科目名 Course Title	物理化学先端講義[Advanced Lecture of Physical Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	佐田　和己 [SADA Kazuki] (大学院理学研究院)		
担当教員 Other Instructors	ISHIMORI Koichiro[ISHIMORI Koichiro](理学研究院), TAKEUCHI Hiroshi[TAKEUCHI Hiroshi](理学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094051
期間 Semester	Summer	**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 5002		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Condensed matter, Macromolecules, Molecular structure, Magnetic resonance

授業の目標 Course Objectives

Firstly, this course reviews a part of fundamental physical chemistry (physical properties of molecules and macromolecules, nuclear magnetic resonance). Secondly, this course provides the skill of understanding advanced application of physical chemistry in material science.

到達目標 Course Goals

Students are expected to understand the important matters of physical chemistry and to apply them to design, synthesis, and study of functional properties of new materials.

授業計画 Course Schedule

Session 1 (1 ~ 3) Instructor: Lecturer Takeuchi, Hiroshi (Faculty of Science)
Basic concepts of nuclear magnetic resonance and its application.
(reference: ATKINS' Physical Chemistry 10th edition; chapter 14, Magnetic resonance)

Session 2 (4 ~6) Instructor: Professor Sada, Kazuki (Faculty of Science)
Basic theory and physical properties of macromolecules
(reference: ATKINS' Physical Chemistry 10th edition; chapter 17, Macromolecules and self-assembly)

Session 3 (7, 8) Instructor: Professor Ishimori, Koichiro (Faculty of Science)
Molecular interactions: Basic theory and its application of dipole-dipole interactions
(reference: ATKINS' Physical Chemistry 10th edition; chapter 16, Molecular interactions)

準備学習 (予習・復習)等の内容と分量 Homework

Preparation for ATKINS' Physical Chemistry 10th edition; chapter 14 (Magnetic resonance), chapter 16 (Molecular interactions), chapter 17 (Macromolecules and self-assembly) or equivalent chapters of previous editions. Review according to instructors.

成績評価の基準と方法 Grading System

Final paper for each instructor (75%), quiz and attendance attitude (25%)
Participation more than 70% is required for grading

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

参考書:アトキンス「物理化学」

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

備考 Additional Information

Prerequisite:
Students are requested to have basic knowledge of physical chemistry

科目名 Course Title	無機化学先端講義[Advanced Inorganic Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	松井　雅樹 [MATSUI Masaki] (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	2023	**時間割番号 Course Number**	094052
期間 Semester	Summer	**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 5012		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Powder X-ray diffraction, Bravais lattice, space group, crystal structural factor, Rietveld refinement

授業の目標 Course Objectives

Powder X-ray diffraction is the most popular structural analyses method in inorganic materials chemistry. In this class we revisit undergrad level crystallography and XRD technique. Advanced measurement and analysis techniques are also introduced in the class.

到達目標 Course Goals

Understand the rietveld refinement technique.

授業計画 Course Schedule

1. Fundamental of powder X-ray diffraction
2. Measurement and analysis of diffraction data1
3. Measurement and analysis of diffraction data2
4. Description of crystallographic data
5. Point group and space group
6. Calculation of peak intensity
7. Rietveld refinement 1
8. Rietveld refinement 2

準備学習 (予習・復習)等の内容と分量 Homework

Check the class text in advance.
Summarize your questions just after the class.

成績評価の基準と方法 Grading System

Attendance 30%, Homework: submit20%, Content50%

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Materials will be provided via ELMS in advance.

講義指定図書 Reading List

粉末 X 先回席の実際　第 3 版／中井泉、泉富士夫(編):朝倉出版, 2021
物質の対称性と群論／今野豊彦:共立出版, 2001
X 線構造解析／早稲田嘉夫、松原英一郎:内田老鶴圃, 1998

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	基礎生物有機化学特論[Introductory Bio-organic Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	永木　愛一郎 [NAGAKI Aiichiro] (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	2023	**時間割番号 Course Number**	094053
期間 Semester	Summer	**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 5022		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Flow Chemistry, Microflow System, Integrated Synthetic Chemistry, Organic Synthetic Chemistry

授業の目標 Course Objectives

Integrated synthetic chemistry, or reaction-integrated synthetic chemistry, is a synthetic chemistry in which a series of reactions are planned and carried out in a coordinated manner, rather than in which each of the reactions required for synthesis is planned and carried out separately and independently. In this lecture, the characteristics of organic synthetic reactions using microflow systems and the integration of reactions using these characteristics will be discussed, and the latest examples will be introduced.

到達目標 Course Goals

Understand the features related to microflow synthesis and acquire the ability to construct integrated synthesis based on these features.

授業計画 Course Schedule

1. Organic synthesis based on fast mixing
2. Organic synthesis based on reaction time control
3. Organic synthesis based on use of short-lived active species
4. Reaction integration

準備学習（予習・復習）等の内容と分量 Homework

It is effective to review the handouts distributed during the lecture.

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 report scores.

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

講義時に指定する。

Introduced as appropriate in class.

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://wwwchem.sci.hokudai.ac.jp/~yuhan/index_e.html

備考 Additional Information

科目名 Course Title	生物化学先端講義[Intermediate Biological Chemistry]		
講義題目 Subtitle			
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	KAMADA Rui[KAMADA Rui](理学研究院), NAKAGAWA Natsumi (理学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094054
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
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 5032		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Biomolecule, Protein, Protein Structure, Regulation of Protein Function, Folding, Molecular Recognition, Enzyme, Bioinfomatics

授業の目標 Course Objectives

The protein function is attributed to its 3D structure and is regulated via control of protein level, activity, and localization by interactions with other biomolecules and posttranslational modification. The class focuses on fundamental aspects of the mechanisms for regulation of protein function based on protein structures. This course also introduces frontier topics of protein function and structures and the course will help the student to expand an understanding of fundamentals of protein structure and function.

In the latter part of the lecture, students participate in virtual research proposals on raising problems and their solutions related to protein structure, function, and control, in Active learning method by the group.

到達目標 Course Goals

After successful completion of this course, you will be able to:

1. Understand the regulation mechanism of protein function based on protein structures.
2. Obtain basic abilities to search the problems in scientific fields and solve them.

授業計画 Course Schedule

In the half of the course, the following items are outlined.

1. Basic structure and stability of protein
2. Molecule recognition of proteins and enzymes
3. Control of protein function
4. Complex formation and ligand binding
5. Protein structure / function prediction

We will also conduct a virtual research proposal by the group on raising problems and their solutions related to protein structure, function and control.

準備学習 (予習・復習)等の内容と分量 Homework

Students are expected to review the material provided by the instructors.

成績評価の基準と方法 Grading System

Problem-based learning on a specific topics of this course (40%). Term examination (40%)

In addition, we also consider it as the important factor for assessment how actively students participate in each class (20%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Materials will be provided in each lecture

講義指定図書 Reading List

タンパク質の構造と機能／グレゴリー A. ペツコ, ダグマール リンゲ著 ; 宮島郁子訳:メディカル・サイエンス・インターナショナル, 2005

“Protein Structure and Function”／Gregory A. Petsko and Dagmar Ringe:New Science Press, 2004

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

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

備考 Additional Information

科目名 Course Title	実践的計算化学[Practical Computational Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	武次　徹也 [TAKETSUGU Tetsuya] (大学院理学研究院)		
担当教員 Other Instructors	ITOH Hajime[ITOH Hajime](工学研究院), SHIMADA Toshihiro[SHIMADA Toshihiro](工学研究院), HASEGAWA Junya[HASEGAWA Junya](触媒科学研究所)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094055
期間 Semester	Fall	**単位数 Number of Credits**	2
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 5200		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Computational Chemistry, Theoretical Chemistry, Molecular Orbital Theory, Density Functional Theory

授業の目標 Course Objectives

Computational chemistry has been a very important research technique in chemistry field. This course is for the students who have no experience of calculation. Objectives of this course is to make the students master how to use calculation on their research issues in accompany with understandings on general aspects of computational chemistry.

到達目標 Course Goals

1. Understand the basics of computational chemistry, theoretical chemistry, molecular orbital theory, density functional theory, excited state calculation.
2. Use Gaussian and GaussView.

授業計画 Course Schedule

1. General Introduction of Computational Chemistry – Prof. T. Taketsugu
2. Computational Analysis of Organic Reactions – Prof. H. Ito
3. Physical Properties Calculations of Inorganic Materials and Organic Semiconductors – Prof. T. Shimada
4. Excited State Calculations – Prof. J. Hasegawa

準備学習 (予習・復習)等の内容と分量 Homework

Students should have a note PC with Windows 7 or later.
Calculation homework and reports.

成績評価の基準と方法 Grading System

The attitude at the lecture (20%) and report scores (80%) are evaluated.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

新版 すぐできる 量子化学計算ビギナーズマニュアル (KS 化学専門書)／武次 徹也 (編集), 平尾 公彦 (監修):講談社サイエンティフィク, 2015

講義指定図書 Reading List

Gaussian プログラムで学ぶ情報化学・計算化学実験／堀 憲次, 山本 豪紀:丸善, 2006
電子構造論による化学の探究

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

Notre PC with Windows7 or later and anti-virus application is necessary.
If many applicant, the student will be determined by lottery.
Campus licensed software will be used (no extra cost). No advance preparation is required. Students aiming to real skill acquisition are favorable.

科目名 Course Title	構造有機化学[Structural Organic Chemistry]		
講義題目 Subtitle			
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			
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094056
期間 Semester	Fall	**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 5050		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Structural Organic Chemistry
Host-guest complexation
Supramolecules
Molecular response systems
Chromism

授業の目標 Course Objectives

Various functions of materials can be derived by proper designing organic pi-electron systems. This course will provide students with the two of the important concepts which are necessary to comprehend this area of organic chemistry.

到達目標 Course Goals

Students will learn the background and basic idea to understand the various intriguing phenomena in the functionalized organic pi-electron systems/organic solids.

授業計画 Course Schedule

Two major topic are as follows:
1) "Host-guest complexation and supramolecule formation"
2) "Molecular response systems and Chromism

The class instruction will be done in Japanese.

準備学習（予習・復習）等の内容と分量 Homework

The following text book is used. (only Japanese version is available)

成績評価の基準と方法 Grading System

Presentations and reports

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

構造有機化学　基礎から物性へのアプローチまで／中筋　一弘：東京化学同人, 2020

講義指定図書 Reading List

構造有機化学　基礎から物性へのアプローチまで／中筋　一弘：東京化学同人, 2020

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	分子変換化学[Molecular Transformation]		
講義題目 Subtitle			
責任教員 Instructor	南　篤志 [MINAMI Atsushi] (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	2023	**時間割番号 Course Number**	094057
期間 Semester	Winter	**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 5060		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Natural products, biosynthesis

授業の目標 Course Objectives

Understanding of basic knowledge of the biological processes to synthesize biologically active natural products including polyketides, terpenes, peptides.

到達目標 Course Goals

Students are requested to understand the biosynthetic pathways and the function of enzymes responsible for the biosynthesis, and to apply the knowledge to their own research subjects.

授業計画 Course Schedule

1. Biosynthesis of polyketides
・type I polyketide synthases
・type II polyketide synthases
・type III polyketide synthases
2. Biosynthesis of peptides
3. Biosynthesis of terpenoids

準備学習（予習・復習）等の内容と分量 Homework

Before lecture, I recommend students to read the specified book or research reports. After lecture, described topics using delivered materials should be reviewed.

成績評価の基準と方法 Grading System

It is required to attend at least 70% of the lectures. Evaluation as pass/fail will be based on the quality of reports (60%) and short tests (40%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

適宜資料を配布する。参考書を適宜示すが，教科書は用いない。

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

備考 Additional Information

科目名 Course Title	超分子化学[Supramolecular Chemistry]		
講義題目 Subtitle			
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	ITOH Hajime[ITOH Hajime](工学研究院), YONEDA Tomoki[YONEDA Tomoki](工学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094058
期間 Semester	Fall	**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 5102		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

host-guest chemistry, intermolecular interactions, hydrogen bond, macrocyclic molecules, ion recognition, structure, stereochemistry, chirality

授業の目標 Course Objectives

The goal of this course is to understand the basis of supramolecular chemistry including driving forces of intermolecular non-covalent interactions, molecular design and synthesis, higher-order structures, and functions as materials.

到達目標 Course Goals

Students will be able to explain

1. the origin of non-covalent intermolecular interactions (hydrogen bond, CH-π interactions, dipole-dipole interactions, Coulomb interactions) from the viewpoint of quantum organic chemistry
2. methods of structural analysis of supramolecular structures and their principles
3. methodology of efficient synthesis of macrocyclic compounds, rotaxanes, and catenanes, and their drawback and advantage
4. expected 3-dimennsional structures and functions from chemical structures of building units

授業計画 Course Schedule

1. what is 'supramolecules', intermolecular interactions
2. molecular recognition, ion recognition, host-guest chemistry
3. self-assembly, giant supramolecular structures
4. reactions and supramolecular chemistry
5. from current research topics
6. summary

準備学習 (予習・復習)等の内容と分量 Homework

Students are expected to prepare the lecture by reading textbook or handouts which will be delivered in class, and to read reference scientific papers which will be introduced in the lecture.

成績評価の基準と方法 Grading System

Evaluation will be based on report submission (50%) and examination (50%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

大学院 Lecture　有機化学　Ⅰ. 分子構造と反応・有機金属化学／野依良治ほか:東京化学同人, 1999
超分子化学／Jean-Marie Lehn(著)、竹内敬人(訳):化学同人, 1997

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

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

備考 Additional Information

Students are strongly recommended to check ELMS frequently.

科目名 Course Title	化学工学熱力学特論[Chemical Engineering Thermodynamics]		
講義題目 Subtitle			
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	2023	**時間割番号 Course Number**	094059
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 5111		
補足事項 Other Information			
授業実施方式 Class Method			

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. Introduction, basic concept of chemical engineering thermodynamics, definition and relation of heat and temperature, force and work, energy, work and power
2. Chemical thermodynamics, energy balance in closed and flow systems, energy balance of chemical processes
3. Ideal gas and real gas, compression and expansion, phase equilibrium, fugacity for multi-component system
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 is evaluated from the quizes in the lecture and a term-end examination with weighting factors of 40% and 60%, respectively. Percentage of attendance above 70% is necessary to take a term-end examination.

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=G066

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	有機反応・構造論[Organic Chemistry of Reaction Mechanism and Molecular Structure]		
講義題目 Subtitle			
責任教員 Instructor	大熊　毅 [OHKUMA Takeshi] (大学院工学研究院)		
担当教員 Other Instructors	ARAI Noriyoshi[ARAI Noriyoshi](工学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094060
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
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 5122		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Molecular Orbital, Chemical Bonding, Reactive Intermediates, Stereochemistry, Molecular Recognition, Pericyclic reactions, The Woodward-Hoffmann rules, Cycloaddition reactions, Electrocyclic reactions, Sigmatropic rearrangements, Group transfer reactions

授業の目標 Course Objectives

1. Pericyclic reactions are the third type of organic mechanism along with ionic and radical reactions. This course explains features of these reactions using a basic molecular orbital theory without the mathematics. The Woodward-Hoffmann rules are introduced to analyze the stereochemical outcome of a series of pericyclic reactions, including cycloaddition reactions, electrocyclic reactions, sigmatropic rearrangements, and group transfer reactions.
2. In the first half of this course, students learn the behavior of electrons in an atom and/or a molecule from a quantum theoretical point of view, and understand the chemical bonding and the electronic properties of molecules. Based on this achievement, they learn the structure and properties of chemical species, such as carbocations, carbanions, radicals, and carbenes. In order to understand the chemical behavior of molecules, they also learn the stereochemistry that includes the concept of chirality, diastereomeric isomerism, and conformational analysis. Finally, the molecular recognition through intermolecular interaction, mainly hydrogen bonding, is briefly explained. The lecture materials will be uploaded in on-demand form by using "lecture group" at the ELMS. Students will be assigned homework to check understanding.

到達目標 Course Goals

1. Pericyclic reactions include some of the most useful synthetic reactions, such as the Diels-Alder reactions, 1,3-dipolar cycloadditions, and Claisen rearrangements. By learning to recognize the various types of pericyclic reactions and details of their mechanisms through the cyclic transition structures, students will learn to predict whether these reactions are allowed in individual cases.
2. Our goal is understanding of
- the chemical bondings and the electronic properties of molecules based on the behavior of electrons.
- the structure and properties of chemical species , such as carbocations, carbanions, radicals, and carbenes.
- the concept of chirality, diastereomeric isomerism, and conformational analysis.
- the molecular recognition.

授業計画 Course Schedule

1. The nature of pericyclic reactions (1): The basis and four classes of pericyclic reactions are introduced.
2. Cycloaddition reactions (2): A wide range of cycloadditions and their regio- and stereochemical properties are presented.
3. The Woodward-Hoffmann rules and molecular orbitals (2): The Woodward-Hoffmann rules based on the fundamental molecular orbital theory are discussed.
4. Electrocyclic reactions (1): The reaction pathway and the stereoselective outcome are interpreted by using the Woodward-Hoffmann rules.
5. Sigmatropic rearrangements and group transfer reactions (1): [1,n] and [m,n] rearrangements of suprafacial or antarafacial type are examined. The features of group transfer reactions are explained using two typical examples, diimide reductions and the ene reactions.
6. Electronic structure of atoms (1): The behavior of electrons in an atom is introduced based on the quantum theory.
7. Chemical bonding, molecular orbital, orbital interaction (2): Expression of molecular orbitals by the linear combination of atomic orbital and their interaction are discussed, followed by an explanation of some electronic properties of molecules.
8. Structure and properties of reactive intermediates (2): Chemical structure and properties of typical reactive intermediates, such as carbocations, carbanions, radicals, and carbenes are discussed.
9. Stereoisomerism, chirality, and conformational analysis (1): The way of expression of molecular chirality and stereoisomerism are instructed, followed by introducing the relationship between structure and properties. The method for the conformational analysis is also discussed.
10. Molecular recognition (1): Molecular interaction through hydrogen bonding is briefly discussed.

準備学習（予習・復習）等の内容と分量 Homework

1. The first half of this course: Students are expected to review the lessons presented in the textbook as well as their own lecture notes. Students are sometimes required to submit assignments.

2. The second half of this course: Students are expected to read relevant contents in the textbook previous to each class (apprx. 15 pages). Students may have short exam or homework, if necessary.

成績評価の基準と方法 Grading System

Grades are awarded based on attitudes through the course and regular assignments (20%) as well as examinations (80%). Students should attend more than 70% of classes.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Pericyclic Reactions, Second edition／Ian Fleming：Oxford University Press, 2015
大学院 Lecture 有機化学 I 第2版／野依良治 他：東京化学同人, 2019
March's advanced organic chemistry: reactions, mechanisms, and structure, 7th Ed.／Smith, M. B.：John Wiley & Sons, 2013

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

http://labs.eng.hokudai.ac.jp/labo/orgsynth/en/

備考 Additional Information

科目名 Course Title	反応工学特論[Chemical Reaction Engineering]		
講義題目 Subtitle			
責任教員 Instructor	中坂　佑太 [NAKASAKA Yuta] (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	2023	**時間割番号 Course Number**	094061
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
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 5132		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Reaction rate, Reactor, Conversion, Selectivity, Ideal/non-ideal flow, Diffusion rate, Transport phenomena

授業の目標 Course Objectives

To design a suitable chemical reactor it is important to understand ideal and non-ideal flow patterns in the reactor and their effects on chemical reactions. Basic models, concepts, and methods for the chemical reactions in ideal and non-ideal reactors will be explained. Mass transport phenomena through the interfaces between solid-gas and solid-liquid phases are discussed using a simple numerical model. Study the derivation of differential equations describing the mass transport phenomena with chemical reactions. Moreover, the effects of diffusion and reaction rates on rate-limiting step are discussed, based on the Thiele modulus and Effectiveness factor.

到達目標 Course Goals

Understand the features of ideal and non-ideal flow reactors and mass transport phenomena with chemical reactions around the interface between different phases and within porous catalyst.

授業計画 Course Schedule

1. Reaction kinetics and homogeneous reactions
2. Flow patterns in reactors
3. Continuous reactions in non-ideal flow reactors
4. Base of mass transport phenomena, Fick's 1st and 2nd lows.
5. Simultaneous reaction and diffusion phenomena around the interfaces between different phases.
6. Simultaneous reaction and diffusion phenomena within a porous catalyst
7. Thiele modulus and effectiveness factor for the catalytic reaction.

準備学習 (予習・復習)等の内容と分量 Homework

Homeworks will be handed out in the class to understand the lecture.

成績評価の基準と方法 Grading System

Grading will be based on quizzes (30%) and reports (70%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Chemical Reaction Engineering／O. Levenspiel：John Wiley & Sons, 1999
Introduction to Chemical Engineering Kinetics & Reactor Design／C. G. Hill：John Wiley & Sons, 1977
反応工学／橋本健治：培風館, 1993

講義指定図書 Reading List

Chemical Reaction Engineering／O. Levenspiel：John Wiley & Sons, 1999
Introduction to Chemical Engineering Kinetics & Reactor Design／C. G. Hill：John Wiley & Sons, 1977
反応工学／橋本健治：培風館, 1993

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

Basic understanding of reaction kinetics and chemical reaction engineering is required. Students should have calculators for each class.

科目名 Course Title	有機合成化学[Advanced Organic Synthesis]		
講義題目 Subtitle			
責任教員 Instructor	石山　竜生 [ISHIYAMA Tatsuo] (大学院工学研究院)		
担当教員 Other Instructors	SENBOKU Hisanori[SENBOKU Hisanori](工学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094062
期間 Semester	Fall	**単位数 Number of Credits**	2
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 5142		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Organic Synthesis, Molecular Transformation, Reaction Mechanism, Selectivity, Control of Stereochemistry

授業の目標 Course Objectives

"Selectivity" is one of important key words in organic synthesis. In this course, students learn several selectivities in organic transformations and their reaction mechanisms for realizing these high selectivities. Moreover, there are many selective transformations in practical organic synthesis. Some papers published in academic journals are picked up as examples for this course and students also learn how to explain the reasons why these high selectivities can be realized from the basis of learned reaction mechanism.

到達目標 Course Goals

・Understanding selectivities and reaction mechanisms for realizing high selectivities in organic transformations.
・Verifying and understanding concrete selective transformations used in synthesis of natural products and highly functional organic molecules.
・Being able to discuss and explain reasons of selectivities in several organic transformations.

授業計画 Course Schedule

1. Oxidation of Organic Compounds
2. Reduction of Organic Compounds
3. Generation of Enolate and Aldol Reaction
4. Olefination Reaction including Wittig Reaction and Reaction of Ylides
5. Stereoelectronic Effects and Baldwin Rule
6. Cram Rule and Felkin-Anh Model
7. Radical Reaction and Cyclization
8. Protection of Functional Groups
9. Attend a seminor or a lecture
10. Drill problems on organic synthesis

準備学習 (予習・復習)等の内容と分量 Homework

Before a lecture, students have to learn basic organic reactions, such as oxidation, reduction, aldol reaction and Wittig reaction, and their mechanisms sufficiently.
After a lecture, students have to learn again organic transformations, their selectivities, and the reason why their selectivities can be realized, which are given in the lecture.

成績評価の基準と方法 Grading System

Examination (100%) (Senboku)
Attendance attitude (20%) and report (80%) (Ishiyama)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

教科書は使用しない。必要な資料は適宜配布する。

講義指定図書 Reading List

大学院講義有機化学 I　分子構造と反応・有機金属化学／野依良治他：東京化学同人, 1999
大学院講義有機化学 II　有機合成化学・生物有機化学／野依良治他：東京化学同人, 1998

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

For attending this course, general knowledge on organic chemistry should be needed.

科目名 Course Title	無機材料化学特論[Inorganic Materials Chemistry]		
講義題目 Subtitle			
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	HIGUCHI Mikio[HIGUCHI Mikio](工学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094063
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
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 5152		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Thin films, glass formation, powder preparation, sintering, microstructure and properties, Structural materials, Electric and electronic materials, Optical materials

授業の目標 Course Objectives

This course provides major processes for obtaining various ceramics such as thin films, powders, polycrystals, glasses and so on, which can efficiently yield the excellent property of each ceramic material and lead to practical usage. Additionally, important and close relationship between their physical and chemical properties and microstructure can be also understood. Students also learn the basic properties, production and future issues of ceramic materials, such as structural materials, electric and electronic materials, and optical materials which are particularly important among those produced industrially.

