

The Chinese University of Hong Kong
Faculty of Science
Science Academy for Young Talent

Summer Courses 2021
Course Outline

*SAYT1001 Bondings in Organic Compounds, and
Reactivity and Selectivity of Organic Reactions*
有機化合物的鍵合，與有機反應的活性及選擇性

Introduction:

This course is designed to allow students to have a basic understanding about the bonding and structures of organic molecules and ions, and their influences on the molecular properties of organic compounds, and the reactivity and selectivity of some organic reactions. This course will focus on the stability of reaction intermediates, and the reactivity and selectivity of addition reactions, nucleophilic substitutions, eliminations, and electrophilic aromatic substitutions.

本課程設計旨在讓同學對有機分子及離子的鍵合及結構，及它們在有機分子的特性和有機反應的活性及選擇性的影響上有基礎的理解。本課程將會集中討論各類反應中間體的穩定性，及加成反應、親核取代反應、消除反應和親電芳香取代反應的活性及選擇性。

Medium of Instruction: English supplemented with Cantonese

Organising Unit:

Department of Chemistry, Faculty of Science, CUHK

Teachers:

Dr. Mak Kin Wah

Department of Chemistry, CUHK

Rm. 355, Science Centre South, CUHK

Tel: 3943 8136, Email: kendrewmak@cuhk.edu.hk

Course Content:

<p>9 August 2021 (Monday)</p> <p>9:30am – 12:30pm 2:00pm – 5:00pm</p>	<p><u>Lecture and Activities:</u></p> <ul style="list-style-type: none"> • Basic atomic structure, chemical bonding and shape of molecules • Atomic orbitals (s, p, d, f) and electron configurations • Formation of σ-bonds and π-bonds • Orbital hybridization, bond formation and molecular shapes <p><u>Assessment:</u></p> <ul style="list-style-type: none"> • Multiple-choice and short-answer test
<p>10 August 2021 (Tuesday)</p> <p>9:30am – 12:30pm 2:00pm – 5:00pm</p>	<p><u>Lecture and Activities:</u></p> <ul style="list-style-type: none"> • Delocalized electrons and resonance • Resonance structures and resonance stabilization • Nomenclature of organic compounds • Reaction of alkanes and alkenes • Reaction mechanism <p><u>Assessment:</u></p> <ul style="list-style-type: none"> • Multiple-choice and short-answer test
<p>11 August 2021 (Wednesday)</p> <p>9:30am – 12:30pm</p>	<p><u>Lecture and Activities:</u></p> <ul style="list-style-type: none"> • Nucleophilic substitutions: SN1 and SN2 • Elimination reactions: E1 and E2 <p><u>Assessment:</u></p> <ul style="list-style-type: none"> • Multiple-choice and short-answer test
<p>13 August 2021* (Friday)</p> <p>9:30am – 12:30pm 2:00pm – 5:00pm</p>	<p>Make-up class</p>

Duration	2.5 day sessions (total 15 contact hours)
Date	9 – 11 August 2021 13 August 2021* (make up class)
Time	9:30am – 12:30pm; 2:00pm – 5:00pm
Teaching Mode[#]	Face to Face (The Chinese University of Hong Kong)
Enrollment	25
Expected applicants	Students who are promoting to or studying S4-S6
Tuition Fee	HKD 3,000.00
Credit	1 University Unit Certificates or letters of completion will be awarded to students who attain at least 75% attendance.

* This date is reserved for make-up classes in case there is any cancellation of classes due to unexpected circumstances.

This course is offered face-to-face lessons at CUHK campus. It may switch to online teaching in accordance with the pandemic development and the policy of the university.

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CUSA1021 Analysis in Modern Chemistry
現代化學分析

Introduction:

This course aims at introducing the basic concepts and techniques in carrying out chemical analysis by using various modern spectroscopic and chromatographic instruments. Students will learn how to use modern instruments to determine the amounts of substances present in a mixture down to part per million levels (ppm), and identify the structure of a compound. Techniques such as infrared spectroscopy, mass spectrometry, UV-Vis spectroscopy, nuclear magnetic resonance spectroscopy, gas chromatography and high performance liquid chromatography will be covered. This course will also discuss some common standard practices of collecting and preparing samples for laboratory testing, the accreditation system in testing laboratories. This course includes lectures and hand-on experimental sessions.

本課程旨在介紹化學分析中所用到的現代光譜和色譜儀器的基本概念和技術。學生將學習使用該等儀器來分析濃度水平低至百萬分之一的物質，並確定化合物的結構。課程內容包括紅外線光譜法、質譜分析法、紫外-可見光譜法、核磁共振、氣相色譜法及高效能液相色譜法的操作技巧，以及化驗工作中的收集及製備樣本的常用標準技巧和香港化驗室所實行的認可系統。課程以講課及實驗形式進行。

Medium of Instruction: Cantonese supplemented with English

Organising Unit: Department of Chemistry, Faculty of Science, CUHK

Teachers: Dr. Chan Wing Fat
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Dr. Cheung Yu San
Department of Chemistry, CUHK
Rm. 234, Science Centre North, CUHK
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Dr. Mak Kin Wah
Department of Chemistry, CUHK
Rm. 355, Science Centre South, CUHK
Tel: 3943 8136, Email: kendrewmak@cuhk.edu.hk

Course Content:

<p>26 July 2021 (Monday)</p> <p>9:30 am – 12:30 pm 2:00 pm – 5:00 pm</p>	<p><u>Lecture:</u></p> <ul style="list-style-type: none"> • UV-Vis Spectroscopy • Infrared Spectroscopy • Mass Spectrometry <p><u>Assessment:</u></p> <ul style="list-style-type: none"> • Short-answer exercise
<p>27 July 2021 (Tuesday)</p> <p>9:30 am – 12:30 pm 2:00 pm – 5:00 pm</p>	<p><u>Lecture:</u></p> <ul style="list-style-type: none"> • Nuclear Magnetic Resonance Spectroscopy <p><u>Assessment:</u></p> <ul style="list-style-type: none"> • Short-answer exercise
<p>28 July 2021 (Wednesday)</p> <p>9:30 am – 12:30 pm 2:00 am – 5:00 pm</p>	<p><u>Lecture:</u></p> <ul style="list-style-type: none"> • GC and HPLC (Analysing the chemical composition of a sample using advanced chromatographic techniques) • Chemical Testing (Sampling techniques and the accreditation system) <p><u>Assessment:</u></p> <ul style="list-style-type: none"> • Essay <p><u>Experiment:</u></p> <ul style="list-style-type: none"> • Determination of the contents of carotene and iron in spinach leaves <p><u>Assessment:</u></p> <ul style="list-style-type: none"> • Calculations of experimental results
<p>29 July 2021* (Thursday)</p> <p>9:30 am – 12:30 pm 2:00 pm – 5:00 pm</p>	<p>Make-up Class</p>

Duration	3 whole day sessions (total 18 contact hours)
Date	26 – 28 July 2021 29 July 2021* (make-up class)
Time	9:30 am – 12:30 pm; 2:00 pm – 5:00 pm
Teaching Mode[#]	Face to Face (The Chinese University of Hong Kong)
Enrollment	30
Expected Applicants	Students who are studying S5-S6 (in the academic year 2020-2021)
Tuition Fee	HKD 3,380.00
Credit	1.25 Academy Unit Certificates or letters of completion will be awarded to students who attain at least 75% attendance.

* This date is reserved for make-up classes in case there is any cancellation of classes due to unexpected circumstances.

This course is offered face-to-face lessons at CUHK campus. It may switch to online teaching in accordance with the pandemic development and the policy of the university.

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CUSA1041 Essentials of Organic Chemistry
有機化學精華

Introduction:

This course aims at introducing the essential concepts of organic chemistry and how it is closely related to our daily life. Students will learn the fundamental knowledge of organic chemistry with a particular emphasis on stereochemistry. Through lectures and video demonstration of important principles and interesting experiments, students will be introduced to lab techniques/instrumentation and scientific methods in organic chemistry. Students can therefore gain appreciation of the daily practice of a synthetic organic chemist in a university setting.

