22 Fall

Course Outline

Instructor

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

Instructional Assistants (IAs)

Ms. CHEUNG Ruby S. W. (Rm4501C; Tel: 2358 8450; Email: rubycheung@ust.hk)

Ms. KAM Kammy W. M. (Rm4501C; Tel: 3469 2080; Email: kamwamei@ust.hk)

Technical Officers

Mr. SEETO K. (Rm4531; Tel: 2358 7371; Email: chkseeto@ust.hk)

Mr. TSE M. L. (Rm4531; Tel: 2358 7371; Email: mltse@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:	Level 3 or above in HKDSE 1/2× Chemistry OR level 3 or above in HKDSE 1× Chemistry OR CHEM 1004
Co-requisite:	CHEM 1010 OR CHEM 1020
Exclusion:	Nil
Grade:	P/F

Description:

This course is the laboratory class designed for students who enrolled in CHEM 1010 or CHEM 1020. With laboratory experience acquired in this course, students will be able to relate the physical and chemical principles and theories in practice.

Intended Learning Outcomes (ILOs)

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

Knowledge/Content Related:

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

Academic Skills/Competencies Related:

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

Assessment Scheme

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

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

Student Learning Resources

- Reference Book: James Hall, *Experimental Chemistry: An Atoms First Approach*, Brooks/Cole, Cengage Learning, **2012**.
- 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
- Gas law
- Boiling point and intermolecular forces
- Solution stoichiometry and volumetric titration
- Chemical energy and calorimetry

CHEM 2110 ORGANIC CHEMISTRY I

Course Outline- Fall 2020

1. Instructor

Name: ***TONG, Rongbiao***

Contact Details: Office @ Rm CYT6011 (Lift 35/36), Tel: 2358-7357, EMAIL: rtong@ust.hk

2. Meeting Time and Venue

Lectures:

Date/Time: Monday (10:30pm-11:50pm) and Wednesday (10:30am-11:50am)

Venue: CYT-LTL and Zoom (mixed mode)

3. Course Description

Credit Points: 3

Pre-requisite: CHEM1030

Exclusion: NIL

Brief Information/synopsis:

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.

4. 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.

5. Assessment Scheme

a. Examination duration: midterm exam: 80 min; final exam: 3 hrs.

b. Percentage of examinations etc.:

Assessment	Assessing Course ILOs
40% Midterm exam	1, 2, 3, 4
60% by final exam	1, 2, 3, 4

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

6. 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.

7. Teaching and Learning Activities

Scheduled activities: 4 hrs (lecture + office hour)

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 Sulfides.

CHEM 2210 Inorganic Chemistry I

Course Outline- Fall 2021

1. Instructor(s)

Name: Prof. Wa-Hung Leung

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

2. Teaching Assistant(s)

Mr. CHAN, Ka Lok	email: klchanbl@connect.ust.hk
Mr. PHAM, Hoang Long	email: hlpham@connect.ust.hk
Mr. XU, Xin	email: xxube@connect.ust.hk

Meeting Time and Venue

Lectures:

Date/Time: Monday (15:00-16:20), Friday (10:30 - 11:50)

Venue: Rm 2407

Tutorials:

Date/Time: N.A.

Venue: N.A.

3. Course Description

Credit Points: 3

Pre-requisite: CHEM 1030

Exclusion: NIL

Brief Information/synopsis:

This course is designed for students who have taken CHEM 1030 under the four-year degree. Key topics include molecular structure and bonding, physical techniques in inorganic chemistry, acids and bases, structure of inorganic solids, molecular symmetry, and introduction to coordination chemistry.

4. Intended Learning Outcomes

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

No.	ILOs
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.

5. Assessment Scheme

a. Examination duration: 2.5 hour

b. Percentage of coursework, examination, etc.:

Assessment	Assessing Course ILOs
8% by assignment	1, 2, 3, 4
8% by quizzes, iPRS tests, class participation	1, 2, 3, 4
36% by mid-term test	1, 2, 3, 4, 5
48% by final exam	1, 2, 3, 4, 5

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

6. Student Learning Resources

Recommended Reading:

Text(s):

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

7. Teaching and Learning Activities

Scheduled activities: 3 hrs (lecture)

8. 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

CHEM 2310 Fundamentals of Analytical Chemistry

Course Outline - Fall 2021

1. Instructor

Dr. Simon W. Chan

Email chanwan@ust.hk, Rm 4517

Office Hours: walk-in or by appointment

2. Teaching Assistant(s)

SUN, Zhihan zsunar@connect.ust.hk

PAN, Guanrui gpanaa@connect.ust.hk

CHIN, Man Lung mlchin@connect.ust.hk

KWOK, Hong Ching hckwokaa@connect.ust.hk

3. Lecture Time and Venue

Date/Time: Wednesday and Friday (16:30 – 17:50); **Venue:** LT-F

4. Course Description

Credit Points: 3; Pre-requisite: CHEM 1030; Exclusion: CHEM 2311

Brief Information/synopsis:

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

5. Assessment Scheme

2 x assignments (10% each; 20% total);

1 x mid-term exam (35%, to be held on Fri ***22nd, Oct 2021***);

1 x final exam (45%);

*** ***5 bonus (5 x 1) points*** *for answering questions during the lecture* ***

6. Intended Learning Outcomes

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

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

7. Student Learning Resources

Textbook: Exploring Chemical Analysis (5th Edition), Daniel Harris, Freeman, 2013
Reference: Quantity Chemical Analysis, Daniel C. Harris, Freeman

8. Teaching and Learning Activities

Scheduled activities: 3 hrs (lecture)

9. Course Schedule

Keyword Syllabus:

Measurements and the tools of an analytical chemist	Polyprotic Acids and Bases
Math Tool-kit, Significant Figures and Errors	EDTA Titrations
Statistics	Introduction to Electrochemistry
Least Squares and Quality Assurance	Potentials and Potentiometry: Electrode Measurements
Gravimetry	Redox Titrations
Titrations	Instrumental Electrochemistry
Acids and Bases	Optical Spectroscopy and Applications
Buffers and Indicators	Chromatography
Acid-Base Titrations & N-Analysis	Mass Spectrometry

CHEM 2350 Analytical Chemistry Laboratory
Course Outline – Fall 2021

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: Carmen GUO <*chgjw@ust.hk* >; Edmund FOK <*chfokmw@ust.hk* >
Contact: Lab: Rm 6122; Tel: 2358 7382

Instructional Assistant:
Name: Jennifer WONG <*wongyc@ust.hk*>
Contact: Lab: Rm 6122; Tel: 2358 7382

Teaching Assistants: *Separate file*

3. Meeting Time and Venue

Date & Time:
LA1: Tuesdays 10.30 - 13.20
LA2: Tuesdays 13.30 - 16.20

Venue: Room 6122, 7122 and Room 7122A

4. Course Description

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

Course Description: Practical aspects of fundamental chemical analysis.

