科目名 Course Title	総合化学特別研究第一[Research in Chemical Sciences and Engineering I]		
Lecture 題目 Subtitle			
責任教員 Instructor	総合化学院代議員（大学院総合化学院）		
担当教員 Other Instructors	Provided by supervisor		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	
期間 Semester	Full Year	**単位数 Number of Credits**	4
授業形態 Type of Class	Experiment	**対象年次 Year of Eligible Student**	1～3
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQUI 7001		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Chemical science and engineering, science, engineering, thesis writing

授業の目標 Course Objectives

Conduct specific research under the guidance of supervisors to acquire ability to solve problems about chemistry and write research papers.

到達目標 Course Goals

Acquire ability to solve specific problems using various knowledge and logical reasoning and write research papers.

授業計画 Course Schedule

Search specific subjects about chemistry, conduct research on them with highly expertized manner, and publish the results as research papers.

準備学習（予習・復習）等の内容と分量 Homework

Continuous efforts are required for experiments, data analysis, preparation of presentation and writing research papers.

成績評価の基準と方法 Grading System

Evaluation is based on the interim presentation, research activities in laboratory, published research papers during the doctor course.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Lecture 指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

The registration of this course is not required since the credit appraisal is made at the time of completion or withdrawal after credit acquisition.

科目名 Course Title	総合化学研究・指導法[Research in Chemical Sciences and Engineering III]		
Lecture 題目 Subtitle			
責任教員 Instructor	総合化学院代議員 (大学院総合化学院)		
担当教員 Other Instructors	Provided by supervisor		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	
期間 Semester	Full Year	**単位数 Number of Credits**	2
授業形態 Type of Class	Seminar	**対象年次 Year of Eligible Student**	1～3
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7101		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Development and improvement of experimental techniques: teaching and research skills: presentation skills: Chemical English

授業の目標 Course Objectives

Graduate course students are requested to play leaderships in both teaching and research. This course examines how to manage research experiments and to present student's achievements in Japanese and English. Also, the course examines how to gain teaching skills and abilities.

到達目標 Course Goals

Through the course, students will be able to

- get abilities on development and/or improvement of experimental techniques and equipment
- get high teaching and research skills
- get high presentation skills in both Japanese and English
- play leadership in each research field and teaching

授業計画 Course Schedule

On the basis of evaluating the teaching and research achievements of each student, the course offers on-the-job-training to

- get abilities in development and/or improvement of experimental skills and/or experimental equipment
- get high oral and poster presentation skills
- get speaking, hearing, and writing abilities in English
- get high teaching and research skills
- play leaderships in both research and teaching

準備学習 (予習・復習)等の内容と分量 Homework

Preparatory works for laboratory experiments

成績評価の基準と方法 Grading System

Evaluate based on total attitudes in teaching (50%), experimental and scientific achievements (50%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Lecture 指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	先端総合化学特論 I [Modern Trends in Chemical Sciences and Engineering I]		
講義題目 Subtitle	総合化学特論 I [Modern Trends in Physical and Material Chemistry]		
責任教員 Instructor	島田　敏宏 [SHIMADA Toshihiro] (大学院工学研究院)		
担当教員 Other Instructors	RYUZAKI Sou (理学研究院), YOMOGIDA Yohei (電子科学研究所), ITATANI Masaki (理学研究院), YOKOKURA Seiya (工学研究院), FUJII Yuta (工学研究院), IWAI Mana (工学研究院), JEONG SEONGWOO (工学研究院)		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095111
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7111		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

molecular materials, ferroelectrics, metal complexes, corrosion, electrochemistry, inorganic materials, ceramics, opto-functional materials, heterogeneous catalysts, 2D semiconductors, chemical sensors, nanomaterials, magnetism

授業の目標 Course Objectives

This course is intended to provide cutting-edge research topics on physical and materials chemistry. The topics include molecular ferroelectrics, metal complexes with various functions, observation of detailed surface processes in electrochemistry, inorganic materials, opto-functional materials, heterogeneous catalysts, 2D semiconductors as sensors, chemo-functional nano-materials.

到達目標 Course Goals

Through a series of lectures, students understand various fields of chemistry and are expected to expand their horizons.

授業計画 Course Schedule

Detailed schedule will be informed one month before the start of this course.
List of lecture titles in this course:

- Next-generation of life science based on nanobiotechnology
- Materials Chemistry of Nanotubes
- Studies on polariton chemistry: strong coupling between light and matter
- Organic Conductors and Semiconductors
- All Solid State Lithium Ion Battery Technology
- Electrochemical Fabrication of Micro- and Nanostructures on Metal Surfaces: Techniques and Applications
- Proton-conducting ceramics and their application to energy conversion devices
- Chemical insights on magnetism and spintronics

準備学習（予習・復習）等の内容と分量 Homework

Students will be required to submit reports after the lectures.

成績評価の基準と方法 Grading System

Students are required to attend at least 70% of the lectures. Evaluation as pass/fail will be based on the submitted reports.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G058

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	先端総合化学特論 I [Modern Trends in Chemical Sciences and Engineering I]		
講義題目 Subtitle	総合化学特論 II [Modern Trends in Organic Chemistry and Biological Chemistry]		
責任教員 Instructor	鈴木　孝紀 [SUZUKI Takanori] (大学院理学研究院)		
担当教員 Other Instructors	TANINO Keiji (理学研究院), MITA Tsuyoshi, SHIMIZU Yohei (理学研究院), ISHIYAMA Tatsuo (工学研究院), YAMAMOTO Takuya (工学研究院), Chai GOPALASINGAM (理学研究院)		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095112
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7111		
補足事項 Other Information			
授業実施方式 Class Method	2 対面授業科目《一部遠隔》		

キーワード Key Words

Physical Organic Chemistry, Organic Synthesis, Computational Chemistry, Biological Chemistry, Life Chemistry, Organic Reaction, Organic Transformations, Polymer Chemistry

授業の目標 Course Objectives

The progress in the fields of organic chemistry and biochemistry is remarkable. In this course, you will learn the basic concepts necessary for understanding research in the fields of advanced organic chemistry and biochemistry, give an overview of the latest trends, and then learn about cutting-edge research results. You will discuss various topics in organic chemistry and biochemistry research. The goal is to be able to write reports that include suggestions for your own ideas on cutting-edge organic and biochemical research.

到達目標 Course Goals

1. You can explain the basic concepts needed to understand advanced organic chemistry and biochemical research.
2. You can explain an overview of cutting-edge organic chemistry and biochemical topics.
3. You can discuss among students with different backgrounds.
4. You can make research proposals that incorporate your own ideas.