本課程旨在介紹有機化學的精華和這一學科與我們日常生活的緊密聯繫。學生將學習有機化學的基本知識及立體化學的專題討論。通過講座及視頻演示的方式對重要的化學原理以及實驗操作進行展示，學生將學到有機化學的實驗技術、儀器和科學方法，從而接觸到有機合成化學家在大學裏的日常工作。

Medium of Instruction:

Cantonese supplemented with English

Organising Unit:

Department of Chemistry, Faculty of Science, CUHK

Teachers:

Prof. Gavin Chit TSUI

Department of Chemistry, CUHK

Office: Room 162, Science Centre South, CUHK

Telephone: 3943 6293 E-Mail: gctsui@cuhk.edu.hk

Course content:

2 August 2021 (Monday)	9:30 am – 12:30 pm	Topic 1: Introduction to Organic Chemistry (lecture)
	2:00 pm – 5:00 pm	Topic 2: Separation of Mixtures by Column Chromatography (lab demonstration)
3 August 2021 (Tuesday)	9:30 am – 12:30 pm	Topic 3: Alkanes and Stereochemistry (lecture)
	2:00 pm – 5:00 pm	Topic 4: Resolution of <i>trans</i> -1,2-diaminocyclohexane (lab demonstration)
4 August 2021 (Wednesday)	9:30 am – 12:30 pm	Topic 5: Chemistry of Life and Basic Organic Reactions (lecture)
	2:00 pm – 5:00 pm	Topic 6: Amazing Molecules that Changed the World (special lecture)
5 August 2021* (Thursday)	make-up class	

Duration	3 days (total 18 contact hours)
Date	2 – 4 August 2021 5 August 2021* (make-up class)
Time	9:30am – 12:30pm, 2:00pm – 5:00pm
Teaching Mode[#]	Face to Face (The Chinese University of Hong Kong)
Enrollment	30
Expected applicants	Students who are promoting to or studying S4-S6
Tuition Fee	HKD 3,380.00
Credit	1.25 Academy Unit Certificates or letters of completion will be awarded to students who attain at least 75% attendance.

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Course Outline

CUSA1071 How Chemistry Works
化學的真相

Introduction:

This course is designed for students to learn about some fundamental chemical principles, and some general chemical knowledge related to our daily lives. This course allows students to understand how chemistry works in various daily life situations. Students will learn the basic principles of chemistry including atoms and molecules, structure and chemical bondings, molecular geometry and properties, spectroscopy, fluorescence and phosphorescence and the uses of modern methods to carry out chemical analysis, etc. This course includes lectures and hand-on experimental sessions.

本課程的設計旨在讓同學學到一些基礎化學原理，及一些與日常生活相關的基本化學知識。課程能夠讓同學們明白在一些生活場景中，化學怎樣發揮它的功用。同學會在課程中學到基礎化學原理如原子與分子、結構與化學鍵合、分子幾何及特性、光譜、熒光、磷光及利用現代方法進行化學分析等。課程以講課及實驗形式進行。

Medium of Instruction: Cantonese supplemented with English

Organising Unit: Department of Chemistry, Faculty of Science, CUHK

Teachers: Dr. Cheung Yu San
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Rm. 355, Science Centre South, CUHK
Tel: 3943 8136, Email: kendrewmak@cuhk.edu.hk

Course Content:

<p>2 August 2021 (Monday)</p> <p>9:30 am – 12:30 pm 2:00 pm – 5:00 pm</p>	<p><u>Lecture and Activities:</u> Spectroscopy Fluorescence and phosphorescence</p> <p><u>Assessment:</u> Short-answer exercise</p>
<p>3 August 2021 (Tuesday)</p> <p>9:30 am – 12:30 pm 2:00 pm – 5:00 pm</p>	<p><u>Lecture:</u> Atoms and molecules, structure and chemical bondings (1)</p> <p><u>Assessment:</u> Short-answer exercise</p>
<p>4 August 2021 (Wednesday)</p> <p>9:30 am – 12:30 pm 2:00 pm – 5:00 pm</p>	<p><u>Lecture:</u> Atoms and molecules, structure and chemical bondings (2)</p> <p><u>Assessment:</u> Short-answer exercise</p> <p><u>Laboratory Activities:</u> Determination of the contents of dyes in mouthwash</p> <p><u>Assessment:</u> Experimental results</p>
<p>5 August 2021* (Thursday)</p> <p>9:30 am – 12:30 pm 2:00 pm – 5:00 pm</p>	<p>Make-up Class</p>

Duration	3 days sessions (total 18 contact hours)
Date	2 – 4 August 2021 5 August 2021* (make up class)
Time	9:30 am – 12:30 pm; 2:00 pm – 5:00 pm
Teaching Mode[#]	Face to Face (The Chinese University of Hong Kong)
Enrollment	24
Expected Applicants	Students who are studying S1-S3 (in the academic year 2020-2021)
Tuition Fee	HKD 3,380.00
Credit	1.25 Academy Unit Certificates or letters of completion will be awarded to students who attain at least 75% attendance.

* This date is reserved for make-up classes in case there is any cancellation of classes due to unexpected circumstances.

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***CUSA1091* Artistic and Colourful Chemistry
色彩斑斕的化學世界**

Introduction:

This course combines the disciplines of science and culture, and aims to provide students with fundamental understanding on the nature of science and their influences on our culture and daily life.

This course aims to provide students, who have a knowledge of the principles of chemistry, an overview on the mechanism of perceiving colors, the production of various classes of dyes and pigments, including their corresponding applications. Graphics, demonstrations, and project presentations are the major elements of interactive learning environment in this course.

本課程將結合科學與文化的內容，目的讓學生對基礎自然科學有更深入認識和了解，以至科學對日常生活和文化的影響。

本課程冀讓對化學有基拙理解的學生們明白顏色接收的基理，不同類型染料和顏料的製作以及其相應的應用。本課程會以不同的圖片，示範，小組專題研習及報告的形式以達至互動的學習環境和氣氛。

Medium of Instruction: Cantonese supplemented with English

Organising Unit: Department of Chemistry, Faculty of Science, CUHK

Teachers: Dr. Sam Chun Kit HAU
Department of Chemistry, CUHK
Rm. G1564, Science Centre South, CUHK,
Tel: 3943 8135, Email: sckhau@cuhk.edu.hk

Course Content:

<p>10 August 2021 (Tuesday)</p> <p>9:00 am – 12:00 pm 2:00 pm – 5:00 pm</p>	<p><u>Lecture:</u> A Brief Historical Introduction on Color The Physical and Chemical Basis of Color</p> <p><u>Lab:</u> <i>Colour Composition in dyes and ink</i></p> <p><u>Assessment:</u> In Class Worksheet or Online Google Form</p>
<p>11 August 2021 (Wednesday)</p> <p>9:00 am – 12:00 pm 2:00 pm – 5:00 pm</p>	<p><u>Lecture:</u> Azo Dyes and Pigments Carbonyl Dyes and Pigments</p> <p><u>Lab:</u> <i>Synthesis of Azo Dyes</i></p> <p><u>Assessment:</u> In Class Worksheet or Online Google Form</p>
<p>12 August 2021 (Thursday)</p> <p>9:00 am – 12:00 pm 2:00 pm – 5:00 pm</p>	<p><u>Lecture:</u> Textile Dyes Inorganic Pigments Applications of Dyes and Pigments</p> <p><u>Lab:</u> <i>Dyeing Method with DIY Dyes</i></p> <p><u>Assessment:</u> In Class Worksheet or Online Google Form</p>
<p>13 August 2021* (Friday)</p> <p>9:00 am – 12:00 pm 2:00 pm – 5:00 pm</p>	<p>Make-up Class</p>

Duration	3 whole day sessions (total 18 contact hours)
Date	10 – 12 August 2021 13 August 2021* (make up class)
Time	9:00 am – 12:00 pm; 2:00 pm – 5:00 pm
Teaching Mode[#]	Face to Face (The Chinese University of Hong Kong)
Enrollment	25
Expected Applicants	Students who are promoting or studying S3-S6
Tuition Fee	HKD 3,380.00
Credit	1.25 Academy Unit Certificates or letters of completion will be awarded to students who attain at least 75% attendance.

* This date is reserved for make-up classes in case there is any cancellation of classes due to unexpected circumstances.

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CUSA1101 Introduction to Environmental Chemistry
環境化學入門

Introduction:

Environmental chemistry deals with chemical processes occurring in the environment and the effects of human activities on them. This course intends to introduce the basic concepts of environmental chemistry and how the knowledge is applied to resolve environmental issues. Students will attend lectures on characteristics and chemical analysis of pollutants arising from human activities. Students will also learn the newest technologies of chemical treatment and pollution prevention. Equipped with scientific knowledge from the lectures, students will perform experiments to analyse pollutants in soil using advanced chemical instruments.

The CUHK community takes great care to conserve the campus ecology and environment. Other than classes, laboratory tour, campus tour and treasure hunt will be arranged for students to understand CUHK and our work for sustainable development, and to make the course more fruitful and enjoyable.