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

5. Intended Learning Outcomes (ILOs)

On completion, students should be able to:

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

6. Assessment Scheme

Course Grading

Weight	Assessment	Course ILOs
60%	Report	1, 2
20%	Lab Quiz	1, 2

20%	Lab Performance	3 - 6

7. Syllabus

Expt No.	Title of Experiment
1	Calibration of Volumetric Glassware
2	HPLC Analysis of Caffeine in Energy and Soft Drinks
3	Determination of Chemical Oxygen Demand in Wastewater Sample
4	Quantitative Analysis of Xylene Isomer (para-Xylene) Using Fourier Transform-Infrared Spectrometer (FT-IR)
5	Determiantion of *n*-Heptane, *n*-Octane and *n*-Decane in unknown sample using Gas Chromatograph - Flame Ionization Detector (GC-FID)

8. Student Learning Resources

- Harris D. C., ***Quantitative Chemical Analysis***, 8th Ed., W. H. Freeman and Company, New York, 2010.
- Skoog D A, West D M, Holler F J, ***Fundamentals of Analytical Chemistry***, 6th Ed, Saunders College Publishing, 1992.

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 2409
Mathematical Methods in Physical Chemistry
Fall 2021

Instructors:

Dr. Haibin Su (Associate Professor)
Room: 4520, Lift 25/26
Tel: 2358-7388
E-mail: haibinsu@ust.hk

Teaching Crew:

Dr. Kaicheng Zhu	Rm 4207
Zhouyi He	Rm 4207
Wilwin	Rm 4207
Lyu Hang	Rm 4207
Muhammad Hasan	Rm 4207
Ziru Huang	Rm 4207
Thanh Long	Rm 4207

Lectures:

Tuesday	9 am -10:20 am	LT-F Meeting ID: 991 5699 1580 Passcode: 210817
Thursday	9 am -10:20 am	LT-F Meeting ID: 999 3548 4536 Passcode: 210817

Tutorials:

Thursday	12:00 pm - 1:20 pm	Rm 2407 (Lift 17/18) Meeting ID: 914 7413 1564 Passcode: 210817

Office Hours:

Thursday	3:30 pm–4:30 pm	Rm 4520 (Lift 25/26)

Course Website:

https://canvas.ust.hk/courses/38900

Course Forum:

https://wiki.laviebay-dev.hkust.edu.hk/Chem2409

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 precursor 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.

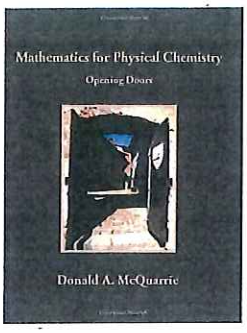
Upon successful completion of this course, students will be able to:

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

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

(13) 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

Week 1	Thursday, 02 Sept	Lecture 1	Introduction & Functions of a Single Variable: Differentiation & Integration *Textbook: Chapters 1,2*
Week 2	Tuesday, 07 Sept	Lecture 2	Functions of a Single Variable: Differentiation & Integration *(continued)* *Textbook: Chapters 1,2*
	Thursday, 09 Sept	Lecture 3	Ordinary Differential Equations *Textbook: Chapter 6*
Week 3	Tuesday, 14 Sept	Lecture 4	Ordinary Differential Equations (continued) *Textbook: Chapter 6*
	Thursday, 16 Sept	Lecture 5	Series and Limits & Complex Numbers *Textbook: Chapters 3,5*
Week 4	Tuesday, 21 Sept	Lecture 6	Fourier Series & Transforms *Textbook: Chapter 9 & 10*
	Thursday, 23 Sept	Lecture 7	Fourier Series & Transforms (continued) *Textbook: Chapter 9 & 10*
Week 5	Tuesday, 28 Sept	Lecture 8	Fourier Series & Transforms (continued) *Textbook: Chapter 9 & 10*
	Thursday, 30 Sept	Lecture 9	Functions of Several Variables *Textbook: Chapter 12*
Week 6	Tuesday, 05 Oct	Lecture 10	Functions of Several Variables (continued) *Textbook: Chapter 12*
	Thursday, 07 Oct	Lecture 11	Functions of Several Variables (continued) *Textbook: Chapter 12*
Week 7	Tuesday, 12 Oct	Lecture R.	Review for Midterm Exam

	Thursday, 14 Oct		Thursday is a holiday
Week 8	**Tuesday, 19 Oct**	**Exam**	**Midterm Exam** (covers Lecture 1 to 11) Time: 9 – 10:20am [19 Oct., Tues.] Location: To be announced
	Thursday, 21 Oct	Lecture 12	Operators/Vectors *Textbook: Chapter 11 & 13*
Week 9	Tuesday, 26 Oct	Lecture 13	Operators/Vectors (continued) *Textbook: Chapter 11 & 13*
	Thursday, 28 Oct	Lecture 14	Operators/Vectors (continued) *Textbook: Chapter 11 & 13*
Week 10	Tuesday, 02 Nov	Lecture 15	Operators/Vectors (continued) *Textbook: Chapter 11 & 13*
	Thursday, 04 Nov	Lecture 16	Plane Polar & Spherical Coordinates *Textbook: Chapter 14*
Week 11	Tuesday, 09 Nov	Lecture 17	Plane Polar & Spherical Coordinates (continued) *Textbook: Chapter 14*
	Thursday, 11 Nov	Lecture 18	Plane Polar & Spherical Coordinates (continued) *Textbook: Chapter 14*
Week 12	Tuesday, 16 Nov	Lecture 19	Laplace Equation *Lecture Notes*
	Thursday, 18 Nov	Lecture 20	The Classical Wave Functions *Textbook: Chapter 15*
Week 13	Tuesday, 23 Nov	Lecture 21	The Classical Wave Functions (continued) *Textbook: Chapter 15*
	Thursday, 25 Nov	Lecture 22	The Classical Wave Functions (continued) *Textbook: Chapter 15*
Week 14	Tuesday, 30 Nov	Lecture R.	Review for Final Exam
Exam Weeks			**Final Exam** (covers Lecture 12 to 22) Arranged by the university

