令　和　5　年　度

（April 2023－March 2024）

授　業　概　要

COURSE SYLLABUS

東北大学理学部

Faculty of Science
Tohoku University

Course	Semester/Credits	Instructor	Affiliation
Introduction to Basic Chemistry (基礎化学序論)	2nd Semester 2 Credits	南後　恵理子	Quantum beam-based structural biology and chemistry

Course code/number：SCH-OCH201E

Course Title：ntroduction to Basic Chemistry（基礎化学序論）

Purpose/Abstract：

This class is offered to freshmen enrolled in the AMC course. Fundamental knowledge and cutting-edge research in chemistry and materials science will be presented in the form of seminars in each laboratory. Throughout these seminars, the differences in high school-level and college-level chemistry will be emphasized, and students will be given motivation for their future studies.

Goal：

Understanding of the basic fields of university-level chemistry spread over a cross-section of each field, such as organic chemistry, inorganic chemistry, analytical chemistry, biochemistry and physical chemistry.

Contents：

Following the schedule distributed during the initial class, students will attend seminars and learn the importance of basic chemistry as well as cutting-edge research.

Books required/referenced：

Indicated by each instructor

Preparation and review：

Indicated by each instructor

Grading：

Class attendance, attitude and activity

Remarks：

Course	Semester/Credits	Instructor	Affiliation
Special Class in Basic Chemistry I (専門基礎化学Ⅰ)	3rd Semester 2 Credits	南後　恵理子	Quantum beam-based structural biology and chemistry

Course code/number：SCH-PCH211E

Course Title：Special Class in Basic Chemistry I

Purpose/Abstract：

In this lecture, we try to understand fundamentals of the quantum mechanics and quantum chemistry that are required for advanced chemistry courses. Starting with a lecture of the early quantum mechanics, we learn how to formulate the Schrödinger equation, which is the basic equation of quantum mechanics. The basic concept of wavefunctions (= solutions of the Schrödinger equations) are presented to understand the wave nature of particles in atomic scale. Then the simple models for vibrational and rotational motions of molecules, and the electronic state of the hydrogen atom are treated quantum mechanically as the prototypes for more complex atoms and molecules.

Goal：

Gain the skill to solve simple Schrödinger equations using a problem of a particle in a box. Extend it to solve quantum mechanical problems of the harmonic oscillator and the rigid rotator of diatomic molecules, and the electronic motion of the hydrogen atom.

Contents：

This course will cover the following themes.

1. Outline and introduction to elementary physical chemistry
2. Dawn of the quantum theory
3. The classical wave equation
4. The Schrödinger equation
5. A particle in a box
6. General Principles of quantum mechanics
7. The harmonic oscillator and the rigid rotator
8. The hydrogen atom

Books required/referenced：

Physical Chemistry - a molecular approach by D.A.McQuarrie and J.D.Simon

Preparation and review：

Read the textbook before and after the lectures and try to solve the examples in the textbook.

Grading：

Attendance + Mid-term exam. + Final exam.（+Additional exam）

Remarks：

Course	Semester/Credits	Instructor	Affiliation
Special Class in Basic Chemistry Ⅱ (専門基礎化学Ⅱ)	3rd Semester 2 Credits	BREEDLOVE BRIAN	Laboratory of Nanomaterials

Course code/number：SCH-INO211E

Course Title：Special Class in Basic Chemistry II (AMC)

Purpose/Abstract：

This course builds from the basic electronic structure of atoms and molecules to bonding in compounds to structure and finally to the relationship between the structure and properties of compounds.It is my aim that students will develop tools needed to predict the properties from the electronic and physical structures of relatively simple compounds.

Goal：

The goal of this course is to learn the basics of electronic structures of atoms and molecules and bonding. In addition, students will be able to understand the relationship among those topics and the properties of compounds.

Contents：

Below is a tentative schedule and content for the course. The schedule may be changed due to time constraints or at the discretion of the professor.