到達目標 Course Goals

1. Understanding of a basic relationship between a variety of functions of ceramics, material forms which can realize those excellent functions, and various processes for fabricating each ceramic with specified material form
2. Understanding of the features of the physical and chemical processes to produce functional ceramics and factors to be controlled in each process
3. Understanding various properties of ceramics such as brittleness, dielectric properties, electrical conduction, crystal optics and luminescence.
4. Understanding applications of ceramics to high strength and high toughness materials, piezoelectrics and ferroelectrics, semiconductors, polarizers, phosphors, scintillators and solid state laser materials.

授業計画 Course Schedule

1. Preparation of Ceramics by solution process
2. Preparation of thin films by solution processes
3. Preparation of thin films by CVD and PVD
4. Glass formation and crystallization
5. Ceramic powder synthesis from gas, liquid and solid phases
6. Sintering and microstructure control of ceramics
7. Surface morphology control of thin films
8. Midterm examination
9. Fracture mechanism of ceramics: brittle and delayed fractures, role of dislocations in fracture.
10. High strength and high toughness materials: partially stabilized zirconia, nitrides and carbides.
11. Ceramic dielectrics: classification of dielectrics on the basis of point group, pyroelectics and ferroelectrics.
12. Ceramic dielectrics: piezoelectrics.
13. Ceramic semiconductors: conduction mechanism in ionic materials, thermistors, gas sensors.
14. Crystal optics: reflection and refraction in anisotropic crystals, optically anisotropic materials for polarizers.
15. Luminescence materials: luminescencec mechanisms, phosphors, scintillators, solid state laser materials.
16. Examination.

準備学習 (予習・復習)等の内容と分量 Homework

Students are expected to read relevant contents in the text beforehand. After class, students are also requested to understand the lecture by reading additionally the related bibliography and solving problems provided there.

成績評価の基準と方法 Grading System

50%: reports, 50%: examination

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Sol-Gel Science: The Physics and Chemistry of Sol-Gel Processing／C.J. Brinker and G.W. Scherer：Academic Press, 1990
Synthesis of Inorganic Materials 2nd ed／U. Schubert and N. Husing：Wiley-VCH, 2004

Physical Ceramics –Principles for Ceramic Science and Engineering／Y-M. Chiang, D. Birnie III, and W. D. Kingery：John Wiley & Sons, 1997

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

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

備考 Additional Information

Basic understanding of Physical chemistry, Inorganic chemistry, Solid state chemistry and Inorganic materials chemistry is required.

科目名 Course Title	エネルギー材料特論[Materials for Energy Conversion and Storage]		
講義題目 Subtitle			
責任教員 Instructor	幅﨑　浩樹 [HABAZAKI Hiroki] (大学院工学研究院)		
担当教員 Other Instructors	KITANO Sho[KITANO Sho](工学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094064
期間 Semester	Summer	**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 5162		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Energy conversion, Energy storage, ionic conductivity, hydrogen storage, solar energy conversion

授業の目標 Course Objectives

Secondary batteries, solar cells and fuel cells are of importance for efficient energy conversion and storage in the 21st century. In this class students learn various functional materials, such as ion conductors, electrocatalysts and semiconductor materials, and their structural characteristics related to their functionality.

到達目標 Course Goals

- Understand the fundamentals of semiconductor electrode reactions, ion conduction in solid materials and hydrogen storage
- Get necessary knowledge on materials design for energy conversion and storage.

授業計画 Course Schedule

1. Materials for fuel cells: Characteristics of various fuel cells and materials used in the fuel cells will be discussed.
2. Semiconductor electrodes: Based on a band model, fundamentals of photoenergy conversion on semiconductor electrodes will be discussed.
3. Ion conductors: Structural design and mechanism of ion conduction in inorganic solids will be introduced and discussed.
4. Electrocatalysts: Structural and electronic design of electrocatalysts for hydrogen evolution and oxygen evolution/reduction will be introduced and discussed.
5. Presentations: Characteristics of several electrochemical energy storage and conversion devices and their materials will be presented by individual students and discussed.

準備学習（予習・復習）等の内容と分量 Homework

Students are requested to prepare presentations of specific topics allocated to each student.

成績評価の基準と方法 Grading System

Presentations (50%) and exam (50%)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

教科書は使用しない。必要に応じ，プリントを配布する。

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

備考 Additional Information

Students need basic knowledge on inorganic chemistry and electrochemistry. This class will be conducted online to avoid Covid-19 infection.

科目名 Course Title	応用生化学特論[Advanced Applied Biochemistry]		
講義題目 Subtitle			
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 Shinichiro (工学研究院), FUJITA Masahiro[FUJITA Masahiro](RIKEN)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094065
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 5171		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

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

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

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

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=G052

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	分子材料化学特論[Molecular Materials Chemistry]		
講義題目 Subtitle			
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	LI FENG[LI FENG](工学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094066
期間 Semester	Fall	**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 5182		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Polymer synthesis, architectural polymers, functional polymers, environmentally benign polymers

授業の目標 Course Objectives

Polymer materials are used in various fields from general-purpose to specialized applications, and the polymer properties are basically optimized by controlling the molecular weight, monomer composition, and so on for each application. However, especially in the cutting-edge fields, novel polymer materials having properties that are difficult to achieve at the same time are required, and the material design requirements are becoming much severe. Therefore, it is not easy to meet the demands from the modern society only with the material design guidelines based on the conventional knowledge. The goal of this courses to quire how to create novel polymer materials through learning various polymer materials, such block copolymers, architectural polymers, and environment-friendly polymers, from the perspective of their synthesis, structure, function, and application based on actual examples.

到達目標 Course Goals

The goal is to acquire methodologies for creating novel polymer materials required by future society through studying the latest topics related to block copolymers, architectural polymers, environment-friendly polymers, and so on.

授業計画 Course Schedule

1. Guidance and introduction
2. Block copolymers
3. Architectural polymers
4. Environment-friendly polymers
5. Functional polymer materials via advanced synthetic strategy
6. Report preparation

準備学習（予習・復習）等の内容と分量 Homework

Carefully reading handouts distributed in advance, if available.

成績評価の基準と方法 Grading System

Attendance of 70% or more of the number of class hours shall be the condition of the grade evaluation. The grade is evaluated by (1) attitude in the class (20%) and (2) the report assignments (80%).
To pass, students must earn at least 60 points out of 100 points.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

特に指定はない。授業時に資料を配付する。
Reference materials will be distributed as necessary.

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

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

備考 Additional Information

科目名 Course Title	化学計測学特論[Instrumentation Chemistry]		
講義題目 Subtitle			
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	2023	**時間割番号 Course Number**	094067
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 5191		
補足事項 Other Information			
授業実施方式 Class Method			

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

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=G057

研究室のホームページ Websites of Laboratory

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

備考 Additional Information

科目名 Course Title	科学倫理安全特論[Advanced Ethics and Safety for Science and Engineering]		
講義題目 Subtitle			
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	中川　浩行(京都大学)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094068
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 5210		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Engineering Ethics, Safety Engineering

授業の目標 Course Objectives

Students will learn fundamentals of ethics and safety engineering for scientists and engineers. In the ethics education, students will understand the influences and effects of science and technology on society and nature, and the responsibilities that scientists and engineers owes to the society. In safety education, students will learn risk avoidance, safety related laws and process safety design methods, through various examples. By understanding these, students will deepen the knowledge to take responsible judgments and actions, that are essential to be a self-independent scientist or engineer.

到達目標 Course Goals

By taking this course, students will be expected to

1. understand procedure to improve a process with consideration of safty, when a proces technology is introduced to the society to enrich the human society.
2. undestand ethics and morals as a scientist or engineer.

授業計画 Course Schedule

1. Basis of engineering ethics (2 periods)

Learn the idea of engineering ethics and role of scientists and engineers. Understand technique and structure for taking ethical behavior.

2. Safety engineering and process design (6 periods)

Understand the system of the safety engineering, the hazards caused by handled substances and risk control techniques, and the purpose and outline of safe assessment method.

Learn basis of process safety design.

準備学習 (予習・復習)等の内容と分量 Homework

Lecture materials will be distributed.

One credit for a lecture is given for 45 hours of study. Since the actual lecture is 90 minutes (counted as 2 hours) × 8 periods = 16 hours, the credit acquisition requires about 4 hours review per period. Keep in mind this point and review the lecture using the lecture materials.

成績評価の基準と方法 Grading System

For grade evaluation, students are required to attend all.

Grade will be evaluated by the degree of accomplishment based on the submitted assignment.

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

研究室のホームページ Websites of Laboratory

備考 Additional Information

Students who already got a credit of "Engineer ethics and safety" of Department of Applied Science and Engineering cannot take this lecture.

科目名 Course Title	総合化学特別研究[Laboratory Exercise in Chemical Sciences and Engineering I]		
講義題目 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	2023	**時間割番号 Course Number**	094091
期間 Semester	Full Year	**単位数 Number of Credits**	10
授業形態 Type of Class	Experiment	**対象年次 Year of Eligible Student**	1～2
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQUI 6302		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Chemical Sciences and Engineering, Master's thesis

授業の目標 Course Objectives

You will develop the ability to identify various problems in chemistry, solve them, and to conduct research. In addition, you will pursue research in individual fields under the guidance of instructors in order to acquire the ability to complete the achievements with excellent academic research papers.

到達目標 Course Goals

Complete Master's thesis.

授業計画 Course Schedule

Research under the guidance of supervisor(s). Please contact to your supervisor for specific research plan.

準備学習 (予習・復習)等の内容と分量 Homework

It takes a lot of time to conduct experiments, to analyze the data, to prepare for presentation, and to write a paper.

成績評価の基準と方法 Grading System

Submission of a master thesis is required. Evaluation is based on the thesis and daily activity in laboratory.

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

研究室のホームページ Websites of Laboratory

備考 Additional Information

Register this course at the semester of graduation.

科目名 Course Title	総合化学実験指導法[Laboratory Exercise in Chemical Sciences and Engineering II]		
講義題目 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	2023	**時間割番号 Course Number**	094092
期間 Semester	Full Year	**単位数 Number of Credits**	2
授業形態 Type of Class	Experiment	**対象年次 Year of Eligible Student**	1～2
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5302		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Teaching skills: teaching assistant

授業の目標 Course Objectives

Graduate students are requested to teach undergraduate-level laboratory experiments. This course examines how to gain teaching abilities and skills in conducting chemical experiments.

到達目標 Course Goals

Through the course, the students will be able to gain proper abilities and skills to teach undergraduate-level chemical experiments.

授業計画 Course Schedule

On the basis of evaluation of student's achievements, the course offers on-the-job-training to

- gain fundamental principle/knowledge on a given chemical experiment and abilities/skills to operate/conduct the experiment
- gain teaching abilities/skills to undergraduate-level students
- play leadership in teaching and laboratory experiments

準備学習 (予習・復習)等の内容と分量 Homework

Daily preparatory works for teaching

成績評価の基準と方法 Grading System

Evaluate based on daily achievements (50%) and seasonal reports (50%)

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

研究室のホームページ Websites of Laboratory

備考 Additional Information

Register this course at the semester of graduation.

科目名 Course Title	総合化学実験研究法[Laboratory Exercise in Chemical Sciences and Engineering III]		
講義題目 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	2023	**時間割番号 Course Number**	094093
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**	1～2
対象学科・クラス Eligible Department/Class			
ナンバリングコード Numbering Code	CHEM_REQEL 5312		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Experimental skills: Teaching skills: Presentation skills

授業の目標 Course Objectives

Students are requested to gain proper knowledges and experiences on various chemical experiments and to manage his/her scientific research. This course examines how to manage various chemical research and to present student's achievements in both Japanese and English.

到達目標 Course Goals

Through the course, students will be able to

- gain experimental and presentation skills/abilities
- play leadership in research works

授業計画 Course Schedule

On the basis of evaluating student's achievements, the course offers the on-the-job-training to

- understand fundamental principles of chemical experiments
- gain experiences in chemical experiments
- gain presentation abilities/skills in both Japanese and English
- play leadership in each research fields

準備学習 (予習・復習)等の内容と分量 Homework

Daily preparatory works on laboratory experiments

成績評価の基準と方法 Grading System

Evaluate based on daily achievements (50%) and seasonal reports (50%)

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

研究室のホームページ Websites of Laboratory

備考 Additional Information

Register this course at the semester of graduation.

科目名 Course Title	分子化学(先端物理化学)[Molecular Chemistry (Advanced Physical Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	村越　敬 [MURAKOSHI Kei] (大学院理学研究院)		
担当教員 Other Instructors	FUKUSHIMA Tomohiro[FUKUSHIMA Tomohiro](理学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094101
期間 Semester	Fall	**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_ELMOL 6002		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Electronic structures, Surface electronic structure, Surface morphology, Surface spectroscopy, Catalysis

授業の目標 Course Objectives

Physical and chemical phenomena such as adsorption and catalytic reaction occur at the solid surface due to the interaction between molecules and solids. Learn basic knowledge and latest research to understand these fundamental chemical properties.

到達目標 Course Goals

Understand the intermolecular force and the structure and electronic state of the solid surface. Understand the origin of the unique physical properties of the surface / interface. In addition, we also acquire basic knowledge on advanced nanostructure analysis methods to understand surface science from physicochemical point of view.

授業計画 Course Schedule

(1) Structure and electronic state of solid surface
(2) Foundations of atomic and intermolecular forces
(3) Outline of the latest surface / interface evaluation method (atomic force microscope, scanning tunneling microscope, etc.)

準備学習 (予習・復習)等の内容と分量 Homework

Homework will be handed out in the class.

成績評価の基準と方法 Grading System

Grading will be evaluated based on attendance and homeworks.

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

研究室のホームページ Websites of Laboratory

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

備考 Additional Information

科目名 Course Title	分子化学(有機構造化学特論)[Molecular Chemistry (Structural and Physical Organic Chemistry)]		
講義題目 Subtitle			
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			
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094102
期間 Semester	Winter	**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_ELMOL 6000		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Structural Organic Chemistry

授業の目標 Course Objectives

Various functions of materials can be derived by proper designing organic pi-electron systems. This course will provide students with the two of the important concepts which are necessary to comprehend this area of organic chemistry.

到達目標 Course Goals

Students will learn the background and basic idea to understand the various intriguing phenomena in the functionalized organic pi-electron systems/organic solids.

授業計画 Course Schedule

Two major topics are as follows:

1) "Disappearance of polymorphs": Intriguing behavior of crystallizaion, rapid/reluctant phase transition of crystalline materials

2) "Orbital interaction through bonds/through space": extremely long C-C bond, X-ray structural analysis, theoretically optimized structure

The class instruction will be done in Japanese.

準備学習(予習・復習)等の内容と分量 Homework

Printed material will be handed out in the class

成績評価の基準と方法 Grading System

Presentations and 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

構造有機化学　基礎から物性へのアプローチまで／中筋　一弘:東京化学同人, 2020

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	分子化学(高分子機能科学)[Molecular Chemistry (Macromolecular Science)]		
講義題目 Subtitle			
責任教員 Instructor	中野　環 [NAKANO Tamaki] (触媒科学研究所)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094103
期間 Semester	Summer	**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_ELMOL 6002		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Polymer, Stereochemistry, Stereoregular, Conformation, Optically Active, Chirality, Helix

授業の目標 Course Objectives

Synthesis, structure, and properties (functions) of various polymers will be introduced. A focus will be on polymer chirality. In order to understand the basic and advanced concepts of polymer stereochemistry, we will discuss examples of polymers and related small molecules.

到達目標 Course Goals

Students aim to learn basic and advanced concepts of synthesis, structure and properties of polymers. In addition, they understand chirality of compounds including its nature, nomenculature, and application, further extend the chirality concept to polymers, and obtain deeper insights on relation between polymers' chiral functions and their chiral structures.

授業計画 Course Schedule

Beginning from the basis aspects of polymer synthesis and its classification, we discuss polymer structure and functions with an emphasis on chirality. The planned contents are as follows:

1. Basics of polymer science (1)
2. History of polymer science (1)
3. Polymer structure: structural features unique to polymers such as mola mass dispersity, tacticity (stereoregularity), and helicity. Nomenclature, classification, and analytical methodologies (2)
4. Synthesis of chiral polymers: asymmetric polymerization (2)
5. Functions of chiral polymers: structure-property relations (2)

準備学習 (予習・復習)等の内容と分量 Homework

Students are asked to read through literature relevant to polymer synthesis and polymer chirality and summarize the points they wish to discuss in the class. After each class, they are asked to find and read newest journal articles that are related to the contents of class teaching and discussions.

成績評価の基準と方法 Grading System

Evaluation will be conducted based on report papers submitted after all planned class teaching is finished, interim exam(s), and also on attitude toward learning.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Polymer Chemistry: An Introduction (3rd Ed.)／Malcom P. Stevens：Oxford, 1999
高分子化学入門／蒲池幹治：NTS, 2009
大学院高分子科学／野瀬卓平、中浜精一、宮田清蔵：講談社, 1997

講義指定図書 Reading List

pi-Stacked Polymers and Molecules／T. Nakano Ed.：Springer, 2014
Stereochemistry of Organic Compounds／E. L. Eliel, S. H. Wilen：Wiley, 1994
NMR Spectroscopy of Polymers／K. Hatada, T. Kitayama：Springer, 2004
Macromolecular Design of Polymeric Materials／K. Hatada, T. Kitayama, O. Vogl：Dekker, 1997
Protein Structure and Function／G. A. Petsko, D. Ringe：New Science Press, 2004
Circular Dichroism／N. Berova, K. Nakahishi, R. W. Woody：Wiley-VCH, 2000

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

http://polymer.cat.hokudai.ac.jp/index-e.html

備考 Additional Information

科目名 Course Title	分子化学(物質変換化学)[Molecular Chemistry (Catalytic Transformation)]		
講義題目 Subtitle			
責任教員 Instructor	福岡　淳 [FUKUOKA Atsushi] (触媒科学研究所)		
担当教員 Other Instructors	HASEGAWA Junya[HASEGAWA Junya](触媒科学研究所), SHROTRI ABHIJIT[SHROTRI ABHIJIT](触媒科学研究所)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094104
期間 Semester	Winter	**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_ELMOL 6002		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Catalysis, catalytic chemistry, effective utilization of resources, environmental issues, green chemistry

授業の目標 Course Objectives

Catalysts are key materials for the effective utilization of resources and energy and for the resolution of environmental issues. In this course, you will learn the fundamentals of catalytic chemistry such as adsorption, kinetics, characterization and green chemistry. You will also learn the examples of homogeneous, heterogeneous and enzymatic catalysts as well as the catalysis design for green chemistry. Use of computer in catalytic research is also included. You will make a presentation of the allocated chapter with a handout.

到達目標 Course Goals

First you assume equilibrium and a rate-determining step for each elementary step, and then you will build a catalytic cycle and derive a reaction rate. You will understand the characteristics of homogeneous, heterogeneous and enzymatic catalysts. The principles and applications of catalyst characterization will be shown to extend the methods to your own research. You will learn the numerical conversion of environmental load in catalytic reactions and understand the necessity of green chemistry for environmental protection.

授業計画 Course Schedule

In this course, a textbook in English will be used. Each chapter will be allocated to a student to make a presentation.

1. Introduction, definition of catalyst, concept of green chemistry, how to quantify the environmental load, various kinds of catalysts
2. How to express reaction rate, activation energy, reaction order, the Langmuir-Hinshelwood mechanism, steady-state approximation
3. The Michaelis-Menten mechanism, consecutive and parallel first-order reaction, pre-equilibrium, initial reaction rates, volcano-shaped pattern, catalyst deactivation
4. Homogeneous catalysis, elementary steps, electronic and steric effects of ligands
5. Asymmetric catalysis, industrial processes with homogeneous catalysts, homogeneous catalysis without metals
6. Heterogeneous catalysis, active sites, promoters and poisons
7. Catalyst characterization, catalyst preparation, reactors, biphasic reactions, industrial processes with heterogeneous catalysts
8. Enzymatic reactions, active sites and substrate binding models, proximity effects, reaction mechanism, applications of enzyme catalysis, non-enzymatic biocatalysis, industrial processes with enzymes

準備学習 (予習・復習)等の内容と分量 Homework

Students are requested to read the chapter of textbook in advance. Each chapter will be allocated to a student who should

成績評価の基準と方法 Grading System

Presentation and reports

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Catalysis-Concepts and Green Applications／Gadi Rothenberg：Wiley-VCH, 2017

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

備考 Additional Information

科目名 Course Title	分子化学(光化学)[Molecular Chemistry (Photochemistry)]		
講義題目 Subtitle			
責任教員 Instructor	上野　貢生 [UENO Kosei] (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	2023	**時間割番号 Course Number**	094105
期間 Semester	Spring	**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_ELMOL 6002		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Electronically Excited State: Fluorescence/Phosphorescence: Nonradiative Processes: Photophysical Processes: Photochemical Reactions: Spectroscopy

授業の目標 Course Objectives

Characteristics of the excited state of molecules and the physicochemical processes from the excited states which are the basis of photochemistry of organic molecules are studied.

到達目標 Course Goals

Characteristics of photochemical reactions and physicochemical phenomena are studied by learning the nature of the electronically excited state of the molecules and various physicochemical processes from the excited states. Principles and usage of related spectroscopy are also learned.

授業計画 Course Schedule

This course describes photochemical and photophysical processes of organic compounds. Fundamental background of photochemical experiments is also described. The main topics of the course is as follows.
1) Photochemistry in chemistry 2) Excited singlet and triplet states 3) Radiative (fluorescence/phosphorescence) and nonradiative processes (internal conversion/intersystem crossing) 4) Characteristics of absorption and emission (fluorescence/phosphorescence) spectra and physicochemical information obtained from spectrum measurements 5) Spectroscopic measurement methods: emission spectrum, emission yield, lifetime, and dynamics of photochemical processes 6) Photochemical reactions 7) Photo-induced electron transfer 8) State-of-the-art of photochemical researches

準備学習 (予習・復習)等の内容と分量 Homework

It is desirable to take basic courses on physical chemistry and instrumental methods in analytical chemistry at the undergraduate school.

成績評価の基準と方法 Grading System

Assignments in classes (30 %), attitude to learning in classes (20 %), and term-end report (homework) (50 %)

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

研究室のホームページ Websites of Laboratory

https://wwwchem.sci.hokudai.ac.jp/~bunseki/

備考 Additional Information

Recommended textbook 1) "Principles of Molecular Photochemistry: An Introduction", N. J. Turro et al., University Science Books, 2009. 2)「光化学 I」, 井上晴夫他著, 丸善, 1999.

科目名 Course Title	分子化学(化学反応創成学特論)[Molecular Chemistry (Advanced Chemical Reaction Design and Discovery)]		
講義題目 Subtitle			
責任教員 Instructor	陳　旻究 [JIN Mingoo] (創成研究機構化学反応創成研究拠点)		
担当教員 Other Instructors	Min Gao[Min Gao], HUANG Chung-Yang[HUANG Chung-Yang], SIDOROV Pavel[SIDOROV Pavel], AKAMA Tomoko[AKAMA Tomoko], LIST Benjamin[LIST Benjamin]		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094106
期間 Semester	Fall	**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_ELMOL 6201		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Design of Chemical reaction and molecular assembly with functions, Chemoinformatics, Computational Chemistry

授業の目標 Course Objectives

This course introduces a brand-new research way for investigating molecular chemistry. Especially, advanced examples of the design of new chemical reactions and molecular assembly systems with photo-physical functions will be gently introduced, and the methodology for these research subjects will be described. Also, the advanced level of computational chemistry and chemoinformatics to solve chemical problems will be introduced. Totally four sessions will be delivered to introduce these contents.

1. Advanced course: Introducing Photocontrol to Molecular Systems:
In these lectures, we will describe technologies that allow researchers to control the molecular systems by light and photochemical methods. Specifically, the course will focus on photoredox catalysis and photoswitches.

2. Design of Molecular Dynamics in Crystals and Evaluation Methodology:
In this session, molecular dynamics in crystalline media will be described with recent research. Especially, crystalline molecular rotors system will be focused as well as how to investigate the molecular motion in solid state.

3. Chemoinformatics in advanced topics:
The class covers the advanced topics in the field of chemoinformatics. Chemoinformatics provides useful tools for chemical search, rational design of compounds with desired properties, synthesis prediction, etc. This part is dedicated to topics such as representation of chemical reactions and modeling their properties, as well as current machine learning techniques, focusing on Deep Learning.

4. Advanced Course for Computational Catalysis
The lectures related to advanced computational catalysis are aimed to deeply understand how does the computational chemistry establish catalytic concept and how computational results explain experimental phenomena of catalytic reactions.

到達目標 Course Goals

The main goal of this course is ″Knowing the molecular chemistry research fields with experimental and computational methodologies″.
Especially, students will know ″the photoredox catalysis and photoswitches on molecular system″, ″the basic ideas to design molecular dynamics in crystal″, ″Chemical reaction in Chemoinformatics with current machine learning techniques″ and ″Applications in Computational Catalysis″.