Updated in August 2021

Instructor: *Prof. Jonathan Halpert* Fall, 2021

Chem2410: Physical Chemistry I
(home: https://canvas.ust.hk/courses/38681)

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 2 – 6, 12) ***(11th Ed. Chap 12 = 9th Ed. Chap 15/16)***

Prerequisites:
(a) CHEM1030; and
(b) One year of calculus (up to MATH1014 or equivalent) **or** CHEM2409

Schedule/Venue:
(a) Lectures: Tuesday (4:30 – 5:50), Rm 2407 & Zoom (see CANVAS)
Thursday (4:30 – 5:50), Rm 2407 & Zoom

(b) Instructors' Office Hours: Friday: 11:00 am – 12:00 pm (on Zoom, by appointment only)
(c) TAs' Tutorial (tentative)**:** **Monday: 7-8 pm**

(d) Examinations (tentative)**:**
Midterm: October 30
Final: **TBA**

Teaching Assistants and Assignments [# L's]:
Cham Heng Angus LI (chaliaa@connect.ust.hk) Chap. 6-12
Pui Kei KO (pkko@connect.ust.hk) Chap. 1-3
Vince St. Dollente MESIAS (vsdmesias@connect.ust.hk) Chap. 4-5

Credit/Grading :

Midterm:	40 % (Chapters 2, 3, 4)
Homework:	20 % (*sum of the best 5 out of 6*)
Final Project:	20 % (Chapters 5, 6, 12)
Final Exam:	20 % (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 Zoom portal.**
(ii) Questions will be marked by the TAs: 50 % completeness, 50 % correctness
(iii) ALSO: **Test** and **Final** examination questions: ~30% 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]**

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 six homework assignments corresponding to Chapters 2+1R, 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).

Late HW will be accepted without penalty up to 2 days late.

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** (+1 lecture w/o penalty)
#1	2+1R	Sep 29
#2	3	Oct 13
#3	4	Oct 23
#4	5	Nov 10
#5	6	Nov 17
#6	12	Dec 3

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 +3 pts to your final grade.

Instructor: *Prof. Jonathan Halpert* **CHEM 2410 Syllabus** Fall, 2021

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($\Delta H^{\varnothing}$) ➢ Standard Enthalpy of Formation($\Delta_f H^{\varnothing}$) ➢ *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 ($\Delta_r G^{\emptyset}$).

Chap. 2* (*Continuous*): Combining the 1st and 2nd Laws (§3.7 –§3.9) **Homework-2***

(a) The Machinery for Thermodynamics (by exploiting Two-Variable Calculus)
--- Derive Various Thermodynamic Equations
(b) Properties of G
(c) Chemical Potential of a Pure Substance (μ)
(d) Real Gas: The Fugacity (f) and Pressure (P)

6-8 **Chap. 4 :** Physical Transformations of Pure Substances (§4.1 –§4.6) **Homework-3**

(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)

9-10 **Chap. 5:** Simple Mixtures (§5.1-§5.13) **Homework-4**

(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

10-11 **Chap. 6 :** Chemical Equilibrium (§6.1 –§6.9) **Homework-5**

(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-6**

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 PROJECT**
Study Break
FINAL EXAM **December 2021**

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.

CHEM 2450 Physical Chemistry Laboratory
Course Outline – Fall 2021

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*>
Contact: Lab: Rm 6122; Tel: 2358 7382

Instructional Assistant:
Name: Jennifer WONG <wongyc@ust.hk>
Contact: Lab: Rm 6122; Tel: 2358 7382

Teaching Assistants: *Separate file*

3. Meeting Time and Venue

Date & Time:
LA1: Wednesdays 10.30 - 13.20
LA2: Wednesdays 13.30 - 16.20

Venue: Rm 6122, 7122 and 7122A

4. Course Description

Credit Points: 1
Pre-requisites: CHEM 1030 General Chemistry, 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

Course Description:
This is the laboratory course corresponding to the lecture course CHEM 2410. The topics of experiments covered in the laboratory course will be related to those taught in the lecture course, such as electrochemical equilibrium, 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	Recognize fundamentals of chemistry including structure, reactivity and properties of chemical substances, and the states of matter
2	Explain the essential facts, principles and theories in the area of physical chemistry.
3	Analyze and interpret experimental data and extract useful data from it
4	Conduct standard laboratory procedures involved in instrumental work.
5	Assess and manage the risks of chemical substances and laboratory procedures by evaluating their potential impact on the environment.
6	Work independently and collaborate effectively in team work

6. Assessment Scheme

Course Grading

Weight	Assessment	Course ILOs
60%	Report	1 - 3
20%	Lab Quiz	1 - 3
20%	Lab Performance	4 - 6

7. Syllabus

Expt No.	Title of Experiment
1	Equipartition Theorem: Heat Capacity of Metals at Constant Volume
2	Second Law of Thermodynamics: Entropy Variation with Temperature
3	Henry's Law: Determination of Henry's Law Constant and Molar Solubility of Carbon Dioxide in Water
4	Binary Liquid-Vapour Equilibrium: Raoult's Law Plot and Liquid-Vapour Phase Diagram of Aromatic and Ketone Systems
5	Electrochemical Equilibrium: Measurement of the Standard Electrode Potential for Silver/Silver Chloride Electrode

8. Student Learning Resources

Atkins P. W., Julio de Paula, ***Atkins' Physical Chemistry,*** 10th Ed., Oxford University Press, 2014.

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 2550 Synthetic Chemistry Laboratory I

2021 Fall

Course Outline

1. Instructor

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

2. Technical support staff / Teaching Assistant:

Technical support staff:

Name: TSE, Wai Pui Veronica (email: chvaipui@ust.hk)
LAU, Chun Tak Disney (email: disney@ust.hk)
CHAN, Ka Lok Kelvin (email: chkelvin@ust.hk)
WONG, Ka Man Joanne (email: joannewong@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
Corequisite: CHEM 2110 and CHEM 2210
Exclusion: CHEM 2155
Brief Information/synopsis:

This is the laboratory course designed for students who 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

#	Assessment items	Weighting	ILO(s) to be assessed
1	Attendance & Punctuality	5%	6
2	Risk Assessment	5%	2
3	Lab Quizzes	20%	1, 2, 3
4	Performance in laboratory	25%	4, 5, 6
5	Product /Results	10%	4, 5
6	Lab Reports	35%	1, 2, 3, 4, 5, 6

† *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*" *5th Edition*, Hoboken: John Wiley ©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 3rd edition*, Harlow: Pearson Prentice Hall ©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 log in 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-visbile Spectroscopy of Inorganic Compounds

Course Outline: CHEM 3010 "Great Ideas in Chemistry"

Instructors: Prof. Ian D. Williams and Prof. Jason Chan

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 mid-term test, and a term paper and presentation.