環境化學涉及化學物質在環境中的作用及人類活動對其的影響。本課程旨在介紹環境化學的基礎概念以及如何運用相關知識解決環境問題。課程內容包括污染物的特性、形成和化學分析。學生也會學習化學處理的尖端技術及預防污染的策略。學生將會運用課堂所學進行實驗，操作先進的化學儀器以分析泥土中的污染物。

中文大學十分重視校園生態和環境。為了令學生更了解中大以及大學推行可持續發展校園的工作，本課程也預備了實驗室參觀、校園遊及校園定向等活動，務求為學生帶來更充實和愉快的活動學習體驗。

Medium of Instruction: Cantonese supplemented with English

Organising Unit: Department of Chemistry, Faculty of Science, CUHK

Teachers: Dr. Chan Ka Long Donald
Department of Chemistry, CUHK
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Course Content:

<p>19 July 2021 (Monday)</p> <p>9:30 am – 12:30 pm 1:30 pm – 4:30 pm</p>	<p><u>Lecture</u></p> <ul style="list-style-type: none"> • Basic concepts: chemical equilibria, acid-base reactions, redox reactions • Water pollution: elemental pollutants, inorganic species, organic pollutants • Air pollution: gaseous oxides, photochemical smog, particulate matter <p><u>Assessment</u></p> <ul style="list-style-type: none"> • Short-answer exercise <p><u>Group Activity</u></p> <ul style="list-style-type: none"> • Laboratory tour • Visit to the Jockey Club Museum of Climate Change
<p>20 July 2021 (Tuesday)</p> <p>9:30 am – 12:30 pm 1:30 pm – 4:30 pm</p>	<p><u>Lecture</u></p> <ul style="list-style-type: none"> • Basic concepts: qualitative and quantitative analysis, measurement uncertainty • Techniques: sampling, extraction • Environmental instrumentation: spectrophotometric methods, chromatography <p><u>Experiment</u></p> <ul style="list-style-type: none"> • Determination of Volatile Organic Compounds (VOCs) in Soil by Gas Chromatography
<p>21 July 2021 (Wednesday)</p> <p>9:30 am – 12:30 pm</p>	<p><u>Lecture</u></p> <ul style="list-style-type: none"> • Water treatment: removal of solids, removal of metals, disinfection • Air pollution control: catalytic converter, clean fuels • Safer chemicals, reactions and products
<p>22 July 2021* (Thursday)</p> <p>9:30 am – 12:30 pm 1:30 pm – 4:30 pm</p>	<p>Make-up Class</p>

Duration	2.5 days sessions (total 15 contact hours)
Date	19 – 21 July 2021 22 July 2021* (Make-up class)
Time	19, 20 July 2021: 9:30 am – 12:30 pm, 1:30 pm – 4:30 pm 21 July 2021: 9:30 am – 12:30 pm
Teaching Mode[#]	Face to Face (The Chinese University of Hong Kong)
Enrollment	30
Expected Applicants	Students who are promoting to or studying S5-S6
Tuition Fee	HKD 3,200.00
Credit	1 Academy Unit Certificates or letters of completion will be awarded to students who attain at least 75% attendance.

* This date is reserved for make-up classes in case there is any cancellation of classes due to unexpected circumstances.

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CUSA1003 Molecular Biology and Biotechnology: An Introduction
分子生物學和生物技術導論

Introduction:

The structure of DNA was discovered by Watson and Crick in 1953. Since then, molecular biology has been developed rapidly and changed our lives in many ways. Another important milestone in biotechnology was the invention of Polymerase Chain Reaction (PCR) by Kary Mullis in 1983 to amplify DNA. One of the well-known examples using these new technologies is the production of recombinant insulin by bacteria for the treatment of diabetes. Now, these topics become part of the new senior secondary biology curriculum in Hong Kong. To prepare students for these challenges, this course aims at helping students to learn the major concepts and methods of molecular biology and biotechnology. Topics include DNA structure, principles of molecular biology and application of recombinant DNA technology. Students will gain hands-on experience in culturing bacteria, introducing foreign DNA into bacterial cells (bacterial transformation) for recombinant protein production, running PCR and using DNA electrophoresis for paternity test.

沃森(Watson)和克里克(Crick)於 1953 年解構了脫氧核糖核酸(DNA)的結構。從那時起，分子生物學得到迅速的發展，改變了我們生活的許多方面。及後凱利穆利斯(Kary Mullis)於 1983 年發明的聚合酶鏈反應(Polymerase Chain Reaction) DNA 擴增技術，亦是生物科技另一個重要的里程碑。結合這些新技術，其中一項比較著名的應用，是利用細菌生產重組胰島素作治療糖尿病之用。現在分子生物學課題已成為香港新高中生物課程的一部分。為迎接這個挑戰，本課程旨在幫助學生加深認識/了解分子生物學和生物技術的概念和方法。主題包括 DNA 的結構，分子生物學原理和重組 DNA 技術的應用。學生將親身體驗如何將外來 DNA 放入細菌內(細菌轉化)生產重組蛋白，怎樣進行聚合酶鏈反應(PCR)和如何應用 DNA 電泳鑑定親子關係等。

Medium of Instruction: Cantonese supplemented with English

Teacher:

Professor SK Kong

Programme of Biochemistry, School of Life Sciences, CUHK

E-mail: skkong@cuhk.edu.hk

Demonstrator:

To be determined

Course Content:

<p>24 July 2021 (Saturday)</p> <p>10:00 am – 12:30 pm 2:00 pm – 5:00 pm</p>	<p><u>Lecture:</u></p> <ul style="list-style-type: none">• Virus and Bacteria• Bacterial Growth (Bring your calculator)• Aseptic Techniques for Bacterial Culture• Bacterial Plasmid• Bacterial Transformation• Expression of Green Fluorescent Protein (GFP) from jellyfish in E. coli <p><u>Laboratory:</u></p> <ul style="list-style-type: none">• Basic Lab Safety• Basic Techniques – Use of pipettes• Aseptic Techniques to Prepare Agar Plates• Bacterial Culture – Part 1• Bacterial Transformation – Part 1• (Expressing GFP in E. coli: 2008 Nobel Prize in Chemistry Work)
<p>31 July 2021 (Saturday)</p> <p>10:00 am – 12:30 pm 2:00 pm – 5:00 pm</p>	<p><u>Lecture:</u></p> <ul style="list-style-type: none">• Gene and DNA Structure• Central Dogma: DNA → RNA → Protein• DNA Isolation, Restriction Enzymes, Ligase• Molecular Cloning to Make Recombinant Proteins• Polymerase Chain Reaction for DNA Isolation and Amplification <p><u>Laboratory:</u></p> <ul style="list-style-type: none">• Bacterial Culture – Part 2• Restriction Cut in DNA• Polymerase Chain Reaction
<p>7 August 2021 (Saturday)</p> <p>10:00 am – 1:30 pm 2:30 pm – 5:00 pm</p>	<p><u>Lecture:</u></p> <ul style="list-style-type: none">• DNA Electrophoresis• DNA Fingerprinting• Biotechnology: Recombinant Insulin Production & Disease Diagnosis <p><u>Laboratory</u> (Bring your camera to record the results):</p> <ul style="list-style-type: none">• Bacterial Transformation – Part 2• DNA Electrophoresis• DNA Fingerprinting <p><u>Assessment:</u></p> <ul style="list-style-type: none">• Written short answer tests will be conducted at 4:30-5:00 pm
<p>14 August 2021 * (Saturday)</p> <p>10:00 am – 1:30 pm 2:30 pm – 5:00 pm</p>	<p>Make-up class</p>

Duration	3 whole day sessions (total 17 contact hours)
Date	24, 31 July, 7 August 2021 14 August 2021* (make up class)
Time	10:00 am – 1:30 pm, 2:30 pm – 5:00 pm
Teaching Mode[#]	Face to Face (The Chinese University of Hong Kong)
Enrollment	25
Expected Applicants	Students who promoting to or studying S6 who are interested in molecular biology
Tuition Fee	HKD 3,320.00
Credit	1.25 Academy Unit Certificates or letters of completion will be awarded to students who attain at least 75% attendance.

* This date is reserved for make-up classes in case there is any cancellation of classes due to unexpected circumstances.

This course is only offered face-to-face lessons at CUHK campus.

**The Chinese University of Hong Kong
Faculty of Science
Science Academy for Young Talent**

Summer Courses 2021
Course Outline

CUSA2023 Introduction to Bionics
仿生學淺談

Introduction:

Bionics is the branch of science dedicated to the studying of the characteristics, structure or functions of bio-systems for innovations in developing new technology, it is also known as “Biomimicry” or “Biomimetics”. Since 1960s, bionics has developed quickly and applied widely in various fields of science and technology. With an emphasis on the scientific basis of various processes or phenomena in nature, this course aims to introduce to the students the various inspirations which human beings acquired from nature, the methodology, the major applications, and the advancements of bionics. Students will learn in form of lectures, videos, demonstrations, quizzes, discussions, and also gain hands-on experience through participating in worksheets and self-exploratory activities.