授業計画 Course Schedule

The entire course contains four sessions as below;

1. Advanced course: Introducing Photocontrol to Molecular Systems:
・ Photoredox Catalysis
・ Photoswitches

2. Design of Molecular Dynamics in Crystals and Evaluation Methodology:
・ General Introduction of Crystalline Molecular Rotors and Structural Design
・ Application and Evaluation for the Molecular Motions in solid state

3. Chemoinformatics in advanced topics:
・ Chemical reactions in Chemoinformatics;

・ Current machine learning techniques.

4. Advanced Course for Computational Catalysis:
・ Applications in Computational Catalysis
・ Challenges in Computational Catalysis

準備学習（予習・復習）等の内容と分量 Homework

Basic knowledge of chemistry at the undergraduate level might be required. And, the students who got the introduction course (化学反応創成学入門: CHEM_ELCOM 5271) would be encouraged to have this advanced course to boost their skills.

成績評価の基準と方法 Grading System

We will give a take-home exam with several open-answer questions for each session, that students have to submit before some deadline.

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

研究室のホームページ Websites of Laboratory

https://www.icredd.hokudai.ac.jp/all-members/the-huang-lab
https://www.icredd.hokudai.ac.jp/the-jin-group
https://www.icredd.hokudai.ac.jp/the-sidorov-group
https://www.icredd.hokudai.ac.jp/the-gao-group

備考 Additional Information

科目名 Course Title	分子化学A(分子理論化学)[Molecular Chemistry A (Theoretical Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	武次　徹也 [TAKETSUGU Tetsuya] (大学院理学研究院)		
担当教員 Other Instructors	HASEGAWA Junya[HASEGAWA Junya](触媒科学研究所), MAEDA Satoshi[MAEDA Satoshi](理学研究院), IIDA Kenji[IIDA Kenji](触媒科学研究所), KOBAYASHI Masato[KOBAYASHI Masato](理学研究院), IWASA Takeshi[IWASA Takeshi](理学研究院), HARABUCHI Yu[HARABUCHI Yu](理学研究院), Min Gao[Min Gao]		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094107
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
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_ELMOL 6012		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Schroedinger equation, molecular orbital, Hartree-Fock theory, multiconfigurational self-consistent field theory, density functional theory, potential energy surface, geometry optimization, intrinsic reaction coordinate, Born-Oppenheimer approximation, Rotational-vibrational state, Reaction dynamics

授業の目標 Course Objectives

This course aims to provide elementary ideas and concepts in quantum chemistry. First, the basics of the electronic structure theory will be addressed. Second, potential energy surface will be explained. Third, reaction-path-based dynamics, molecular vibrational theory, reaction dynamics, and theoretical approaches to condensed phases will be given to learn the methodology in modern computational chemistry.

到達目標 Course Goals

Students are expected to understand the basic concepts in electronic structure theory, such as Schroedinger equation, wave function, molecular orbital, angular momentum, Hartree-Fock theory, multi-configurational self-consistent field theory, density functional theory. Students are also expected to achieve the basic ideas on the potential energy surface to understand the mechanism of chemical reactions and reaction dynamics, such as potential energy surface, geometry optimization, intrinsic reaction coordinate, and reaction path dynamics. As a result, students understand

1. Scientific papers that describes quantum chemical computations of electronic structures and chemical reactions
2. Knowledges to design, perform, and understand the result of quantum chemical calculations

授業計画 Course Schedule

1. Schroedinger equation, Hydrogen atom, Angular momentum
2. Slater determinant, Molecular orbitals
3. Hartree-Fock theory
4. Electron correlations, Density functional theory
5. Potential energy surface, Vibrational analysis, Geometry optimization
6. Transition state, Intrinsic reaction coordinate
7. Born-Oppenheimer approximation
8. Theory of molecular vibration and rotation
9. Reaction Path dynamics
10. Transition state theory
11. Ab initio Molecular dynamics approach

準備学習 (予習・復習)等の内容と分量 Homework

Students are expected to derivate the equations introduced in the class and to solve some exercises.

成績評価の基準と方法 Grading System

The attitude at the lecture (30%) and report scores (70%) are evaluated.

テキスト・教科書 Textbooks

講義指定図書 Reading List

分子理論の展開／永瀬茂、平尾公彦:岩波書店, 2002

新版 すぐできる　量子化学計算ビギナーズマニュアル／平尾公彦(監修)、武次徹也(編集):講談社サイエンティフィク, 2015

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	分子化学A(有機金属化学)[Molecular Chemistry A (Organometallic Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	澤村　正也 [SAWAMURA Masaya] (大学院理学研究院)		
担当教員 Other Instructors	ITOH Hajime[ITOH Hajime](工学研究院), SHIMIZU Yohei[SHIMIZU Yohei](理学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094108
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
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_ELMOL 6212		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Organometallic Chemistry, Catalysts for Organic Synthesis, Design of Reactions, Mechanisms of Organometallic Reactions, Structures of Organometallic Complexes, Asymmetric Synthesis, Hydrogenation, Cross-coupling

授業の目標 Course Objectives

Spring Term: Objectives of this course is to acquire the basis for designing new metal-catalyzed organic reactions. To this end, students learn that organometallic chemistry is playing important roles to solve problems in synthetic organic chemistry in various aspects and gain a systematic understanding on how organometallic complexes participate in organic reactions.

Summer Term: This course is intended to familiarize the student with advanced concepts in organometallic chemistry. This course mainly focuses on the organic synthetic reactions where the transition-metal-catalyzed process is a key step.

到達目標 Course Goals

Spring Term: The goal of this course is understand various modes of metal?carbon bonds and their reactivities in a systematic way based on molecular orbital considerations.

Summer Term: The goal of this course is to provide graduate students with comprehensive understandings of organometallic chemistry. Students will be familiar with various transition-metal-catalyzed reactions, reaction mechanisms, application of catalysis, basic concept of catalyst design.

授業計画 Course Schedule

Spring Term: The course goes forward along the recommended reading (Hegedus, Chapter 1, Chapter 2, Chapter 9).

Summer Term:
1. Synthetic Applications of Transition Metal Hydrides I
2. Synthetic Applications of Transition Metal Hydrides II
3. Synthetic Applications of Complexes Containing Metal-Carbon sigma-Bonds I
4. Synthetic Applications of Complexes Containing Metal-Carbon sigma-Bonds II
5. Synthetic Applications of Complexes Containing Metal-Carbon sigma-Bonds III
6. Synthetic Applications of Transition Metal Carbene Complexes
7. Synthetic Applications of Transition Metal Carbene Complexes II

準備学習 (予習・復習)等の内容と分量 Homework

Students will be expected to have read the assigned materials prior to each class period.

成績評価の基準と方法 Grading System

Attendence rate over 70% is mandatory.
Spring Term: Evaluation is performed based on the score of final exam.
Summer Term: Midterm (30%) and final exam (70%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

ヘゲダス遷移金属による有機合成　第3版／L. S. Hegedus 著・村井真二訳：東京化学同人, 2011

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

http://wwwchem.sci.hokudai.ac.jp/~orgmet/index.php?id=25
http://labs.eng.hokudai.ac.jp/labo/organoelement/
https://www.icredd.hokudai.ac.jp

備考 Additional Information

It is advisable to take all lectures and experiments on organic chemistry in the undergraduate study.

Moodle in ELMS will be used in case of distance learning.

科目名 Course Title	応用分子化学(化学エネルギー変換)[Applied Molecular Chemistry (Chemical Energy Conversion)]		
講義題目 Subtitle			
責任教員 Instructor	坪内 直人 [TSUBOUCHI Naoto] (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	2023	**時間割番号 Course Number**	094109
期間 Semester	Winter	**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_ELMOL 6102		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Material Balance, Enthalpy Balance, Chemical Equilibrium, Reaction Rate, Combustion, Steam Reforming, Energy Efficiency, Cold Gas Efficiency, Heat Loss

授業の目標 Course Objectives

About 80% of total primary energy supply depends on oil, coal and natural gas, and this dependency will be almost unchanged in the not-too-distant future according to a recent IEA (International Energy Agency) world energy outlook. It is thus probable that ultimately-efficient utilization of fossil fuels is the best way to reduce CO2 emissions in a carbon-constrained economy. This course will provide students with basic theories about chemical energy conversion systems of organic resources through the designing of an adiabatic fixed bed reformer for methane steam reforming.

到達目標 Course Goals

・Understand the fundamentals of chemical reaction engineering, such as material balance, enthalpy balance, chemical equilibrium and reaction rate.
・Eluciate methane steam reforming in a fixed bed reformer at adiabatic conditions.

All students are also required to present and discuss their own research subjects from a view of reactor designing.

授業計画 Course Schedule

1. Fundamentals of chemical reactor theory: Material balance calculation method
2. Fundamentals of chemical reactor theory: Enthalpy balance calculation method
3. Fundamentals of chemical reactor theory: Chemical equilibrium calculation method
4. Fundamentals of chemical reactor theory: Reaction rate calculation method
5. Simulation of properties of an adiabatic fixed bed reformer: Steam reforming and combustion of methane
6. Simulator development: Homogeneous gas phase reaction, gas-solid reaction, gas-solid catalytic reaction

準備学習 (予習・復習)等の内容と分量 Homework

Students are expected to read relevant contents in the text beforehand. After class, students are also requested to understand the lecture by reading additionally the related bibliography and solving problems provided there.

成績評価の基準と方法 Grading System

Grades are awarded based on regular assignments, presentation and discussion in the class.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

教科書は特に指定せず, Lecture 時にプリントを配布する。
Handout made by the instructor will be delivered.

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://chemeng-hokudai.jp/en/

備考 Additional Information

Students are required to understand the basic knowledge of related Chemical Engineering Stoichiometry, Thermodynamics and Reaction Kinetics in advance.

科目名 Course Title	応用分子化学(分離プロセス工学Ⅰ)[Applied Molecular Chemistry (Separation Process Engineering I)]		
講義題目 Subtitle			
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	2023	**時間割番号 Course Number**	094110
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_ELMOL 6101		
補足事項 Other Information			
授業実施方式 Class Method			

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, Langmiur 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

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=G064

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	応用分子化学(分離プロセス工学Ⅱ)[Applied Molecular Chemistry (Separation Process Engineering II)]		
講義題目 Subtitle			
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	2023	**時間割番号 Course Number**	094111
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_ELMOL 6101		
補足事項 Other Information			
授業実施方式 Class Method			

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 (including statistical 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 (I-chapter 1, II-chapter 1$2)
2. Thermodynamics and transport phenomena relevant to separation processes (I-chapter 2&3)
3. Adsorption process (I-chapter 15)
4. Case study 1: water filter (II-chapter 5)
5. Case study 2: waste-water treatment (I-chapter 15, II-chapter 5)
6. Membrane separation process (I-chapter 14)
7. Case study 3: reverse osmosis membrane unit (II-chapter 5)
8. Project(*)

*Invited lecture on membrane separation processes
(Remarks) I:textbook #1, II:textbook #2

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

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 and homework scores (30%) and final project scores (50%). Quizzes and homework will be used to evaluate the level of understanding of each class and to aid understanding on separation principles, and the final project will be used to evaluate the applied skills.

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=G065

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	応用分子化学A(触媒設計)[Applied Molecular Chemistry A (Catalyst Design)]		
講義題目 Subtitle			
責任教員 Instructor	清水　研一 [SHIMIZU Kenichi] (触媒科学研究所)		
担当教員 Other Instructors	TOYAO Takashi[TOYAO Takashi](触媒科学研究所)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094113
期間 Semester	Fall/Winter	**単位数 Number of Credits**	2
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_ELMOL 6112		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Catalysis, surface chemistry, environmental catalysis, kinetics, industrial chemistry

授業の目標 Course Objectives

To understand recent research on the mechanism and design concept of heterogeneous catalysts, students should understand surface spectroscopy and physical chemistry. The goal of this lecture is to understand spectroscopy, kinetics and thermodynamics in terms of catalysis and use these basic knowledge for catalyst design and catalysis research. In addition, we discuss design concept and practical role of heterogeneous catalysis in current catalytic processes for automotive emission control and organic synthesis.

到達目標 Course Goals

Exercises for understanding spectroscopy, kinetics and thermodynamics in terms of catalysis. Application of the knowledge to understand recent catalytic research and presentation on it. We will also learn important catalytic processes in petroleum refining, petrochemical industry, and emission control. In the presentation, students explain the role of the catalysis in the energy and environment technologies. Presentation techniques of students will be improved.

授業計画 Course Schedule

1. Geometry of solid surface
2. Evaluation of catalytic activity
3. Characterization of catalyst I
4. Characterization of catalyst II
5. Design of solid catalyst
6. Catalyst preparation
7. Computational chemistry for catalysis
8. Intermediate exam
9. Environmental catalysis
10. Catalysis for fossil fuel conversions
11. Catalysis for industrial production of chemicals
12. Catalysis for green chemistry
13. Presentation
14. Presentation
15. Final exam

準備学習 (予習・復習)等の内容と分量 Homework

For the former-half lectures, PDF files to be used in the lectures are uploaded in ELMS prior to each lecture. Attendee must print and bring it for each lecture. Students should understand basic physical chemistry, reading textbooks. Using scientific electronic calculator, students' laptop, they solve kinetic problems, draw solid surface and create a presentation file.

成績評価の基準と方法 Grading System

Intermediate exam (50%), final exam (20%), the number of questions in the latter-half (30%)

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

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	物質化学(固体物性化学)[Materials Chemistry (Organic Solid State Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	原田　潤 [HARADA Jun] (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	2023	**時間割番号 Course Number**	094201
期間 Semester	Spring	**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_ELMAT 6002		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

molecular materials, crystal structures, symmetry, intermolecular interactions, charge-transfer interactions, hydrogen bonding, band structures, electrical conductivity, solid-state reactions, molecular motions

授業の目標 Course Objectives

This course deals with the chemistry of solid-state materials, which are aggregates of molecules and atoms. In this course, you can learn the relationship between intermolecular interactions and the structures/functions/physical properties of molecular crystals. You can also learn how crystal and electronic structures of molecular materials are related to their physical properties and how molecular motions and reactions in crystals can be understood in terms of crystal structures.

到達目標 Course Goals

After successful completion of this course, you will be able to

1. Understand the principles by which molecular crystals are constructed.
2. Understand the relationship between structural features of molecular crystals and their physical properties, molecular motions, and reactivities.
3. Acquire basic idea of functional material design: from molecular design to crystal design.

授業計画 Course Schedule

The following topics will be lectured in order:

1. Molecular structures and symmetry of crystals

The relationship between the shapes of molecules and the structure/symmetry of their crystals will be discussed.

2. Intermolecular interactions and molecular arrangements in crystals

The influence of charge-transfer interaction and hydrogen bonding on crystal structures will be discussed. Guidelines for controlling the molecular arrangement will be presented.

3. Electronic structures of molecular crystals

The electronic structures (band structures) of radical crystals will be discussed. Neutral-to-ionic transitions and formal charges of component molecules in charge-transfer complex crystals will be explained.

4. Chemical reactions and molecular motions in crystals

Chemical reactions and molecular motions in crystals will be illustrated and explained in terms of the crystal structures.

準備学習 (予習・復習)等の内容と分量 Homework

You are expected to have basic knowledge of physical chemistry and need to review it beforehand. Reports will be assigned.

成績評価の基準と方法 Grading System

Unless there are special circumstances, more than 70% class attendance is required for the grade evaluation. The grade will be evaluated based on the reports assigned during the 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

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	物質化学(ナノフォトニクス材料論)[Materials Chemistry (Nano-Photonics Materials)]		
講義題目 Subtitle			
責任教員 Instructor	松尾　保孝 [MATSUO Yasutaka] (電子科学研究所附属グリーンナノテクノロジー研究センター)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094202
期間 Semester	Summer	**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_ELMAT 6002		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Photonic Materials, Photonic devices, Subwavelength Optics, Plasmonics, Optical wave Analysis, Nanofabrication, Nano spectroscopy, Electron microscopy

授業の目標 Course Objectives

The purpose of this lecture is to understand the relationships between functions and structures of several materials and devices. Especially, this lecture focuses on the fabrication and analysis of photonics materials and their applications to information network and digital appliances.

到達目標 Course Goals

1. Understanding on the relation between electronic structure and photonic function of several nanophotonic materials and devices.
2. Understanding on oxide-based photonic materials and metal−based plasmonic materials from the aspect of electronic structures, interactions between photon and electron, optical wave propagation.

授業計画 Course Schedule

This lecture will review the photoncs materials, the device applications, and the engineering innovations in the avanced information society.
(1) Photonic materials
(2) Fundanentals on refraction, diffraction and interference,
(3) Optical communication devices and materials using optical diffraction
(4) Phtonic devices using optical phase.
(5) Plasmonics and its application for analysis
(6) Fabricaton methods of Photonic devices and Plasmonic devices
(7) Optical spectroscopy for device analysis
(8) Structure analysis of photonic devices by electron beam

準備学習 (予習・復習)等の内容と分量 Homework

The outline can be understood from the deliverd documents in each lectures.
The report works will be given at end of each section.

成績評価の基準と方法 Grading System

As a general rule, attendance of 70% or more of the lectures is a condition for the evaluation.
The evaluation is based on the total score of the mini-examination for each lecture.

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

回折光学入門／応用物理学会日本光学会:オプトロニクス社
第ニ版　応用光学　光計測入門／谷田貝豊彦:丸善
光エレクトロニクス入門／西原浩、裏升吾:コロナ社

参照ホームページ Websites

https://www.es.hokudai.ac.jp

研究室のホームページ Websites of Laboratory

https://www.es.hokudai.ac.jp/english/

備考 Additional Information

When you want to study the fundamental of optics including lens, grating, hologram, or you use optical microscope or laser, feel free to attend this lecture.

科目名 Course Title	物質化学(材料化学)[Materials Chemistry (Introduction to Material Science)]		
講義題目 Subtitle			
責任教員 Instructor	髙橋　啓介 [TAKAHASHI Keisuke] (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	2023	**時間割番号 Course Number**	094203
期間 Semester	Fall	**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_ELMAT 6001		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Material science, Atomic structure, Defect, Diffusion, Dislocation, Processing, Properties

授業の目標 Course Objectives

Provide an introduction to the basic concepts and principles involved in the description, evolution, and characterization of multi-length scale structure in materials systems. Develop an appreciation for the link between these issues, their manipulation through material formulation and processing, and the resulting material properties and performance.

到達目標 Course Goals

(1) Develop an understanding of the nature and the structure of atoms.
(2) Develop an understanding of the nature of different bonding types in solids.
(3) Develop an understanding of specific properties of solids and their relationship to the nature of bonding and structure of solid materials.
(4) Develop an understanding of periodic crystalline structures and their experimental determination.
(5) Develop an understanding of materials properties

授業計画 Course Schedule

Introduction/Materials classifications
Atomic structure and bonding
Crystalline structure and description
Imperfections in material structure
Solid-state diffusion in materials
Properties of Material
Processing

準備学習 (予習・復習)等の内容と分量 Homework

Class lectures will be based on assigned textbooks and literature, and students are required to read the assigned chapters before attending lectures.

成績評価の基準と方法 Grading System

Class attendance and discussion participation will account for 20% of the overall class grade.
A final exam will also be held and will account for 80% of the overall class grade.

Grades will be awarded using the following distribution:
A(100-90), B(89-80), C(79-70) D(69-60), F(Below 60)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Callister's Materials Science and Engineering, 10th Edition, Global Edition／William D. Callister Jr., David G. Rethwisch: Wiley, 2020

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://takahashigroup.github.io/

備考 Additional Information

科目名 Course Title	物質化学(現代化学反応理論)[Materials Chemistry (Advanced Chemical Reaction Rate Theory)]		
講義題目 Subtitle			
責任教員 Instructor	小松﨑 民樹 [KOMATSUZAKI Tamiki](電子科学研究所 附属社会創造数学研究センター)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094204
期間 Semester	Winter	**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_ELMAT 6002		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

chemical reactions, nonequilibrium, collective motion, dynamical systems theory, machine learning, AI

授業の目標 Course Objectives

Chemical reactions inevitable for maintaining living systems correspond to the change of rearrangement of atoms constituting molecules. Even though the corresponding scale differs from that of the molecular level at the order of 10^20, the motion of the planets in our universe is also regarded as that of molecules at the same footing. However, because the motions of particles are interacting with each other in complicated fashions nonlinearly, the prediction of the future is apparently almost impossible due to arbitrary small uncertainty at the initial condition. People will understand that mathematical science enables us to provide a special route in the phase space along which one can predict the fate of reactions, and actually is utilized for controlling reactions and designing a route of a spacecraft to travel different plants with the minimum cost.

到達目標 Course Goals

We will understand the motion of particles from the viewpoint of the geometry of the phase space composed of the coordinates and the conjugate momenta of particles. We will understand the history of the development of chemical reaction theories from the viewpoint of not chemistry but Hamiltonian systems, and learn a set of problems forgotten in the history of chemistry. Then, we learn the so-called normal form and that even under the existence of chaos there exists a deterministic regularized route in the phase space. We will learn the question of whether such deterministic regularized route exists or not will shed light on the question of why reactions occur, i.e., chance and necessity of the changes, which has been asked from the day of alchemy. Furthermore, we will learn the applications of quantum computing and machine learning to chemical reaction design and discovery.

授業計画 Course Schedule

The lecture will be organized for students who have not learned chemical reactions theory and Hamiltonian dynamical systems more than Newton's law.

We will take an ample of time to accept questions from students and ask students to write a short report on which you must write what you learned at each lecture and what the most difficult to follow were.

0: An overview of the history of chemical reactions: from dynamical system viewpoint.

1: Universal chemical reaction theories based on high-dimensional phase space geometry

2: Breakdown of normally hyperbolic invariant manifolds: alternation of degree of freedom between reactive and nonreactive degrees of freedom

3: Reinforcement learning on chemical reaction design and discovery

4: Quantum Computing on chemical reaction design and discovery

準備学習 (予習・復習)等の内容と分量 Homework

I make a timeslot of Q&A, and ask a report to write any questions he/she feel during each lecture.

成績評価の基準と方法 Grading System

Grading is mainly based on the report on the exercises that were given in the class, and based on activity (how much he/she made questions as a report) in a class as well.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

I do not supply any books, but hope that all students learn how the interdisciplinary research between chemistry and mathematics is potentially deeper than the design of a spacecraft pathway, and that students actively imagine and dig what type of new research may exist in between chemical reactions and the other research arena.

講義指定図書 Reading List

参照ホームページ Websites

http://mlns.es.hokudai.ac.jp/

研究室のホームページ Websites of Laboratory

http://mlns.es.hokudai.ac.jp/

備考 Additional Information

科目名 Course Title	物質化学A(ナノ物質化学)[Materials Chemistry A (Mesoscopic Material Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	佐田　和己 [SADA Kazuki] (大学院理学研究院)		
担当教員 Other Instructors	MATSUOKA Keitaro(理学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094206
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
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_ELMAT 6012		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Self-organization, Molecular Networks, Molecular Machine, Molecular Assembly, Supramolecular Chemistry, Gel, Nanoporous Materials, Crystals, Kinesin, Myosin, Dynein

授業の目標 Course Objectives

Based on the understanding of the essence of materials, this lecture will provide specialized knowledge for designing and developing the functions of inorganic, metallic, organic, and biomaterials and composite materials. In particular, students will learn the fundamentals to consider the physical properties design and application guidelines for materials ranging from hard materials such as crystals to soft artificial materials such as gels and biomacromolecules such as proteins and nucleic acids. In particular, the course aims to understand self-organization and complex systems, to control intermolecular interactions, and to provide guidelines for designing functional materials. In particular, two topics, molecular network materials and astatine-based radiotherapy, will be reviewed and their applications to nanotechnology and other fields will be introduced based on cutting-edge research.

In addition, we will discuss what research is, reflect on our own research, and discuss how to solve problems or deepen our own research through PBL or presentation-style exercises that transcend the boundaries of engineering and science.

(I) Material Design

Preparation, structure, and function of materials with network structures such as supramolecular chemistry, gels, crystals, and MOFs will be reviewed and their applications will be introduced.

(II) Astatine-based radiotherapy

Organic chemistry using astatine, an α-ray emitting nuclide emitted by accelerators for radiotherapy, and its applications will be introduced.

(III) Deepening research through PBL (Problem-Based Learning)

Students will discuss how to solve problems or deepen their own research by using their own research as a subject matter.

到達目標 Course Goals

Firstly this course reviews fundamentals of molecular network structures and bio-molecular machines with respect to self-organization.