Dates for in-class group activities:

(To be held at Classroom 4503)

15 Sept (Wed) 4:30 – 5:50 pm

29 Sept (Wed) 4:30 – 5:50 pm

13 Oct (Wed) 4:30 – 5:50 pm

27 Oct (Wed) 4:30 – 5:50 pm

10 Nov (Wed) 4:30 – 5:50 pm

24 Nov (Wed) 4:30 – 5:50 pm

Please attend the classes on the above days. An attendance will be taken.

Assessment:

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

On-line Work and Quizzes	30%
In-class Discussion and Quizzes	20%
Mid-term test(1.5 hr)	30%
Term papers and Presentations	20%

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

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.

CHEM 4120 Biomolecular Chemistry

Fall semester, 2021

INSTRUCTOR:

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

TEACHING ASSISTANT:

Mr. Yu Liu
Rm. 7133, Tel. 2358-7352
Email: yliuil@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 and Wednesday 12:00-1:20 pm

Venue: Rm. 2406.

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 and Amino acids, peptides and proteins (1)
Week 2	Sept. 6	Introduction and Amino acids, peptides and proteins (2)
	Sept. 8	Synthesis of amino acids and peptides
Week 3	Sept. 13	Solid-state synthesis of peptides
	Sept. 15	Synthesis of proteins
Week 4	Sept. 20	Analysis of amino acids and proteins: Mass spectroscopy
	Sept. 22	***No class, Mid-Autumn Festival***
Week 5	Sept. 27	Peptide fingerprinting of proteins
	Sept. 29	Proteomics
Week 6	Oct. 4	Lipids—Fatty acids, wax, and triacylglycerols
	Oct. 6	Lipids—Components and structure of cell membranes (1)
Week 7	Oct. 11	Lipids—Components and structure of cell membranes (2)
	Oct. 13	Biosynthesis of lipids and drug development
Week 8	Oct. 18	Carbohydrates—Stereochemistry and hemiacetal forms
	Oct. 20	**Mid-term exam, in class.**
Week 9	Oct. 25	Carbohydrates—Reactions of monosaccharides
	Oct. 27	Carbohydrates—Di-, oligo- and polysaccharides
Week 10	Nov. 1	Carbohydrates—Synthesis of oligosaccharides
	Nov. 3	DNA structure, properties, and reactivity (1)
Week 11	Nov. 8	DNA structure, properties, and reactivity (2)
	Nov. 10	DNA replication and amplification
Week 12	Nov. 15	DNA chemical synthesis
	Nov. 17	DNA sequencing (1)
Week 13	Nov. 22	DNA sequencing (2)
	Nov. 24	RNA structure and properties
Week 14	Nov. 29	RNA functions
Week 15	Dec. 1-6	**Study Break**
Final exam	Dec.7-18	To be arranged.

CHEM 4140 Intermediate Organic Chemistry

Fall Semester (1 Sept – 30 Nov, 2021)

INSTRUCTOR: Prof. HUANG, Yong
Office: 4530
Telephone: 3469 2625
E-mail: yonghuang@ust.hk

TEACHING ASSISTANTS:

TBA

LECTURE TIME: Mon, 10:30-11:50
Wed, 10:30-11:50

VENUE: Rm 2126D, Lift 19

COURSE DESCRIPTION:

[Previous Course Code: CHEM 313] Provides further training in the multistep organic synthesis of natural and unnatural products, and will focus on the retrosynthetic analysis, control of stereochemistry, carbonyl group chemistry, and pericyclic reactions with a brief coverage on new synthetic methodologies for efficient synthesis of compound libraries. A prerequisite for students wishing to take CHEM 5110/5120 as part of their undergraduate program. 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 and T. Montagnon; Weinheim: Wiley-VCH, 2008.

COURSE OBJECTIVES AND INTENDED LEARNING OUTCOMES:

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

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

1. Recognize and explain the 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 advancement in social and daily life.
3. Formulate and analyze synthetic planning and products of multistep organic transformations by applying principles of retrosynthetic analysis.
4. Communicate effectively in the community of synthetic organic chemistry both orally and in writing.

EXAMS AND GRADING SCHEME:

SYLLABUS

1-Introduction: brief revision on atomic theory, the periodic table, impact of molecules such as steroids and taxol on life, and importance of chemical synthesis including total synthesis of natural products.

2-Stereochemistry part I: molecular chirality, stereoisomers, Fischer convention, CIP convention, chiral center, and axis, chirality and symmetry, optical activity, physical properties of enantiomers, prochiral relationship, stereochemical drawing techniques, stereochemical 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.

3-Stereochemistry part II: Stereochemistry of Reactions: chemoselectivity, regioselectivity, and stereoselectivity, heterogeneous and homogeneous catalytic hydrogenation and polar group directing effects, hydride reduction of acyclic ketones and cyclohexanones, nucleophilic addition to acyclic carbonyl groups, Cram's rule, and Felkin–Ahn model, the role of electronegative

substituents in Felkin–Ahn model, 1,3-asymmetric induction on reduction of β-hydroxyketones, chelation control in reduction of α-hydroxyketones, β-ketoesters, and Grignard addition to α-alkoxyketones, the Houk conformation for reactions of alkenes with electrophiles, catalytic enantioselective hydrogenation of alkenes and carbonyl groups, Sharpless asymmetric epoxidation (AE), and Sharpless asymmetric dihydroxylation (AD).

4- Retrosynthetic Analysis & Synthetic Strategy: bond disconnection approach, valid retrosynthetic steps, the advantage of convergent synthesis, normal and umpolung synthons, synthetic equivalents, functional group interconversion (FGI), and functional group addition (FGA), selected strategies for reaction control.

5-Functional Group Interconversion: Mitsunobu reaction, selected mild methods for conversion of alcohols into alkyl halides and sulfonates and reactions with cyanides, nitrogen, oxygen, sulfur, and phosphorus nucleophiles, selected methods for the formation of esters from alcohols using acyl chlorides, acyl imidazoles, mixed anhydrides O-acyl isourea, and thiol esters, selected methods for the formation of amides from amines and carboxylic acids, cleavage of ethers and esters using TMSI, selected hydride reagents for reduction of esters and Weinreb's amides to aldehydes, selective reduction of aldehydes and ketones in the presence of esters, reductive amination of aldehydes and ketones, CBS reduction of ketones to chiral alcohols, Swern oxidation, and Dess–Martin periodinane oxidation.