授業計画 Course Schedule

1. Guidance (Suzuki)
2. Advanced structural organic chemistry (Suzuki): Dication, Near IR, Bioimaging
3. Advanced organic synthetic chemistry (Tanino): Carbocycles, Ring Strain, Ene-diyne
4. Advanced computational reaction chemistry (Mita): Radial reaction, Carbon dioxide, Computational chemistry
5. Advanced life chemistry (Chai): Metalloenzyme, Nitric Oxide, Structural Biology
6. Advanced organic reaction chemistry (Shimizu): Catalysis, Chemoselectivity
7. Advanced organic transformation chemistry (Ishiyama): Transition metal-catalyst, borylation, diboron
8. Advanced polymer chemistry (Yamamoto): Polycyclic polymer, Supramolecular chemistry, Self-organization

(Course is scheduled on Sept 2nd - 4th, 2025)

準備学習 (予習・復習)等の内容と分量 Homework

In this course, you will be given an assignment each time. You choose two assignments and submit an answer (report) by the specified date.

成績評価の基準と方法 Grading System

You will be evaluated by learning attitude (20%) and two submitted reports (80% in total). You will be given assignment by instructors each time, among which you choose two assignments to submit. Attendance of 70% or more classes is the minimum condition to evaluate a student.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G045

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Leading and Advanced Molecular Chemistry and Engineering IA – 2025[Leading and Advanced Molecular Chemistry and Engineering IA – 2025]		
責任教員 Instructor	猪熊　泰英 [INOKUMA Yasuhide] (大学院工学研究院)		
担当教員 Other Instructors	Jonas Mindemark (Uppsala University)		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095121
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7121		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Organic chemistry, Electrochemistry, Battery, Functional molecules, Electrolyte

授業の目標 Course Objectives

Organic and materials chemistry is becoming very important to provide functional materials that support our sustainable society. In this lecture, leading researchers from abroad and Hokkaido University will give intensive lectures on cutting edge research in materials chemistry, particularly in battery development, and students will obtain an understanding of the synthetic design, application and device development of functional molecules.

到達目標 Course Goals

On completion of this course, students will be able to explain and discuss the basic principles of functional molecule design, electrochemical measurements and device processing.

授業計画 Course Schedule

Course Schedule (the order of the following lectures is subject to change)

1. Basic electrochemistry: oxidation and reduction
2. Fundamentals of both electron and ion transport in polymer materials
3. Synthesis of ion- and electron-conducting polymers
4. Applications for Battery: solid-state batteries, organic battery electrode materials, polymer solar cells and light-emitting electrochemical cells

準備学習（予習・復習）等の内容と分量 Homework

Students will be asked to write a report at the end of lecture.

成績評価の基準と方法 Grading System

Grades are judged based on class attitude during the course and report.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G054

研究室のホームページ Websites of Laboratory

https://www.eng.hokudai.ac.jp/labo/lor/HP/index_e.html

https://www.uu.se/en/contact-and-organisation/staff?query=N6-658

備考 Additional Information

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Leading and Advanced Molecular Chemistry and Engineering IB – 2025[Leading and Advanced Molecular Chemistry and Engineering IB – 2025]		
責任教員 Instructor	美多 剛 [MITA Tsuyoshi] (総合イノベーション創発機構化学反応創成研究拠点)		
担当教員 Other Instructors	Robert R. Knowles (Princeton University), HUANG Chung-Yang, JIN Mingoo		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095122
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7121		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Synthetic organic chemistry, Photoredox reactions, Radical reactions, Molecular photochemistry in solid-state

授業の目標 Course Objectives

This course will feature Professor Robert R. Knowles, a leading expert in photoreactions at Princeton University and a former member of the MacMillan research group, which was awarded the Nobel Prize in Chemistry. Students will learn about the fundamentals and applications of radical reactions using photocatalysts, as well as the latest advancements in photocatalytic technology. A key focus will be on Proton-Coupled Electron Transfer (PCET), a concept proposed by Professor Knowles that has been widely applied to various photoreactions due to its high versatility.

The goal of this course is to develop an understanding of the fundamental principles of photoredox catalysis and to explore how these principles can be applied to the design and optimization of chemical reactions. In photoredox catalytic reactions, catalysts activated by light facilitate electron transfer, enabling efficient chemical transformations. This process is environmentally friendly and holds great potential for sustainable chemical synthesis. The course will provide a detailed discussion of specific reaction examples, particularly focusing on applications in C-C bond formation.

To complement Professor Knowles' lectures, Professor Mita will provide foundational instruction on photochemical and radical reactions. Associate Professor Huang will introduce new applications, including photoredox defluorination reactions and the photochemical switching of indigo compounds. Associate Professor Jin will lecture on structural changes of solid-state molecules induced by light.

到達目標 Course Goals

Through this course, students will be able to understand how light influences chemical reactions and molecular functions, gaining deeper knowledge of the design and application of photocatalytic reactions. In particular, students will learn the fundamental principles of photoredox catalysis, understand how light-driven electron transfer processes function in organic synthesis, and apply these concepts to reaction design and optimization.

With lectures from Professor Robert R. Knowles, a leading expert in photoreactions at Princeton University and a former member of the MacMillan group, which was awarded the Nobel Prize in Chemistry, students will explore the fundamentals and applications of radical reactions using photocatalysis, as well as the latest advancements in photocatalytic technology. Special emphasis will be placed on the Proton-Coupled Electron Transfer (PCET) mechanism proposed by Professor Knowles, which has been widely applied in diverse photoreactions. Students will be able to understand its fundamental principles and learn how to apply it to various organic transformations. By studying concrete examples, particularly C-C bond formation, students will develop the ability to consider its applications in sustainable organic synthesis.

To support the understanding of photocatalytic reactions, additional lectures will be provided by other faculty members. Professor Mita will cover the fundamentals of photochemical and radical reactions, helping students build a strong foundation. Associate Professor Huang will introduce new photoredox defluorination reactions and photo-switchable indigo derivatives, allowing students to explore applied research. Associate Professor Jin will discuss the photophysical properties of solid-state molecular assemblies and their functional applications, helping students understand molecular behavior in solid state.

By integrating these perspectives, students will be able to develop a comprehensive understanding of the relationship between light, chemical reactions, and molecular functions, equipping them with practical knowledge for further studies and research in the field of photochemistry.

授業計画 Course Schedule

June 10 (Tue) 2,3,4
Mingoo Jin - Solid-State Molecular Photophysics and Functions I
Mingoo Jin - Solid-State Molecular Photophysics and Functions II
Dennis Chung-Yang Huang - Radicals and Photoreactions

June 11 (Wed) 2,3,4
Tsuyoshi Mita - Basics of Radical Reactions (Photochemical and Electrochemical Generation of Radicals)
Robert Knowles - Visible-Light-Driven Reactions I

Robert Knowles - Visible-Light-Driven Reactions II

June 12 (Thu) 3,4
Robert Knowles - Visible-Light-Driven Reactions III
Robert Knowles - Special Lecture

準備学習（予習・復習）等の内容と分量 Homework

No preparation required. Only review is needed.