Students will be able to acquire basic knowledge both on preparation and molecular design of network structures and on bio-molecular machines, understand their construction and working principle in advanced applications of physical chemistry and material science. Students will be able to discuss problem solving or deepening their own research using their own research as a subject.　Students will be able to know organic chemistry of alpha-ray emitting astatine prepared by using an accelerator for radiotherapy.

授業計画 Course Schedule

(Topic I) Material Design provided by K. S.

(Topic II) Astatine-based radiotherapy by K. M.

(Topic III) Problem Based Learning (PBL) for deepening of own research by K. S. &　K. M.

Using your own research as the subject, discuss how to solve problems or deepen your own research.

準備学習 (予習・復習)等の内容と分量 Homework

Students will read reviews and the primary literature on each topic, and submit questions for instrutor after every classes and some written reports on the topics.

成績評価の基準と方法 Grading System

Attendance more than 11 times among 15 classes is essentail for evaluation of the credit.

The grade is evaluated in the following three items;(1) learning attitude (15%), (2) report/homework or presentation (70%), (3) term paper (15%). Understanding for each class is evaluated by report/homework/presentation, and the basic knowledge for whole subjects is confirmed by term examination.

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

「科学的思考」のレッスン：学校で教えてくれないサイエンス／戸田山和久：NHK 出版, 2011

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

http://wwwchem.sci.hokudai.ac.jp/~matchemS/english/index.html

備考 Additional Information

科目名 Course Title	応用物質化学(有機物性化学)[Applied Materials Chemistry (Physical Chemistry of Organic Materials)]		
講義題目 Subtitle			
責任教員 Instructor	田地川　浩人 [TACHIKAWA Hiroto] (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	2023	**時間割番号 Course Number**	094207
期間 Semester	Fall	**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_ELMAT 6100		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Pi-stacking, Sigma-Huckel method, Soliton, Anderson localization, Degradation Mechanism

授業の目標 Course Objectives

Approach of a condensed matter chemistry is an important method for understanding the structure and driving mechanisms of electronic materials, such as organic thin-film solar cells and organic electroluminescent (EL) materials, which are based on organic molecules. In this course, the physical properties of several organic molecules, their aggregates, oligomers, and polymers will be lectured from theoretical approaches such as quantum chemistry.

到達目標 Course Goals

By the end of the lecture, you should be able to:
- Acquire the basic ability to understand the relationship between molecular functions and physical properties, and
- Develop the ability to discover problems in actual materials chemistry and to solve them using a theoretical approach.

授業計画 Course Schedule

Physical properties of the following systems will be discussed mainly by quantum chemical approach. (in no particular order)
(1) Charge-transfer complex (Pi-stacking)
(2) Thiophene system (degradation mechanism)
(3) Silane system (sigma-Huckel, Anderson localization)
(4) Graphene-based system (polycyclic aromatic compounds)
(5) Polyacetylenes (solitons)
(6) Spectroscopy (spectroscopic approach)
(7) Current topics

準備学習 (予習・復習)等の内容と分量 Homework

Students should review quantum mechanics or quantum chemistry from the undergraduate course.

成績評価の基準と方法 Grading System

In principle, attendance of 70% or more of the class sessions is a requirement for grading. The attitude at the lecture (20%) and report (30%) are evaluated.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

有機エレクトロニクス入門／筒井 哲夫(他)：日刊工業新聞社, 2012

講義指定図書 Reading List

有機半導体のデバイス物性 (KS 物理専門書)／安達千波矢：講談社, 2012

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	応用物質化学(界面電子化学)[Applied Materials Chemistry (Interfacial Electrochemistry)]		
講義題目 Subtitle			
責任教員 Instructor	伏見　公志 [FUSHIMI Koji] (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	2023	**時間割番号 Course Number**	094208
期間 Semester	Summer	**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_ELMAT 6102		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Electrode structure, interfacial reaction, charge transfer process, mass transport process, electrochemical methods, micro-electrochemistry

授業の目標 Course Objectives

The reactions occurring at interfaces between electrolyte and materials, i.e., electrodes are discussed. Students learn electrode reactions from views of interfacial thermodynamics, charge transfer kinetics, and mass transport process at the interface. They then proceed to principle and application using electrochemical methods as well as physical chemistry at the interface.

到達目標 Course Goals

Discussions start from basic aspects of electrochemistry, mainly for electrode structure including atomic level surface, electric double layer, electrode potential, etc. and are extended to interfacial reaction such as charge transfer process and mass transfer process. The goal of this course is supply details of electrochemical methods both to evaluate and to apply electrochemical reaction. Students are finally required to present and discuss electrochemical or interfacial subjects as well as their own research subjects.

授業計画 Course Schedule

1-3. Fundamentals of electrochemistry; electrode structure, electrode potential, non-Faradaic and Faradaic processes, energy conversion, electrolyte
4. Outline of electrochemical methods; apparatus, electrochemical cell, and electric circuit used in electrochemistry
5-6. Polarization technique; controlling processes of interfacial reaction (charge transfer process and mass transfer process), cyclic voltammetry, hydrodynamic method, microelectrode technique
7. Transient technique; potentiometry, ammerometry, coulometry, AC impedance spectroscopy, electrochemical sensor
8. Presentation; electrochemical theory and methods in newest research topics are introduced and discussed.

準備学習（予習・復習）等の内容と分量 Homework

Students are requested to read relevant contents in the textbook and/or documents beforehand. Students are also expected to study journal articles in interfacial electrochemistry and prepare presentation materials to be used in class discussions.
Students are requested to submit a report about class.

成績評価の基準と方法 Grading System

Students will be evaluated by presentations (50%) and reports (50%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Electrode Dynamics／A.C. Fisher：Oxford University Press, 1996

講義指定図書 Reading List

電気化学測定法(上)／藤嶋昭,相澤益男,井上徹：技報堂出版, 1984
Electrochemical Methods, Fundamentals and Applications, 2nd ed.／Allen J. Bard, Larry R. Faulkner：Wiely, 2001
Analytical and Physical Electrochemistry／Hubert H. Girault：EPFL Press

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

http://www.eng.hokudai.ac.jp/labo/amc/index.html

備考 Additional Information

科目名 Course Title	応用物質化学(無機物性化学)[Applied Materials Chemistry (Inorganic Solid State Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	鱒渕 友治 [MASUBUCHI Yuji] (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	2023	**時間割番号 Course Number**	094209
期間 Semester	Fall	**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_ELMAT 6102		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Sintering, Thin film, Single crystal, Nano materials, Morphology

授業の目標 Course Objectives

Inorganic solids are known to show various properties depending on their constituent elements and crystal structure. Additionally, from the viewpoint of “material” their morphology and microstructure must be optimized to achieve their applications. This lecture will be dealing with preparation process of sintered body, thin film, single crystal, and nano materials for inorganic materials. We will also discuss how their physical properties relate to their morphology and micro structure.

到達目標 Course Goals

In-person lessons (Depending on the BCP level, it will be changed to online lessons.)
To understand a relationship between various properties and microstructure. To learn preparation methods of sintered body, thin film, single crystal, and nano materials. To understand fundamental mechanism of diffusion, nucleation, crystal growth, and grain growth.

授業計画 Course Schedule

1. Introduction: properties and morphology of inorganic solids
2. Sintering: solid and liquid phase diffusion, sintering of metal nitrides
3. Thin film: deposition process, vacuum deposition, vapor and liquid phase deposition
4. Single crystal: crystal growth mechanism, various crystal growth process
5. Nano material: properties, nano particles, composites, assemblage

準備学習 (予習・復習)等の内容と分量 Homework

Students are encouraged to read the handouts which will be given prior to each class.

成績評価の基準と方法 Grading System

Examination 30% (on each lecture) and final report 70%

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

適宜、資料を配付する。

講義指定図書 Reading List

参照ホームページ Websites

http://www.eng.hokudai.ac.jp/labo/strchem/lectures.html

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	応用物質化学(電子材料化学特論)[Applied Materials Chemistry (Physical Chemistry of Electronic Materials)]		
講義題目 Subtitle			
責任教員 Instructor	青木　芳尚 [AOKI Yoshitaka] (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	2023	**時間割番号 Course Number**	094210
期間 Semester	Winter	**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_ELMAT 6102		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Energy devices, semiconductors, ion conductors, heterojunctions, defect thermodynamics

授業の目標 Course Objectives

solid state electrochemical devices including solid oxide fuel cells, all solid state battery, hybrid solar cells

到達目標 Course Goals

Fundamentals of all solid state electrochemical devices.
To understand the phenomena at solid electrolyte-electrode interfaces.
Band structures at meta/semiconductor hetero junctions.
Interplays between ion and electron carriers in solid state electrolytes.

授業計画 Course Schedule

1. Introduction of band theory
2. Correlation between catalytic activity and electronic properties of Pt ORR catalysts
3. Fundamental of electrochemical impedance analysis of interfacil polarization
4. Correlation between elecronic carriers and defects in metal oxides
5. Design of solid state ionics devices based on interfacial properties
6. Novel solid state energy devices with the inter-plays between ion and electron carriers.

準備学習 (予習・復習)等の内容と分量 Homework

Students are encouraged o understand the working principals of fuel cells and all solid state batteries, fundamentals of defect thermodynamics and basic concepts of electronic properties at hetero-interfaces.

成績評価の基準と方法 Grading System

The scores are determined by (1) questions or discussion after lectures (30%), (2) learning attitude (10%) and (3) reports at end of semester

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Physics of semiconductor devices／S. M. Sze
電極化学　上／佐藤教男

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

備考 Additional Information

科目名 Course Title	応用物質化学(機能固体材料化学)[Applied Materials Chemistry (Functional Solid State Materials Chemistry)]		
講義題目 Subtitle			
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	2023	**時間割番号 Course Number**	094211
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_ELMAT 6101		
補足事項 Other Information			
授業実施方式 Class Method			

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

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=G058

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	応用物質化学(先端材料化学)[Applied Materials Chemistry (Advanced Materials Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	北川　裕一 [KITAGAWA Yuichi] (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	2023	**時間割番号 Course Number**	094213
期間 Semester	Summer	**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_ELMAT 6102		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Molecular photochemistry, light absorption, luminescence, organic compound, metal complex

授業の目標 Course Objectives

In this course, advanced photofunctional materials and fundamental principles of photochemistry are presented. This course enhances the understanding of advanced photofunctional research and the ability to design photofunctional materials.

到達目標 Course Goals

Students will be able to understand basic concepts of photochemistry such as electronic energy in materials, light absorption, and excited state dynamics to understand the basic principles of designing photofunctional materials and advanced photofunctional material studies. The goal of this course is to provide students with sufficient background to understand photofunctional studies in various research fields.

授業計画 Course Schedule

1-2. Fundamentals of photochemistry
3. Light absorbing materials
4-5. Luminescent materials
6. Polarized absorbing and luminescent materials
7. Photo-induced electron transfer・Photochemical reaction
8. Examination

準備学習 (予習・復習)等の内容と分量 Homework

Students are requested to review the contents in the lecture slide.

成績評価の基準と方法 Grading System

According to the class attendance and test, the score will be calculated.

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

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	応用物質化学(応用材料化学Ⅰ)[Applied Materials Chemistry (Applied Inorganic Materials Chemistry I)]		
講義題目 Subtitle			
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	KIJIMA Norihito[KIJIMA Norihito](AIST), SUE Kiwamu[SUE Kiwamu](AIST)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094214
期間 Semester	Fall	**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_ELMAT 6100		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Functional inorganic materials, Secondary batteries, Nanostructural analysis, High-temperature/high-pressure solvent, Flow production, Data-driven materials development

授業の目標 Course Objectives

The relation between the functionality of materials, especially inorganic functional materials, and their nanostructure and macroscopic form such as bulk will be lectured.
The appearance mechanism of various functionality obtained by controlling the composition and microstructure of the materials, the process development method for production of functional materials with desired structures, and feature of high-temperature / high-pressure solvent properties and controlling methods of the properties, will be addressed.
The prospects for industrial application in the future will be discussed by taking up some topics, including the synthesis and characterization of electrode and electrolyte materials for lithium ion batteries, and the production of nanoparticles and nanocomposites.

到達目標 Course Goals

The relation between the materials properties and nano/micro-structures drawing the required functions will be understood. In addition, the basic science and skills for materials processing and analysis will be mastered. The task to find a topic for oneself and investigate it will be given to the students as training to select and treat information scientifically.

授業計画 Course Schedule

Lectures will be given by Professor Professor Norihito KIJIMA and Kiwamu SUE(AIST).

The following contents will be lectured using the documents edited for the class by the lecturers:

1. Material chemistry of secondary batteries: Overview of secondary batteries, compnent materials for secondary batteries
2. Material chemistry for secondary batteries: Preparation and characterization of materials for batteries
3. Fundamentals for development of functional materials production process: high-temperature / high-pressure solvent properties, controlling method of the properties such as flow production, application to functional materials production
4. Data-driven method for development of materials production process: how to develop apparatus, how to collect and analyze data, application to functional materials production

準備学習 (予習・復習)等の内容と分量 Homework

Review the distributed documents and blackboard demonstration contents, and ask any questions at the next class.

成績評価の基準と方法 Grading System

Your attitude in classes (20%) and reports (80%) will affect your final grade

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

なし。適宜資料を配布する。

講義指定図書 Reading List

参照ホームページ Websites

http://www.aist.go.jp/

研究室のホームページ Websites of Laboratory

備考 Additional Information

Some documents will be distributed if necessary.

科目名 Course Title	応用物質化学(応用材料化学Ⅱ)[Applied Materials Chemistry (Applied Inorganic Materials Chemistry II)]		
講義題目 Subtitle			
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	KUWATA Naoaki[KUWATA Naoaki](NIMS)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094215
期間 Semester	Fall	**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_ELMAT 6100		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Functional inorganic materials, materials processing, microstructure analysis, characterization of functionality, diffusion in solids, thermodynamics of batteries, ion dynamics measurements

授業の目標 Course Objectives

For various materials, mainly inorganic materials, you will learn about the functionality obtained by controlling the composition, crystal structure and microstructure, and the mechanism by which they are expressed. For example, solid-state battery materials will be subjected to understand the fundamentals of material properties through a physicochemical approach. Ion dynamics measurement methods including nuclear magnetic resonance will be introduced too. Students will also learn about processing and characterization methods (instrumental analysis, spectroscopy, etc.) for fabricating functionally designed materials.

到達目標 Course Goals

Students will be able to understand the relationship between various properties of materials and nano-micro-macro structures, and understand the mechanism by which various physical properties are expressed. In addition, you will be able to consider what microstructure should be designed to maximize the desired function, and what kind of method should be used to obtain such a structure in terms of "materials processing".

授業計画 Course Schedule

The following contents will be lectured using the distributed materials.

1. Introduction ･･ About the structure and function development of materials.

2. Synthesis: Process chemistry for grain synthesis, bulk formation, and microstructure control.

3. Characteristic evaluation ･･ Relationship between nano-micro-macro structure of materials and electrical, magnetic, optical, and mechanical properties. Also, about their evaluation methods.

4. Summary: Industrial application and future prospect of material sciences and materials technology. About the role and potential of materials in a sustainable society.

準備学習 (予習・復習)等の内容と分量 Homework

Review the distributed lecture materials and contents, and ask questions in the next class.

成績評価の基準と方法 Grading System

Attendance of 75% or more of the number of classes is a condition for grade evaluation. Grades are evaluated based on (1) learning attitudes (20%) and (2) reports (80%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

なし。適宜資料を配布する。

No textbook required. Materials will be distributed each time.

講義指定図書 Reading List

参照ホームページ Websites

http://www.nims.go.jp/

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	生物化学A(Ⅰ)[Biochemistry A (I)]		
講義題目 Subtitle			
責任教員 Instructor	村上　洋太 [MURAKAMI Yota] (大学院理学研究院)		
担当教員 Other Instructors	TAKAHASHI Masayuki[TAKAHASHI Masayuki](理学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094301
期間 Semester	Fall/Winter	**単位数 Number of Credits**	2
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_ELBIO 6012		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

genetic information、DNA、RNA、Protein、Chromatin、chromosome、motor protein, muscle contraction, cell motility, cytoskeleton, cell shape

授業の目標 Course Objectives

Cells differentiate into various cell types, each of which has specific function and cell shape, through regulation of their gene expression. The course will provide students with an overview of the molecular mechanisms of expression and maintenance of genetic information and the function of various proteins involved in the change and maintenance of cell shape.

到達目標 Course Goals

Students are expected to deeply understand the molecular mechanism of gene expression and maintenance through chromatin structure and the molecular mechanism of muscle contraction and various cell motile processes.

授業計画 Course Schedule

1) The role of chromatin structure in the regulation of genetic information
2) Epigenetic regulation of gene expression and iPS cells
3) Telomere regulation and cell senescence
4) Transposons and their regulation
5) Mechanism of chromosome segregation
6) Molecular mechanism of muscle contraction and its regulation?
7) Structure and mechanism of motor proteins?
8) Dynamics of cytoskeletal proteins?
9) Molecular mechanism of cell migration?
10) Molecular mechanism of cell division?
11) Morphological changes of neuronal cells

準備学習（予習・復習）等の内容と分量 Homework

Students are expected to review the material provided by the instructors.

成績評価の基準と方法 Grading System

20%: Reports, 20%: Short tests, 60% examination

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

特にもうけない。

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

備考 Additional Information

科目名 Course Title	生物化学A(Ⅱ)[Biochemistry A (II)]		
講義題目 Subtitle	生体システムのシグナル伝達―形態形成と生体防御[Signal Transduction for Biological Morphogenesis and Host Defense Systems]		
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[TAKAOKA Akinori](遺伝子病制御研究所)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094302
期間 Semester	Fall/Winter	**単位数 Number of Credits**	2
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_ELBIO 6012		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Signal transduction, genetic mutations, cellular architectures and morphogenesis, host defense, molecular mechanisms of diseases, immunology, basic medicine, infectious diseases, cancer, basic skills for scientific writing, basic and advanced skills for scientific presentation, experimental techniques of cell biology/molecular biology/immunology

授業の目標 Course Objectives

< Comprehensive understanding of life phenomena at molecular to in vivo levels >

Life system can be considered as an orchestral unit, which is composed of multiple biomolecular components. Each part of the orchestra exquisitely responds and/or adjusts to various external and internal stresses to keep the whole harmony, which is important for the homeostasis of life system. On the other hand, dysfunction of some part makes the orchestra play an inharmonic music as a whole, leading to breakdown in the homeostasis of life system, that is, developing a disease. Thus, the life system is spatiotemporally regulated under the molecular networks, which are controlled by the biochemical machinery. This course aims at the stepwise understanding about the static organization of life system and its dynamic changes in response to stresses, from molecular to cellular, and further to individual aspects. In particular, we focus on the signaling transduction system that underlies the host defense against pathogen invasion and cancer development.

The prime purpose in this course is to comprehensively and integratively learn about human organism on the basis of knowledge of chemistry that students have learned during the undergraduate program. This course will also provide an opportunity to fundamental knowledge and skills for manuscript process as well as scientific presentation, which may be practically crucial for the postgraduates.

到達目標 Course Goals

< To acquire an interdisciplinary view of research and to develop basic skills of flexible and creative thinkings>

The final goal of this course is to foster an integrative understanding and research view of chemistry by learning physiological functions of biomolecular components and their dysfunctions as a pathogenic condition (i.e., a disease development) from an interdisciplinary view of chemistry and medicine. We hope that this course contributes to rearing a researcher with a broad-based knowledge below the chemistry as well as the ability of creative and imaginative thinkings. This course will also support students to learn the general process of paper publication, how to write a “fascinating” research paper as well as how to prepare the accessory documents, and basic skills to make better use of molecular biological or immunological approaches.

授業計画 Course Schedule

This module will cover two major topics in (1) Cellular and tissue morphogenesis and (2) The host defense system during normal and disease contexts. A major challenge in biology is how to comprehend the enormous complexity underlying biological systems, and how to translate this knowledge into biomedical technologies. A set of lectures aims to understand how molecules interact with each other to produce the signals that orchestrate complex physiological functions. The detailed schedule will be informed in the first day of the course. Lecture contents, such as color-printed synopsis and/or lecture slide notes, will be provided in advance of each lecture.

Section 1: Molecular mechanisms of cellular and tissue morphogenesis

This section aims to understand the basic principles in animal body plan by introducing molecular mechanisms underlying “morphogenesis of cells and tissues” during normal development and in disease conditions. Growth and form are fundamental to all living organisms, and crucial to health and diseases. Development in methods and tools for molecular imaging has transformed biological and biomedical sciences. In particular, this section will introduce several basic concepts in molecular imaging with light microscopy and their applications. Introduction of each imaging technology will be linked with a set of biological problems of fundamental interests and biomedical implications. With a quantitative and holistic understanding of how molecular functions are ensured during normal development and how they are maladapted in disease, students will gain better insights into biomedical implications that effectively protect and regenerate organ functions and to better treat human diseases.

Section 2: The host defense system against pathogen invasion and cancer development
The second section will introduce the physiological functions of human organs from a macroscopic viewpoint, zooming them down to the functions at cellular and molecular levels. Next, we provide additional explanation about host responses to external and internal stresses to keep homeostasis in human living organism. Particularly, we focus on host defense against microbial infection that is an external stress, i.e., immunity. Students explore the following issues from the point of view of signal transduction as a cascade of intracellular chemical reactions: How does a living organism recognize invasion by microbes? What is the molecular mechanism for the specific elimination of the invading pathogens? In addition, we further review a mechanism for host defense against oncogenesis, which can be considered as an internal stress.
Students will also learn about the molecular mechanism for disease pathogenesis, particularly in terms of immunodeficiency that develops as a result of impairment of the immune system due to genetic abnormalities. Here, students further explore the outcome of abnormalities of biochemical events in human at the molecular to cellular and in vivo levels. This is helpful to students to acquire the relevant knowledge about basic medicine and to deepen their understanding of not only disease pathogenesis, but also the molecular-based strategy for disease treatment.

Section 3: Practical techniques to write “attractive” scientific papers.
This course will provide students the opportunity to learn research-based knowledge and skills in a more practical way. Students have a 10-min explanation about basic experimental techniques of molecular biology/immunology at the end of every class, by introducing a scientific paper published in a major journal such as Nature and Science. In addition, this part covers an overview of manuscript process (from submission to revision, resubmission, and acceptance) and also conveys essentials to a high-quality paper, by introducing actual examples of a manuscript and its related documents (Cover letter, Review comments, Rebuttals, Proof, etc.), which were successfully accepted in high-profile journals.

Section 1: Cellular and tissue morphogenesis in normal and disease contexts
(1) Visualization of biological molecules in vivo
(2) Visualization of biochemical reactions in vivo
(3) Cell and tissue morphogenesis (I)
(4) Cell and tissue morphogenesis (II)
(5) Basics of scientific presentation
(6) How to make effective scientific presentation (I)
(7) How to make effective scientific presentation (II)
(8) Practical exercise of scientific presentation

Section 2: The host defense system against pathogen invasion and cancer development
§2.1:Physiology of life system
(1) Macroscopic presentation of human body including a anatomical structure, biochemical, physiological functions of each organs
(2) General introduction of host defense (innate immunity and adaptive immunity)
(3) Basic knowledge of antibody molecules and their clinical application
(4) Roles of immune cells (e.g., dendritic cells, lymphocytes) and molecular mechanisms whereby these cells are functionally activated.
(5) Soluble factors that regulate the immune system, and their mechanisms of action
§2.2:Pathology of life system
(6) Fundamental knowledge of pathogenic microbes (e.g., viruses and bacteria)
(7) Diseases and pathological conditions as a result of breakdown in life system (e.g., infectious diseases, cancers)
(8) Molecular mechanisms for disease pathogenesis (genetic abnormalities and immunodeficiency)
(9) Therapeutic principle that is based on a molecular abnormality responsible for a disease (e.g., gene therapy)

Section 3:Basic knowledge of research and its practical application
(1) Basic and application of experimental methods that are often used in the research field of molecular biology/immunology
(2) Overview of manuscript process (from submission to revision, resubmission, and acceptance)
(3) Essentials to a high-quality paper

準備学習（予習・復習）等の内容と分量 Homework
There is no obligatory assignment that students have to prepare or review during this course. We think that what is essential is that students can maximally concentrate their attentions on each class and find something interesting to move them to spontaneously explore it further. We therefore will make maximum efforts to make each class attractive and to support students to learn the topic of each class in an extended manner.