6-Carbonyl Group Chemistry I: preparation of Grignard reagents, preparation of organolithium via lithium–halide exchange, lithium–hydrogen exchange (α-lithiation, lateral lithiation, and DoM), and lithium–metal exchange, solution structures of organolithium and Grignard reagents, the addition of organolithium and Grignard reagents with aldehydes, ketones, carboxylic acid derivatives, and CO2, Wittig olefination of unstabilized, semi-stabilized, and stabilized ylides, Horner–Wadsworth–Emmons (HWE) reaction, the Schlosser modification of Wittig reaction, the Horner–Wittig reaction, the Peterson reaction, the Julia reaction and variations, reactions of sulfur ylides.

7-Carbonyl Group Chemistry II: chemo- and regio-selectivity in enol and enolate formation, regio-, stereoselective aldol reactions, the Zimmermann–Traxler (chair-like) transition state, open transition state, anti-selective aldols of lithium enolates of hindered aryl esters, syn-selective aldols of boron enolates of phenylthio esters and ketones, syn-selective aldols of zirconium enolates of amides, thioesters, and cyclic ketones, aldols of silyl enol ethers via open transition state, chiral enolates of Evans oxazolidinones, syn-selective aldol reaction of boron enolates of chiral N-acyl oxazolidinones, anti-selective aldol reaction of boron enolates of chiral N-acyl oxazolidinones under Lewis acid catalysis, proline-catalyzed enantioselective aldol reaction, the Robinson annulation, Michael addition of organo-copper(I) compounds.

8-Pericyclic Reactions: the Diels–Alder cycloaddition, stereospecificity, endo-selectivity, "ortho" and "para" regioselectivity, intramolecular version, the effect of aqueous media, organocatalysis, Lewis acid catalysis, chiral auxiliary-derived substrates.

9-Examples of Total Synthesis: total synthesis of amphidinolide T1–T5, Fürstner's total synthesis strategy via ring-closing metathesis and hydrogenation, Dai's total synthesis via ring-closing

metathesis, and asymmetric dihydroxylation.

10-Diversity-Oriented Synthesis & Multicomponent Reactions: diversity-oriented synthesis (DOS) vs. target-oriented synthesis (TOS), examples of complexity-generating reactions, examples of diversity-generating processes in terms of appendage diversity, stereochemical diversity, and skeletal diversity, types of multicomponent reactions (MCRs), examples of historically significant MCRs, mechanisms of Passerini three-component reaction (P-3CR) and Ugi four-component reaction (U-4CR), examples of U-4CR using 2-aminophenols and post Ugi annulation.

11-Microwave-Assisted Organic Synthesis, Solid-Phase Organic Synthesis & Combinatorial Synthesis: mechanisms of microwave dielectric heating, the difference of microwave vs. conventional thermal heating, major advantages of microwave heating, difference of solid-phase vs. solution organic synthesis, major advantages of solid-phase organic synthesis, types, and roles of linkers used in solid-phase organic synthesis, the difference in parallel synthesis and mix-split synthesis.

Week 1	Sept. 1	*1-Introduction*
Week 2	Sept. 6	*2-Stereochemistry part I: Stereochemical Principles*
	Sept. 8	*2-Stereochemistry part I: Stereochemical Principles (continue)*
Week 3	Sept. 13	*2-Stereochemistry part I: Stereochemical Principles (continue)*
	Sept. 15	*2-Stereochemistry part I: Stereochemical Principles (continue)*
Week 4	Sept. 20	*3-Stereochemistry part II: Stereochemistry of Reactions*
	Sept. 22	*No Class: Public Holiday*
Week 5	Sept. 27	*3-Stereochemistry part II: Stereochemistry of Reactions (continue)*
	Sept. 29	*3-Stereochemistry part II: Stereochemistry of Reactions (continue)*
Week 6	Oct. 4	*3-Stereochemistry part II: Stereochemistry of Reactions (continue)*
	Oct. 6	*3-Stereochemistry part II: Stereochemistry of Reactions (continue)*
Week 7	Oct. 11	*4- Retrosynthetic Analysis & Synthetic Strategy*
	Oct. 13	*5-Functional Group Interconversion*
Week 8	Oct. 18	*NO Class: search & read reference materials and writing the essay*
	Oct. 20	*5-Functional Group Interconversion (continue)*
Week 9	Oct. 25	*Mid-term Examination (Normal Classroom)*
	Oct. 27	*5-Functional Group Interconversion (continue)*
Week 10	Nov. 1	*6-Carbonyl Group Chemistry I*
	Nov. 3	*6-Carbonyl Group Chemistry I (continue)*
Week 11	Nov. 8	*7-Carbonyl Group Chemistry II*
	Nov. 10	*7-Carbonyl Group Chemistry II (continue)*
Week 12	Nov. 15	*7-Carbonyl Group Chemistry II (continue)*
	Nov. 17	*8-Pericyclic Reactions; 9-Examples of Total Synthesis*
Week 13	Nov. 22	*9-Examples of Total Synthesis (continue)*
	Dec. 24	*10-Diversity-Oriented Synthesis & Multicomponent Reactions*
Week 14	Nov. 29	*11-Microwave-Assisted Organic Synthesis, Solid-Phase Organic Synthesis & Combinatorial Synthesis*
	Dec. 1-6	*Study Break*
	Dec. 7-18	*Final Examination (TBD)*
EXAMS AND GRADING SCHEME:		

1. Assignments/essay (20%)
2. Mid-term Examination (35%)
3. Final Examination (45%)

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
2021 Fall semester
Course Outline

1. Instructor

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

2. Technician/ Instructional Assistant/ Teaching Assistant:

Technicians:
Name: TSE, Wai Pui Veronica (chvaipui@ust.hk)
WONG, Ka Man Joanne (joannewong@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

Grading type: letter grade.

Assessment Criteria	ILOs
10% Attendance and risk assessment♣	3
20% Lab Quiz†	1, 2
25% Performance in laboratory	4, 5, 6
10% Product	4
35% Reports	1, 2

♣ *5% - punctuality, 5% - safety sheet*

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

7. Student Learning Resources

Reference books:

(a) "*Macroscale and Microscale Organic Experiments 3rd edition*," Kenneth L. Williamson, Boston: Houghton Mifflin ©1999.