成績評価の基準と方法 Grading System

Evaluation will be based on learning attitude (20%) and reports (80%). However, attendance of at least 70% of the classes is the minimum requirement for evaluation. Students must choose one of the assigned topics from each professor and submit the report by the deadline.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

資料を用意する。
Materials will be provided.

講義指定図書 Reading List

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://knowleslab.princeton.edu/
https://mitagrouphp.icredd.hokudai.ac.jp/en.html
https://sites.google.com/view/huang-chemlab/
https://jingrouphp.icredd.hokudai.ac.jp/en.html

備考 Additional Information

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Leading and Advanced Molecular Chemistry and Engineering IIA - 2025[Leading and Advanced Molecular Chemistry and Engineering IIA - 2025]		
責任教員 Instructor	村越　敬 [MURAKOSHI Kei] (大学院理学研究院)		
担当教員 Other Instructors	Yen-Ku WU (National Yang Ming Chiao Tung University)		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095123
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7121		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

retrosynthesis, asymmetric synthesis, catalysis, cascade reaction, step economy

授業の目標 Course Objectives

The goal of this short course is to provide students with an understanding of the strategies, methodologies, and problem-solving approaches involved in the total synthesis of natural products. By examining classic and modern examples of complex molecule synthesis, students will develop the ability to analyze synthetic problems and design reasonable routes to target compounds.

到達目標 Course Goals

By the end of the course, students will be able to: (1) Explain key concepts and principles in retrosynthetic analysis of natural products. (2) Understand the importance of stereoselectivity, functional group compatibility, and step economy in synthesis. (3) Evaluate case studies of total synthesis and extract insights for innovative synthetic planning. (4) Analyze synthetic problems and propose logical, efficient solutions.

授業計画 Course Schedule

1. The Art and Science of Total Synthesis
2. Functional Group Transformations in Total Synthesis
3. Cascade Reactions and Reactive Intermediates in Total Synthesis
4. Modern Strategies for Natural Products Synthesis
5. The Quest for Pseudo Natural Products

準備学習（予習・復習）等の内容と分量 Homework

Reviewing named reactions, functional-group transformations, and common protecting groups is highly recommended. Students are recommended to read the original papers cited in each class.

成績評価の基準と方法 Grading System

One final written exam will be given to students for the grading.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G056

研究室のホームページ Websites of Laboratory

https://www.ykwulab.com/yenkuwu

備考 Additional Information

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Leading and Advanced Molecular Chemistry and Engineering IIB - 2025[Leading and Advanced Molecular Chemistry and Engineering IIB - 2025]		
責任教員 Instructor	村越　敬 [MURAKOSHI Kei] (大学院理学研究院)		
担当教員 Other Instructors	Chang Yun SON (Seoul National University)		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095124
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7121		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Single-molecule fluorescence, FRET, RNA folding

授業の目標 Course Objectives

This course explores the principles and computational techniques of modern statistical mechanics and molecular dynamics (MD) simulations, with an emphasis on their utilization for energy/bio-materials design. Students will learn (1) the theoretical foundations of statistical mechanics and MD simulations, (2) how these methods enable the prediction of macroscale thermodynamic properties from molecular interactions, and (3) the application of these methods to design and study energy and biomaterials. Topics include the theoretical foundations of statistical mechanics, MD simulation algorithms, and practical applications in the fields of energy storage materials, organic electronics, drug design, and biorefinery. The course combines lectures and hands-on computational exercises, equipping students with the tools to address challenges in chemistry, physics, biology, and materials science.

到達目標 Course Goals

The goal of this course is to help students (1) understand the principles of statistical mechanics and molecular dynamics simulations, and (2) gain a general perspective on what is currently possible with the state-of-art theory, MD simulation, and AI techniques to model and analyze functional materials for energy and bio applications.

授業計画 Course Schedule

1. From molecules to functional materials: an introduction to statistical mechanics and MD simulations
2. Fundamentals: Foundations of statistical mechanics
3. The Language of Uncertainty: Probability and Stochastic Processes in Statistical Mechanics
4. The Engine Behind Simulations: Molecular Dynamics Theory and Algorithms
5. Powering the future: Simulating energy materials
6. Life's building blocks: Simulating biomaterials
7. Pushing Boundaries: Advanced Techniques and Practical Applications

準備学習（予習・復習）等の内容と分量 Homework

To read the basic parts of Physical Chemistry and Statistical Thermodynamics textbooks at undergraduate level is highly recommended.

成績評価の基準と方法 Grading System

One final written exam will be given to students for the grading.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G057

研究室のホームページ Websites of Laboratory

https://songroup.github.io/sonlab-website/

備考 Additional Information

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Chemical Engineering Thermodynamics[Chemical Engineering Thermodynamics]		
責任教員 Instructor	菊地　隆司 [KIKUCHI Ryuji] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095125
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Chemical Engineering Thermodynamics, Phase Equilibrium, Chemical Equilibrium, Material-Energy Conversion, Exergy

授業の目標 Course Objectives

Thermodynamics is lectured to utilize it in chemical engineering. Basic laws of heat phenomena are reviewed for advanced applications. This lecture helps you understand that thermodynamics deals with conversion of materials and energy. Preservation and loss of energy is lectured by introducing a concept of “exergy”. You can learn the quality of energy is expressed in terms of exergy, and energy/material conversion systems are to be analyzed to minimize exergy loss for designing clean energy systems. Fuel cell systems and hydrogen production processes are used as examples for exergy analysis.

到達目標 Course Goals

You can extend basic knowledge on thermodynamics in small closed systems to large open systems such as reactors, power plants, and chemical plants. You can understand the concept of exergy, that is, exergy quantifies the available amount of energy based on environmental conditions, and learn the method to calculate exergy for respective energy forms. You can also learn to express exergy losses accompanied with energy conversion by using energy conversion diagram.

授業計画 Course Schedule

First half of this course you will review and expand the concept of chemical thermodynamics to chemical engineering thermodynamics. Second half you will learn the concept of exergy, calculation procedure of exergy, and drawing of energy conversion diagram.

1. World trends regarding hydrogen and energy, introduction to hydrogen production
2. Basic concept of chemical engineering thermodynamics, chemical thermodynamics, energy balance in closed and flow systems, energy balance of chemical processes
3. Ideal gas and real gas, compression and expansion
4. Chemical equilibrium, equilibrium of heterogeneous reactions
5. Introduction to exergy concept, exergy change in energy conversion, energy diagram for energy conversion
6. Calculation procedure for exergy of various energy forms
7. Exergy for mixing and separation processes, synthesis of process systems
8. Exergy analysis of conversion processes in chemical engineering

準備学習（予習・復習）等の内容と分量 Homework

It is required to study physical chemistry for preparation for the class. Materials are distributed for each class. Homework is assigned every class to well understand the course content. Unit of class is 1, which corresponds to 45 hours study. By considering total time of class, additional study of 3.6 hours is necessary before and after each class.