1. Elemental Origin and Atomic Composition
2. Quantum Mechanics,
3. Periodic Table General Properties and Periodicity, Magnetic Properties
4. Covalent Bonding, Lewis Structure, Molecular Orbital Method
5. Atoms, Molecule, polyatomic molecules
6. Valence bonding method, hybrid orbital, π bond
7. Molecular structure and polarity
8. Symmetry and group theory
9. Group theory molecular orbital, application to molecular vibration
10. Crystal structure (1)
11. Crystal structure (2)
12. Ionic solids
13. Metal and metal like
14. Electric conduction, semiconductor, superconductivity

Books required/referenced：

Primary text: Inorganic Chemistry 6th Ed,
General Chemistry 9th Ed. by Ebbing and Gammon
and other texts

Preparation and review：

You should be reading the chapters and trying problems not assigned by the professor.

Grading：

Class attendance, homework and two exams

Remarks：

email: breedlove.brian.b1@tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
Special Class in Basic Chemistry Ⅲ (専門基礎化学Ⅲ)	3rd Semester 2 Credits	和田　健彦	Laboratory of Nanobio Functional Materials/Chemical Biology & Supramolecular Photochirogenesis

Course code/number：SCH-ORG211E

Course Title：Special Class in Basic Chemistry Ⅲ (Basic Organic Chemistry I)

Purpose/Abstract：

Purpose/Abstract：

Objective and Summary of Class：
Students will learn how to understand organic chemical reactions. The purpose is to learn the reactions of basic organic compounds, such as alkanes, alkenes, and organic halides, via the flow of electrons shown using arrows.

(1) Structure and Bonding.
(2) Organic Compounds
(3) Stereochemistry
(4) Alkanes
(5) Alkenes
(6) Alkynes

Intended for those students majoring in organic chemistry, this class will provide the broad fundamentals of organic chemistry needed to become a chemist. It is desirable to continue taking Chemistry C, Special Class in Basic Chemistry Ⅲ, and General Organic Chemistry A, B and C as well as to take Exercises in Organic Chemistry A and Organic Chemistry Ⅰ A and Ⅱ A (class concerning spectroscopy)

Goal：

- To understand chemical bonds and structure of organic compounds.
- To understand streochemisry.
- To understand the main reactions of alkanes via electron flow arrows.
- To understand the main reactions of alkenes via electron flow arrows.
- To understand the main reactions of alkynes via electron flow arrows.

Contents：

During the class, chapters 1-8 of" Organic Chemistry, 9th ed." by McMurry will be studied.
Basically, I will give quizzes for each chapter, so please do your best at preparation and review using the textbook.

Books required/referenced：

"Organic Chemistry 9th ed." by John McMurry

Preparation and review：

Preparation / review / tasks are instructed during lecture.

Grading：

Quiz and reports and a final exam. Quizzes will be given at the beginning of classes.

Remarks：

The office hours are basically from 10 am to 5 pm, from Monday to Friday

Course	Semester/Credits	Instructor	Affiliation
Special Class in Basic Chemistry Ⅳ (専門基礎化学Ⅳ)	3rd Semester 2 Credits	BREEDLOVE BRIAN	Laboratory of Nanomaterials

Course code/number : SCH-INO211E

Course Title : Special Class in Basic Chemistry IV (AMC)

Purpose/Abstract :

This class will cover general analytical and inorganic chemistry, such as equilibria, acids and bases, acid-base equilibria, oxidation and reduction reactions, electrochemistry, etc.

Goal :

Students will gain an understanding in basic topics in analytical and inorganic chemistries, which will aid them in their future studies.

Contents :

Contents and Schedule:

1. Chemical equilibria
2. Acid and bases
3. Acid-base equilibria
4. Oxidation and reduction
5. Introduction to coordination complexes and solubility
6. Electrochemistry
7. Introduction to symmetry

Books required/referenced :

Inorganic Chemistry 6th ed.
Ebbing and Gammon, General Chemistry 9th ed.

Preparation and review :

read and do problems in the appropriate chapters

Grading :

Attendance, homework and two exams

Remarks :

breedlove.brian.b1@tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
General Physical Chemistry A (物理化学概論A)	5th Semester 2 Credits	米田　忠弘	Advanced Scanning Probe Microscopy, IMRAM (Tagen)

Course code/number : SCH-PCH221E

Course Title : Thermodynamics and statistical physics

Purpose/Abstract :

In this course, we study thermodynamics, statistical mechanics, and the properties of many-body systems at finite temperature. The course is intended for the understanding both of chemical physical phenomena appeared in material science. We will cover the classical thermodynamics, the relationship between the macroscopic phenomena and the microscopic properties (statistical mechanics), and the application of these ideas to the observed states of actual materials.