(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 (http://canvas.ust.hk).*

8. Teaching and Learning Activities

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

9. Keyword Syllabus

- Chemistry 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
- Protecting Groups for Carbohydrate
- Regioselective Substitution Reaction
- Diastereoselectivity Control in Substitution
- Glycosylation Reaction

CHEM 4155

Biomolecular Characterization Laboratory

2021 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: TSE, Wai Pui Veronica (chvaipui@ust.hk)
WONG, Ka Man Joanne (jaonnewong@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 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

Grading type: letter grades.

Assessment Criteria	ILOs
10% Attendance and risk assessment♣	3
20% Lab Quiz†	1, 2
25% Performance in laboratory	4, 5, 6
10% Product	4
35% Reports	1, 2

♣ *5% - punctuality, 5% - safety sheet*

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

7. Student Learning Resources

Reference books:

(a) *"Macroscale and Microscale Organic Experiments" 3rd edition*, by Kenneth L. Williamson, Boston: Houghton Mifflin ©1999.

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

(c) *"Quantitative chemical analysis"* by Daniel C. Harris, New York : W. H. Freeman and Co., ©2007.

(d) *"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 (http://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

CHEM 4220
Materials Chemistry
Fall 2021

Instructors:
Dr. Haipeng Lu (Assistant Professor)
Room: 4542, Lift 25/26
Tel: 3469-2097
E-mail: haipenglu@ust.hk

Teaching Assistants:
SHEN, Hanchen: hshenaf@connect.ust.hk

Lectures:
Tue, Thu 16:30-17:50

Course Website:
Canvas:

COURSE OUTLINE:

Chapter 1: fundamentals

Symmetry & Crystal Structure	**2 weeks**
Representation of crystal structures	**2 weeks**
Bonding in solids, Pauling rule, band theory	**2 weeks**

Assignment 1-2

Chapter 2: synthesis & characterization

Synthesis of solid-state and nano-materials	**1 week**
Structural characterization	**1 week**
Optical characterization	**1 week**

Assignment 3+midterm

Chapter 3: properties & applications

Optical/electrical/magnetic properties	**3.5 week**
Special topics	**1 week**

Assignment 4-5+final

COURSE SCHEDULE

Week 1	09/02	Lecture 1	Introduction & Symmetry & Crystal Structure 1	
Week 2	09/07	Lecture 2	Symmetry & Crystal Structure 2	
	09/09	Lecture 3	Close packed structures	
Week 3	09/14	Lecture 4	Crystal structures & Visualization of complex crystals **Assignment #1**	
	09/16	Lecture 5	Bonding in solids, Pauling rule	
Week 4	09/21	Lecture 6	Bonding in solids	
	09/23	Lecture 7	Electronic structure of solids 1	
Week 5	09/28	Lecture 8	Electronic structure of solids 2 **Assignment #2**	
	09/30	Lecture 9	Synthetic methods 1: solid state materials	
Week 6	10/05	Lecture 10	Synthetic methods 2: nanomaterials	
	10/07	Lecture 11	Materials characterization: structural characterization 1	
Week 7	10/12	Lecture 12	Materials characterization: structural characterization 2 **Assignment #3**	
	10/14		Holiday	
Week 8	10/19		Midterm exam	
	10/21	Lecture 13	Optical materials 1	
Week 9	10/26	Lecture 14	Optical materials 2	
	10/28	Lecture 15	Spectroscopic methods	**Assignment #4**
Week 10	11/02	Lecture 16	Conducting materials 1	
	11/04	Lecture 17	Conducting materials 2	
Week 11	11/09	Lecture 18	Magnetic materials 1	

	11/11	Lecture 19	Magnetic materials 2	**Assignment #5**
Week 12	11/16	Lecture 20	Quantum-confined semiconductors	
	11/18	Lecture 21	Hybrid materials	
Week 13	11/23		Study break	
	11/25		Final Presentation	
Week 14			Final Exam	

CHEM 4250 Materials Preparation Laboratory

2021 Fall semester

Course Outline

1. Instructor

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

2. Technician/ Instructional Assistant/ Teaching Assistant:

Name: CHAN, Ka Lok Kelvin (chkelvin@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

Grading tyep: letter grade.

Assessment Criteria	ILOs
10% Attendance and risk assessment♣	3
20% Lab Quiz†	1, 2
25% Performance in laboratory	4, 5, 6
10% Product	4
35% Reports	1, 2

♣ *5% - punctuality, 5% - safety sheet*

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

7. Student Learning Resources

Reference books:

(a) "*Macroscale and Microscale Organic Experiments 3rd edition*," Kenneth L. Williamson, Boston: Houghton Mifflin ©1999.

(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 (http://canvas.ust.hk).*

8. Teaching and Learning Activities

Laboratory work related to preparative chemistry related to material chemistry.

9. Keyword Syllabus

- Preparation of Nano Particle Suspensions
- Size Control of Nano Particles in a Bottom-up Synthesis
- Synthesis of Light Emitting Metal Complex with Bidentate Ligands
- Construction of Organic Light-Emitting Device from Metal Organic Complex
- Synthesis by Suzuki cross coupling
- Organic Synthesis by Transition Metal Catalysis
- Synthesis of Solid-State Material by Partial Oxdiation of Metal Oxides
- Synthesis of Mixed-Valence Metal Oxides by Precipitation

CHEM 4255 Materials Characterization Laboratory

2021 Fall semester

Course Outline

1. Instructor

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

2. Technician/ Instructional Assistant/ Teaching Assistant:

Name: CHAN, Kelvin Ka Lok (chkelvin@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 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

Grading type: letter grades.

Assessment Criteria	ILOs
10% Attendance and risk assessment♣	3
20% Lab Quiz†	1, 2
25% Performance in laboratory	4, 5, 6
10% Product	4
35% Reports	1, 2

♣ *5% - punctuality, 5% - safety sheet*

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

7. Student Learning Resources

Reference books:

(a) "*Macroscale and Microscale Organic Experiments 3rd edition*," Kenneth L. Williamson, Boston: Houghton Mifflin ©1999.

(b) "*Quantitative chemical analysis*" by Daniel C. Harris, New York: W. H. Freeman and Co., ©2007.

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

8. Teaching and Learning Activities

Tutorial + Laboratory work related to chemical analysis related to material chemistry.