仿生學又稱為「模擬生物學」或「生物模仿學」，是一門研究生物系統的特質、結構及功能原理的科學，主要用以研發各種創新科技。自六十年代開始，仿生學的迅速發展使其在各個科學及技術範疇中漸漸普及。本課程旨在以各種科學現象或過程的原理為基礎，通過講解、視頻、示範、測驗、及討論等內容介紹仿生學的原理及仿生學在各方面的應用。學生亦可通過工作紙及在家實驗等活動，親身了解仿生學的基本原理。

Medium of Instruction: Cantonese supplemented with English

Organising Unit: Centre for Promoting Science Education, Faculty of Science, CUHK

Teacher:

Dr. Chung Kwok Cheong
School of Life Sciences, CUHK
Email: kcchung@cuhk.edu.hk

Course content:

21 August 2021 (Saturday) 2:00 pm – 5:00 pm	<p><u>Lecture:</u></p> <ul style="list-style-type: none"> • Introduction: history, methodology and scope of Bionics <p><u>Demonstration:</u></p> <ul style="list-style-type: none"> • Relationship between the number of setae in Gecko foot & its holding force
23 August 2021 (Monday) 2:00 pm – 5:00 pm	<p><u>Lecture:</u></p> <ul style="list-style-type: none"> • Application of Bionics: structures / materials / architecture <p><u>Demonstration:</u></p> <ul style="list-style-type: none"> • Superhydrophobicity, the lotus effect and water striders <p><u>Homework:</u></p> <ul style="list-style-type: none"> • How to build stronger bones?
24 August 2021 (Tuesday) 2:00 pm – 5:00 pm	<p><u>Lecture:</u></p> <ul style="list-style-type: none"> • The secrets of flying: Principle of animal flight & aerodynamics <p><u>Homework:</u></p> <ul style="list-style-type: none"> • Practice flying with a Glider/Pterosaur model
25 August 2021 (Wednesday) 2:00 pm – 5:00 pm	<p><u>Lecture:</u></p> <ul style="list-style-type: none"> • Use of sound by animals • Application of Bionics: art / energy / management <p><u>Homework:</u></p> <ul style="list-style-type: none"> • The folding leaves exercise
26 August 2021 (Thursday) 2:00 pm – 5:00 pm	<p><u>Lecture:</u></p> <ul style="list-style-type: none"> • Application of Bionics: health / medicine
27 August 2021 (Friday) 2:00 pm – 5:00 pm	<p><u>Lecture:</u></p> <ul style="list-style-type: none"> • Application of Bionics: environmental and sustainability <p><u>Homework:</u></p> <ul style="list-style-type: none"> • Find out the golden ratio: Constructing the “Golden Section Gauge”
28 August 2021 * (Saturday) 2:00 pm – 5:00 pm	Make-up Class

Duration	6 half day sessions (total 18 contact hours)
Date	21, 23 – 27 August 2021 28 August 2021* (make-up class)
Time	2:00 pm – 5:00 pm
Teaching Mode[#]	Face to Face (The Chinese University of Hong Kong)
Enrollment	40
Expected applicants	Students who are promoting to or studying S2-S3
Tuition Fee	HKD 3,380.00
Credit	1.25 Academy Unit Certificates or letters of completion will be awarded to students who attain at least 75% attendance and awarded B grade or above in the course.

* This date is reserved for make-up classes in case there is any cancellation of classes due to unexpected circumstances.

This course is offered face-to-face lessons at CUHK campus. It may switch to online teaching in accordance with the pandemic development and the policy of the university.

The Chinese University of Hong Kong
Faculty of Science
Science Academy for Young Talent

Summer Courses 2021
Course Outline

SAYT1005 Introduction to University Physics
大學物理入門

Introduction:

Systematically introduce the basic concepts for university physics in mechanics, including the concept of vectors, motions in 2 dimensions and 3 dimensions, and the relation between force and motion described by Newton's three fundamental laws. It will lay a solid foundation for the students to start the physics courses at the university level.

本課程將系統講授大學物理的力學，包括矢量、運動學、以及運動與受力的關係。牛頓三大定律在平動與轉動中的應用、動量與能量守恆等關鍵物理知識將是本課程強調的重點。本課程將為學生的大學物理學習打下堅實的基礎。

Medium of Instruction: English

Organising Unit:

Department of Physics, Faculty of Science, CUHK

Teacher:

Prof. Xu Lei

Department of Physics, Faculty of Science, CUHK

Rm. G06, Science Centre, CUHK

Tel: 3943 6307, E-mail: xulei@phy.cuhk.edu.hk

Homepage: <http://www.phy.cuhk.edu.hk/~xulei/homepage/>

Demonstrator:

To be determined

Course Content:

16 August 2021 (Monday) 9:30 am – 12:00 pm	<u>Lecture:</u> • Ch0-Introduction, Ch1-Vectors and Motion <u>Assessment:</u> Attendance, homework
17 August 2021 (Tuesday) 9:30 am – 12:00 pm	<u>Lecture:</u> • Ch1.5-Motion in 2D and 3D <u>Assessment:</u> Attendance, homework
18 August 2021 (Wednesday) 9:30 am – 12:00 pm	<u>Lecture:</u> • Ch2-Force and Motion <u>Assessment:</u> Attendance, homework
19 August 2021 (Thursday) 9:30 am – 12:00 pm	<u>Lecture:</u> • Ch3-Kinetic Energy <u>Assessment:</u> Attendance, homework
20 August 2021 (Friday) 9:30 am – 12:00 pm	<u>Lecture:</u> • Ch4-Potential Energy and Energy Conservation <u>Assessment:</u> Attendance, homework
23 August 2021 (Monday) 9:30 am – 12:00 pm	<u>Lecture:</u> • Ch5-Momentum Conservation <u>Assessment:</u> Attendance, homework
24 August 2021 (Tuesday) 9:30 am – 12:00 pm	<u>Lecture:</u> • Ch6-Rotation and Moment- Part I <u>Assessment:</u> Attendance, homework
25 August 2021 (Wednesday) 9:30 am – 12:00 pm	<u>Lecture:</u> • Ch6-Rotation and Moment- Part II <u>Assessment:</u> Attendance, homework
26 August 2021 * (Thursday) 9:30 am – 12:00 pm	Make-up Classes

Duration	8 half day sessions (total 20 contact hours)
Date	16 – 20, 23 – 25 August 2021 26 August 2021* (make-up class)
Time	9:30 am – 12:00 pm
Teaching Mode[#]	Face to Face (The Chinese University of Hong Kong)
Enrollment	15 – 40
Expected Applicants	Students who are promoting to or studying S5 - S6
Tuition Fee	HKD 3,300.00
Credit	1 University Unit Certificates or letters of completion will be awarded to students who attain at least 75% attendance.

* This date is reserved for make-up classes in case there is any cancellation of classes due to unexpected circumstances.

This course is offered face-to-face lessons at CUHK campus. It may switch to online teaching in accordance with the pandemic development and the policy of the university.

**The Chinese University of Hong Kong
Faculty of Science
Science Academy for Young Talent**

Summer Courses 2021
Course Outline

CUSA1045 Discovering the Universe
探索宇宙

Introduction:

Humans want to explore the universe by looking up into the sky since ancient times. This course offers the outline about the selected phenomena which were observable with the naked eye. Upon finishing the course, students will acquire the development of modern astronomy, knowledge of the basic observational features of the sky, and the application of physical principles to astronomy.

The course includes lectures, experiments, and observation sessions. The experiments session is aimed to provide students with hand-on experience in basic physical principles and ideas in Astronomy. Student will have indoor observation of simulated night in class. Outdoor solar observation will be held if weather permits.