成績評価の基準と方法 Grading System

Grade will be evaluated based on the grades of small questions and report assignments assigned during the lecture. The evaluation is based on 40% of the small questions and 60% of the report assignments.

テキスト・教科書 Textbooks

必要な教材は毎回配布する。参考書は，講義指定図書のとおり。
Handout made by the instructor will be delivered.

講義指定図書 Reading List

熱力学(基本の理解と応用)／石田愈：培風館, 1995
演習化学工学熱力学(第 2 版)／大竹伝雄・平田光穂：丸善, 1991
エクセルギー工学／吉田邦夫編：共立出版, 1999

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G061

研究室のホームページ Websites of Laboratory

https://apchem.eng.hokudai.ac.jp/en/lab/chemical-system-engineering/

備考 Additional Information

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Separation Process Engineering I[Separation Process Engineering I]		
責任教員 Instructor	向井　紳 [MUKAI Shin] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095126
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7121		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Porous Materials, Adsorption

授業の目標 Course Objectives

In this course, you can learn the basic principles of separation processes with a particular focus on processes using porous materials such as adsorption.

到達目標 Course Goals

By the end of this course, a successful learner will:
1. Understand the mechanisms which cause adsorption
2. Understand methods to obtain adsorption isotherms, and become able to describe the characteristics of the material from its isotherm
3. Understand general adsorption theories and adsorption equations, and become able to analyze adsorption isotherms using them

授業計画 Course Schedule

This course will be held as an in-person class at Sapporo Campus.

1. Overview of Adsorption Phenomena and Adsorbents
2. Adsorption Phenomena
3. Typical Adsorbents and Their Production Processes
4. Adsorption Mechanisms
5. Adsorption Isotherms
6. Adsorption Theories and Adsorption Equations (Henry Equation, Freundlich Equation, Langmuir Equation)
7. Adsorption Theories and Adsorption Equations (BET Equation)
8. Examination

準備学習（予習・復習）等の内容と分量 Homework

Students are encouraged to read relevant materials ahead of time and review what they have been taught, especially the contents of quizzes after classes to deepen their understanding.

成績評価の基準と方法 Grading System

The attendance rate must be over 70% to be qualified to take the final project. Evaluations will be made based on (1) learning attitude (20%), (2) quiz scores (20%) and final examination scores (60%). Quizzes will be used to evaluate the level of understanding of each class and examinations will be used to evaluate the achievement level of this course.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G059

研究室のホームページ Websites of Laboratory

備考 Additional Information

Prerequisite courses include undergraduate-level mathematics, transport phenomena, thermodynamics, statistical thermodynamics, and separation process.

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Separation Process Engineering II[Separation Process Engineering II]		
責任教員 Instructor	荻野　勲 [OGINO Isao] (大学院工学研究院)		
担当教員 Other Instructors	Ron C. Runnebaum (University of California, Davis)		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095127
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7121		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Porous Materials, Adsorption, Membrane Separation, Chromatography

授業の目標 Course Objectives

To understand the basic principles of separation processes with a particular focus on processes using porous materials such as adsorption and membrane separation.

到達目標 Course Goals

1. Understand the roles of separation operation in industrial processes
2. Understand the classification of separation processes in terms of rate and equilibrium
3. Deepen understanding on thermodynamics and transport phenomena relevant to the design of separation processes
4. Understand the fundamental principles of industrial adsorption and membrane separation processes and perform basic design of these processes
5. Perform the basic design of devices and products equipped with adsorption and membrane-separation functions

授業計画 Course Schedule

1. Roles of industrial separation processes
2. Thermodynamics and transport phenomena relevant to separation processes
3. Adsorption process
4. Case study 1
5. Case study 2
6. Membrane separation process
7. Case study 3
8. Project

準備学習（予習・復習）等の内容と分量 Homework

Students are encouraged to read the textbook and relevant materials ahead of time. Students are required to submit assigned homework.

成績評価の基準と方法 Grading System

Students must maintain a 70% attendance rate or higher to be eligible for the final project. Evaluations will be performed using three factors: learning attitude (20%), which includes engagement and participation, assignment scores (30%), which assess understanding of class material and separation principles, and the final project score (50%), which evaluates practical application of skills learned.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

1. Separation Process Principles: With Applications Using Process Simulators, 4th Edition／J. D. Seader, Ernest J. Henley, D. Keith Roper：John Wiley & Sons, Inc., 2016
2. Product and Process Design Principles: Synthesis, Analysis and Evaluation, 4th Edition／Warren D. Seider, Daniel R. Lewin, J. D. Seader, Soemantri Widagdo, Rafiqul Gani, Ka Ming Ng：Wiley, 2016

講義指定図書 Reading List

現代化学工学／橋本健治、荻野文丸　編：産業図書, 2001

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G060

研究室のホームページ Websites of Laboratory

備考 Additional Information

Prerequisite courses include undergraduate-level mathematics, transport phenomena, thermodynamics, statistical thermodynamics, and separation process.
It is desirable for students to be able to understand numerical methods to solve differential equations.

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Leading and Advanced Materials Chemistry and Engineering IA – 2025[Leading and Advanced Materials Chemistry and Engineering IA – 2025]		
責任教員 Instructor	三浦　章 [MIURA Akira] (大学院工学研究院)		
担当教員 Other Instructors	Christopher J. Bartel (University of Minnesota)		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095128
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7121		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Materials Chemistry, Python, Machine Learning

授業の目標 Course Objectives

This course will introduce students to the key aspects that make up machine learning projects, with an emphasis on the types of data and problems often encountered in solid-state chemistry.

到達目標 Course Goals

By the end of this course, students will understand how machine learning can be applied to solid-state chemistry, what is needed to initiate a machine learning project, and how to train, validate, and interpret machine learning models using Python.

授業計画 Course Schedule

1) Applications and basics of machine learning in chemical sciences
2) Introduction to supervised learning: data, features, models
3) Introduction to data science with Python: numpy, pandas, matplotlib
4) Validating supervised learning models
5) Training machine learning models with Python: sklearn
6) Interpretable machine learning
7) Finding and analyzing a new tolerance factor for perovskite stability
8) Collaboration between experimentalists and theorists

準備学習（予習・復習）等の内容と分量 Homework

1–5 hours of practice and homework using Python

成績評価の基準と方法 Grading System

Homework

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G047

研究室のホームページ Websites of Laboratory

https://strchem.eng.hokudai.ac.jp/
https://bartel.cems.umn.edu/

備考 Additional Information

Laptop is needed.