9. Keyword Syllabus

- Characterization of nano-particles by plasmon resonance absorptions
- Materials Characterization by thermal analytical method – DSC
- Materials Characterization by thermogravimetric analytical method – TGA
- Materials Characterization by transmission FT-IR, ATR FT-IR
- Characterization of molecular materials by Fluorescence Spectrocopy
- Characterization of molecular materials by UV-vis Spectrocopy
- 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 spectrocopy
- Characterization of molecular materials by 2-dimensional NMR - COSY

CHEM4340: Bioanalytical Techniques Fall 2021

Instructor: Prof. Hongkai WU

This course will introduce a selected series of bioanalytical techniques with an emphasis on the analytical methods of biochemical samples. The characterization methods will include various optical microscopic techniques from traditional ones such as bright field to modern ones such as super-resolution microscopy, and various molecular analytical techniques such as separations of biomolecules, DNA/protein sequencing techniques and immunoassays.

Course Outline:

0. Course introduction

Part 1: Optical Microscopy

1.1. Basic of microscope

1.2. Optical microscopic techniques

1.3. Fluorescence and fluorescence probes

1.4. Imaging sensors and images

Part 2: biomolecular assays

2.1 Protein

2.2. From DNA to protein

2.3. Electrophoresis and other separation techniques for biomolecules

2.4 DNA amplification techniques

2.4. DNA sequencing

2.5. Protein sequencing

2.6. CRISPR, DNA microarrays and other DNA biotechniques

2.7. Immobilization of biomolecules

2.8. Immunoassay

Part 3: Microfluidics (we will talk this part only if we have enough time)

3.1. Introduction to microfluidics

3.2. Applications of microfluidics in analytical chemistry

3.3. Biosensors

Evaluation:

3-4 homeworks but the scores are not included in final grade

Oral Presentation (1-2 students in a group): 20% in final grade

Mid-term exam: 40%

Final exam: 40%

Intended Learning Outcome:

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

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

(2) Evaluate and discuss the relevance of the bioanalytical techniques to social and daily life, for example in relation to human health.

(3) Analyze a wide range of analytical chemical problems by applying the analytical principles.

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

CHEM4350 Environmental Chemistry Laboratory
Course Outline – Fall 2021

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: Wilson LEUNG <*wilsonleung@ust.hk*>; Rowena LEUNG <*chlsy@ust.hk* >
Contact: Lab: Rm 6122; Tel: 2358 7382
Instructional Assistant: *Jennifer WONG* <*wongyc@ust.hk*>
Contact: Lab: Rm 6122; Tel: 2358 7382
Teaching Assistants: *Separate file*

3. Meeting Time and Venue

Date & Time: Thursdays 10.30 - 13.20
Venue: Room 6122, 7122 and 7122A

4. Course Description

Credit Points: 1
Pre-requisite: CHEM2310 Fundamentals of Analytical Chemistry or CHEM2311 Analytical Chemistry
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
60%	Report	1 - 3
20%	Lab Quiz	1 - 3
20%	Lab Performance	4 - 7

7. Syllabus

Expt No	Title of Experiment
E1	Application of Ion Chromatography (IC) to Determination of Water Soluble Anions on $PM_{2.5}$ Air Filters
E2	Volatile Organic Compounds (VOCs) Collected by a Passive Sampler and Analysed by Gas Chromatography - Flame Ionisation Detector (GC-FID)
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 Chromatography – 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

- Harris D. C., *Quantitative Chemical Analysis*, 8th Ed., W. H. Freeman and Company, New York, 2010.
- Skoog D. A., Holler F. J. and Crouch S. R., *Principles of Instrumental Analysis*, 6th Ed., Chapter 27, 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 2021

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: Wilson LEUNG <wilsonleung@ust.hk>; Kwong K CHAN <chankk@ust.hk>
Contact: Lab: Rm 6122; Tel: 2358 7382

Instructional Assistant:

Name: Jennifer WONG <wongyc@ust.hk>
Contact: Lab: Rm 6122; Tel: 2358 7382

Teaching Assistants: *Separate file*

3. Meeting Time and Venue

Date & Time: Thursdays 13.30 - 16.20
Venue: Room 6122, 7122 and 7122A

4. Course Description

Credit Points: 1
Pre-requisite: CHEM2310 Fundamentals of Analytical Chemistry or CHEM2311 Analytical Chemistry; and CHEM2350 Analytical Chemistry Laboratory or CHEM2355 Fundamentals 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
60%	Report	1 - 3
20%	Lab Quiz	1 - 3

20%	Lab Performance	4 - 7

7. Syllabus

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 Handheld Near-Infrared (NIR) Spectrometer with Chemometric Method
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

- Harris D. C., *Quantitative Chemical Analysis*, 8th Ed., W. H. Freeman and Company, New York, 2010.
- Skoog D. A., Holler F. J. and Crouch S. R., *Principles of Instrumental Analysis*, 6th Ed., Chapter 27, 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
2021 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: LAU, Disney Chun Tak (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

Grading type: letter grades.

Assessment Criteria	ILOs
10% Attendance and risk assessment♣	3
20% Lab Quiz†	1, 2
25% Performance in laboratory	4, 5, 6
10% Product	4
35% Reports	1, 2

♣ *5% - punctuality, 5% - safety sheet*

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

7. Student Learning Resources

Reference books:

(a) "*Macroscale and Microscale Organic Experiments 6th edition*," by Kenneth L. Williamson and Katherine M. Masters, Australia: Brooks/Cole ©2011.

(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 chemistry.

9. Key word Syllabus

- Synthesis of Organometallic Compounds and its Light-senstive Derivatives
- Substitution of Aromatic Ligand in Sandwich Organometallic Compounds
- Synthesis of Metallo-Organic Chelate Complex
- Wittig-Horner Synthesis
- Use of Organophosphorus Reagent
- Suzuki Cross Coupling
- Transition Metal Catalyzed Organic Synthesis
- Protecting Groups for Carbohydrate
- Regioselective Substitution Reaction
- Control of Distereoseletivity in Substitution Reactions
- Glycosylation Reaction

CHEM 4555 Advanced Molecular Characterization Lab

2021 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: LAU, Disney Chun Tak (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

Grading type: letter grades.

Assessment Criteria	ILOs
10% Attendance and risk assessment♣	3
20% Lab Quiz†	1, 2
25% Performance in laboratory	4, 5, 6
10% Product	4
35% Reports	1, 2

♣ *5% - punctuality, 5% - safety sheet*

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

7. Student Learning Resources

Reference books:

(a) "*Macroscale and Microscale Organic Experiments 6th edition*," by Kenneth L. Williamson and Katherine M. Masters, Australia: Brooks/Cole ©2011.

(b) "*Quantitative chemical analysis*" by Daniel C. Harris, New York : W. H. Freeman and Co., ©2007.

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

8. Teaching and Learning Activities

Tutorial + Laboratory work related to chemical analysis.