人類自古以來已希望通過觀察天文現象來探索身處的宇宙。本課程的設計正旨在概述這些肉眼能見的天象。完成課程的學生會了解當代天文的發展、有關天象的基本知識，以及物理定律在天文學上的應用。

本課程分為講座、實驗，和天文觀察三部份。實驗部份的目的是讓學生有機會親身驗證認識基本科學原理和天文概念。學生在天文觀察部份，可以參與模擬星空觀察。若天氣許可，學生會於室外作太陽的觀察。

Medium of Instruction: Cantonese supplemented with English

Organising Unit:

Department of Physics, Faculty of Science, CUHK

Teacher:

Dr. LEUNG Po Kin

Department of Physics, CUHK

Rm. 220, Science Centre North Block, CUHK

Tel: 3943 4078, E-mail: pkleung@cuhk.edu.hk

Demonstrators:

Students from Department of Physics, CUHK

Course Content:

<p>9 August 2021 (Monday)</p> <p>9:00 am – 1:00 pm 2:00 pm – 5:00 pm</p>	<p><u>Lecture 講課:</u> (3 hrs)</p> <ul style="list-style-type: none">• Introduction to Astronomy 天文學簡介• Ancient Greek Astronomy (Plato, Aristotle) 古希臘天文 (柏拉圖、阿里士多德)• Modern Astronomy (Copernicus, Kepler, Newton) 現代天文 (哥白尼、開普勒、伽利略、牛頓)• Newton's laws of motion and law of gravitation 牛頓運動定律和重力定律• Basics concepts of celestial sphere 天球介紹 <p><u>Assessment 評核:</u></p> <ul style="list-style-type: none">• MC, short questions, etc 選擇題、短題目..... <p><u>Lab 實驗:</u> (3 hrs)</p> <ul style="list-style-type: none">• Newtonian mechanics (Measuring gravitational acceleration; If time permits, also verifying Newton's second law.) 牛頓力學 (例如: 量度地心引力加速、確認牛頓運動定律) <p><u>Assessment 評核:</u></p> <ul style="list-style-type: none">• Lab report 實驗報告 <p><u>Observation 天文觀察:</u> (1 hr)</p> <ul style="list-style-type: none">• Indoor simulated night sky observation 室內模擬星空觀察
<p>11 August 2021 (Wednesday)</p> <p>9:00 am – 1:00 pm 2:00 pm – 5:00 pm</p>	<p><u>Lecture 講課:</u> (3 hrs)</p> <ul style="list-style-type: none">• Constellations 星座• Seasons 季節• The Moon 月球 (月相、潮汐、掩蝕) <p><u>Lecture 講課:</u> (2 hrs)</p> <ul style="list-style-type: none">• Overview of the Solar System 太陽系概覽• Planets 行星• Dwarf planets and asteroids 矮行星和小行星• Comets 彗星• Meteors 流星 <p><u>Assessment 評核:</u> MC, short questions, etc 選擇題、短題目.....</p> <p><u>Observation 天文觀察:</u> (2 hrs)</p> <p>(note: this session would be moved to the 3rd day in case of bad weather 若天氣欠佳, 此部份將順延到第三天)</p> <ul style="list-style-type: none">• Basics related to observation 有關天文觀察的基本知識• Physical principles behind telescope 望遠鏡的原理• Outdoor solar observation (if weather permits)• (如天氣許可) 室外太陽觀察

<p>13 August 2021 (Friday)</p> <p>9:00 am – 1:00 pm 2:00 pm – 5:00 pm</p>	<p>Lecture 講課: (3 hrs)</p> <ul style="list-style-type: none"> • The Sun – the nearest star 太陽 – 最接近的恆星 • Stars 恆星 • Star light 星光 <p>Lab 實驗: (3 hrs)</p> <ul style="list-style-type: none"> • Light (e.g. observing the spectra of elements; verification of Bohr’s model.) 光 (例如：觀察原素光譜、確認玻爾模型) <p>Assessment 評核: Lab report 實驗報告</p> <p>Lecture 講課: (1 hr)</p> <ul style="list-style-type: none"> • Conclusion 總結 • Brief introduction to other fields in Astronomy 其他天文學範疇概覽 • Assessment 評核: MC, short questions, etc 選擇題、短題目……
<p>14 August 2021* (Saturday)</p> <p>9:00 am – 1:00 pm 2:00 pm – 5:00 pm</p>	<p>Make-up class 補課</p>

Duration	3 whole day sessions (total 21 contact hours)
Date	9, 11, 13 August 2021 14 August 2021* (make-up class)
Time	9:00 am – 1:00 pm; 2:00 pm – 5:00 pm
Teaching Mode[#]	Face to Face (The Chinese University of Hong Kong)
Enrollment	30
Expected Applicants	Students who are promoting to or studying S4-S6
Tuition Fee	HKD 3,560.00
Credit	1.5 Academy Unit Certificates or letters of completion will be awarded to students who attain at least 75% attendance.

* This date is reserved for make-up classes in case there is any cancellation of classes due to unexpected circumstances.

This course is only offered face-to-face lessons at CUHK campus.

Sample of lecture notes from previous years:

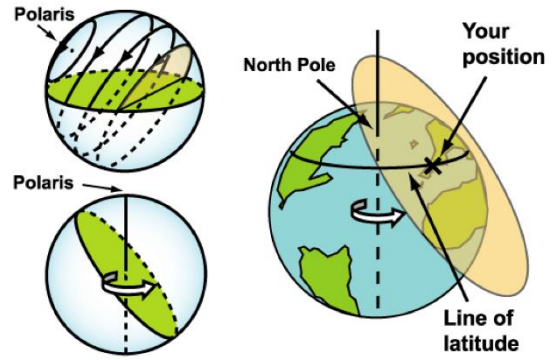
Universal Gravitation

- **The Law of Universal Gravitation** : The attractive force (F) between any two bodies is directly proportional to the product of their masses (M_1 and M_2) and is inversely proportional to the square of their separation (r).

$$F = -\frac{GM_1M_2}{r^2}$$

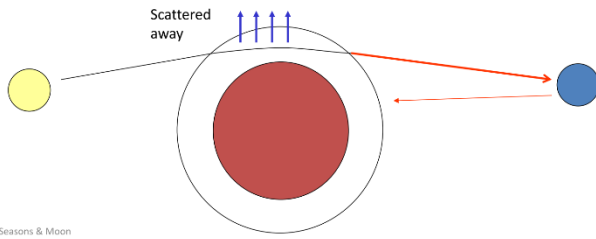
Gravitational constant $G=6.67 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$

1. Hong Kong

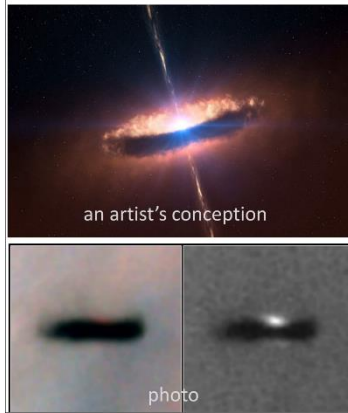


Total lunar eclipse

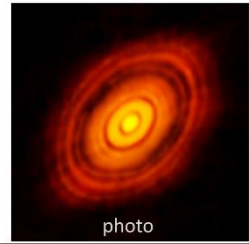
- The Moon enters the umbra completely; only sunlight *scattered* by the Earth's atmosphere can arrive
- The Moon appears **red** and **dim** because ...



Protoplanetary disk



- In 2014, the Atacama Large Millimeter Array (ALMA) took this image of another closer disk:



Sample of lab manuals from previous years:

CUHK, Faculty of Science
 Science Academy for Young Talent
 CUSA1045 Discovering the Universe
 Experiment 3: Blackbody radiation

Background theories

A blackbody is an object that absorbs all electromagnetic radiations that fall onto it. Practically, it is usually constructed by a platinum box (called cavity) with a small hole on one of its surfaces. At non-zero temperature, radiation emerging from the hole is called blackbody radiation¹. Its characteristic depends only on the temperature T of the cavity walls and not at all on the shape of the cavity or on the material forming the cavity walls.

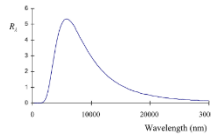


Figure 1 Spectral radiance of a blackbody at 500 K.

Fig. 1 shows how the radiation energy emitted by a blackbody is distributed in wavelength. The quantity R_λ , plotted on the vertical axis in Fig. 1, is called the spectral radiance. It is defined so that $R_\lambda d\lambda$ is the rate at which energy is radiated per unit area of surface for wavelengths lying in the interval λ to $\lambda + d\lambda$. The relation between R_λ , λ , and T is given by Planck's radiation law,

$$R_\lambda = \frac{8\pi hc}{\lambda^5 (e^{hc/\lambda kT} - 1)} \quad [\text{Eq.1}]$$

When the values of temperature T and the wavelength λ are small, Eq.1 can be approximated by Wien's radiation law,

$$R_\lambda = \frac{8\pi hc}{\lambda^5} e^{-hc/\lambda kT} \quad [\text{Eq.2}]$$

In this experiment you will be using a tungsten filament as the blackbody radiator to study the radiance R_λ as a function of temperature T and determine the value of hc/k , where h , c , and k , are Planck's constant, speed of light in vacuum, and Boltzmann constant, respectively.

¹ The cavity can be considered as an absorber as well as an emitter of light. If the cavity block is held at room temperature and viewed by ambient light the small hole that penetrates to its interior appears black. Light that enters this hole is trapped within the cavity, which behaves like a perfect absorber of the incident light. It is on this basis that cavity radiation is called blackbody radiation.