成績評価の基準と方法 Grading System
During our interactive classes, we consider it as one of the important factors for assessment how actively students participate in each class (PARTICIPATION). In this respect, for example, to spontaneously participate in Q&A activity and to think

logically are much more important than to simply make a correct answer. Basically, there is no written exam for assessment, but students will be required to submit a report once at the end of this course. This report is regarded as a main factor for assessment (REPORT). As a theme of report, students can make a choice of one topic that they have become most interested in during this course. No specific format of report, and students are recommended to describe a topic of interest together with more detailed information that they additionally investigate by themselves, and to include some content of their research themes in a way that creates a link to a topic of their choice.
The course employs the grading system that is generally used for the student assessment in this university: Excellent plus, excellent, very good, good, and not good. In addition to the basic score of ATTENDANCE, the following major factors are considered to comprehensively and fairly make the final assessment:
1) PARTICIPATION: 10%
2) REPORT: 70%
3) ATTENDANCE: 20%

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks
教科書やテキストは特定しない。免疫学、分子生物学、生化学、生理学など、とくに基礎医学に関連した多様な分野の参考資料をはじめ、時には最新の関連学術論文を紹介するなど、毎回 Lecture 用のプリントを作成することを計画している。もちろん、希望者には関連する教科書や資料に関するアドバイスを積極的に行いたい。

There is no specified textbook in this course, because we think it desirable that students learn from a broad range of literatures and materials without any bias. In each class, we prepare a color-printed synopsis of a lecture and introduce up-to-date reference materials including textbooks and papers, which are closely related to the topic of each lecture.

講義指定図書 Reading List

参照ホームページ Websites
http://www.igm.hokudai.ac.jp/sci/, http://www.igm.hokudai.ac.jp/sci/

研究室のホームページ Websites of Laboratory
Motegi lab homepage: https://www.motegilab.com
Takaoka lab homepage: https://www.igm.hokudai.ac.jp/sci/

備考 Additional Information
Feel free to contact us for further information.

Fumio Motegi, Ph. D. Division of Developmental Physiology, Institute for Genetic Medicine, Hokkaido University
Tel:011-706-5527; ext. 5527
E-mail: motegi@igm.hokudai.ac.jp

Akinori Takaoka, M.D., Ph.D., Division of Signaling in Cancer and Immunology, Institute for Genetic Medicine, Hokkaido University
Phone 011-706-5020; ext. 5020
E-mail takaoka@igm.hokudai.ac.jp

科目名 Course Title	生物化学A(Ⅲ)[Biochemistry A (III)]		
講義題目 Subtitle			
責任教員 Instructor	内田　毅 [UCHIDA Takeshi] (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	2023	**時間割番号 Course Number**	094303
期間 Semester	Spring/Summer	**単位数 Number of Credits**	2
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_ELBIO 6012		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Absorption Spectroscopy, Infrared Spectroscopy, Optical Activity, Raman Scattering, Magnetic Resonance, Single-molecular Detection

授業の目標 Course Objectives

Spectroscopies have been revealed detailed structures of biological molecules such as proteins, nucleic acids, and other related molecules. This course will provide students with basic theories of spectroscopies and knowledge about their biological applications.

到達目標 Course Goals

Students will learn the background and basic theories of various kinds of spectroscopies for analyzing structures and functions of biological molecules.

授業計画 Course Schedule

[1st Half]
Explain the basic theory of some spectroscopies.
Week 1: Orientation and Introduction
Week 2: Basic Theory of Mass Spectroscopy in Biochemistry
Week 3: Basic Theory of Absorption Spectroscopy in Biochemistry
Week 4: Basic Theory of Infrared Spectroscopy in Biochemistry
Week 5: Basic Theory of Raman Spectroscopy in Biochemistry
Week 6: Basic Theory of Fluorescence Spectroscopy in Biochemistry
Week 7: Basic Theory of Circular Dichroism Spectroscopy in Biochemistry
Week 8: Basic Theory of Nuclear Magnetic Resonance Spectroscopy in Biochemistry
Week 9: Basic Theory of Single-Molecule Detection and Other Spectroscopic Techniques in Biochemistry
Week 10: Presentation by students

[2nd Half] Explain the application of the spectroscopies to bimolecular studies.
Week 11: Biological Application of Absorption Spectroscopy
Week 12: Biological Application of Raman Scattering
Week 13: Biological Application of Fluorescence Spectroscopy
Week 14: Biological Application of Nuclear Magnetic Resonance
Week 15: Exercise

準備学習 (予習・復習)等の内容と分量 Homework

Assignment is required for every lecture.

成績評価の基準と方法 Grading System

Quiz & Assignment, 60%; examination, 40%

テキスト・教科書 Textbooks

講義指定図書 Reading List

Methods in Molecular Biophysics／Serdyuk, I. N.,他：Cambridge, 2007
アトキンス 物理化学(下) 第 10 版／P. Atkins：東京化学同人, 2017
生体分子分光学入門／尾崎 幸洋、岩橋 秀夫：共立出版, 1992

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

http://wwwchem.sci.hokudai.ac.jp/~stchem/

備考 Additional Information

Lecture format will be determined later. On-site classes are expected.

科目名 Course Title	生物化学A(IV)[Biochemistry A (IV)]		
講義題目 Subtitle			
責任教員 Instructor	谷野　圭持 [TANINO Keiji] (大学院理学研究院)		
担当教員 Other Instructors	SUZUKI Takahiro[SUZUKI Takahiro](理学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094304
期間 Semester	Fall/Winter	**単位数 Number of Credits**	2
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_ELBIO 6012		
補足事項 Other Information			
授業実施方式 Class Method	1		

キーワード Key Words

Carbocation, Lewis acid, Enol silyl ether, Allylsilane, Electrophilic addition reaction, Carbon radical, Radical reduction, Radical addition reaction, Radical cyclization reaction

授業の目標 Course Objectives

The chemistry of enol silyl ethers as well as allylsilanes provides powerful methods in modern organic synthesis. The reactions of these compounds usually proceed through cationic intermediates, and it is very important to know the properties of carbocation species. This course increases students' understanding of useful carbon-carbon forming reactions mediated by Lewis acids.

This lecture also discuss about the features of carbon radicals such as the relationship between structure and stability, typical generation methods, and the addition to the multiple bonds. The attainment target is acquirement of practical knowledge, which enable comprehension of the complex synthetic schemes.

到達目標 Course Goals

At the end of the course each student should be able to:

1. explain the relationship between structure, stability, and reactivity of various carbocation species.
2. explain the "scope and limitations" in reactions involving carbocation intermediates, comparing with those in reactions of carbanion species or organometallic compounds.
3. discuss the mechanism of the reactions mediated by a Lewis acid by assuming appropriate reactive intermediates.
4. explain the relationship between structure, stability, and reactivity about various carbon radicals.
5. explain the "scope and limitations" about the reactions using radicals in comparison with the common ionic reactions.
6. discuss the mechanism of the cascade reactions involving radical species.
7. suggest appropriate schemes involving a several-step transformation for the synthesis of small organic molecules.

授業計画 Course Schedule

1. general properties of carbocation species
2. methods for generating carbocation species
3. preparation and reactions of enol silyl ethers
4. preparation and reactions of allylsilanes
5. reactions of vinylsilanes and alkynylsilanes
6. Prince reaction and carbonyl-ene reaction
7. alkylation reaction using organometallic reagents
8. basic property and generation of radical species
9. radical reduction by using alkyltin hydrides
10. radical reduction by using low valent metal salts
11. addition reactions of carbon radical with alkenes
12. radical cyclization leading to carbocycles or heterocycles

準備学習 (予習・復習)等の内容と分量 Homework

Students are requested to take enough time to go over each subject noted down during the lecture. A full understanding of the reaction mechanisms is especially important.

成績評価の基準と方法 Grading System

based on a mid-term examination (50%) and a term examination (50%)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Textbooks are not assigned.

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://wwwchem.sci.hokudai.ac.jp/~oc2/

備考 Additional Information

科目名 Course Title	応用生物化学(生合成工学)[Applied Biochemistry (Biosynthetic and Metabolic Engineering)]		
講義題目 Subtitle			
責任教員 Instructor	大利　徹 [DAIRI Toru] (大学院工学研究院)		
担当教員 Other Instructors	OGASAWARA Yasushi[OGASAWARA Yasushi](工学研究院), SATOH Yasuharu[SATOH Yasuharu](工学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094305
期間 Semester	Fall	**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_ELBIO 6102		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

microorganism, natural products, biosynthesis, genes, enzymes, bioinformatics

授業の目標 Course Objectives

Understanding of basic knowledge and techniques essential for biotechnology/bioengineering with microorganisms. 1. Principle of bioinformatics, 2. Michaelis Menten kinetics of enzyme reaction, 3. Outline of primary/secondary metabolites and metabolic pathways.

到達目標 Course Goals

Students are requested to understand papers about the microbial metabolites/metabolic pathways and the enzymes responsible for them, and to apply the basic knowledge/technology to their own research subjects.

授業計画 Course Schedule

1. Introduction
2. Principle of bioinformatics
3. Michaelis Menten kinetics of enzyme reaction-1-
4. Michaelis Menten kinetics of enzyme reaction-2-
5. Review of the primary metabolic pathway.
6. Diversity of the primary metabolic pathway in microorganisms
7. Review of the representative secondary metabolites and their biosynthetic pathways
8. Examples of microbial production of useful compounds based on biosynthetic engineering and metabolic engineering

準備学習 (予習・復習)等の内容と分量 Homework

Students are requested to understand papers related to biochemistry and summarize its contents concisely.

成績評価の基準と方法 Grading System

Minimum 70% attendance is required and grade is evaluated by learning volition (20%) and the quality of reports (80%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

適宜資料を配布する。下記の参考書を推奨するが教科書は使用しない。

講義指定図書 Reading List

マクマリー生化学反応機構 : ケミカルバイオロジー理解のために／John McMurry, Tadhg Begley 著 ; 浦野泰照 [ほか] 訳:東京化学同人, 2007

Antibiotics : actions, origins, resistance／Christopher Walsh:ASM Press, 2003

レーニンジャーの新生化学／レーニンジャー, ネルソン, コックス [著] ; 中山和久編集:廣川書店, 2010

バイオインフォマティクス, 2nd Edition ／David W. Mount 監訳:岡崎康司、坊農秀雅 :株式会社メディカル・サイエンス・インターナショナル, 2005

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

https://www.eng.hokudai.ac.jp/labo/tre/ABCLab_en/

備考 Additional Information

Students are requested to have basic knowledge of biochemistry.

科目名 Course Title	応用生物化学(生命システム工学)[Applied Biochemistry (Biosystem Engineering)]		
講義題目 Subtitle			
責任教員 Instructor	菊川　寛史 [KIKUKAWA Hiroshi] (大学院工学研究院)		
担当教員 Other Instructors	HIRAISHI Tomohiro[HIRAISHI Tomohiro](理化学研究所)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094306
期間 Semester	Fall	**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_ELBIO 6100		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

gene, protein, transcription, translation, enzyme, biochemistry, evolutionary engineering, molecular design, protein engineering, physical chemistry, bioplastic, biodegradation, biotechnology, genome, omics, bacteria, fungi

授業の目標 Course Objectives

Organisms have an excellent synthetic mechanism to produce complex molecules and to properly degrade and utilize them. This system contributes to the natural element cycle. Enzymes play a central role in this cycle. Biotechnologies that apply such advanced biological functions to engineering applications are used in a wide range of fields, such as the synthesis of chemicals and pharmaceuticals, and environmental protection.In this lecture, we aim to learn about examples of applied engineering research, with a chemical understanding of life systems at the molecular level, centering on the function of enzyme molecules. The first stage explains the mechanism of the underlying gene and transcription / translation system, analysis methods, and further, taking bioplastics as an example, the molecular mechanism of biosynthesis and biodegradation, artificial modification technology of enzyme molecules, structure and Learn about function, how to measure activity, and the thermodynamic understanding of biological reactions. In the next stage, we aim to understand the cells where these biological functions are exhibited.

到達目標 Course Goals

Understand the mechanism and methodology for synthesizing and functioning the target protein (enzyme molecule) by genetic engineering. Understanding enzyme reactions and metabolism based on chemistry and thermodynamics. Understand the structure and function of enzyme molecules and their analysis methods. To understand how to use exhaustive analysis methods and data such as genomic DNA sequences, transcriptomes, proteomes and metabolome. Using these biological functions, we will learn the ideas for making them applicable to the field of engineering.

授業計画 Course Schedule

Enzyme applications: 1, Production, biochemical assay
Protein Engineering: 1, Protein mutagenesis, engineering
Genetic engineering: genetic modification, genome editing
Synthetic biology: molecular design, modeling

準備学習 (予習・復習)等の内容と分量 Homework

It is desirable to have at least 2 hours of preparation and 2 hours of review for each course content.

成績評価の基準と方法 Grading System

The minimum standard for evaluation is attendance rate 70% or more. The degree of achievement is comprehensively evaluated by the questions and answers during the lecture, and the contents of the report given as appropriate. The attendance of intensive lectures is essential to be credited.

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

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	応用生物化学(生物分析化学)[Applied Biochemistry (Analytical Biochemistry)]		
講義題目 Subtitle			
責任教員 Instructor	谷　博文 [TANI Hirofumi] (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	2023	**時間割番号 Course Number**	094307
期間 Semester	Fall	**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_ELBIO 6102		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Molecular recognition, Enzyme assay, Immunoassay, Biomolecular interaction, Analytical biochemistry

授業の目標 Course Objectives

Basics and applications of analytical chemistry exploiting highly sophisticated molecular recognition in biological and biochemical processes such as enzymatic- and immuno-reactions will be introduced.

到達目標 Course Goals

The goals of this course are to be able to;

- Explain the basics of molecular recognition in biological and biochemical processes, and the applications to analytical chemistry exploiting biomolecules as a probe.
- Design a suitable bioanalytical system for a target molecule.

授業計画 Course Schedule

1. Biological and biochemical reactions exploited in analytical chemistry: Chemical analysis, molecular recognition in biological and biochemical reactions, biomimetics, biochemical and biological analyses, selectivity and sensitivity, spectrophotometry, fluorometry, bioluminescence
2. Enzyme assay: Structure and activity of enzyme, kinetics, and equilibrium of enzyme reaction, assays for enzyme activity using synthetic substrates, substrate assays using enzymes, and enzymatic cycling method
3. Immunoassay: Basic of immunoreaction, antibody, antigen, hapten, epitope, immunoprecipitation, immuno-enzymometric assay, labels in immunoassay
4. Nucleic acid analysis: Fundamental and type of nucleic-acid hybridization, Detection techniques of nucleic acid probes, Analysis of nucleic acid sequence, DNA chip
5. Proposal of new bioanalytical methods: Students will be divided into multiple teams, and then team discussion to propose new bioanalytical methods and presentation will be carried out.

準備学習 (予習・復習)等の内容と分量 Homework

Students are expected to read the handouts that are given at least in a week ahead. Students are also requested to review each lecture and study the journal articles quoted in the lecture.

成績評価の基準と方法 Grading System

A comprehensive evaluation is based on the degree of achievement judged from the learning status and understanding of the analytical methods using/of in-vivo reactions. Specifically, the term-end report, presentation in the class, and the contribution to the class (remarks in discussions, answers to question during class) will be assessed.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

テキストは指定せず，適宜 Lecture 資料を配布する。その他，参考となる文献を適宜紹介する。
Not specify texts. Handouts will be distributed. In addition, reference documents will be introduced as appropriate.

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

備考 Additional Information

It is advisable to master biochemistry, analytical chemistry, and instrumental analysis in advance.

科目名 Course Title	応用生物化学(細胞培養工学)[Applied Biochemistry (Cell Processing Engineering)]		
講義題目 Subtitle			
責任教員 Instructor	藤原　政司 [FUJIWARA Masashi] (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	2023	**時間割番号 Course Number**	094308
期間 Semester	Winter	**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_ELBIO 6100		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

animal cell cultivation, biopharmaceuticals production, large scale cultivation, bioreactor, engineering of mammalian cell culture

授業の目標 Course Objectives

It is difficult to produce proteins together with sugar chains such as therapeutic antibodies and interferons by chemical reaction and cultivation of microbe. Industrial cultivation of animal cells in large scale becomes very important for the production of such products. The aim of this subject is to understand history, industrial field, adhesion, scaffold materials, culture media, cell analysis, and reactors about animal cell cultivation. Based on those basic knowledge, the more advanced aim is to understand engineering in animal cell cultivation.

到達目標 Course Goals

Understanding of the basics and practical engineering issue about the large scale production of biopharmaceuticals by animal cell culture.

授業計画 Course Schedule

1. History, industrial field in animal cell culture
2. Comparison of animal cell culture with microbial culture
3. Animal cell adhesion and scaffold materials
4. Animal cell analysis
5. Media for animal cell culture
6. Reactors for animal cell culture
7. Problems in production of biopharmaceuticals by animal cell culture

準備学習 (予習・復習)等の内容と分量 Homework

Self-review of already attended lectures is recommended (1.5 h).

成績評価の基準と方法 Grading System

More than 70% of attendance is essential for grade evaluation in principle.
All students are evaluated by active learning attitude(20%) and last examination (80%).

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

セルプロセッシング工学 (増補)／高木　睦、岩井良輔:コロナ社, 2021

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	応用生物化学A(マイクロシステム化学)[Applied Biochemistry A (Microsystem Chemistry)]		
講義題目 Subtitle			
責任教員 Instructor	渡慶次　学 [TOKESHI Manabu] (大学院工学研究院)		
担当教員 Other Instructors	MAEKI Masatoshi[MAEKI Masatoshi](工学研究院), ISHIDA Akihiko[ISHIDA Akihiko](工学研究院), HIBINO Mitsue (工学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094309
期間 Semester	Fall	**単位数 Number of Credits**	2
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_ELBIO 6112		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Micro total analysis system, Microfluidic device, Microanaltyical device, Micro medical diagnostic device

授業の目標 Course Objectives

This course will understand the principles of microfluidic device development and biochemical analysis, drug discovery and medical diagnostic applications. In addition, acquire the latest knowledge and ideas regarding the development of microanalytical devices and their application to biochemical analysis and medical diagnosis. Through these, it becomes possible to construct an appropriate measurement system according to the measurement target.

到達目標 Course Goals

The goals of this course are to be able to;
- Explain the fundamentals and techniques of the microdevices for biochemical and biomedical analyses.
- Design a suitable micro analysis system for a target molecule.
- Explain the fundamentals and techniques of the microfluidic devices for drug design and therapy.

授業計画 Course Schedule

This course will be held twice a week by multiple lecturers.

1. Concept of analysis using microdevices
2. Blood analysis system using microdevices: immunoassay, circulating tumor cells, cell-free DNA
3. Separation analysis using microdevices
4. Drug design and therapy using microfluidic devices: microdroplet, nanoparticles, drug delivery system and genome editing, structure analysis of biomolecules, particle separation method and devices
5. Paper-based analytical device
6. Microfluidic-based separation system
7. Electrochemical biosensors
8. Portable analytical systems and wearable sensing systems

準備学習 (予習・復習)等の内容と分量 Homework

Students are expected to read the handouts that are given at least in a week ahead. Students are also requested to review each lecture and study the journal articles quoted in the lecture.

成績評価の基準と方法 Grading System

Learning attitude and report

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

テキストは指定せず, 適宜 Lecture 資料を配布する。その他, 参考となる文献を適宜紹介する。
Not specify texts. Handouts will be distributed. In addition, reference documents will be introduced as appropriate.

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://microfluidic.chips.jp/en/

備考 Additional Information

It is advisable to master biochemistry, analytical chemistry, and instrumental analysis in advance.

科目名 Course Title	応用生物化学A(機能性高分子特論)[Applied Biochemistry A (Advanced Functional Polymer)]		
講義題目 Subtitle			
責任教員 Instructor	佐藤 敏文 [SATOH Toshifumi] (大学院工学研究院)		
担当教員 Other Instructors	YAMAMOTO Takuya[YAMAMOTO Takuya](工学研究院), LI FENG[LI FENG](工学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094310
期間 Semester	1学期	**単位数 Number of Credits**	2
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_ELBIO 6111		
補足事項 Other Information			
授業実施方式 Class Method	1		

キーワード Key Words

Polymer synthesis, Precise polymerization, Controlled/Living polymerization, Radical polymerization, Cationic polymerization, Anionic polymerization, Coordination polymerization, Functional polymer, Polymer structure, Polymer design, Polymer solution, Phase separation behavior

授業の目標 Course Objectives

To utilize polymeric materials and to design new functionality, the methodology of the polymer synthesis must be understood. To learn various polymerization-methods and the various polymerization mechanisms is mainly studied as the basics of the macromolecular synthesis, and to understand the latest macromolecular synthesis method is a goal. Moreover, students study and understand the precise syntheses based on the free-radical polymerization, the cationic polymerization, the anionic-polymerization, and coordination polymerization, which is used for the design and synthesis of functional macromolecules.

到達目標 Course Goals

Our goals are to learn various polymerization-methods and the various polymerization mechanisms and to understand the latest macromolecular synthetic method. Moreover, students learn the precise synthesis based on the living polymerization, which is used for the design and synthesis of functional polymeric materials as a goal of this course.

授業計画 Course Schedule

1. Polymerizations by Zieglar-Natta.
2. Polymerizations by metallocene catalysts.
3. Metathesis polymerization
4. Ring-opening polymerization leading to environment-conscious polymer and medical polymer
5. polycondensation and chain-growth polycondensation leading to engineering plastic and electrofunctional polymer
6. Radical polymerization: characteristics of radical polymerization and the primary structure of the resulting polymers.
7. Anionic polymerization: characteristics of anionic polymerization and the primary structure of the resulting polymers.
8. Cationic polymerization: characteristics of cationic polymerization and the primary structure of the resulting polymers.
9. Functional materials by assembly of polymers with designed architectures.

準備学習 (予習・復習)等の内容と分量 Homework

Students are required to carefully read distributed handouts, if any, beforehand and submit reports for assigned problems by specified dates. Also, students present a report for problems after the class ends.

成績評価の基準と方法 Grading System

In principle, students who attend 70% or more classes are graded. The final grade is determined by his/her learning attitude (20%) and reports (80%). The reports are evaluated based on the student's understanding on the synthesis and design of polymers and the logic of the writing. A, 100-90; B, 89-80; C, 79-70; D, 69-60; F, < 60.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

特に指定はしないが,「高分子合成化学」(大津隆行著, 化学同人)と「大学院高分子科学」(野瀬卓平, 中濱精一, 宮田清蔵編, 講談社サイエンティフィク)を参考にしていただきたい。The documents will be distributed.

講義指定図書 Reading List

大学院 高分子科学／野瀬卓平・中浜精一・宮田清蔵:講談社サイエンティフィック, 2000

参照ホームページ Websites

研究室のホームページ Websites of Laboratory

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

備考 Additional Information

The class is opened by face-to-face.
Please carefully see ELMS.

科目名 Course Title	化学研究先端講義[Topical Lectures in Chemical Sciences and Engineering]		
講義題目 Subtitle			
責任教員 Instructor	村上　洋太 [MURAKAMI Yota] (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	2023	**時間割番号 Course Number**	094401
期間 Semester	Irregular	**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_ELCOM 6201		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Cutting Edge Researches in Chemistry, Foreign Lecturers, English Lectures

授業の目標 Course Objectives

A series of English lectures on cutting edge researches in chemistry will provide enough knowledge and information on understanding recent progress in chemistry.

到達目標 Course Goals

Students will learn the background and recent progress in cutting edge researches in chemistry. Communicating with English speaking lecturers will be expected.

授業計画 Course Schedule

Invited English speaking lecturers will give lectures on their recent researches in various fields of chemistry and discuss their topics with students.

準備学習（予習・復習）等の内容と分量 Homework

Assignments will be required by lecturers.

成績評価の基準と方法 Grading System

Class participation (more than 7 lectures) 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

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	総合化学研究先端講義[Internship]		
講義題目 Subtitle			
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	2023	**時間割番号 Course Number**	094402
期間 Semester	Fall	**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_ELCOM 6212		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Internship (domestic and oversea)

授業の目標 Course Objectives

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

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 for overseas internship).
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	化学産業実学[Industrial Practice in Chemical Processes]		
講義題目 Subtitle			
責任教員 Instructor	長谷川　淳也 [HASEGAWA Junya] (触媒科学研究所)		
担当教員 Other Instructors			
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094403
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_ELCOM 5200		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Practical Science of Chemical Industry, Research and Development, Chemical Technology, Industry-academia Collaboration

授業の目標 Course Objectives

Invited lecturers have a background in science and are working at the forefront in industry as well as academia. They share their experience, success and /or failure to educate how the things you learn at universities will help you in the future and what is requested by companies.
The aim of this course is to grasp the image of working in industry and consider your future and the way in which you relate to the society.

到達目標 Course Goals

The Course Goals are to study the real necessity of chemical technology for the society, how researches should behave in industry, and consider research ethics, ensuring safety, environmental protection, the importance of transmission of information, and to cultivate a wide field of view.