Goal :

Chemical energetics; entropy; work and reversibility; phase equilibria; solution properties; a statistical approach to chemical energetics and equilibria Introduction to quantum chemistry:- applications to the bonding and structure of molecules, materials and nanoparticles. Molecular properties and reactivity

Contents :

The following topics will be discussed, each of which takes two weeks.

Properties of ideal gases
Statistical thermodynamics principles
Statistical thermodynamics principles
Entropy accounting principles
Free-energy functions & the chemical potential
Application to multi-phase systems
Application to solids, surfaces & nanostructures
Fuel cell

Topics like as chemical reaction of fuel cells and spin ordering of magnetic materials are both included.

Books required/referenced :

Hand out materials based on Physical Chemistry – molecular approach by D.A. McQuarrie and J.D. Simon

Preparation and review :

Homeworks at adequate occasions

Grading :

Midterm and Final Examination, plus reports of several classes, and the attendance

Remarks :

Course	Semester/Credits	Instructor	Affiliation
General Physical Chemistry B (物理化学概論B)	4th Semester 2 Credits	組頭　広志	Nano Physical Chemistry

Course code/number：SCH-PCH222E

Course Title：General Physical Chemistry B

Purpose/Abstract：

The course deals with the introduction to the principles of quantum mechanics and their application to chemical systems.Topics include the formalism and mahtematical tools of quantum mechanics; approximate methods; atomic structure; the chemical bond,valence bond; and molecular orbital theory.

Goal：

The aim of this courseis that students are able to;(1) understand approximation methods,including the variational method and perturbation theory;(2) explain the atomic structures and their spectroscopic properties;(3) understand the quantum mechanical description of the chemical bond and molecular structures;(4) be familiar with the concept of molecular orbital theory.

Contents：

The contents and schedule are as shown in below:

(1) Introduction
(2) Approximation method in quantum mechanics:Variational method
(3) Apporoximation method in quantum mechanics:Perturbation theory
(4) Structure of the helium atom
(5) Multiple electron atoms and the Pauli principle
(6) Multiple electoron atoms:term symbol and atomic spectra
(7) Chemical bond:the hydrogen molecular ion
(8) Chemical bond:The molecular orbital method
(9) Chemical bond:the structure of diatomic molecules
(10) Bonding in polyatomic molecules
(11) Hybridization and molecular structure
(12) Conjugated pi-electron systems:The Hückel molecular orbital method
(13) Computational quantum chemistry

Books required/referenced：

Physical Chemistry - a molecular approach by D.A.McQuarrie and J.D.Simon

Preparation and review：

The session time is limited and therefore self-directed learning is important.Students are required to prepare and review for each class.

Grading：

Students are evaluated on their class attendance,the midterm report, and the final examination.

Remarks：

Course	Semester/Credits	Instructor	Affiliation
General Physical Chemistry C (物理化学概論C)	5th Semester 2 Credits	荒木　保幸	Institute of Multidisciplinary Research for Advanced Materials

Course code/number：SCH-PCH223E

Course Title：General Physical Chemistry C

Purpose/Abstract：

Chemical kinetics, also known as reaction kinetics, is the study of the speed of chemical processes.

A study of chemical kinetics includes investigations of how experimental conditions can influence on the speed of a chemical reaction. In this class, appropriate construction of mathematical models that can describe the characteristics of a chemical reaction will be discussed. Concept of "order of reaction" and "how to determine order of reaction along with integrated rate laws" are also the most important topics of this class. Moreover, the enzymatic reaction kinetics will be introduced to understand the specific examples of chemical reaction rate determination.

On the other hand, starting from the discussion of molecular velocities in the gas phase (Maxwell-Boltzmann distribution), the relationship between molecular collisions and reaction rates will be discussed. This discussion will be continued to study the relationship between chemical reactions in the gas phase and the internal and potential energies of the reacting molecules.Through the trial to solve the problems in the textbook, the establishment of the knowledge will be achieved.

Goal：

The main goal is to teach principles of reaction kinetics and catalysis. Topics covered include the laws and theories governing reaction rates and mechanisms in gas, condensed phase and at the solid-liquid interface. Modern experimental approaches to study kinetics in complex chemical and biochemical systems and analysis of experimental data will be introduced. Computational approaches to estimate rates of chemical reactions and study the mechanism of catalysis will be discussed.