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Leading and Advanced Materials Chemistry and Engineering IB - 2025[Leading and Advanced Materials Chemistry and Engineering IB - 2025]		
責任教員 Instructor	忠永　清治 [TADANAGA Kiyoharu] (大学院工学研究院)		
担当教員 Other Instructors	Nataly Carolina Rosero Navarro (Institute of Ceramic and Glass) FUJII Yuta (工学研究院)		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095129
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7121		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Electrochemical devices; Electrolyte; Electrode; Nano-structure; Batteries

授業の目標 Course Objectives

Recently, safe, low-cost, high-energy density, and long-lasting electrochemical devices for energy conversion and storage are highly required for mobile devices, electric vehicles, and storage for renewable energy to build a sustainable society. Development of novel materials and structural/morphological control of these materials are key issues. The aim of this course is to describe the importance of electrochemical devices and materials science involved in the development of such electrochemical devices. Fundamental concepts in electrochemical energy conversion and storage are overviewed at first, and then the materials chemistry for the electrochemical devices will be described. The preparation process for materials of electrochemical devices, the effect of nano-structures in electrodes for batteries, and the development of all-solid-state batteries are also described.

到達目標 Course Goals

By the end of this course you will be able to
1. explain and compare various electrochemical energy conversion and storage systems
2. understand the basic requirements for materials used in electrochemical energy conversion and energy storage devices
3. explain the effects of structure and morphology on the properties of electrochemical devices
4. understand and discuss materials and electrochemical devices in future energy storage system

授業計画 Course Schedule

As an HSI course, Dr. Nataly Carolina ROSERO-NAVARRO (Institute for Ceramics and Glass, CSIC, Spain) will give most of the lectures.

The following topics will be covered during this course.

1. Fundamental concepts about electrochemical energy conversion and storage
2. Materials used in electrochemical devices
3. Introduction of inorganic materials science for electrochemical devices
4. Nanostructured materials applied to electrodes for lithium and sodium ion batteries
5. Fundamentals of solid electrolyte
6. All-solid-state lithium secondary batteries
7. Overview of recent trends in materials for electrochemical devices and future energy storage system
8. Students presentation on topics in electrochemical devices

準備学習 (予習・復習)等の内容と分量 Homework

Students will be expected to download class notes from WEB page and read designated chapter in advance.
Students should read some papers on electrochemical devices during this course and make presentation.

成績評価の基準と方法 Grading System

Grade will be determined by how well one's achievement in this course through
1. a report on nanostructured materials in electrochemical devices (weightage 80%), and
2. a presentation on one's research or some topics in electrochemical devices (weightage 20%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

No textbook required. Handouts will be distributed.

講義指定図書 Reading List

"Recent Advances in Energy Storage Materials and Devices", Li Lu edited, Materials Research Forum LLC, ISBN 978-1945291265 (2017).

"Ceramic Electrolytes for All-Solid-State Li Batteries", M. Kotobuki, S. Song, C. Chen, and Li Lu, World Scientific Pub Co Inc ISBN: 978-9813233881(2018).

参照ホームページ Websites

This course will be provided as part of the Hokkaido Summer Institute., For more information (invited lecturers, course details, etc.), please visit the website below:, https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G048

研究室のホームページ Websites of Laboratory

http://www.eng.hokudai.ac.jp/labo/inorgsyn/

備考 Additional Information

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Leading and Advanced Materials Chemistry and Engineering II – 2025[Leading and Advanced Materials Chemistry and Engineering II – 2025]		
責任教員 Instructor	村越　敬 [MURAKOSHI Kei] (大学院理学研究院)		
担当教員 Other Instructors	Boyang HUA (Nanjing University)		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095130
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Single-molecule fluorescence, FRET, RNA folding

授業の目標 Course Objectives

This course introduces the concept of RNA folding, structures, and functions. We will talk about the different types of RNAs and their important and diverse roles in cells. In order to study RNAs, researcher need to employ a variety of tools. The class will discuss techniques commonly used in the field to synthesize, label, isolate, and characterize RNAs in vitro and in vivo, including some advanced single-molecule fluorescence techniques. After this, we will use real research examples to illustrate how real problems about RNA biology are solved using the various tools we have covered.

到達目標 Course Goals

The goal of this course is to help students (1) understand the physical and chemical basis of RNAs; (2) understand the biological processes that RNAs are involved in; (3) understand the modern tools, especially the single-molecule fluorescence tools, that are used to study the complex and dynamic mechanisms of RNA function and regulation; (4) get the students familiar with and interested in the field of RNA biology and single-molecule biophysics.

授業計画 Course Schedule

1. Introduction to RNA folding, structures, and functions
2. RNA types and their roles in cells
3. Bulk techniques for RNA synthesis, manipulation, and characterization
4. Single-molecule fluorescence techniques for RNA studies
5. Frontier research topics on RNA biology

準備学習（予習・復習）等の内容と分量 Homework

To read the basic parts of Biochemistry textbooks at undergraduate level is highly recommended. Several seminal literature will also be recommended

成績評価の基準と方法 Grading System

One final written exam will be given to students for the grading.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G049

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Leading and Advanced Materials Chemistry and Engineering IIIA – 2025[Leading and Advanced Materials Chemistry and Engineering IIIA – 2025]		
責任教員 Instructor	村越　敬 [MURAKOSHI Kei] (大学院理学研究院)		
担当教員 Other Instructors	YOSHIO Masafumi (NIMS), MASUDA Takuya (NIMS), KITAURA Ryo (NIMS), TSUJIMOTO Yoshihiro (NIMS)		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095131
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7121		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Supramolecular Chemistry, Inorganic Material Chemistry, Quantum Material Chemistry, Electrochemistry, Advanced Characterization Techniques, Device Fabrication

授業の目標 Course Objectives

In this course, students will explore the chemistry and physics of nanostructured organic and inorganic materials, including quantum materials, with a focus on their applications in ionic, electronic, and optoelectronic devices. They will also gain expertise in advanced interface analysis techniques. The lectures will cover the design and synthesis of functional materials through various methods, such as molecular self-assembly, flux growth, chemical vapor deposition, and epitaxial crystallization. These materials diverse applications, including actuators, sensors, batteries, photovoltaics, and photoemitters. Additionally, the course will introduce advanced characterization techniques, including X-ray photoelectron spectroscopy, vibrational spectroscopy, electron microscopy, and scanning probe microscopy. Students will learn how nanoscale structural control in organic and inorganic materials enhances their properties and enables novel functionalities. They will also develop a deeper understanding of surface chemistry transformations and heterointerface phenomena.

到達目標 Course Goals

The goal of this course are as follows: Understand structural control in organic assemblies, inorganic crystals, and atomically thin films, and grasp the fundamental operating principles of ionic, electronic, and photonic devices. Gain insight into materials design, engineering, and processing, and as well as the relationships between structure and properties, to optimize material functionality. Develop problem-solving skills and explore innovative solutions based on acquired knowledge. By achieving these objectives, students will cultivate the expertise necessary to make meaningful contributions on a global scale in their respective fields.