Furthermore, the resistance and the temperature of the tungsten filament is related by the following equation

$$r/r_{\text{room}} = (T/T_{\text{room}})^2 \quad [\text{Eq.3}]$$

where T is measured in absolute temperature and r_{room} is the resistance at room temperature.

In this experiment, you are going to verify Wien's radiation law of blackbody radiation.

Equipments

- (1) Tungsten light bulb (acts as a blackbody, emitting radiations).
- (2) Monochromator, photomultiplier tube (PMT) (by photoelectric effect, PMT can convert radiations R_λ to currents I_p).
- (3) Resistor (1 kΩ), power supplies, digital multimeters, and connecting wires.

Procedures

- 1) Record the room temperature.
- 2) Set up experiment as shown in Fig. 2.

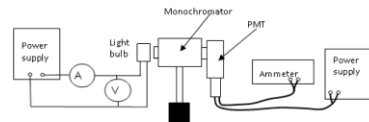


Figure 2 Experimental setup.

- 3) Add the 1-kΩ resistor in series with the tungsten light bulb. Adjust the current to 1 mA and record the voltage across the tungsten light bulb. Calculate the resistance r_{room} of the tungsten light bulb at room temperature.
- 4) Replace the resistor with a cable. Set the monochromator to 350 nm.
- 5) When the voltage across the light bulb is 0 V, record the background current I_b of the PMT.
- 6) Adjust the input voltage of the PMT to 12 V.
- 7) Adjust the voltage of the power supply such that the voltage across the light bulb is 4 V.
- 8) Adjust the position of the light bulb such that the output current of the PMT is maximum.
- 9) Record the voltage V and current I across the tungsten light bulb and the output current I_p of the PMT.
- 10) Repeat step 8 with different voltage V across the tungsten light bulb.
- 11) Fill in the table on the data sheet and plot $\ln(I_p - I_b)$ against $1/T$.

The Chinese University of Hong Kong
Faculty of Science
Science Academy for Young Talent

Summer Courses 2021
Course Outline

CUSA1085 The Space Explorer's Survival Guide to the Universe
太空探索者的宇宙生存指南

Introduction:

The universe is a dangerous place for us space explorers. To give you a fighting chance to survive the journey, we will discuss some basic mechanics, the law of gravity, astronomy, and other necessary physics. More importantly, since the laws of the universe are written in the language of mathematics, we need to go through some basic calculus (don't be afraid, my friend) and elementary differential equations (now you can panic a little bit). We will also introduce you with the concept of scientific modelling, and learn to use computer to numerically solve problems (we will not use HAL 9000, for those of you who are worried). By the end of our course, you will be well equipped to apply the new tools to tackle a wide range of problems.

Some of you probably have never learned calculus before. While it could be intimidating at first, you can still do it if you put in effort. Some hands-on examples in our course should get you up to speed.

Now buckle up, and we will get started!

對我們這些太空探索者來說，宇宙是一個很危險的地方。為求讓你有能力完成旅程，我們會討論一些基本的力學、重力定律、天文學和其他必要的物理原理。更重要的是，宇宙的定律是用數學語言寫成的，因此我們需要進行學習一些基本的微積分（請不要太擔心……）和簡單的微分方程（你現可以有些少許恐慌了）。我們亦將會介紹科學建模的概念，並學習使用電腦來解決問題（放心，我們不會使用 HAL 9000）。在課程結束時，你將會有能力應用這些新的工具來處理各種問題。

你們當中有些人可能從未學過微積分。這課題在初學時可能真的嚇人的，但只要你付出努力，仍然可以學到。而且在課程中的實際操作示例應該能使你快速上手。

好！現在就扣好安全帶，讓我們開始！

Medium of Instruction: Cantonese supplemented with English

Organising Unit:

Department of Physics, Faculty of Science, CUHK

Teacher:

Dr. LEUNG Po Kin

Department of Physics, CUHK

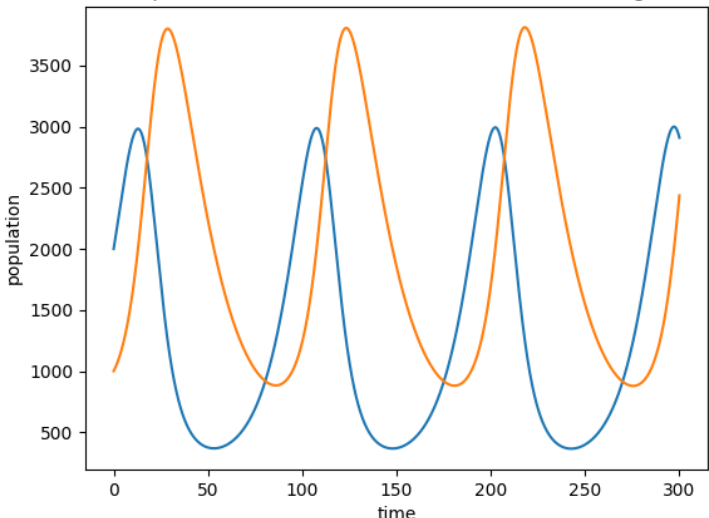
Rm. 220, Science Centre North Block, CUHK

Tel: 3943 4078, E-mail: pkleung@cuhk.edu.hk

Demonstrators:

Students from Department of Physics, CUHK

Course Content:

<p>19 July 2021 (Monday)</p> <p>1:00 pm – 5:00 pm</p>	<p>Lecture 講課: (4 hrs)</p> <ul style="list-style-type: none">• Dimensional analysis 量綱分析• Newton's laws of motion 牛頓運動定律• Linear momentum 動量• Basics of calculus, I 微積分入門, I <p>Assessment 評核:</p> <ul style="list-style-type: none">• Homework (short questions) 功課 (短題目)
<p>20 July 2021 (Tuesday)</p> <p>1:00 pm – 5:00 pm</p>	<p>Lecture 講課: (4 hrs)</p> <ul style="list-style-type: none">• Basics of calculus, II 微積分入門, II• Basics of scientific modelling 科學建模入門 (e.g. radioactivity, examples in mechanics 例：放射性、力學的例子)• Simple differential equations (i.e. rate equations) 簡單微分方程 (即改變率方程) <p>Assessment 評核:</p> <ul style="list-style-type: none">• Homework (short questions) 功課 (短題目)
<p>21 July 2021 (Wednesday)</p> <p>1:00 pm – 5:00 pm</p>	<p>Lecture 講課: (4 hrs)</p> <ul style="list-style-type: none">• Kepler's law of planetary motion 開普勒行星運動定律• Newton's law of universal gravitation 牛頓萬有引力定律• Scientific modelling, revisited 科學建模, 再探 (e.g. the interplay of prey and predator, motion of planets 例：獵物和捕食者的互動、行星運動)• Solving differential equations with computer 以電腦解微分方程 <p>Populations of rabbit (blue) and wolf (x100, orange)</p>  <p>Assessment 評核:</p> <ul style="list-style-type: none">• Homework (short questions) 功課 (短題目)

<p>22 July 2021 (Thursday)</p> <p>1:00 pm – 5:00 pm</p>	<p><u>Lecture 講課: (4 hrs)</u></p> <ul style="list-style-type: none"> • Air drag force 空氣阻力 • Force of spring 彈簧力 • More examples of solving differential equations with computer 更多以電腦解微分方程的例子 <p><u>Assessment 評核:</u></p> <ul style="list-style-type: none"> • Homework (short questions) 功課 (短題目)
<p>23 July 2021 (Friday)</p> <p>1:00 pm – 6:00 pm</p>	<p><u>Lecture 講課: (4 hrs)</u></p> <ul style="list-style-type: none"> • Oscillation 振動 • More examples of solving differential equations with computer 更多以電腦解微分方程的例子 • If possible, will arrange a remote meeting of researchers from the HK Observatory, to learn about the application of computer simulations 會嘗試安排和天文台的研究員遙距會面，了解電腦模擬的應用 <p><u>Final test 測驗: (1 hr)</u></p> <p><u>Assessment 評核:</u></p> <ul style="list-style-type: none"> • Final test 測驗
<p>24 July 2021* (Saturday)</p> <p>9:00 am – 1:00 pm</p>	<p>Make-up class 補課</p>

Duration	5 half-day sessions (total 21 contact hours)
Date	19 – 23 July 2021, 24 July 2021* (make-up class)
Time	19 – 22 July 2021: 1:00 pm – 5:00 pm 23 July 2021: 1:00 pm – 6:00 pm 24 July 2021*: 9:00 am – 1:00 pm
Teaching Mode[#]	Face to Face (The Chinese University of Hong Kong)
Enrollment	20
Expected Applicants	Students who are promoting to or studying S4-S6
Tuition Fee	HKD 3,560.00
Credit	1.5 Academy Unit Certificates or letters of completion will be awarded to students who attain at least 75% attendance.