Contents：

Contents and Progress Schedule of the Class:

In this class, the contents from Chapter 27 to Chapter 31 of the textbook (Physical Chemistry – a molecular approach by D. A. McQuarrie and J.D. Simon) will be discussed.

Chapter 27 / The Kinetic Theory of Gases
Chapter 28 / Chemical Kinetics : Rate Laws
Chapter 29 / Chemical Kinetics : Reaction Mechanisms
Chapter 30 / Gas-phase Reaction Dynamics
Chapter 31 / Solid and Surface Chemistry

Books required/referenced：

Physical Chemistry – a molecular approach by D. A. McQuarrie and J.D. Simon

Preparation and review：

Students who joins in this class is expected to keep prep.

Grading：

Record and Evaluation Method:

Class attendance (perfect attendance assigns 60 points), reports (perfect submission assigns 20 points) and scores of final examinations (full score assigns 20 points) are totally evaluated.

Person who gains over 90 points gets AA score.

Remarks：

This class will be conducted in English.

Course	Semester/Credits	Instructor	Affiliation
General Physical Chemistry D (物理化学概論D)	5th Semester 2 Credits	髙岡　毅	Advanced Scanning Probe Microscopy

Course code/number：SCH-PCH224E

Course Title：Principles of spectroscopic methods in physical chemistry

Purpose/Abstract：

Gain the skill for the analysis of molecules, focusing on the understanding and application to the spectroscopic methods. We cover wide area of the spectroscopic methods, including optical absorprion/emission spectroscopy and magnetic resonance spectroscopy.

Goal：

Gain the skill for the analysis of molecules, focusing on the understanding and application to the spectroscopic methods. We cover wide area of the spectroscopic methods, including optical absorprion/emission spectroscopy and magnetic resonance spectroscopy.

Contents：

1）molecular spectroscopy
2）magnetic resonance NMR
3）photochemistry、laser spectroscopy

Books required/referenced：

Textbook: Physical Chemistry – a molecular approach by D .A. McQuanie and J.D.Simon

Preparation and review：

preparation and review

Grading：

Score: every week's attendance + Final exam

Remarks：

Katahira Campus - South Multidisciplinary Research Laboratory Building 1 "E02" Room308
Email: tsuyoshi.takaoka.b1@tohoku.ac.jp
Office hours: Mon - Fri, 9:00 - 17:00
Closed: Saturdays and Sundays

Course	Semester/Credits	Instructor	Affiliation
Exercises in Physical Chemistry A (物理化学演習A)	4th Semester 1 Credit	米田　忠弘 髙岡　毅	Advanced Scanning Probe Microscopy & Laboratories at Katahira Campus.

Course code/number：SCH-PCH251E

Course Title：Exercises of problems and topics in physical chemistry A

Purpose/Abstract：

Through lectures of physical chemistry classes, fundamentals of physical and mathematical knowledge will be lectured. However, it is also necessary to solve actual problems in physical chemistry issues. Topics and exercises in special cases will be extended.

Goal：

In this course, we try to solve problems related to the issues discussed in AMC courses. The goal of this class is to require skills through these process.

Contents：

Part of this class will go along with 'Problems ands solutions to accompany Physical Chemistry – molecular approach by D.A. McQuarrie and J.D. Simon' in which the problems shown in each chapter of the text book are analyzed.

Books required/referenced：

Indicated by each instructor.

Preparation and review：

Homework at adequate occasions

Grading：

class attendance, reports and scores of emaminations

Remarks：

Course	Semester/Credits	Instructor	Affiliation
Exercises in Physical Chemistry B (物理化学演習B)	5th Semester 1 Credit	米田　忠弘	Advanced Scanning Probe Microscopy & Laboratories at Katahira Campus.

Course code/number : SCH-PCH252E

Course Title : Exercises of problems and topics in physical chemistry B

Purpose/Abstract :

Through lectures of physical chemistry classes, fundamentals of physical and mathematical knowledge will be lectured. However, it is also necessary to solve actual problems in physical chemistry issues. Topics and exercises in special cases will be extended.

Goal :

In this course, we try to solve problems related to the issues discussed in AMC courses. The goal of this class is to require skills through these process.

Contents :

Part of this class will go along with 'Problems ands solutions to accompany Physical Chemistry – molecular approach by D.A. McQuarrie and J.D. Simon' in which the problems shown in each chapter of the text book are analyzed.