授業計画 Course Schedule

1. Overview of the Course and Structural Control of Organic Nanomaterials
2. Organic and Inorganic Electrochemical Devices
3. Secondary Batteries and Advanced Analytical Techniques
4. Exercises on Electrochemical Devices and Discussion on Future Devices
5. Structure and Function of Inorganic 2D Thin Films
6. Physics of 2D Materials and Fundamentals of Inorganic Crystals
7. Structural Control and Functionality of Inorganic Crystals
8. Exercises on Structural Symmetry and Physical Properties of Inorganic Crystals, Discussion on Future Devices, and Course Summary

準備学習（予習・復習）等の内容と分量 Homework

To read the basic parts of Organic and Physical Chemistry textbooks at undergraduate level is highly recommended.

成績評価の基準と方法 Grading System

One final written exam will be given to students for the grading.

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G050

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Leading and Advanced Materials Chemistry and Engineering IIID - 2025[Leading and Advanced Materials Chemistry and Engineering IIID - 2025]		
責任教員 Instructor	島田　敏宏 [SHIMADA Toshihiro] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095132
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7121		
補足事項 Other Information			
授業実施方式 Class Method	4 遠隔授業科目《遠隔のみ》		

キーワード Key Words

materials informatics, python

授業の目標 Course Objectives

The course provides lectures combined with exercises. In the lecture, basic knowledge of statistical methods and machine learning for materials research. In the exercises, we start from basic python programming and instruct how to use various libraries including tensorflow, scikit learn, stan, GPy etc. and databases.

到達目標 Course Goals

1. Understanding the basics of data science and machine learning, especially about terminology.
2. Learning how to use libraries and databases for python.
3. Practical usage of packages for materials informatics.

授業計画 Course Schedule

1. Neural networks
2. Rdkit library for chemicals
3. Machine learning for molecules
4. Sckit learn - library for machine learning
5. Reinforced learning toward protein-folding analysis
6. Genetic algorithm
7. Bayesian concept
8. Interpritation of machine learning results
9. Generative AI

準備学習（予習・復習）等の内容と分量 Homework

Requirement: personal computer equipped with a keyboard and internet connection
Homework: After each day, homework will be assigned.

成績評価の基準と方法 Grading System

After each day, homework will be assigned. The answer and final report will be used for grading.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

None

講義指定図書 Reading List

Any textbooks or websites on python language

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G053

研究室のホームページ Websites of Laboratory

https://www.eng.hokudai.ac.jp/labo/kotai/en/index.html
https://www.eng.hokudai.ac.jp/labo/inorgsyn/cover-e.htm

備考 Additional Information

Required Equipment for a class (Laptop, etc.)
A computer with python installed. Instruction of installation will be given to registered students prior to the course.The participants may be contacted in advance for preparation of python language.

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Instrumentation Chemistry[Instrumentation Chemistry]		
責任教員 Instructor	長谷川　靖哉 [HASEGAWA Yasuchika] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095133
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7121		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Chemical Information, elemental analysis, conditional analysis, structural analysis in nano- and micro-area.

授業の目標 Course Objectives

Grounding in physical, organic and inorganic chemistry.
In this course, instrumentation chemistry containing elemental analysis, configurational analysis, structural analysis in nano- and micro-area are introduced. Based on their studies, students learn fundamental knowledges and various information about chemical analysis of organic and inorganic materials.

到達目標 Course Goals

Students learn principle, variety and characterization of instrumentation chemistry for material analysis. Based on instrumentation chemistry containing elemental analysis, configurational analysis, structural analysis in nano- and micro-area, students make the most of their knowledges for construction of their chemical research.

授業計画 Course Schedule

1-2. introduction of instrumentation chemistry: importance for structural analysis on the material surface, classification of chemical instruments, grounding in high vacuum engineering
3. configurational analysis (TEM, SEM, AFM, STM)
4. elemental analysis (AES, EPMA, XPS, XRF)
5. structural analysis (XRD, EXAFS, HEED, LEED, SAXS)
6. photo-physical analysis (UV-Vis absorption spectra, fluorescence and phosphorescence spectra, emission lifetime, Raman spectra)
7. MS spectral analysis (EI-MS, CI-MS, ESI-MS, MALDI-MS, SIMS)
8. examination

準備学習（予習・復習）等の内容と分量 Homework

Pre-examination for review of instrumentation chemistry

成績評価の基準と方法 Grading System

The attendance rate must be over 70% to be qualified to take the final exam. Evaluations will be made based on (1) learning attitude (20%), (2) exercise (10%), (3) final examination scores (70%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G051

研究室のホームページ Websites of Laboratory

https://www.eng.hokudai.ac.jp/labo/amc/en/en-index.html

備考 Additional Information

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Functional Solid State Materials Chemistry[Functional Solid State Materials Chemistry]		
責任教員 Instructor	島田　敏宏 [SHIMADA Toshihiro] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095134
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7121		
補足事項 Other Information			
授業実施方式 Class Method	4 遠隔授業科目《遠隔のみ》		

キーワード Key Words

electronic materials and devices, thermoelectrics, solar cells, hard materials, solid state physics

授業の目標 Course Objectives

The first goal is to understand the "heart" of chemistry and physics of solid state functional materials and obtain the ability to design and crate new materials. The second goal is to understand what is written in literature with theoretical description. The lecture and the homeworks will be organized to achieve this goal.

到達目標 Course Goals

By the end of this course you will be able to
1. Explain how the devices explained in the lecture works.
2. Obtain basic knowledge of solid state materials.
3. Read advanced literature about the related topics.

授業計画 Course Schedule

Topics other than the following list can also be lectured according to request.
1. Introduction to solid state chemistry / physics and thermoelectricity
2. Semiconductors focused on solar cells
3. Transparent conductors (oxides, nanowires, graphene)
4. Advanced ligand field theory and basics of photophysics – lasers, nonlinear optics, optical fibers
5. Interfaces: work function and chemistry of semiconductor junction devices
6. Phase memory materials (DVD-R/W, shape memory alloys)
7. Ferroelectrics and liquid crystal
8. Thermography and strongly correlated electron systems
Related theoretical concepts will be introduced every time.

準備学習（予習・復習）等の内容と分量 Homework

Preparation: read the handout posted on the website (URL will be given at the first lecture).
Homework: solve the problem given in the lecture and write a brief final report.