授業計画 Course Schedule

Invited lecturers are researchers as well as managers working at the forefront at a company and an national research institute. This lecture will be provided as an intensive lecture. For the schedule, see "Additional Information" below.
The concrete plan of lectures is as follows;

1. Forefront of research and development of companies
Explanation on the product development including its background as well its social significance.
2. Outlook and Task of chemical research
Explanation on future outlook and agenda-setting・research strategy by point of global view including concrete examples.
3. Chemist image pursued in the society
Explanation on the necessary capability for chemical researchers who are to be involved in research in future and items which need to be studied during school days based on their experiences of the lecturers.
4. Explanation on the weight of responsibility and its efforts of the chemical technology towards environmental protection.
Consideration on the chemical technology which contribute to establishing sustainable society including food issues and energy problem.

準備学習（予習・復習）等の内容と分量 Homework

Review the lesson contents by the next time.

成績評価の基準と方法 Grading System

As a general rule, the percentage of your attendance rate should be more than 75%.
An absent report should be submitted in advance.
The test conducted in the each lecture is evaluated.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

教科書はとくに指定せず、講義時はパワーポイントを使用する。
Textbooks are not used. Slides prepared with PowerPoint are used.

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

備考 Additional Information

This lecture will be offered as an intensive lecture in October. The schedule and place of the lecture will be noticed later.

科目名 Course Title	マイクロ・ナノ化学[Micro-Nanochemistry]		
講義題目 Subtitle			
責任教員 Instructor	中坂　佑太 [NAKASAKA Yuta] (大学院工学研究院)		
担当教員 Other Instructors	MURAKOSHI Kei[MURAKOSHI Kei](理学研究院), UENO Kosei[UENO Kosei](理学研究院), TOKESHI Manabu[TOKESHI Manabu](工学研究院), TANI Hirofumi[TANI Hirofumi](工学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094404
期間 Semester	Fall	**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_ELCOM 5222		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Microchemistry, Nanochemistry, Microchip, Biochip, Microreactor, Single Atom/Molecule Manipulation

授業の目標 Course Objectives

This course investigates modern chemistry in micrometer – nanometer dimensions including microfabrication technologies in chemistry, microchips/biochips, and microreactors.

到達目標 Course Goals

The students will be able to learn the basic concents and characteristics of
-Fundamental aspects in microfabrication techniques
-Chemical applications of microchips/biochips and microreactors
-Single molecular and atom manipulation techniques

授業計画 Course Schedule

K. Ueno (2 lectures)
- Micro/nanofabrication techniques / Micro/nanostructures / Light-field enhancement / Radiation force

K. Murakoshi (2 lectures)
-Single atom / Molecule manipulation / Nanochemistry

M. Tokeshi (2 lectures)
-Historical background of micro-nanochemistry / State of the art technologies and recent topics in Microchips/Biochips

H. Tani (1 lecture)
-Biochip

Y. Nakasaka (1 lecture)
-Microreactors

準備学習 (予習・復習)等の内容と分量 Homework

Basic analytical and physical chemistry in undergraduate level

成績評価の基準と方法 Grading System

Learning attitude and report

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

なし。適宜, 資料を配布する

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

備考 Additional Information

科目名 Course Title	生命分子化学特論[Modern Trends in Biomolecular Chemistry]		
講義題目 Subtitle			
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	MURAKAMI Yota[MURAKAMI Yota](理学研究院), MATSUMOTO Kenichiro[MATSUMOTO Kenichiro](工学研究院), UCHIDA Takeshi[UCHIDA Takeshi](理学研究院), MINAMI Atsushi[MINAMI Atsushi](理学研究院), TAJIMA Kenji[TAJIMA Kenji](工学研究院), OGASAWARA Yasushi[OGASAWARA Yasushi](工学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094405
期間 Semester	Summer	**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_ELCOM 5230		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Genetic information, protein structure, molecular mechanism, biosynthetic mechanism, animal cells, secondary metabolites, biopolymers, bioremediation

授業の目標 Course Objectives

Synthesis, structure, function, and novel engineering subjects on of bio-molecules will be studied focusing on 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

Eight lecturers belonging to the CSE will give lectures on the following topics, from basic to cutting-edge.

1. Functional RNAs
2. Mmechanism of antimicrobial peptide apidecin
3. Oligomer formation and functional regulation in proteins
4. Life Science Studies using Vibrational Spectroscopy
5. Synthesis of nano cellulose using a bacterium and its application
6. Microbial exploration for enzyme conversion and fermentation production of compounds
7. Thinking about the Central Dogma from the Biosynthesis of Natural Products
8. Biosynthetic strategies for secondary metabolites in microorganisms

準備学習 (予習・復習)等の内容と分量 Homework

Students are asked to submit a report on the subject which instructor give every time.

成績評価の基準と方法 Grading System

You will be evaluated by active participation including quiz (30%), and assignment on each topic (70%).
Attendance of 70% or more of regular classes is the minimum condition to evaluate.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

適宜資料を配布する。

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

備考 Additional Information

科目名 Course Title	総合化学特論 I (Modern Trends in Physical and Material Chemistry)[Modern Trends in Physical and Material Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	松井 雅樹 [MATSUI Masaki] (大学院理学研究院)		
担当教員 Other Instructors	KUWATA Naoaki[KUWATA Naoaki](NIMS), AOKI Yoshitaka[AOKI Yoshitaka](工学研究院), IIDA Kenji[IIDA Kenji](触媒科学研究所), FUKUSHIMA Tomohiro[FUKUSHIMA Tomohiro](理学研究院), NASU Akira[NASU Akira](理学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094406
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_ELCOM 5241		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

inorganic synthesis, defect thermodynamics in solids, solid electrolytes, nanomaterial, water, chemical sensing, battery, transition metal sulfide

授業の目標 Course Objectives

This course aims to provide opportunity for students to contact with different majors' professors and to expand students' horizons. In this course, professors explain the basic concept and overview absolutely essential for understanding of advanced research topics, and introduce their recent research works.

Topics introduced by professors are: Low temperature synthesis process for highly crystaline layered alkaline transition metal oxides, Metal/oxide-electrolyte heterointerfaces boost power generation of protonic solid oxide fuel cells, Lithium diffusion in solid-state battery materials, Theoretical and Computational Study on Nanostructures under Light and Voltage Bias, Physicochemical Properties of Water under Strong Coupling, Molecular recognition electronics based on materials chemistry, Development of Metastable Nanomaterials for Next Generation Battery Cathodes, Development of new functional polymorphs in transition metal sulfides as active materials for sodium secondary batteries

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

・Low temperature synthesis process for highly crystaline layered alkaline transition metal oxides
・Metal/oxide-electrolyte heterointerfaces boost power generation of protonic solid oxide fuel cells
・Lithium diffusion in solid-state battery materials
・Theoretical and Computational Study on Nanostructures under Light and Voltage Bias
・Physicochemical Properties of Water under Strong Coupling
・Molecular recognition electronics based on materials chemistry
・Development of Metastable Nanomaterials for Next Generation Battery Cathodes
・Development of new functional polymorphs in transition metal sulfides as active materials for sodium secondary batteries

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=G063

研究室のホームページ Websites of Laboratory

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/
https://www.cse.hokudai.ac.jp/en/

備考 Additional Information

科目名 Course Title	総合化学特論Ⅱ(Modern Trends in Organic Chemistry and Biological Chemistry)[Modern Trends in Organic Chemistry and Biological Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	渡慶次　学 [TOKESHI Manabu] (大学院工学研究院)		
担当教員 Other Instructors	OGASAWARA Yasushi[OGASAWARA Yasushi](工学研究院), MAEKI Masatoshi[MAEKI Masatoshi](工学研究院), KAMADA Rui[KAMADA Rui](理学研究院), ISHIGAKI Yusuke[ISHIGAKI Yusuke](理学研究院), YURINO Taiga[YURINO Taiga](工学研究院), YONEDA Tomoki[YONEDA Tomoki](工学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094407
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_ELCOM 5251		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Physical Organic Chemistry, Organic Synthesis, Organic Reaction, Organic Transformations, Biological Chemistry, Applied Biochemistry, Microsystem 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 and Introduction to microsystem chemistry: learn the history of microsystem chemistry research and the basic concepts needed to understand microsystem chemistry research.
2. Advanced microsystem chemistry: introducing cutting-edge micro system chemistry.
3. Advanced biochemistry: introducing current topics in innate immune system
4. Advanced applied biochemistry: learn current topics on medicinal chemistry to develop useful unnatural natural products.
5. Advanced organic transformations: learn the basic concepts and examples of transition metal catalysed enantioselective addition reaction for synthesis of chiral organic compounds.
6. Advanced organic chemistry: introducing cutting-edge physical organic chemistry based on highly strained organic molecules.
7. Advanced organic synthesis: introducing the novel organic synthesis based on the precise control of the reactive sites.
8. Advanced organic reaction: learn cutting-edge physical organic chemistry and reaction chemistry of π-conjugated molecules.

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 and will 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 submitted reports (each time, 80% in total). You will submit a report each time according to the instructor's instructions. 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

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=G051

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	基礎物理化学特論[Introductory Physical Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	村越　敬 [MURAKOSHI Kei] (大学院理学研究院)		
担当教員 Other Instructors	ISHIMORI Koichiro[ISHIMORI Koichiro](理学研究院), MARUTA Goro[MARUTA Goro](理学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094408
期間 Semester	Spring	**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_ELCOM 5002		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Molecular orbital theory, Spectroscopy, Surface, Equilibrium and Kinetics

授業の目標 Course Objectives

The purpose of this course is to understand the fundamental concepts of molecular orbital theory, spectroscopy, surface, equilibrium as well as kinetics in physical chemistry.

到達目標 Course Goals

Goals are to develop skills to solve problems in physical chemistry and acquire the capacity how the knowledge is applied for chemical application.

授業計画 Course Schedule

1. Processes on solid surfaces (Atkins' Physical Chemistry 10th edition, Chapter 22)
Structure of solid surfaces, the extent of adsorption, heterogeneous catalysis, processes at electrode
2. Rotational and vibrational spectra (Atkins' Physical Chemistry 10th edition, Chapter 12)
General features of spectroscopy
3. Electronic transitions and magnetic resonance (Atkins' Physical Chemistry 10th edition, Chapter 13, 14)
The characteristics of electronic transitions, the fates of electronically excited states, the effect of magnetic fields on electrons and nuclei, nuclear magnetic resonance
4. Molecular orbital theory (Atkins' Physical Chemistry 10th edition, Chapter 10)
Molecular orbital theory, diatomic molecules, chemical bonding, Hückel approximation

準備学習（予習・復習）等の内容と分量 Homework

To be announced.

成績評価の基準と方法 Grading System

The attitude at the lecture (30%) and report scores (70%) are evaluated.

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

Physical Chemistry 10th edition／P. W. Atkins, Julio De Paula：Oxford University Press, 2014

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	無機化学特論[Frontiers of Inorganic Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	小林　厚志 [KOBAYASHI Atsushi] (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	2023	**時間割番号 Course Number**	094409
期間 Semester	Spring	**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_ELCOM 5012		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

coordination chemistry, solid state chemistry, material chemistry, nano materials, nano science, photocatalysts, bioinorganic chemistry

授業の目標 Course Objectives

The objectives of this course are: To understand the properties, structures, and functionalities of the coordination compounds which play important roles in the various fields such as materials, bioinorganic chemistry, and nano science, To get the latest information of cutting-edge research concerning inorganic and coordination chemistry.

到達目標 Course Goals

The goal of this course is total understanding of the importance of coordination compounds from the viewpoints of coordination structures and electronic states, and to develop the ability to predict structures, properties and (photo)reactivity of coordination compounds. At the same time, students learn the sense of study in the fields of inorganic and coordination chemistry (typical concepts are listed below).

1) Ligand-field theory
2) Marcus Theory
3) Nano-science of coordination compounds
4) Importance of metal complexes in applied chemistry and biochemistry

授業計画 Course Schedule

(1) Basics and application of ligand-field theory
(2) Ligand exchange and electron transfer of metal complexes
(3) Photo-induced electron transfer and artificial photosynthesis
(4) Important effect of impurities -in the cases of solar and fuel cells-
(5) Interesting properties of nano materials and porous materials
(6) Group discussion about recent research papers

準備学習（予習・復習）等の内容と分量 Homework

(1) You must answer to mini-exam in each class.
(2) You must submit a report about recently published research paper by the final class of this course. Your submitted report will be used in the group discussion.

成績評価の基準と方法 Grading System

You will be evaluated by mini-exam in each class (40%), and report and presentation (60%). More than 70% attendance is mimimum 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

Shriver & Atkins' Inorganic Chemistry／Peter Atkins：Oxford University Press, 2010

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

To prevent the spread of the new coronavirus infection, this course will be possibly held online by using ELMS and Zoom.

科目名 Course Title	有機化学特論[Special Lecture on Organic Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	谷野　圭持 [TANINO Keiji] (大学院理学研究院)		
担当教員 Other Instructors	ITOH Hajime[ITOH Hajime](工学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094410
期間 Semester	Summer	**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_ELCOM 5262		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

basic organic chemistry, physical organic chemistry, organometallic chemistry, synthetic organic chemistry, polymer chemistry

授業の目標 Course Objectives

This course aims to introduce participants to the latest trends and progresses in organic chemistry and related sciences. The class is opened to the students who have not studied the specialized course of organic chemistry.

到達目標 Course Goals

On completion of this course, students should be able to understand the recent trends and future problems in physical organic chemistry, organometallic chemistry, synthetic organic chemistry, and polymer chemistry.

授業計画 Course Schedule

Lecture 1. Electroorganic synthesis
Lecture 2. Introduction to asymmetric reduction reactions
Lecture 3. New methods for functionalization of organic compounds: the boration approach
Lecture 4. How to understand the schemes of natural product synthesis
Lecture 5. The C-H--O hydrogen bond: the role and future in controlling the alignment of molecules
Lecture 6. Lessons from enzymes for designing chiral catalysts
Lecture 7. Nature's way to synthesize natural products: Comparison between chemical synthesis and enzymatic synthesis

準備学習（予習・復習）等の内容と分量 Homework

Students are expected to comprehend the lecture for preparing reports. Details for preparation and review for each topic are given by the lecturer.

成績評価の基準と方法 Grading System

It is required to attend at least 70% of the lectures. Evaluation as pass/fail will be based on the level of attendance (20%) and submitted reports (twice, 40% each).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Textbooks are not assigned.

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

備考 Additional Information

科目名 Course Title	基礎生物化学特論[Introduction to Basic Biological Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	村上　洋太 [MURAKAMI Yota] (大学院理学研究院)		
担当教員 Other Instructors	TAKAOKA Akinori[TAKAOKA Akinori](遺伝子病制御研究所), MOTEGI Fumio[MOTEGI Fumio](遺伝子病制御研究所)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094411
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_ELCOM 5021		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

cell growth and differentiation, gene expression, epigenetics, oncogene, immunity, infectious disease, cellular asymmetry

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 behavior in living cells 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: Prof. Fumio Motegi
Interior design of cellular asymmetry
Day 2: Prof. Akinori Takaoka
Molecular signalings in host defense systemProf.
Day 3, 4: Yota Murakami
Regulation of Gene Expression for Cell Differentiation

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

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=G050

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	分子物理化学特論[Molecular Physical Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	佐藤　信一郎 [SATOH Shinichiro] (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	2023	**時間割番号 Course Number**	094412
期間 Semester	Spring	**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_ELCOM 5100		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Quantum Mechanics, Perturbation Theory, Stark Effect, Zeeman Effect, Photoabsorption and Emission

授業の目標 Course Objectives

Quantum theory is essential to understand molecular physical chemistry.　The lecture is intended for graduate students who have a general background in elementary quantum dynamics, and concentrates on the perturbation theory to give students a deep and essential understand on the interactions between molecular system and external fields such as electric, magnetic, and photon fields.

到達目標 Course Goals

By the end of the semester you should be able to:
-Apply the mathematical formalism of quantum mechanics to solve simple model problems.
-Analyze experiments that probe the quantum mechanical nature of matter to gain insight into the structure and dynamics of atoms, molecules, and nanomaterials.

授業計画 Course Schedule

I.　Steady-state perturbation theory: first-order perturbation theory including degenerate system and second-order perturbation theory
II.　Stark effects of hydrogen atom: the first-order interactions for 2s, 2px, 2py, 2pz degenerate states and the second-order interaction for 1s state.　The polarizability of hydrogen atoms will be discussed on the basis of the second-order perturbation theory.
III . Time-dependent perturbation theory
IV . Photoabsorption and emission processes will be discussed on the basis of time-dependent perturbation theory.

準備学習 (予習・復習)等の内容と分量 Homework

Students are requested to read relevant contents in the textbook beforehand: page ranges will be announced at least in a week ahead.

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) reports (80%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

現代量子化学の基礎／中島威　藤村勇一:共立出版, 1999

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

http://cma.eng.hokudai.ac.jp/index_english.html

備考 Additional Information

Attend "Quantum Chemistry" or an equivalent lecture ("Quantum Mechanics") in undergraduate school

科目名 Course Title	物質構造解析学特論[Structural Analysis of Inorganic Materials]		
講義題目 Subtitle			
責任教員 Instructor	三浦　章 [MIURA Akira] (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	2023	**時間割番号 Course Number**	094413
期間 Semester	Spring	**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_ELCOM 5112		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

x-ray structure analysis, electron microscope, neutron diffraction, X-ray absorption spectroscopy, solid-state NMR, Computational chemistry

授業の目標 Course Objectives

X-ray diffraction theory will be introduced to understand the relation between crystal structure and electron density distribution. Electron microscopy will also be applied for the analysis of inorganic materials. Neutron diffraction is useful to analyze the magnetic structure and the position of light elements. The principle of X - ray absorption spectroscopy and the difference from the diffraction method will be discussed. Structural analysis of inorganic materials using solid state NMR will be introduced.

到達目標 Course Goals

X-ray diffraction theory will be introduced to understand the relation between crystal structure and electron density distribution. Electron microscopy will also be applied for the analysis of inorganic materials. Neutron diffraction is useful to analyze the magnetic structure and the position of light elements. The principle of X - ray absorption spectroscopy and the difference from the diffraction method will be discussed. Structural analysis of inorganic materials using solid state NMR will be introduced.

授業計画 Course Schedule

1. What is x-ray? : Its generation, diffraction, scattering, absorption of x-ray etc.
2. X-ray diffraction for inorganic solids: powder diffractometer, qualitative and quantitative analyses, lattice parameter determination, crystallite size and distortion, crystal orientation etc.
3. Neutron diffraction: Difference from x-ray diffraction.
4. X-ray scattering and X-ray absorption spectroscopy
5. Electron microscopy: Transmission, analytical and scanning electron microscopies for microstructure and electronic structure analysis.
6. Solid State NMR
7. Computational chemistry: DFT and data science
8. Examination

準備学習（予習・復習）等の内容と分量 Homework

Report submissions are required to apply structural analysis methods for the materials under investigation by each student.

成績評価の基準と方法 Grading System

(1) report(40%) and (2) End of term examination (60%). [this may change to final report]

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

教科書は用いず，プリントを配布する。

講義指定図書 Reading List

これならわかるX線結晶解析 これならわかるX線結晶解析／安岡則武：化学同人，2000
セラミックスのキャラクタリゼーション技術：日本セラミックス協会

参照ホームページ Websites

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

Basic knowledge about physical chemistry, inorganic chemistry, solid state chemistry and inorganic materials chemistry are required.

科目名 Course Title	材料環境化学特論[Corrosion Engineering]		
講義題目 Subtitle			
責任教員 Instructor	幅﨑　浩樹 [HABAZAKI Hiroki] (大学院工学研究院)		
担当教員 Other Instructors	藤田　栄(工学研究院客員教授)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094414
期間 Semester	Irregular	**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_ELCOM 5122		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

metallic materials, corrosion, corrosion protection, classification of corrosion, corrosion monitoring

授業の目標 Course Objectives

The degradation of materials used in many structures and functional devices is a very important issue to sustain and develop our modern society. Understanding the degradation mechanism, predicting the lifetime of materials, and suppressing corrosion is, therefore, one of the major subjects of engineering. In the lecture, a theory of corrosion phenomena, examples of typical corrosion and degradation, strategies of corrosion protection, development of degradation resistive materials, and evaluation methods of corrosion rate and lifetime will be introduced.

到達目標 Course Goals

・Understanding the practical corrosion phenomena based on physical chemistry
・Learning how to treat corrosion-related phenomena quantitatively.
・Understanding the engineering techniques applicable to various practical problems.

授業計画 Course Schedule

1. Introduction
・Corrosion costs (corrosion loss and corrosion protection costs)
・Corrosion phenomena of steel materials in various environments (freshwater, seawater, soil, and other environments)

2. Chemical reaction of metal/environment (electrochemical reaction)
・Potential, standard electrode potential, electromotive force, characteristics of potential-current density curve (Tafel's law, mass diffusion dominance, etc.), passive state
・Metal-water system phase diagram (Pourbaix Diagram, etc.)
・Metal – high temperature oxygen system phase diagram (Ellingham diagram, etc.)

3. Characteristics of corrosion of various metallic materials
・Classification of corrosion form
・Uniform corrosion
・Localized corrosion (dissimilar metal contact corrosion, pitting corrosion, crevice corrosion, intergranular corrosion, stress corrosion cracking, hydrogen embrittlement, corrosion fatigue, erosion/corrosion, high temperature corrosion)

4. corrosion prevention technologies
・Classification of corrosion prevention technologies
・Coating, lining, plating (zinc, nickel, chromium plating)
・Electrochemical corrosion protection (cathodic protection)
・Corrosion-resistant materials (low alloy steel, stainless steel, titanium, aluminum, copper, etc.)

5. Corrosion Analysis and Evaluation Methods
・Introduction to Corrosion Analysis Techniques
・Sensing and analysis techniques
・Evaluation techniques (deterministic, probabilistic, etc.)
・Prediction of corrosion resistance and corrosion protection life

準備学習（予習・復習）等の内容と分量 Homework

Students are expected to read the text booklet before and after the lecture. Students are also required to put in a report.

成績評価の基準と方法 Grading System

Reports (homework is given at each lecture) (60%), contribution to the discussion at the class (40%).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Lecture 資料を配布予定(Lecture materials will be distributed.)

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

備考 Additional Information

科目名 Course Title	生物資源化学特論[Bioresources Chemistry]		
講義題目 Subtitle			
責任教員 Instructor	田島　健次 [TAJIMA Kenji] (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	2023	**時間割番号 Course Number**	094415
期間 Semester	Spring	**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_ELCOM 5132		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Natural polymer materials, Eco-friendly material, Polyhydroxyalkanoates, Nano-fibers, Bacterial cellulose, Collagen

授業の目標 Course Objectives

Biomacromolecules are the basic units of living organisms, and can be divided into proteins, nucleic acids, and polysaccharides. Of these, the polymers that exist in large quantities are called natural polymers, and have been used by mankind since ancient times. In this course, students will understand the structure and physical properties of these natural polymers (in other words, biological resource polymers), and then acquire knowledge about their advanced utilization and functionalization.

到達目標 Course Goals

To understand the synthetic mechanism, structure, and physical properties of biopolymers such as proteins, polysaccharides, lignin, and bio-polyesters, which exist abundantly in nature, to read and understand the latest papers on their applications, and to acquire basic knowledge for material applications.

授業計画 Course Schedule

1. Guidance and introduction
2. Natural polymers as materials
3. Cellulose
4. Polyhydroxyalkanoate
5. Nano-fiber(collagen)
6. Nano-fiber(plant cellulose)
7. Nano-fiber(bacterial cellulose)
8. Creation of a report

準備学習（予習・復習）等の内容と分量 Homework

Students will be given assignments that correspond to the content of the lecture and will be required to write reports. Students will deepen their understanding by reading the latest academic papers and writing reports on them.

成績評価の基準と方法 Grading System

In this course, students will be evaluated by submitting a report at the end of the lecture. Students will be evaluated based on their basic knowledge of the molecular structure and functionality of biopolymer materials and their applications, and on the persuasive and logical development of their reports. To pass, students must earn at least 60 points out of 100 points.

[Syu]: > ca.90 points, [Yu]: > ca. 80 points, [Ryo]: > ca.70 points, [Ka]: > ca. 60 points

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

適宜資料を配布する。参考書を適宜示すが，教科書は用いない。

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

備考 Additional Information

Students should take courses in polymer chemistry and biochemistry in advance. The maximum number of students is about 30.