* This date is reserved for make-up classes in case there is any cancellation of classes due to unexpected circumstances.

This course is offered face-to-face lessons at CUHK campus. It may switch to online teaching in accordance with the pandemic development and the policy of the university.

The Chinese University of Hong Kong
Faculty of Science
Science Academy for Young Talent

Summer Courses 2021
Course Outline

*SAYT1016 Unlocking the Secrets of Randomness: from Paradoxes
to Sport Predictive Modeling to Algorithmic Trading*
解開未知的秘密：由悖論到運動預測模型到算法交易

Introduction:

Uncertainty exists in many real-life problems, ranging from stock returns to sport results to medication effects to election outcomes. Statistics offers methods to handle uncertainty with a higher precision. Improving a decision with 50-50 certainty to 60-40 certainty makes a huge difference in many practical problems. This course introduces ways to (i) define, (ii) model and (iii) forecast uncertainty through real-life examples and counterintuitive phenomena. Topics include (i) birthday paradox, Simpson's paradox; (ii) linear regression model, auto-regressive regression model, logistic regression model, non-parametric regression model; and (iii) historical simulation, and k-mean clustering.

不確定性存在於許多現實生活中的問題，例子涵蓋股票回報、運動結果、藥物效果、選舉結果等。統計科學提供了具更高準定性的方法，以處理不確定性的問題。在許多實際問題中，將 50-50 的不確定性提高至 60-40，可令數據分析變得更精確。本課程以實際示例和違反直覺的現象引導，來 (i) 定義、(ii) 模型和 (iii) 預測不確定性。主題包括 (i) 生日悖論，辛普森悖論；(ii) 線性迴歸模型，自迴歸模型，邏輯迴歸模型，非參數迴歸模型；(iii) 歷史模擬法，k 平均演算法。

Medium of Instruction: Cantonese supplemented with English

Organising Unit:

Department of Statistics, CUHK

Teacher:

Prof. CHAN Kin Wai

Department of Statistics, CUHK

Room 115, Lady Shaw Building, CUHK

E-mail: kinwaichan@sta.cuhk.edu.hk

Course Content:

26 July 2021 (Monday) 9:30am – 12:30pm 2:30pm – 5:30pm	Basic statistics and statistical paradoxes
27 July 2021 (Tuesday) 9:30am – 12:30pm 2:30pm – 5:30pm	R-programming and historical simulation
28 July 2021 (Wednesday) 9:30am – 12:30pm 2:30pm – 5:30pm	Simple linear regression model and multiple linear regression model
29 July 2021 (Thursday) 9:30am – 12:30pm 2:30pm – 5:30pm	Autoregressive model and Logistic regression model
30 July 2021 (Friday) 9:30am – 12:30pm 2:30pm – 5:30pm	Nonparametric regression model and k-mean clustering
2 August 2021* (Monday) 9:30am – 12:30pm 2:30pm – 5:30pm	Make-up class

Duration	5 whole day sessions (total 30 contact hours)
Date	26 – 30 July 2021 2 August 2021* (make-up class)
Time	9:30am – 12:30pm, 2:30pm – 5:30pm
Teaching Mode[#]	Face to Face (The Chinese University of Hong Kong)
Enrollment	50
Expected applicants	Students who are promoting to S4-S5 with good knowledge in mathematics and with strong interest in solving real problems
Tuition Fee	HKD 3,900.00 (Students who have attended all sessions will be granted a HKD 1,000 scholarship)
Credit	1 University Unit Certificates or letters of completion will be awarded to students who attain at least 75% attendance.

* This date is reserved for make-up classes in case there is any cancellation of classes due to unexpected circumstances.

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The Chinese University of Hong Kong
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Summer Courses 2021
Course Outline

CUSA1026 Statistical Modeling and Big Data Analytics
統計模型及大數據分析

Introduction:

Data from various fields, such as climatology, finance and sports, exhibit different properties. This course aims to use the R-package (a statistical software) to visualize the properties of the data, fit the data into various statistical models, evaluate model performance and perform model predictions. Topics include exploratory data analysis, time series models, hidden Markov models, Poisson process and analysis of big data problems. Students will gain hands-on experience in statistical programming at the computer lab.

各種領域的數據（如氣候學，金融及運動）會展示不同的特質。本課程目標是透過統計軟件 R 去透視數據多方面的特性，從而用適當的統計模型去解釋，評估模型的表現及作出數據預測。本課程涵蓋範圍包括：探索性數據分析，時間序列模型，隱馬爾可夫模型，泊松過程和大數據問題的分析。學生將親身體驗統計程式的編寫。

Learning Outcomes:

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

- 1) Understand data from various fields
- 2) Apply the exploratory data analysis (EDA) to visualize the properties of the data;
- 3) Understand the theories behind various statistical models, and how the models can be fitted into different data sets;
- 4) Write computer programs in R to perform various statistical analysis;
- 5) Develop a systematic approach in solving statistical problems;

Medium of Instruction: Cantonese supplemented with English

Organising Unit:

Department of Statistics, CUHK

Teacher:

Dr. LEE Pak Kuen Philip

Department of Statistics, CUHK

Room 116, Lady Shaw Building, CUHK

E-mail: pklee@sta.cuhk.edu.hk

Course Content:

<p>13 August 2021 (Friday)</p> <p>9:30am – 1:00pm 2:00pm – 5:30pm</p>	<p><u>Lecture:</u></p> <ul style="list-style-type: none"> • Basics in Statistical Modeling: Random Variables, Probability Distributions • Sports Data: Properties, Poisson Process, Implied Probability and Odds • Exploratory Data Analysis (EDA): Scatter plot, Box plot, Histogram, Quartile-quartile Plot, Correlation and Autocorrelation <p><u>Computer Lab Activities:</u></p> <ul style="list-style-type: none"> • R programming: The Basics, Sports Data Modeling, EDA, <p><u>Assessment:</u></p> <ul style="list-style-type: none"> • Data Modeling in R
<p>17 August 2021 (Tuesday)</p> <p>9:30am – 1:00pm 2:00pm – 5:30pm</p>	<p><u>Lecture:</u></p> <ul style="list-style-type: none"> • Climate Data: Properties, Seasonal ARIMA Model, Model Prediction • Financial Data: Properties, Hidden Markov Model, GARCH Model • Monte Carlo Simulation • Big Data Problems and Analysis <p><u>Computer Lab Activities:</u></p> <ul style="list-style-type: none"> • R programming: Estimation of Time Series Models, <p><u>Case Discussion and Assessment:</u></p> <ul style="list-style-type: none"> • Data Modeling in R
<p>20 August 2021* (Friday)</p> <p>9:30am – 1:00pm 2:00pm – 5:30pm</p>	<p><u>Make up class</u></p>

Duration	2 whole day sessions (total 14 contact hours)
Date	13, 17 August 2020 20 August 2020* (make-up class)
Time	09:30am – 1:00pm; 2:00pm – 5:30pm
Teaching Mode[#]	Face to Face (The Chinese University of Hong Kong)
Enrollment	30
Expected Applicants	Students who are studying S4-S5 with good knowledge in mathematics
Tuition Fee	HKD 3,140.00
Credit	1 Academic Unit Certificates or letters of completion will be awarded to students who attain at least 75% attendance.

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**The Chinese University of Hong Kong
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Science Academy for Young Talent**

Summer Courses 2021
Course Outline

CUSA1007 Climate Physics and Chemistry
氣候物理與化學

Introduction:

This course presents an integrated scientific introduction to our climate system, focusing on the physics and chemistry of the atmosphere and ocean. The course applies basic scientific and mathematical principles to explain the history, current state and future projections of weather and climate, natural hazards, human-induced climate change, as well as their impacts on natural ecosystems and human society. Students will learn to build a simple climate model using computer software.