成績評価の基準と方法 Grading System

Grading is based on the quiz given at each lecture and the final report.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Handout will be given prior to the lecture via website

講義指定図書 Reading List

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G052

研究室のホームページ Websites of Laboratory

https://www.eng.hokudai.ac.jp/labo/kotai/en/index.html

備考 Additional Information

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Leading and Advanced Biological and Polymer Chemistry and Engineering IA – 2025[Leading and Advanced Biological and Polymer Chemistry and Engineering IA – 2025]		
責任教員 Instructor	坂口　和靖 [SAKAGUCHI Kazuyasu] (大学院理学研究院)		
担当教員 Other Instructors	Paul Francois (University of Montreal) ABE Kazuhiro (理学研究院), NAKAGAWA Natsumi (理学研究院)		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095135
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7121		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

systems biology, gene regulatory networks, machine learning, mathematical modelling

授業の目標 Course Objectives

1. Introducing the fundamental principles of systems biology
2. Introducing techniques for modeling complex biological networks
3. Explore the intersection between biological systems and machine learning in the context of gene regulatory networks and deep learning.
4. Develop the skills to analyze biological data using systems biology models and machine learning algorithms to extract meaningful insights.

到達目標 Course Goals

1. To appreciate how gene regulatory networks (GRNs) shape cellular dynamics
2. To appreciate how non-linearity and interactions can be modeled to give rise to complex biological dynamics
3. To appreciate how the structure of gene networks relates to artificial neural networks

授業計画 Course Schedule

Day 1 :Introduction to systems Biology
- Gene regulatory networks
- Modelling Production, degradation, regulation
- Non-linearity in networks

Day 2 : Systems Modelling
- Network motifs : transcription
- Feed forward and Feedback
- Gene networks vs neurons dynamics
- Positive and negative feedbacks. Selector genes, speed, genetic oscillators

Day 3: Regulation layers
- Feed forward gene networks
- Case study : the gap gene patterning system in drosophila
- A gene regulatory network view of the perceptron, a perceptron view of embryonic patterning
- Information encoding

Day 4: From gene networks to machine learning
- Multilayer perceptrons and Deep learning.
- Latent space and autoencoders for gene regulatory networks

準備学習（予習・復習）等の内容と分量 Homework

Read the articles in the ″Reading List″

成績評価の基準と方法 Grading System

Assignment on specified topics (60%); Active student participation in class (40%)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

<Reading list>

https://doi.org/10.1038/nature02678

https://10.1016/s0955-0674(03)00017-6

https://doi.org/10.1073/pnas.2113651119

Reference Books : An Introduction to Systems Biology, Design Principle of Biological Circuits, Uri Alon; Why Machines Learn. The Elegant Math Behind Modern AI, Anil Ananthaswamy

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G042

研究室のホームページ Websites of Laboratory

https://www.francoisresearch.org

https://wwwchem.sci.hokudai.ac.jp/~biochem/en

https://wwwchem.sci.hokudai.ac.jp/~molbio/home-en/

備考 Additional Information

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Leading and Advanced Biological and Polymer Chemistry and Engineering IB - 2025[Leading and Advanced Biological and Polymer Chemistry and Engineering IB - 2025]		
責任教員 Instructor	磯野　拓也 [ISONO Takuya] (大学院工学研究院)		
担当教員 Other Instructors	Brian J. Ree (Kean University) SATOH Toshifumi (工学研究院), LI FENG (工学研究院)		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095136
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7121		
補足事項 Other Information			
授業実施方式 Class Method	2 対面授業科目《一部遠隔》		

キーワード Key Words

Polymer characterization, Statistical dynamics, Phase transition, Mechanical properties, and Morphology

授業の目標 Course Objectives

The current state of polymer science enables targeted synthesis of specialized polymers for a wide variety of specific purposes. This unique aspect of polymer science calls for the evaluation of their chemical structure, physical properties, and morphology for truly comprehending their behavior. Therefore, having a sound comprehension of the core principles in physics will aid in developing novel materials to new practical applications. Specific topics such as statistical dynamics, phase equilibria, thermal properties, mechanical properties, morphology and self-assembly characteristics will be explored. Therefore, having a sound comprehension of the core principles in physics will aid in developing novel materials to new practical applications.

到達目標 Course Goals

This course is intended to be an introduction to polymer characterization methods and physics of macromolecules. Beginning with ideal single chain behavior, concepts and principles will be expanded and deepened to accommodate various boundary conditions that represent real situations involving novel polymers. By the end of the course, the students are expected to be familiar with the core principles and diverse situations in preparation for handling and understanding the behaviors of various novel polymers they will develop in the future.

授業計画 Course Schedule

1. Introduction of Polymers: A Brief History and Reflection
2. Innate Statisticality and Configuration of Polymers: Ideal to Real
3. Statistical Dynamics of Polymer Solutions
4. Phase Equilibria in Various Polymer Systems
5. Polymer Physical Properties I : Thermal and Phase Transition Characteristics
6. Polymer Physical Properties II : Mechanical Characteristics
7. Polymer Physical Properties III : Morphology and Self-assembly
8. Experimental Horizons of Polymer Characterization and Application

準備学習（予習・復習）等の内容と分量 Homework

Final report on the subjects relating to the characterization and physical properties of polymers involving the application of the concepts learned from the lectures.

成績評価の基準と方法 Grading System

Your grade will be determined by how well you demonstrate your achievement of the course goals through
1. Participation to the discussion (10%)
2. Final report regarding to "characterization and physical properties of polymers" (90%)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

No textbook required, all teaching materials/slides to be provided

講義指定図書 Reading List

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G043

研究室のホームページ Websites of Laboratory

http://poly-ac.eng.hokudai.ac.jp/index_e.html

備考 Additional Information

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Advanced Applied Biochemistry[Advanced Applied Biochemistry]		
責任教員 Instructor	松本　謙一郎 [MATSUMOTO Kenichiro] (大学院工学研究院)		
担当教員 Other Instructors	HACHISUKA Shin-ichi (工学研究院), FUJITA Masahiro (RIKEN)		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095137
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7121		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Genetic information, protein structure, molecular mechanism, biosynthetic mechanism, animal cells, secondary metabolites, biopolymers, bioremediation, physical chemistry, Genetic engineering, Bioinformatics

授業の目標 Course Objectives

To learn synthesis, structure, function, and novel engineering subjects on of biomolecules in the fields of life science, information, medicine, and environment.

到達目標 Course Goals

Students are expected to understand deeply the topics of genetic information, protein structure, animal cell cultivation, secondary metabolites, biopolymers, and clean environments in the fields of life science, information, medicine, and environment.

授業計画 Course Schedule

1-4: Structure, function and analytical methods of RNA and other biomolecules
5-8: Strategies of metabolic pathways, and principles of enzymatic reactions, Genetic engineering, Bioinformatics

準備学習（予習・復習）等の内容と分量 Homework

Students review the lecture contents by the next time. Students submit a report after the lecture.