科目名 Course Title	化学反応創成学入門[Introduction to Chemical Reaction Design and Discovery]		
講義題目 Subtitle			
責任教員 Instructor	陳　旻究 [JIN Mingoo] (創成研究機構化学反応創成研究拠点)		
担当教員 Other Instructors	Min Gao[Min Gao], HUANG Chung-Yang[HUANG Chung-Yang], SIDOROV Pavel[SIDOROV Pavel], AKAMA Tomoko[AKAMA Tomoko], LIST Benjamin[LIST Benjamin]		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094416
期間 Semester	Summer	**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_ELCOM 5271		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Design of Chemical reaction and molecular assembly with functions, Chemoinformatics, Computational Chemistry

授業の目標 Course Objectives

This course introduces a brand-new research way for investigating molecular chemistry. Especially, the design of new chemical reactions and molecular assembly systems with photo-physical functions will be gently introduced, and the methodology for these research subjects will be described. Also, the basics of computational chemistry and chemoinformatics to solve chemical problems will be introduced. Totally four sessions will be delivered to introduce these contents.

1. Applications of Transition Metal Catalysis:
In these lectures, fundamentals of transition metal catalysis will be introduced to provide an overview on important chemical reactions that utilize metal catalysts. Representative examples of their applications in industry and recent research will then be described.

2. Fundamental Idea of Designing Molecular Crystals and Related Functions:
The lecture introduces basic ideas of designing molecular assembly in a solid state in terms of molecular crystals. Also how the molecular crystals can be related to photo-functional properties.

3. Introduction to Chemoinformatics:
The class introduces the field of chemoinformatics - or, simply put, the application of informatics methods to solve chemical problems. As the amount of information on chemical compounds and reactions grows, there is a need for rationalization of that information. Chemoinformatics provides useful tools for chemical search, rational design of compounds with desired properties, synthesis prediction, etc.

4. Introductory Computational Catalysis:
The lectures related to introductory computational catalysis are aimed to understand the basics of computational chemistry, and how to analyze the computational result and energy profile.

到達目標 Course Goals

The main goal of this course is "Knowing the molecular chemistry research fields with experimental and computational methodologies".
Especially, students will know "the fundamentals of transition metal catalysis and their application and recent research", "the basic ideas to design molecular crystals and photo-functions", "What the cheminformatics is and how to use it" and "fundamental knowledge to use computational chemistry on catalysis".

授業計画 Course Schedule

The entire course contains four sessions as below;

1. Applications of Transition Metal Catalysis
・Fundamentals of Organometallic Chemistry
・Examples of Transition Metal Catalysis

2. Fundamental Idea of Designing Molecular Crystals and Related Functions:
・Introduction to Molecular Crystal Engineering
・Introduction to Photo-functions with Molecular Crystals

3. Introduction to Chemoinformatics:
・Introduction to Chemoinformatics
・Machine Learning in Chemistry

4. Introductory Computational Catalysis:
・Introduction to Computational Catalysis I
・Introduction to Computational Catalysis II

準備学習（予習・復習）等の内容と分量 Homework

Basic knowledge of chemistry in the undergraduate level might be required.

成績評価の基準と方法 Grading System

We will give a take-home exam with several open-answer questions for each session, that students have to submit before some deadline.

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

研究室のホームページ Websites of Laboratory

https://www.icredd.hokudai.ac.jp/all-members/the-huang-lab
https://www.icredd.hokudai.ac.jp/the-jin-group
https://www.icredd.hokudai.ac.jp/the-sidorov-group
https://www.icredd.hokudai.ac.jp/the-gao-group

備考 Additional Information

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	物理化学特別講義 2023[Physical Chemistry 2023]		
責任教員 Instructor	佐田　和己 [SADA Kazuki] (大学院理学研究院)		
担当教員 Other Instructors	松田　建児(京都大学)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094501
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_ELCOM 6400		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Photo-functional materials, photochemical reactions, excited states, circular dichroism, photoisomerization

授業の目標 Course Objectives

Review the basics of photochemical reactions and understand the relationship between the structure of organic materials and light. Based on the above, students will acquire knowledge of photofunctions and photophysical properties, and learn how to design photofunctional materials. Students will also learn about cutting-edge research on photo-functional materials.

到達目標 Course Goals

Review the basics of photochemical reactions and understand the relationship between the structure of organic materials and light, including the excited states of organic materials and electronic and radiative transitions, based on molecular orbital theory. At the same time, students will understand the relationship between light and chirality in optically active organic materials such as circular dichroism and optical rotation. Furthermore, students will understand organic photochemical reactions such as photoisomerization based on the behavior of molecules in excited states, and will gain knowledge of research on cutting-edge photofunctional materials.

授業計画 Course Schedule

The following topics related to the design and synthesis of photo-functional materials will be introduced.

1. Fundamentals of photochemical reactions
2. Excited states based on molecular orbital theory
3. Electronic transitions
4. Radiation transitions
5. Molecules in excited state
6. Circular dichroism and optical rotation
7. Photoisomerization and Photo-functional Materials

準備学習（予習・復習）等の内容と分量 Homework

Hand out materials will be supplied.

成績評価の基準と方法 Grading System

Evaluation will be based on the student's attitude toward learning and the content of the reports on each class.

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

http://www.sbchem.kyoto-u.ac.jp/matsuda-lab/

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	無機分析化学特別講義 2023[Inorganic and Analytical Chemistry 2023]		
責任教員 Instructor	髙橋　啓介 [TAKAHASHI Keisuke] (大学院理学研究院)		
担当教員 Other Instructors	DAM Hieu-Chi (北陸先端科学技術大学院大学)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094502
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_ELCOM 6401		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Materials informatics, data science, machine learning, materials science

授業の目標 Course Objectives

The objective of the course is to understand the basic concept of materials informatics. This contains how data science techniques such as machine learning and data mining.

到達目標 Course Goals

Throughout the course, students would acquire the basic data science knowledge and techniques used in materials informatics.

授業計画 Course Schedule

Professor, Dam Hieu Chi from Japan Advanced Institute of Science and Technology (JAIST), gives lectures about materials informatics.
The course covers the basic concept of materials informatics.
Lectures talks about machine learning and data mining in material science.
Furthermore, design and understanding of materials properties from data science techniques are mainly discussed.

準備学習（予習・復習）等の内容と分量 Homework

Class materials are required to review after the lecture.

成績評価の基準と方法 Grading System

The class grade is evaluated based on the report requested the last day of lecture.
Students are asked to write the report about what students learned in the class where A4 2 pages reports are required to submit after the lecture.

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://www.jaist.ac.jp/laboratory/cci/dam.html

研究室のホームページ Websites of Laboratory

https://takahashigroup.github.io/

備考 Additional Information

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	生物化学特別講義 2023[Biochemistry 2023]		
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	武田　弘資(長崎大学)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094504
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_ELCOM 6400		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

biochemistry, intracellular signal transduction, stress response, protein phosphorylation, mitochondria, inflammation

授業の目標 Course Objectives

The organism maintains homeostasis by resisting and adapting to various types and intensities of stress. The stress response is mediated by sensing and signaling mechanisms in each cell, and their malfunction leads to the development of various diseases. In this course, students will learn about post-translational modifications of proteins as a regulatory mechanism of intracellular signal transduction, and then how cells sense stress and how this information is transmitted into the cell to lead to an appropriate response.

到達目標 Course Goals

After successful completion of this course, you will be able to:
1. Explain the importance of post-translational modifications of proteins in intracellular signal transduction mechanisms.
2. Explain the major intracellular signaling mechanisms mediated by protein phosphorylation.
3. Explain the mechanisms of stress response at the cellular level and their importance.

授業計画 Course Schedule

1. post-translational modification of proteins
2. Basis of Intracellular Signaling Mechanisms
3. Intracellular Signaling Mechanisms Involving Protein Phosphorylation
4. Intracellular signaling mechanisms regulating stress response (5) Stress response and inflammation (1) (2)
5. Stress response and inflammation (1) (2)
6. Mitochondrial stress sensing mechanisms and cellular responses (1) (2)

準備学習 (予習・復習)等の内容と分量 Homework

Fundamentals of protein post-translational modifications and intracellular signal transduction mechanisms

成績評価の基準と方法 Grading System

You will be evaluated by active participation includin (investigation, consideration, and discussion (70%), and assignment on a specified topic (30%, mandatory).

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

適宜、資料を配布する。

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

備考 Additional Information

Lecturer: Professor Kohsuke Takeda, Nagasaki University, Graduate School of Biomedical Science

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	Leading and Advanced Molecular Chemistry and Engineering IA - 2023[Leading and Advanced Molecular Chemistry and Engineering IA - 2023]		
責任教員 Instructor	石森 浩一郎 [ISHIMORI Koichiro] (大学院理学研究院)		
担当教員 Other Instructors	Peter BRZEZINSKI (Stockholm University), SADA Kazuki[SADA Kazuki](理学研究院), UCHIDA Takeshi[UCHIDA Takeshi](理学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094505
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_ELCOM 6401		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Electron Transfer, Proton Transfer, Respiratory Chain, Cytochromes, Kinetic Analysis

授業の目標 Course Objectives

The course aims to provide students with a foundation in the basic concepts of biophysics in electron and proton transfer. Topics will include functional and structural characterization of protein complexes in the respiratory chain. Basic ideas of diffusion, thermodynamics and kinetics will be discussed in the context of biological processes. Fundamental concepts that underlie biomolecular interactions will be discussed and biophysical methods that are employed for the structural analysis of these systems will be introduced, and some examples of the recent advance in this field are also included.

到達目標 Course Goals

After the course students should know how to explain thermodynamic principles if biological energy conversion. Account for the structure of membrane protein complexes for electron and proton transfer in the respiratory chain and photosynthesis. Account for processes of electron and proton transport proteins in the respiratory chain and photosynthesis. Account for the mechanisms of energy converting systems in living organisms. Understand spectroscopic and other physical and analytical methods for studying membrane processes. Understand modern biophysical methods to study molecular mechanisms in respiration system.

授業計画 Course Schedule

1. Introduction and Guidance
2. History, Peter Mitchell and Chemiosmotic Theory
3. Protons, Other Ions and Membranes
4. The Respiratory Chain, Complexes I, III, IV; Reduction of O2
5. Proton Transfer in Biology (Grotthuss Mechanism); Kinetics
6. Electron Transfer in Biology (Bacterial Photosynthesis)
7. Recent Advance of Biophysics in Bioinorganic Chemistry -1
8. Recent Advance of Biophysics in Bioinorganic Chemistry -2

準備学習（予習・復習）等の内容と分量 Homework

Short essay will be assigned at the end of each lecture.

成績評価の基準と方法 Grading System

The final grade corresponds to a weighted average of the results of the essays (40%) and two reports on the lectures of "Recent Advance of Biophysics in Bioinorganic Chemistry" (60%).

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

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=G059

研究室のホームページ Websites of Laboratory

https://www.su.se/english/profiles/brzez-1.181925
http://wwwchem.sci.hokudai.ac.jp/~matchemS/english/index.html
http://wwwchem.sci.hokudai.ac.jp/~stchem/en/

備考 Additional Information

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	Leading and Advanced Molecular Chemistry and Engineering IIA - 2023[Leading and Advanced Molecular Chemistry and Engineering IIA - 2023]		
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-Ju CHENG (National Yang Ming Chiao Tung University)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094506
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_ELCOM 6401		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Organic Chemistry, Polymer Chemistry, Optoelectronics, Organic Semiconductors, Conjugated Molecules

授業の目標 Course Objectives

In this course students will learn design, synthesis, characterization and applications of organic materials for innovative optoelectronic applications, such as chemical sensors, nonlinear optics (NLOs), organic light-emitting diodes (OLEDs), organic transistor (OFETs), organic solar cells (OPVs) and photocatalysis. Particular emphasis will be placed on the classic examples of organic materials including semiconducting polymers, small molecules, molecular devices, self-assembled systems in the literature. Students will study how structure in organic molecules dictates materials properties and ultimately controls function. The objective of the course is to learn structure-property relationships in organic-based functional materials.

到達目標 Course Goals

The goal of this course is help students (1) understand the fundamental working principles of organic optoelectronic devices such as device physics, device engineering and fabrication; (2) understand the molecular design, molecular engineering and structure-property relationships to achieve optimal function of materials and properties; (3) familiar with the synthetic methods and tools to prepare state-of-the-art organic and polymer materials.

授業計画 Course Schedule

1. Introduction to organic materials chemistry
2. Organic thin film transistors
3. Organic solar cells
4. Visible-light-driven organic photocatalysis for hydrogen evolution
5. Advanced carbon-carbon bond formation for synthesis of organic semiconducting molecules and conjugated polymers.

準備学習 (予習・復習)等の内容と分量 Homework

The basic parts of a Physical Chemistry textbook covering the sections of Quantum Chemistry and Thermodynamics.

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=G061

研究室のホームページ Websites of Laboratory

https://sites.google.com/view/yjclab?pli=1

備考 Additional Information

Other Instructor: Prof Yen-Ju CHENG (National Yang Ming Chiao Tung University)

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	Leading and Advanced Materials Chemistry and Engineering II - 2023[Leading and Advanced Materials Chemistry and Engineering II - 2023]		
責任教員 Instructor	村越　敬 [MURAKOSHI Kei] (大学院理学研究院)		
担当教員 Other Instructors	Peng ZHENG (Nanjing University)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094507
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_ELCOM 6401		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Single-molecule force spectroscopy, atomic force microscopy, molecular dynamics simulations, protein (un)folding, protein-protein interaction

授業の目標 Course Objectives

This course is designed to acquire basic knowledge and recent advance in the field of atomic force microscopy (AFM)-based single-molecule force spectroscopy (SMFS) for biomolecular interaction, including the general introduction of AFM, force spectroscopy and molecule dynamics (MD) simulation. It will focus on the application of AFM-SMFS to study protein (un)folding and protein-protein interactions, such as the folding of metalloprotein and viral adhesion of SARS-CoV-2. MD simulation which can provide molecular insight for protein unfolding and unbinding will be briefly introduced as well.

到達目標 Course Goals

You will be able to;
1. discuss about the basic knowledge about AFM and single-molecule force spectroscopy
2. give a presentation about the state-of-art force spectroscope techniques using AFM
3. understand the effect of mutations of SARS-CoV-2 on its transmission by attending the course.

授業計画 Course Schedule

(1) Basics of AFM and AFM imagining
(2) Different types of single molecule force spectroscopy and AFM-SMFS
(3) AFM-SMFS studies of protein (un)folding
(4) AFM-SMFS studies of protein-protein interaction
(5) MD simulations for AFM-SMFS studies
This course provides overviews of recent research on some topics from (1) to (5).

準備学習（予習・復習）等の内容と分量 Homework

To read text books for basic principle of atomic force microscopy or some chapters of protein science at undergraduate level is highly recommended.

成績評価の基準と方法 Grading System

Assignment on a specified subject regarding to "Recent advance of AFM-based single-molecule force spectroscopy " (60%).
In addition, we also consider it as the important factor for assessment how actively students participate in each 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

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G055

研究室のホームページ Websites of Laboratory

https://hysz.nju.edu.cn/pengzhenglab/main.htm

備考 Additional Information

Other Instructor: Prof.Peng ZHENG (Nanjing University)

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	Leading and Advanced Materials Chemistry and Engineering IIIA - 2023[Leading and Advanced Materials Chemistry and Engineering IIIA - 2023]		
責任教員 Instructor	村越 敬 [MURAKOSHI Kei] (大学院理学研究院)		
担当教員 Other Instructors	YAMAURA Kazunari[YAMAURA Kazunari](NIMS), TSUJIMOTO Yoshihiro[TSUJIMOTO Yoshihiro](NIMS)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094508
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_ELCOM 6401		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Inorganic synthesis, phase equilibrium, magnetic materials, superconductors, dielectrics

授業の目標 Course Objectives

To gain a deeper understanding of solid-state compounds, a broad knowledge of crystallography, electromagnetism, quantum chemistry and condensed matter physics is required. This lecture aims to provide students with a general knowledge and understanding of these fields, while introducing the basic knowledge and concepts of each field. The basic understanding of solid-state compounds acquired in this lecture will help the student to acquire the knowledge and understanding necessary to devote themselves to research activities in the future. In particular, solid-state compounds related to electrical devices, and power and energy, such as dielectrics, magnetic materials, semiconductors, superconductors, and thermoelectric materials, will be introduced.

到達目標 Course Goals

You will be able to
(1) Explain the fundamental properties of solid-state compounds.
(2) Explain the crystal structures of solid-state compounds and their synthesis methods.
(3) Explain the outline of electromagnetic properties of solid-state compounds.
(4) Explain the outline of applications of solid-state compounds.

授業計画 Course Schedule

(1) Crystallography of solid-state compounds
(2) Fundamentals of solid-state synthesis, phase equilibria
(3) Laws and concepts underlying solid-state compounds
(4) Phenomenology of magnetic solid-state compounds
(5) Phenomenology of superconducting solid-state compounds
(6) Phenomenology of dielectric solid-state compounds
(7) Phenomenology of thermoelectric solid-state compounds
This course provides overviews of recent research on some topics from (4) to (7).

準備学習 (予習・復習)等の内容と分量 Homework

Reading textbooks on solid state physics and inorganic chemistry at undergraduate level is strongly recommended.

成績評価の基準と方法 Grading System

Assignments on some specified topics in solid state chemistry (60%).
Students will also be assessed on how actively they participated in each 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

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.nims.go.jp/eng/research/group/quantum-solid-state/index.html

備考 Additional Information

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	Leading and Advanced Biological and Polymer Chemistry and Engineering IA - 2023[Leading and Advanced Biological and Polymer Chemistry and Engineering IA - 2023]		
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	James G. OMICHINSKI (University of Montreal), KAMADA Rui[KAMADA Rui](理学研究院), NAKAGAWA Natsumi(理学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094509
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_ELCOM 6401		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

metal-binding proteins, zinc, mercury resistance, arsenic, stress granules, zinc fingers, p53, PML nuclear bodies, SUMO1, SUMO-SIM interactions, MerA, MerB, environmental niches

授業の目標 Course Objectives

1. To establish the importance of regulating precise metal concentrations in different cellular compartments and how these are determined experimentally
2. To establish how to accurately assess the affinity of protein-metal interactions
3. To discuss the importance of zinc in regulating cellular responses to stress
4. To introduce compounds that can alter intracellular metal concentrations and discuss the potential of therapeutic applications of metal containing compounds.
5. To discuss how the environmental niche of the organism has influenced the evolution of mercury resistance in microorganisms in extreme environments.

到達目標 Course Goals

1. To achieve an appreciation the role of biological metals in regulating cellular functions as well as how toxic metals can bind to macromolecules and disrupt biological metals.
2. To appreciate the importance of zinc-binding sites in regulating the structure, activity and function of proteins.
3. To appreciate the potential of metal-based therapeutics in treatment of diseases such as cancer
4. To appreciate how microbial organisms have evolved to adapt to high concentrations of toxic metals in their environment

授業計画 Course Schedule

Lecture 1: Fundamental concepts in metals in biological system
1) Biologically important metals and toxic metals
2) Metal concentrations in cells
3) Quantifying metal-protein interactions

Lecture 2: The role of zinc in regulating the formation of membrane-less bodies in response to stress.
1) The over-abundance of zinc-binding proteins in the proteome
2) The importance of zinc in stress granule formation
3) The role of zinc in regulating SUMO1 binding in PML nuclear bodies

Lecture 3: Metals that stabilize the structure of p53.
1) Zinc binding to the DNA-binding domain of p53
2) Stabilization of variant p53 proteins by arsenic trioxide
3) Metal binding to the p53 tetramerization domain

Lecture 4: The importance of the environmental in the evolution of enzymes involved in bacterial resistance to mercury.
1) Mercury resistant bacteria and the Mer enzymes MerA and MerB
2) Structure and Mechanism of Carbon-Hg bond cleavage by MerB
3) The role of the environmental niche in the transfer of the mercury ion product from MerB to MerA

準備学習（予習・復習）等の内容と分量 Homework

Read the articles in the "Reading List"
Reading List
Lecture 1:
1) doi.org/10.1016/B978-0-444-64225-7.00001-8
2) doi.org/10.1093/jxb/erab481
3) doi.org/10.1016/j.cub.2021.03.054

Lecture 2:
1) 10.1038/cddiscovery.2017.71
2) doi.org/10.1093/nar/gkac620
3) doi.org/10.1016/j.celrep.2017.12.036

Lecture 3:
1) doi.org/10.1016/j.ccell.2020.11.013
2) doi.org/10.1016/j.celrep.2022.110622
3) 0.3389/fmolb.2022.895887
4) 10.1038/s41598-017-01442-8

Lecture 4:
1) doi.org/10.1016/j.envres.2017.08.051
2) doi.org/10.1021/acsenvironau.1c00022
3) doi.org/10.1021/jacs.6b11327
4) doi.org/10.1021/es400527m

成績評価の基準と方法 Grading System

Assignment on specified topics regarding "metal binding" and "mercury resistance" (60%); Student participation in class (40%)

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

Lecture 1:
1) doi.org/10.1016/B978-0-444-64225-7.00001-8
2) doi.org/10.1093/jxb/erab481
3) doi.org/10.1016/j.cub.2021.03.054

Lecture 2:
1) 10.1038/cddiscovery.2017.71
2) doi.org/10.1093/nar/gkac620
3) doi.org/10.1016/j.celrep.2017.12.036

Lecture 3:
1) doi.org/10.1016/j.ccell.2020.11.013
2) doi.org/10.1016/j.celrep.2022.110622
3) 0.3389/fmolb.2022.895887
4) 10.1038/s41598-017-01442-8

Lecture 4:
1) doi.org/10.1016/j.envres.2017.08.051
2) doi.org/10.1021/acsenvironau.1c00022
3) doi.org/10.1021/jacs.6b11327
4) doi.org/10.1021/es400527m

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

備考 Additional Information

Other Instructor: James G. Omichinski (University of Montreal)

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	キャリアマネジメント特別セミナー[Career Management Special Seminar]		
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	七澤　淳(理学研究院客員教授)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094510
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_ELCOM 6400		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Company, Research and Development, Career Path, Management Education

授業の目標 Course Objectives

1. From the early stages, students will learn what society expects from its Ph.D.s.
2. Students will acquire the knowledge of social situations which help set research themes.

到達目標 Course Goals

1. Through logical and mathematical thinking with a high level of expertise, students will be actively involved in non-specialized social issues.
2. Students will connect social issues with their own specialties (strength), then incorporate them into a “research theme”.
3. Students will actively involve themselves in group discussions while considering other participants.

授業計画 Course Schedule

Classes will be conducted in small groups (generally around 5 students).
1: Introduction of economics, patents, and corporate research cases by visiting professor Atsushi Nanasawa, who was active in the private sector for many years. (60min)
2: Read books on social issues and practice (1) problem identification and (2) suggest solutions in the form of workshops.
3: Individual interviews (specialization / research situation / career preference) will be held around the 1st and 2nd classes. A follow up meeting will be held in March 2024.

[Themes of lecture / Work shop] Total 6 classes, 120 min each
1. Concept of production cost / Objectives and operational issue of group work and workshop
2. What is a patent? / Environment, natural resources and energy
3. Research cases of young employees / Artificial intelligence
4. Research cases of veterans / Life science
5. Research cases of responsible people / Population and generational attitudes
6. Summary of workshops / Theme setting for Company Consortium

Classes will generally be held during the week around the 20th of each month, the dates decided in consultation with students.
Classes will generally be conducted face-to-face, but online (hybrid) participation is also possible depending on the situation. In some cases, classes may be offered only online.
Slack and Miro online whiteboard will be used for information exchange.

準備学習（予習・復習）等の内容と分量 Homework

Choose and read one book on each designated lecture theme in advance so that you can discuss it.

成績評価の基準と方法 Grading System

Students will be evaluated by i) attitude toward learning (20%), ii) status of homework efforts (degree of information collection and understanding) (30%), iii) contribution to group discussions and group work in each class (e.g., active participation and quality of comments) (30%), iv) quality of reports and other submissions (20%).

他学部履修の条件 Other Faculty Requirements

Priority will be given to participants in the Ambitious Leader’s Program and other degree programs, and this may limit the available places.

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://phdiscover.jp/alp/

研究室のホームページ Websites of Laboratory

備考 Additional Information

· For convenience, this course is offered as a subject at the graduate level, but it is recommended for doctoral course participants.

· Priority will be given to participants in the ALP and other degree programs who are required to complete this course. If there are too many applicants for the course, the instructor in charge will contact you via the ELMS to confirm your place.

*The first class will be held between 4/17-21. Students interested in attending must complete the scheduling form (Deadline for responses: April 10). Information on scheduling is available on the ELMS.