9. Key word Syllabus

- Characterization by 1D NMR spectroscopies: ^{1}H-NMR, ^{13}C-NMR, DEPT135
- Characterization by 2D NMR correlation spectroscopy - COSY
- Characterization by 2D NMR multiple bond coherence spectroscopy - HMBC
- Chemical Kinetics Study: Determining Rate Constant and Activation Energy
- Computational Study using MMFF and Time-dependent DFT
- Simulation of Electronic Absorption Spectra
- 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

The Hong Kong University of Science and Technonology
Department of Chemistry

CHEM 4680 Undergraduate Research
Course Outline

1. Course Description

Credit Points: 3
Pre-requisite: CHEM 2150 and CHEM 2250
Instructor(s): Research Faculties of Chemistry Department

Brief Information/synopsis:

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

2. Intended Learning Outcomes

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

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

3. Course Requirements and Grading

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

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

CHEM 4689 Capstone Project

Course Outline (Fall 2021-2022)

1. Course Coordinators:

Prof. Jason Chan	(kkjchan@ust.hk)	Rm 4543; Tel: 34692098
Prof. Emily Tsang	(chetsang@ust.hk)	Rm 4536; Tel: 34692100

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

Prof. Dennis Chan	(chanhw@ust.hk)
Prof. Jason Chan	(kkjchan@ust.hk)
Dr. Ryan Kwok	(chryan@ust.hk)
Prof. Yong Huang	(yonghuang@ust.hk)
Dr. Jacky Lam	(chjacky@ust.hk)
Dr. Fu Kit Sheong	(chemfksheong@ust.hk)
Dr. Xuefeng Tan	(xuefengtan@ust.hk)
Prof. Emily Tsang	(chetsang@ust.hk)

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

Mr. Samson Choi, Sci-Tech Librarian	(lbsamson@ust.hk)
Mr. Lewis Li, Sci-Tech Librarian	(lblewis@ust.hk)
Dr. Brian Tang	(cwtangac@connect.ust.hk)

2. Class Time and Venue:

Date/Time: Fridays 9:30 – 10:20 (*refer to timetable)
Venue: LSK 1026 / Zoom – for mixed-mode student

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).*

CAPSTONE NINJA: English Lanugage Support App for CHEM capstone projects
Contents are co-developed by Center for Language Education and Department of Chemistry

Capstone Ninja can be downloaded from

For iphone, ipad: (Apple Appstore) https://apps.apple.com/hk/app/capstone-ninja/id1352231678
For Andriod (Google Play Store) https://play.google.com/store/apps/details?id=hk.edu.polyu.edc.capstoneninja&hl=zh_HK

7. Teaching and Learning Activities

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

Consultations: With your supervisor (at least 3 times)
Individual Coaching: With your 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	3 Sept (Fri) 9:30-10:20 *before 9 Sept*	**Course Introduction &** **Introduction to 'Capstone Ninja'** [† ***meet your supervisor for topic assignment***] [† ***upload topic to Canvas after assignment***]	**LSK1026** Profs. Chan/Tsang
2	10 Sept (Fri) 9:30-10:20	**Literature Search Training**	**Library LG1** **Computer Room B** Mr L. Li/Mr S. Choi
3	17 Sept (Fri) 9:30-10:20 ***between*** ***13 – 30 Sept***	**SciFinder Workshop** **Literature Search Individual Coaching Session** [***Compulsory***] (with your Referencing Advisor during Weeks 3-5)	**Zoom Meeting** SciFinder vendor (based in Singapore) (by appointment with your referencing advisor)
4	24 Sept (Fri) 9:30-10:20 ***between*** ***13 – 30 Sept***	**Chemical Structure Drawing Training** **Literature Search Individual Coaching Session** [***Compulsory***] (with your Referencing Advisor during Weeks 3-5)	**Library LG1** **Computer Room B** Prof. Tsang (by appointment with your referencing advisor)
5	1 Oct (Fri) *before 1 Oct*	Public Holiday (National Day) [† ***submit Weekly Timetable to Canvas for scheduling Oral Presentation Time***]	
6	During this week *before 8 Oct*	**Consultation with supervisor #1** [† ***submit Research Plan***]	(by appointment with your supervisor)
7	15 Oct (Fri) 9:30-10:20	**Referencing Training**	**Library LG1** **Computer Room B** Mr L. Li/ Mr S. Choi
8	22 Oct (Fri) 9:30-10:20 During this week	**Poster Design Workshop** **Consultation with supervisor #2**	**LSK1026** Prof. Chan (by appointment with your supervisor)
9 10	29 Oct (Fri) 5 Nov (Fri)	*Work on your project* **Referencing Individual Coaching Session** [***Optional***] (with your Referencing Advisor during Weeks 9-11)	(by appointment with your referencing advisor)
11	During this week	**Consultation with supervisor #3**	(by appointment with your supervisor)
12	19 Nov (Fri) *before 25 Nov*	*Work on your project* [† ***submit Poster file to Canvas***]	
13	26 Nov (Fri)	**Oral Presentations**	TBA
Study break	3 Dec (Fri) 14:00-17:00	**Poster Mini-Conference**	**Library LG4** **Multi-function Room**
	12 Dec (Sun)	† ***Deadline for Literature Research Report***	

CHEM 4691 Capstone Research I

Course Outline (Fall 2021/22)

1. Course Description

Pre-requisite: CHEM 3550 and CHEM 3555

Exclusion: CHEM 4689

Instructor(s): Research Faculties of Chemistry Department

Reference Librarians:

Mr. CHOI, Samson (lbsamson@ust.hk) (Tel: 2358 6763)

Mr. LI, Lewis (lblewis@ust.hk) (Tel: 2358-6769)

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 sessions are ***mandatory***. Attendances will be taken and counted towards your course participation scores.

Date	Activity	Venue
10/9 (Fri, 9:30 – 10:20)	**Library - Literature Search Training**	Classroom B (Lib LG1) (Mr. L. Li/Mr. S. Choi)
17/9 (Fri, 9:30 – 10:20)	**SciFinder Workshop**	Zoom Meeting (SciFinder vendor)
24/9 (Fri, 9:30 – 10:20)	**Chemical Structure Drawing Training**	Classroom B (Lib LG1) (Profs. J. Chan/E. Tsang)
15/10 (Fri, 9:30 – 10:20)	**Library - Referencing Training**	Classroom B (Lib LG1) (Mr. L. Li/Mr. S. Choi)

CHEM 4692 Capstone Research II
Course Outline

1. Course Description

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

Brief Information/synopsis:

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

2. Intended Learning Outcomes

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

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

3. Grading

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