成績評価の基準と方法 Grading System

Active class participation and reports
The attendance rate must be over 70% to be qualified to be graded.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G046

研究室のホームページ Websites of Laboratory

https://biosynchem.eng.hokudai.ac.jp/

備考 Additional Information

科目名 Course Title	先端総合化学特論Ⅱ[Modern Trends in Chemical Sciences and Engineering II]		
講義題目 Subtitle	Introduction to Basic Biological Chemistry[Introduction to Basic Biological Chemistry]		
責任教員 Instructor	茂木　文夫 [MOTEGI Fumio] (遺伝子病制御研究所)		
担当教員 Other Instructors	TAKAOKA Akinori (遺伝子病制御研究所), ABE Kazuhiro (理学研究院)		
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095138
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Lecture	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7121		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

cell growth and differentiation, gene expression, oncogene, immunity, infectious disease, Membrane proteins, Primary transporters

授業の目標 Course Objectives

The class focuses on fundamental aspects of molecular mechanisms that underlie basic biological phenomena such as cell growth, cell differentiation, immunity and cellular asymmetry. How disorder of the regulatory mechanism causes diseases including cancer and infectious disease will be discussed. In addition, various technologies for imaging dynamic molecular behaviour in living cells, X-ray crystallography, Cryo-EM, will be also discussed.

到達目標 Course Goals

Students to be able to understand the basic regulatory mechanisms of gene expression, cell growth and immune system and developing mechanisms for the related diseases.

授業計画 Course Schedule

Day 1, 2: Fumio Motegi
Interior design of cellular asymmetry
Day 3: Akinori Takaoka
Molecular signalings in host defense system
Day 4: Kazuhiro Abe
Membrane transport proteins including active tansporters

準備学習（予習・復習）等の内容と分量 Homework

Review the contents of each lecture by the next time.

成績評価の基準と方法 Grading System

Report of the task (100%)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義指定図書 Reading List

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G044

研究室のホームページ Websites of Laboratory

https://www.motegilab.com
https://www.igm.hokudai.ac.jp/sci/index-english.html
https://wwwchem.sci.hokudai.ac.jp/~molbio/home-en/

備考 Additional Information

科目名 Course Title	総合化学研究インターンシップ[Internship]		
講義題目 Subtitle	ショート・ビジット[Short Visit]		
責任教員 Instructor	仙北　久典 [SENBOKU Hisanori] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095151
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Internship	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7141		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Internship

授業の目標 Course Objectives

For overseas internship, students develop global vision by their experience overseas, gain expertise and experimental techniques which seem to be hard to obtain in Japan.

到達目標 Course Goals

For overseas internship, students start to contact with where to do internship, then improve skills of communication, language, research practice, research network and community formation etc, so that they can raise consciousness as an engineer or a researcher.

Students should try not to keep the experience at only level of basic studies, try to apply the experience to collaborative researches with a practical level in the future.

授業計画 Course Schedule

The program will be generally conducted following the schedule below.

1. Announcement
2. Application (not equal to Registration)
3. Preparation
4. Internship for about between two weeks and two months
5. Submission of a report for the internship, presentation

準備学習（予習・復習）等の内容と分量 Homework

Students need to do preliminary search and to prepare ecperiments in advance.

成績評価の基準と方法 Grading System

Basically, students must submit a report and do a presentation in English language.

They will be evaluated by the above elements.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

使用しない

講義指定図書 Reading List

使用しない

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	総合化学研究インターンシップ[Internship]		
講義題目 Subtitle	ALP インターンシップ[ALP Internship]		
責任教員 Instructor	中冨　晶子 [NAKATOMI Akiko] (大学院理学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095152
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Internship	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7142		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Internship (domestic and oversea)

授業の目標 Course Objectives

ALP Corporate Internship: Students improve their skill and knowledge by being engaged in an actual work relating their future career.

ALP Overseas Internship: For overseas internship, students develop global vision by their experience overseas, gain expertise and experimental techniques which seem to be hard to obtain in Japan.

到達目標 Course Goals

Students start to contact with where to do internship, then improve skills of communication, language, research practice, research network and community formation etc, so that they can raise consciousness as an engineer or a researcher.

For overseas internship, students should try not to keep the experience at only level of basic studies, try to apply the experience to collaborative researches with a practical level in the future.

授業計画 Course Schedule

ALP Corporate Internship:

· Period of Internship: As a rule, the internship period is more than 2 weeks within 12 months.
· Posts: Domestic posts may consist of corporate research institutions or plant.
· In principle, deadlines for submissions are four weeks prior to departure.
· Obtain the Personal Accident Insurance for Students Pursuing Education and Research (PAS) prior to travel.

ALP Overseas Internship:

· Period of Internship: As a rule, the internship period is more than 1 month within 12 months.
· Posts: Overseas posts will mainly consist of university research institutions or corporation.
· In principle, deadlines for submissions are six weeks prior to departure.
· Obtain travel insurance prior to travel.

Students are required to submit a report within one month of completing the internship.

準備学習 (予習・復習)等の内容と分量 Homework

Students need to do preliminary search and to prepare experiments in advance.

成績評価の基準と方法 Grading System

Basically, students must submit a report and do a presentation (in English language for overseas internship).
They will be evaluated by the above elements.

他学部履修の条件 Other Faculty Requirements

Only ALP students can take this course.

テキスト・教科書 Textbooks

使用しない。

講義指定図書 Reading List

使用しない。

参照ホームページ Websites

https://phdiscover.jp/hu/alp/

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	総合化学研究インターンシップ[Internship]		
講義題目 Subtitle	ジョブ型研究インターンシップ[Cooperative Education through Research Internship]		
責任教員 Instructor	仙北　久典 [SENBOKU Hisanori] (大学院工学研究院)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2025	**時間割番号 Course Number**	095153
期間 Semester	Intensive	**単位数 Number of Credits**	1
授業形態 Type of Class	Internship	**対象年次 Year of Eligible Student**	～
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 7142		
補足事項 Other Information			
授業実施方式 Class Method	1 対面授業科目《対面のみ》		

キーワード Key Words

Domestic internship

授業の目標 Course Objectives

Students improve their skill and knowledge by being engaged in an actual work relating their future career.

到達目標 Course Goals

Students start to contact with where to do internship, then improve skills of communication, language, research practice, research network and community formation etc, so that they can raise consciousness as an engineer or a researcher.

授業計画 Course Schedule

The program will be generally conducted following the schedule below.

1. Announcement
2. Application (not equal to Registration)
3. Preparation
4. Internship for two months or more
5. Recieve evaluation form from the company

準備学習（予習・復習）等の内容と分量 Homework

Students need to do preliminary search and to prepare experiments in advance.

成績評価の基準と方法 Grading System

Pass/fail will be determined based on the evaluation forms submitted by the companies.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

使用しない

講義指定図書 Reading List

使用しない

参照ホームページ Websites

https://coopj-intern.com/

研究室のホームページ Websites of Laboratory

備考 Additional Information

Only MEXT "ジョブ型研究インターンシップ" participants can register for this program.