科目名 Course Title	化学特別講義[Advanced Chemistry]		
講義題目 Subtitle	実践的データ科学[Practical Data Science]		
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	和田　陽一郎((株)D4c アカデミー)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094511
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_ELCOM 6400		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Data Science, Social Implementation, Programming, Presentation, Career Making

授業の目標 Course Objectives

As we move to Society 5.0, people who can implement various methods of data science in society (hereafter, simply described as “social implementation”) are required. Since the process of social implementation is similar to the process of conducting academic research, there are cases where people who have received an academic research education at graduate school will proceed to be social implementation specialists. The purpose of this class is to acquire skills necessary for social implementation (programming, various methods of data science, quality control, output for society) regardless of current knowledge of data science. Students are expected to become leaders in various fields by adding data science to the skills they have cultivated in their current specialized field.

到達目標 Course Goals

Students will

1. be able to understand various methods of data science and implement them.
2. be able to learn and practice how to manage quality control when implementing data science in society.
3. be able to learn and practice the techniques to communicate results obtained by data science methods to society.

授業計画 Course Schedule

This class will be offered as an intensive lecture by Dr. Yoichiro Wada (CEO and Dean, D4c Academy/Executive Officer, Data4c’s/Visiting Professor, Hokkaido University/Visiting Associate Professor, Kyusyu University/Visiting Associate Professor, The University of Electro-Communications) who has been active as a data scientist for more than 10 years.

Units 1 to 5: lecture (60 minutes), exercises (20 minutes), and explanations (10 minutes)
Units 6 to 9: Students will be divided into groups to perform social implementation role play. Therefore, discussions and data analysis are mainly conducted by students.

Unit 1: Introduction to Data Science for Social Implementation, Programming-1 (introduction to Python)
Unit 2: Programming-2 (control syntax, data handling)
Unit 3: Understanding and practice of data science methods-1 (modeling and validation)
Unit 4: Understanding and practice of data science methods-2 (various modeling methods and their implementation)
Unit 5: Quality control in data science (project management, program test, output check), Communicating to society (reporting / presentation)
Unit 6: Explanation of the case, scheduling / division by group, presentation of the results of each group
Unit 7: Performing data analysis, creation of presentation file
Unit 8: Performing data analysis, creation of presentation file
Unit 9: Presentation and question-and-answer session for each group, summary of the lecture

準備学習 (予習・復習)等の内容と分量 Homework

Advance preparation
It is necessary to bring your personal PC. Install the necessary software (all free) before class. Procedure manual will be distributed.
Pre-learning materials will be provided for computer language beginners.

If the exercises are not completed in time, take them home and submit them by the deadline announced during class.
If you want to revise the contents of the presentation in Unit 9, please do so and submit it before the deadline announced during class.

The e-mail address for submission will be given during class.

成績評価の基準と方法 Grading System

(1) Submit assignments that will be given during class by e-mail to the designated address.

Accuracy and logical consistency of the submitted content will be evaluated.
The level of understanding of the lecture will also be evaluated through the the submitted content.
(2) Present the output of the role play that the group worked on.
Then, Submit presentation file by e-mail to the designated address.
Originality of the problem setting, accuracy of the analysis, logical consistency of the presentation and ease of understanding of the submitted content will be evaluated.
The percentage of the total evaluation is 40% for (1) and 60% for (2).

他学部履修の条件 Other Faculty Requirements

Priority will be given to participants in the Ambitious program for smart materials science (SMatS) and other degree programs who are required to complete this course. If there are too many applicants for the course, the instructor in charge will contact you to confirm your place.

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://phdiscover.jp/hu/smats/

研究室のホームページ Websites of Laboratory

備考 Additional Information

The schedule will be announced to registered students individually as soon as it is determined, and will also be posted in this column.

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	有機プロセス工学特別 Lecture 2023[Chemical Process Engineering 2023]		
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	杉山　弘和(東京大学)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094551
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_ELCOM 6410		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Chemical Engineering, Process System Engineering, Modeling, Simulation, Optimization

授業の目標 Course Objectives

Learn process flow sheeting using Python. Using the propylene glycol manufacturing process as an example, a manufacturing process consisting of reaction, distillation, and recycling is modeled, and the material and heat balances are calculated. Evaluate the economic efficiency of the process and search for the optimum process while understanding the trade-offs of process combinations and parameter settings. Through exercises, students will learn that it is important to connect various elements as a system in chemical process design.

到達目標 Course Goals

Learn that industrial-scale chemical processes consist of separation, recycling, utility supply, etc. in addition to reactions. In the lecture, using Python, each unit operation is described as a mathematical model, and they are linked so that the whole process can be treated as a system. Furthermore, we will be able to calculate an economic evaluation index based on the mass balance, heat balance, and equipment size of the entire process. Using this, we will be able to select the type of reactor, optimize parameters, and analyze scenarios related to changes in market trends.

授業計画 Course Schedule

Targeting the manufacturing process of propylene glycol, the following modules will be advanced in a practice format. The original version of the distributed source code is modified as appropriate, and finally the entire process program is completed. Basic chemical engineering knowledge related to modeling of reaction and separation processes will be explained as appropriate.

1. Introduction
2. Mixers and heat exchangers
3. Reactor (Continuous Stirred Tank Reactor / Plug Flow Reactor)
4. Distillation column
5. Recycling
6. Economic evaluation

準備学習（予習・復習）等の内容と分量 Homework

・Bring a PC (Windows or Mac).
・Be sure to prepare the Python environment by referring to the separately distributed "How to install Python".
・Try to complete the exercises as much as possible during the lecture time.

成績評価の基準と方法 Grading System

Evaluate by attendance, class participation, and practice report.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

必要な教材・ソースコードは配布する。
Necessary teaching materials and source code will be distributed.

講義指定図書 Reading List

参照ホームページ Websites

Ullmann's Encyclopedia of Industrial Chemistry, https://onlinelibrary.wiley.com/doi/book/10.1002/14356007

研究室のホームページ Websites of Laboratory

https://www.pse.t.u-tokyo.ac.jp/Sugiyama/index_eng.html

備考 Additional Information

It is prohibited to disclose the code used in the lecture (code created by yourself or model code presented) to others (eg uploading to Google Drive etc. where others can see).
Lecture schedule: October 2nd (Mon), 3rd (Tue)

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	物質化学特別講義 2023[Materials Chemistry 2023]		
責任教員 Instructor	鱒渕　友治 [MASUBUCHI Yuji] (大学院工学研究院)		
担当教員 Other Instructors	本郷　研太(北陸先端科学技術大学院大学)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094552
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_ELCOM 6410	
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Materials Informatics, first-principles calculations, molecular orbital method, band theory, density functional theory, machine learning, regression, classification, descriptors, Bayesian statistics, evolutionary computation

授業の目標 Course Objectives

Materials Informatics (MI) is an interdisciplinary research combining materials science with information, data, and statistics sciences, which has been recently established and attracted much attention. This lecture course aims to provide fundamental knowledge of MI, i.e., materials simulations and machine learning, and further to develop practical skills in simulations and data analysis through the lecture.

到達目標 Course Goals

You will obtain not only fundamental knowledge of MI, but also practical skills in materials simulations and data analysis. You will understand your own research projects from theoretical as well as experimental perspectives. Furthermore, you should be able to apply MI to your own projects.

授業計画 Course Schedule

1. Introduction to materials informatics
2. Probability and statistics: estimation theory
3. Machine learning: materials discovery and identification
4. Computational materials science (theory): molecular orbital method, band theory, density functional theory
5. Computational materials science (practical)
6. Hands-on tutorial

準備学習（予習・復習）等の内容と分量 Homework

It is desirable for you to have basic knowledge of undergraduate-level course of mathematics/physics: calculus, linear algebra, probability and statistics/classical mechanics, electromagnetism, statistical mechanics, quantum mechanics. In addition, you are expected to be familiar with computer operations, especially touch typing.

成績評価の基準と方法 Grading System

You will be evaluated by active participation in class and report.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義資料は講義中に提供します。
Lecture materials will be provided during class.

講義指定図書 Reading List

動かして理解する第一原理電子状態計算:DFT パッケージによるチュートリアル／前園涼、市場友宏：森北出版, 2020

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

Bring your laptop.

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	生物機能高分子特別 Lecture 2023[Advanced Applied Biochemistry 2023]		
責任教員 Instructor	佐藤　敏文 [SATOH Toshifumi] (大学院工学研究院)		
担当教員 Other Instructors	佐藤　浩太郎(東京工業大学)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094553
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_ELCOM 6410	
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Precision Polymerization, Chain-Growth Polymerization, Stereochemistry, Living Polymerization, Anionic polymerization, Cationic polymerization, Radical polymerization, Environmentally-Friendly Polymer

授業の目標 Course Objectives

To utilize polymeric materials and to design new functionality, the methodology of the polymer synthesis must be understood. To learn various polymerization methods and the various polymerization mechanisms is mainly studied as the basics of the macromolecular synthesis, and to understand from a practical point of view and a basic organic chemistry point of view is a goal.

到達目標 Course Goals

Our goals are to learn various polymerization-methods and the various polymerization mechanisms and to understand the latest precision synthetic methods of sequence-controlled polymers and cyclic polymers.

授業計画 Course Schedule

Polymer chemistry and organic chemistry around us

1. Polymers in our daily life: commodity plastics
2. Stereochemistry of polymers
3. Precision polymerization 1: Anionic polymerization
4. Precision polymerization 2: Cationic polymerization
5. Precision polymerization 3: Radical polymerization」
6. Environmentally-Friendly Polymer Chemistry
7. Seminar: Novel polymerization systems through various mechanisms

準備学習 (予習・復習)等の内容と分量 Homework

Students are required to carefully read distributed handouts, if any, beforehand and submit reports for assigned problems by specified dates. Also, students present a report for problems after the class ends.

成績評価の基準と方法 Grading System

In principle, students who attend 70% or more classes are graded. The final grade is determined by his/her learning attitude (20%) and reports (80%). The reports are evaluated based on the student's understanding on the synthesis and design of polymers and the logic of the writing. A, 100-90; B, 89-80; C, 79-70; D, 69-60; F, < 60.

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

講義資料を配付します。The documents will be distributed.

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

http://www.satoh-cap.mac.titech.ac.jp/eng/e_index.html
http://poly-ac.eng.hokudai.ac.jp/index_e.html

備考 Additional Information

Please carefully see ELMS.

Other Instructor: Tokyo Institute of Technology Prof. Kotaro Satoh

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	Leading and Advanced Molecular Chemistry and Engineering IB - 2023[Leading and Advanced Molecular Chemistry and Engineering IB - 2023]		
責任教員 Instructor	清水　研一 [SHIMIZU Kenichi] (触媒科学研究所)		
担当教員 Other Instructors	E. PIDKO (TU Delft), Y. YEING (CUHK), C. SIEVERS (GT), M. LUNDBERG (Uppsala U), IIDA Kenji[IIDA Kenji](触媒科学研究所), TOYAO Takashi[TOYAO Takashi](触媒科学研究所), NAKAJIMA Kiyotaka[NAKAJIMA Kiyotaka](触媒科学研究所), ASANO Keisuke[ASANO Keisuke](触媒科学研究所)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094554
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_ELCOM 6411		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

catalysis, reaction mechanism, catalyst design, catalysis theory

授業の目標 Course Objectives

Materials that promote chemical reactions are called Catalyst. Because many useful chemical compounds are produced using catalysts, there has been considerable interest in catalysis from academic and industrial viewpoints. Catalysts provide environmentally-friendly ways of chemical synthesis because catalysts do not change their catalytic properties and drive the chemical reaction with less energy. Therefore, catalysis is indispensable for realizing sustainable human society. However, the research on the catalytic mechanism is still in progress. Another important aspect is catalyst design. More efficient catalysts are desired for keeping the existing human society that is based on the energy consumptions. Therefore, both rational and efficient methods for the catalyst development are highly desirable.

This lecture provides electronic structure theory of catalysis, catalytic mechanism, theoretical methods to investigate catalysis, and material design for efficient catalytic systems. We also show current state of catalyst development. This lecture provides a unique opportunity to explain the forefront of the research by the front runners in the field of catalysis science.

到達目標 Course Goals

By the end of this course you will be able

1-1. to acquire fundamental knowledge of halogenation

1-2. to understand different methods of halogenation reactions

1-3. to learn applications of halogenation reactions in the synthesis of useful building blocks

2. to explain advanced techniques and methods used in computational modeling of heterogeneous catalysts

3. to explain quantum mechanical methods to investigate catalytic reactions

4. to explain how X-ray spectroscopy can be used to probe electronic and geometric structure of molecular catalysts

5-1. to correlate structure and composition of zeolites with the activity, selectivity and longevity in catalytic processes

5-2. to judge the advantages and disadvantages of using mechanical energy instead of heat for specific applications

授業計画 Course Schedule

1-1. Introduction of the background of halogenation

1-2. Discussion of different approaches of halogenation reactions including halide substitution, electrophilic halogenation and radical halogenation

2-1. Introduction of different halogenating agents. Their effects on reactions will be discussed.

2-2. Discussion of different methods including metal catalysis, organocatalysis, photo-triggered halogenation, and electrochemical method

2-3. Discussion of asymmetric halogenation

2-4. Discussion of applications of halogenation reactions in the synthesis of different building blocks. Their synthetic utilities will also be discussed.

3. Computations, Modeling and Catalysis

4. Chemical Complexity and Performance Metrics in Catalysis

5. Basic of Quantum Mechanical Method to Investigate Catalysis

6. Insights into molecular catalysts from X-ray spectroscopy

7. Structure-Performance Relationships of Zeolites in Catalysis

8. Fundamentals and Opportunities of Mechanocatalysis

Since the course schedule may be changed, please confirm final schedule.

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 each lecture.

成績評価の基準と方法 Grading System

Grades are judged based on active attendance records and reports at the end of each lecture.

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=G060

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	Leading and Advanced Molecular Chemistry and Engineering IIB - 2023[Leading and Advanced Molecular Chemistry and Engineering IIB - 2023]		
責任教員 Instructor	伊藤　肇 [ITOH Hajime] (大学院工学研究院)		
担当教員 Other Instructors	Jeung Gon KIM (Jeonbuk National U), SAJIKI Hironao (Gifu Pharmaceutical U), KUBOTA Koji[KUBOTA Koji](工学研究院), JIN Mingoo[JIN Mingoo]		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094555
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_ELCOM 6411		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

organic chemistry, organic synthesis, mechanochemical synthesis

授業の目標 Course Objectives

Organic chemistry is a field of study that is important for the effective use of resources and for supporting people's comfortable and healthy lives. In this lecture, leading researchers from abroad and Hokkaido University will give intensive lectures on organic chemistry fields that have been developed remarkably recently and will be useful for students to have knowledge in the future. The courses will cover mechanochemical organic synthesis.

到達目標 Course Goals

After the completion of this course, you will be able to know concepts and recent progress in mechanochemical organic synthesis.

授業計画 Course Schedule

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

1. Mechanochemical organic synthesis I
2. Mechanochemical organic synthesis II
3. Mechanochemical organic synthesis III
4. Mechanochemical organic synthesis IV
5. Research proposal I
6. Research proposal II

準備学習（予習・復習）等の内容と分量 Homework

Students will make proposal presentations and reports.

成績評価の基準と方法 Grading System

Grades are judged based on attendance records, presentations, and reports during the 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=G062

研究室のホームページ Websites of Laboratory

備考 Additional Information

Other instructors: Prof. Jeung Gon Kim and Prof. Hironao Sajiki

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	Leading and Advanced Materials Chemistry and Engineering IA - 2023[Leading and Advanced Materials Chemistry and Engineering IA - 2023]		
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	2023	**時間割番号 Course Number**	094556
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_ELCOM 6411		
補足事項 Other Information			
授業実施方式 Class Method			

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

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

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=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	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	Leading and Advanced Materials Chemistry and Engineering IB - 2023[Leading and Advanced Materials Chemistry and Engineering IB - 2023]		
責任教員 Instructor	三浦　章 [MIURA Akira] (大学院工学研究院)		
担当教員 Other Instructors	Wenhao SUN (University of Michigan)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094557
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_ELCOM 6411		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Materials Chemistry, Python, Machine Learning

授業の目標 Course Objectives

Students will learn how to use Python to access big data from existing materials databases and how to design and execute a data-driven research project in MSE. State-of-the-art methods in statistical analysis supervised and unsupervised machine learning, and data visualization will be covered.

到達目標 Course Goals

The students understand the basics and hands-on experience of informatics in chemistry and materials science. The students can use their laptops to the cloud and start from the basics of python, and eventually become used to libraries and databases for chemical/materials informatics.

授業計画 Course Schedule

1) Introduction + Classic Examples: Periodic Table, Pettifor Maps, Ashby Diagrams, Ternary Structure Maps.
2) Recent Examples: Survey of Big-Data Materials Science Publications
3) Data Exploration: Interactive Python Data Visualization (Plotly, Bokeh)
4) Unsupervised Machine Learning: Clustering, Dimensionality Reduction
5) Supervised Machine Learning: Classification, Regression
6) Execution: Database Infrastructure. API/REST interfaces. Python Data Visualization
7) High-Throughput Computation, Computational Materials Design
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

Evaluated by 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=G054

研究室のホームページ Websites of Laboratory

備考 Additional Information

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	Leading and Advanced Biological and Polymer Chemistry and Engineering IB - 2023[Leading and Advanced Biological and Polymer Chemistry and Engineering IB - 2023]		
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	Harald GROGER (Bielefeld University), MIURA Akira[MIURA Akira](工学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094558
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_ELCOM 6411		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Biocatalysis, Enzyme, Enzyme catalysis in organic synthesis, Sustainable Aviation Fuel

授業の目標 Course Objectives

This course will be provided as part of the Hokkaido Summer Institute.
This lecture aims to deepen the understanding of basics in biocatalysis and chemoenzyme synthesis.
The lecture will cover basics in biocatalysis, practical aspects of biocatalysis, mechanisms of biocatalytic reaactions, synthetic applications of enzyme catalysis in organic synthesis, and industrial applications of biocatalysis in the chemical and pharmaceutical industry.

到達目標 Course Goals

By understanding the fundamentals of biocatalysis and chemoenzyme synthesis and learning about its applications, students will gain a deeper understanding of the role that biocatalysis and chemoenzyme synthesis play in chmical synthesis, and will be able to introduce new perspectives to their research activities.

授業計画 Course Schedule

0. Guidance of Lectures
1. Basics in biocatalysis
2. Practical aspects of biocatalysis
3. Selected mechanisms of biocatalytic reaactions
4. Synthetic applications of enzyme catalysis in organic synthesis
5. Industrial applications of biocatalysis in the chemical and pharmaceutical industry

準備学習 (予習・復習)等の内容と分量 Homework

Review the distributed documents and contents in the lectures, and ask any questions at the next class.

成績評価の基準と方法 Grading System

Your attitude in classes (20%) and reports (80%) will affect your final grade.

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

Enzyme Catalysis in Organic Synthesis,Third Edition／Editors: Karlheinz Drauz, Harald Groeger, Oliver May：Wiley-VCH, 2012

参照ホームページ Websites

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G048

研究室のホームページ Websites of Laboratory

https://wwwhomes.uni-bielefeld.de/oc1-groeger/HG/index.html

備考 Additional Information

This course will be provided as part of the Hokkaido Summer Institute.
Prof. Harald Gröger of Bielefeld University, Germany will also be in charge of this lecture.

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	Leading and Advanced Biological and Polymer Chemistry and Engineering II - 2023[Leading and Advanced Biological and Polymer Chemistry and Engineering II - 2023]		
責任教員 Instructor	佐藤　敏文 [SATOH Toshifumi] (大学院工学研究院)		
担当教員 Other Instructors	Cheng-Liang LIU (National Taiwan University), ISONO Takuya[ISONO Takuya](工学研究院)		
科目種別 Course Type			
開講年度 Year	2023	**時間割番号 Course Number**	094559
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_ELCOM 6411		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Organic semiconductor, Solution-processable, Organic thermoelectric material

授業の目標 Course Objectives

Organic and polymeric electronics/optoelectronics materials are defined broadly as carbon-based materials that can transport charge in liquid-supported and solid systems. Two classes of these organic-based materials have emerged: small molecules and polymers. This course covers the molecular properties and microstructural characterization of organic semiconductors and charge generation/transport properties. Furthermore, we will evaluate how these materials can be implemented in organic light emitting diodes (OLEDs), organic photovoltaics (OPVs), and organic thin film transistors (OTFTs). In this way, we aim to train the students of this course to establish the relationship between molecular design, molecular transport phenomena, and macroscopic device response.

到達目標 Course Goals

This course will help students with no or limited prior background in this field to acquire a general and overall understanding of organic electronics, especially basic theory, applications, challenges, and recent developments, etc.

授業計画 Course Schedule

1. Lecture: History of organic conjugated polymers
2. Lecture: Design and synthesis of organic conjugated polymers
3. Lecture: Organic light emitting diode
4. Lecture: Organic transistor
5. Lecture: Organic photovoltaic
6. Seminar: Development of Organic Thermoelectric Materials and Device

Organic thermoelectric materials can directly transform the waste heat into electrical power without causing any pollution, but their development is limited due to poor performance, especially low conductivity. In my talk, we outline the design strategies which aim to develop high-performing organic semiconductors and their materials in organic thermoelectrics. A series of solution-processed organic semiconducting molecules are reported. These results indicate that these materials can be modulated through successive changes in conjugation length/side chain substituent length and molecular interaction based on a combination of molecular design and solution-processing techniques. Doping organic semiconductors, conjugated polymer composites, and gels with ionic salt or redox couples are used to achieve enhanced thermoelectric performance. Flexible/wearable thermoelectric generator based on these materials will be demonstrated.

準備学習（予習・復習）等の内容と分量 Homework

Final report regarding to "Design, Synthesis and Applications of Organic Thermoelectric Materials".

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 "Design, Synthesis and Applications of Organic Thermoelectric Materials" (90%)

他学部履修の条件 Other Faculty Requirements

テキスト・教科書 Textbooks

Lecture notes in PDF files will be provided.
PDF ファイルの講義ノートを提供します。

講義指定図書 Reading List

https://pubs.acs.org/doi/10.1021/acs.macromol.2c00957
https://onlinelibrary.wiley.com/doi/10.1002/adfm.202200880

参照ホームページ Websites

https://pubs.acs.org/doi/10.1021/acs.macromol.2c00957

https://onlinelibrary.wiley.com/doi/10.1002/adfm.202200880
https://hokkaidosummerinstitute.oia.hokudai.ac.jp/en/courses/CourseDetail=G049

研究室のホームページ Websites of Laboratory

http://www.mse.ntu.edu.tw/index.php?option=com_zoo&task=item&item_id=215&Itemid=896&lang=en
https://poly-ac.eng.hokudai.ac.jp/index_e.html

備考 Additional Information

Other Instructor: Prof. Cheng-Liang LIU (National Taiwan University)
The class is opened on campus and/or in real-time web system.
Please carefully see ELMS.

科目名 Course Title	応用化学特別講義[Advanced-Applied Chemistry]		
講義題目 Subtitle	異分野ラボビジット		
責任教員 Instructor	幅﨑　浩樹 [HABAZAKI Hiroki] (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	2023	**時間割番号 Course Number**	094560
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_ELCOM 6412		
補足事項 Other Information			
授業実施方式 Class Method			

キーワード Key Words

Interdisciplinary research, Cross-disciplinary exchange, comprehensive perspective

授業の目標 Course Objectives

The goal is to lean about the expert knowledges and skills in the different fields provided by a host laboratory. For this purpose, the students are requested to stay in the host laboratory for a period of about 2 weeks to 2 months.

到達目標 Course Goals

・To be able to conduct research with researchers with different backgrounds by cultivating a wide range of communication skills through discussions.
・To be able to correlate the student's own research and those in different fields by acquiring comprehensive perspectives, which is necessary to promote cross-disciplinary research,

授業計画 Course Schedule

・This class will be limited to graduate students of "Ambitious leaders program" and those joining MANABIYA program of WPI ICReDD.
・Staying a host laboratory will be for a period of two weeks to two months between April to next March.
・Students are requested to leave their own laboratory and stay in the host laboratory to engage the research project provided by the host laboratory and to acquire specialized knowledge and skills in different fields.

準備学習（予習・復習）等の内容と分量 Homework

・Students are requested to investigate research activities of each laboratory thoroughly and select a laboratory that matches the research field you wish to study.

成績評価の基準と方法 Grading System

・The grade is evaluated based on the content of the submitted report and the discussion with the teacher of this lecture about the training content.

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://phdiscover.jp/alp/, https://www.icredd.hokudai.ac.jp/ja/manabiya

研究室のホームページ Websites of Laboratory

備考 Additional Information

Follow the instructions of the host laboratory.