本課程綜合介紹我們的氣候系統，重點討論大氣層與海洋的物理和化學。課程利用基本科學和數學原理來解釋天氣及氣候的歷史、現狀和未來預測，探討在人為影響下所構成的自然災害及全球氣候變化，及其對自然生態和人類社會的影響。學生亦會運用電腦程式來學習建構簡單的氣候模型。

Medium of Instruction: English supplemented with Cantonese

Organising Unit:

Earth System Science Programme
Faculty of Science, The Chinese University of Hong Kong

Teacher:

Professor Amos Tai
Earth System Science Programme, CUHK
Rm. 316, Mong Man Wai Building, CUHK
Tel: 3943 9687, E-mail: amostai@cuhk.edu.hk

Course Content:

<p>18 August 2021 (Wednesday)</p> <p>9:30 am – 12:30 pm 2:00 pm – 4:00 pm</p>	<p><u>Lecture:</u></p> <ul style="list-style-type: none"> • Basic physics of energy and radiation • Earth's energy balance model • Greenhouse effect <p><u>Laboratory Activities:</u></p> <ul style="list-style-type: none"> • Simple climate model <p><u>Assessment:</u> Exercises from the lab</p>
<p>19 August 2021 (Thursday)</p> <p>9:30 am – 12:30 pm 2:00 pm – 4:00 pm</p>	<p><u>Lecture:</u></p> <ul style="list-style-type: none"> • Climate feedback mechanisms • Basic physics of the atmosphere and oceans • General atmospheric and ocean circulation <p><u>Laboratory Activities:</u></p> <ul style="list-style-type: none"> • Climate feedbacks in the simple climate model <p><u>Assessment:</u> Exercises from the lab</p>
<p>20 August 2021 (Friday)</p> <p>9:30 am – 12:30 pm 2:00 pm – 4:00 pm</p>	<p><u>Lecture:</u></p> <ul style="list-style-type: none"> • Biogeochemical cycles • Marine chemistry and carbon cycle • Future climate change: observations and predictions <p><u>Laboratory Activities:</u></p> <ul style="list-style-type: none"> • Student presentations on climate change adaptation and mitigation <p><u>Assessment:</u> Exercises from the lab and presentations</p>
<p>21 August 2021 * (Saturday)</p> <p>9:30 am – 12:30 pm 2:00 pm – 4:00 pm</p>	<p>Make-up class</p>

Duration	3 whole day sessions (total 15 contact hours)
Date	18 – 20 August 2021 21 August 2021* (make-up class)
Time	9:30 am – 12:30 pm; 2:00 pm – 4:00 pm
Teaching Mode[#]	Face to Face (The Chinese University of Hong Kong)
Enrollment	20
Expected Applicants	Students who are studying S4-S6 (with background in physics, chemistry or mathematics)
Tuition Fee	HKD 3,200.00
Credit	1 Academy Unit Certificates or letters of completion will be awarded to students who attain at least 75% attendance.

*This date is reserved for make-up classes in case there is any cancellation of classes due to unexpected circumstances.

#This course is offered face-to-face lessons at CUHK campus. It may switch to online teaching in accordance with the pandemic development and the policy of the university.

The Chinese University of Hong Kong
Faculty of Engineering & Faculty of Science

Summer Courses 2021
Course Outline

STEM1040 A Trilogy of Hands-on Machine Learning
親身體驗機器學習三部曲

Introduction:

Artificial intelligence (AI) is all the rage these days. We are promised a future of more gadgets and services with AI-powered features such as intelligent chatbots, virtual assistants, and self-driving cars. The current AI boom was largely fuelled by breakthroughs in an area known as machine learning. It involves training computers to perform tasks based on examples rather than programming by a human. A branch of this approach called deep learning has made it more promising for solving perceptual problems such as image classification, face recognition, and natural language processing.

This course offers a hands-on exploration of machine learning through a trilogy approach: mathematical concepts, algorithms, and programming. We will begin with introducing what machine learning is, how it works, and what it can achieve. With a comprehensive treatment of the mathematics and theories involved, we will walk through typical implementations of artificial neural networks to see how the theories turn into practice. Then we will move on to teaching students to make some interesting AI applications (e.g. games) using the Python programming language and machine learning frameworks such as TensorFlow and Keras.

近年來，人工智能（AI）浪潮席捲全球。未來，智能聊天機器人，虛擬助手和自動駕駛汽車等人工智能設備和服務將逐步融入我們的生活。「機器學習」領域中的突破是目前 AI 迅速發展的主要驅動力。機器學習利用樣本數據來訓練計算機自主完成任務，而非依賴人工編程。作為機器學習的一個重要分支，「深度學習」在解決如圖像分類，人臉識別和自然語言處理等智能認知問題上取得了豐碩的成果。

本課程透過「三部曲」（數學概念，算法和編程）訓練讓同學親自動手探索機器學習。首先，我們會介紹什麼是機器學習、它如何運作及其應用層面。之後，我們會講解機器學習背後的數學和理論基礎，並分析「人工神經網絡」的代碼，以展示如何將理論轉化為實踐。最後，我們會教導學員使用 Python 編程語言，TensorFlow 和 Keras 等機器學習框架來實現一些有趣的 AI 應用（例如：遊戲）。

Medium of Instruction: English supplemented with Cantonese

Organizing Unit: Faculty of Engineering & Faculty of Science

Teacher: Dr. LAM King Tin
Department of Computer Science and Engineering, Faculty of Engineering
Email: ktlam@cse.cuhk.edu.hk

Dr. PAN Li Lily
Department of Mathematics, Faculty of Science
Email: lpn@math.cuhk.edu.hk

Course Content:

26 July 2021 (Monday)	9:30 am - 12:30 pm	<ul style="list-style-type: none">• Mathematics Lecture	Functions, Vectors, Matrices and Tensors
	12:30 pm - 1:30 pm	<ul style="list-style-type: none">• Lunch	
	1:30 pm - 4:30 pm	<ul style="list-style-type: none">• Engineering Workshop	Python Basics and Data Structures
27 July 2021 (Tuesday)	9:30 am - 11:30 pm	<ul style="list-style-type: none">• Mathematics Lecture	Vector Spaces
	11:30 am - 12:30 pm	<ul style="list-style-type: none">• Mathematics Tutorial	Functions, Vectors, Matrices, Tensors, and Vector Spaces
	12:30 pm - 1:30 pm	<ul style="list-style-type: none">• Lunch	
	1:30 pm - 4:30 pm	<ul style="list-style-type: none">• Engineering Workshop	Python Classes and Objects; Module and Packages; NumPy
28 July 2021 (Wednesday)	9:30 am - 11:30 am	<ul style="list-style-type: none">• Mathematics Lecture	Linear transformation and Norms
	11:30 am - 12:30 pm	<ul style="list-style-type: none">• Guest Talk	
	12:30 pm - 1:30 pm	<ul style="list-style-type: none">• Lunch	
	1:30 pm - 4:30 pm	<ul style="list-style-type: none">• Engineering Workshop	NumPy, SciPy, Data Visualization
29 July 2021 (Thursday)	9:30 am - 12:30 pm	<ul style="list-style-type: none">• Mathematics Lecture	Eigenvalues, Eigenvectors, and Singular Value Decomposition
	12:30 pm - 1:30 pm	<ul style="list-style-type: none">• Lunch	
	1:30 pm - 4:30 pm	<ul style="list-style-type: none">• Engineering Workshop	TensorFlow and Keras
30 July 2021 (Friday)	9:30 am - 11:30 pm	<ul style="list-style-type: none">• Mathematics Lecture	Differentiation, Partial Differentiation and Gradients
	11:30 am - 12:30 pm	<ul style="list-style-type: none">• Mathematics Tutorial	Linear transformation, Norms, Eigenvalues, Eigenvectors, Singular Value Decomposition, Differentiation, Partial Differentiation, and Gradient
	12:30 pm - 1:30 pm	<ul style="list-style-type: none">• Lunch	
	1:30 pm - 4:30 pm	<ul style="list-style-type: none">• Engineering Workshop	Artificial neural networks; Multilayer perceptron

2 August 2021 (Monday)	9:30 am - 12:30 pm	• Mathematics Lecture	Convex function and Gradient Descent Method
	11:30 am - 12:30 pm	• Guest Talk	
	12:30 pm - 1:30 pm	• Lunch	
	1:30 pm - 4:30 pm	• Engineering Workshop	Deep learning; Convolution Neural Net (CNN)
3 August 2021 (Tuesday)	9:30 am - 11:30 pm	• Mathematics Tutorial	Convex function and Gradient Descent Method
	11:30 am - 12:30 pm	• Engineering Workshop	ML Applications
	12:30 pm - 1:30 pm	• Lunch	
	1:30 pm - 2:30 pm	• Assessment(Mathematics)	
	2:30 pm - 4:30 pm	• Assessment(Engineering)	
4-5 August 2021* (Wednesday & Thursday)	Make-up Class		

Duration	7 whole day sessions (total 42 contact hours)
Date	26 - 30 July, 2 - 3 August 2021; 4 - 5 August 2021 * (reserved for make-up class)
Time	9:30 am – 4:30 pm
Teaching Mode[#]	Face to Face (The Chinese University of Hong Kong)
Enrollment	40
Expected applicants	Students studying S4-S6 or equivalent who must have taken at least one science course which include Biology, Chemistry, Combined Science, Physics, Information and Communication Technology, Design and Applied Technology, Mathematics Extended Module 1 or 2
Tuition Fee	HKD 3500.00 (Students who have attended all sessions will be granted a HKD 500 scholarship)
Credit	2 University Units Certificates or letters of completion will be awarded to students who attain at least 75% attendance.

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