Books required/referenced :

indicated by each instructor

Preparation and review :

Homework at adequation occasions

Grading :

class attendance, reports and scores of emaminations

Remarks :

Course	Semester/Credits	Instructor	Affiliation
General Inorganic and Analytical Chemistry A (無機分析化学概論A)	4th Semester 2 Credits	BREEDLOVE BRIAN	Laboratory of Nanomaterials

Course code/number : SCH-INO221E

Course Title : General Inorganic and Analytical Chemistry A (AMC)

Purpose/Abstract :

Analytical chemistry is an important area of chemistry as it covers not only qualitative anaylsis of samples using forms of spectroscopy, electrochemistry, etc. and quantification of species in samples but also data analysis. This class is designed for students to gain knowledge in analytical techniques and concepts involved in those techniques.

Goal :

The goal of this course is for students to learn what is used in chemical analysis and some tools to help them perform chemical analysis.

Contents :

Below is a tentative schedule:

1. Overview
2. Separation techniques
3. Activity and equilibrium
4. Spectroscopy
5. Mass Spectrometry and nuclear magnetic resonance
6. Electrochemistry

Books required/referenced :

Fundamentals of Analytical Chemistry 9ed; Skoog, West,, Holler and Crouch

Preparation and review :

read the book

Grading :

Attendance and two exams

Remarks :

breedlove.brian.b1@tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
General Inorganic and Analytical Chemistry B (無機分析化学概論B)	4th Semester 2 Credits	BREEDLOVE BRIAN	Laboratory of Nanomaterials

Course code/number : SCH-INO222E

Course Title : General Inorganic and Analytical Chemistry B (AMC)

Purpose/Abstract :

This class is a survey of the general properties and reactivity of main group elements and transition metals. During the course, we cover chapters 9–22 in Inorganic Chemistry, 6th ed.

Goal :

The goal of this class is to learn the general trends in reactivity of the chemical elements.

Contents :

Contents and Schedule:

1. Chemistry of main group elements
2. d-Block metals
3. Structure of d-block metal complexes
4. Basics of coordination chemistry

Books required/referenced :

Inorganic Chemistry 6th Ed. (formerly Shriver and Atkins)

Preparation and review :

Read the chapters and do the problems at the end of the chapter

Grading :

Attendance and two exams

Remarks :

breedlove.brian.b1@tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
General Inorganic and Analytical Chemistry C (無機分析化学概論C)	5th Semester 2 Credits	BREEDLOVE BRIAN	Laboratory of Nanomaterials

Course code/number : SCH-INO223E

Course Title : General Inorganic and Analytical Chemistry C (AMC)

Purpose/Abstract :

The objective of this class is to introduce frontiers of inorganic chemistry. The aim of the class is to show how developments in inorganic chemistry impinges on the other disciplines, such as life science, condensed matter physics, and materials chemistry. We will discuss materials chemistry focusing on solid-state compounds, their structures, and electronic, magnetic, and optical properties. In addition, we will discuss nanomaterials and biosensors and introduce the area of catalysis.

Goal :

Students will gain an understanding of the properties of solid-state materials and nanomaterials and learn about f-block elements. In addition, you will learn basic concepts of catalysis and biosensors.

Contents :

Basic Contents and Schedule:

1. f-block elements
2. Introduction to catalysis
3. Homogeneous catalysis
4. Heterogeneous catalysis
5. Other catalytic systems (e.g., photocatalysis and electrocatalysis)
6. Biological inorganic chemistry
7. Biological inorganic processes
8. Band structures of solids and semiconductors
9. Magnetic properties of solids
10. Electronic properties of solids
11. Optical properties of solids
12. Solid-state and materials chemistry
13. Nanoscience
14. Biosensors

Books required/referenced :

Inorganic Chemistry 6th Ed.

Preparation and review :

reading

Grading :

Class attendance and two exams

Remarks :

breedlove.brian.b1@tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
General Inorganic and Analytical Chemistry D (無機分析化学概論D)	6th Semester 2 Credits	火原　彰秀	Laboratory of Nano-Micro Chemical Analysis

Course code/number : SCH-INO224E

Course Title : General Analytical Chemistry: two-phase equilibrium, electroanalytical chemistry, and instrumental analysis

Purpose/Abstract :
In this course, students will understand various analytical methods based on the fundamental knowledge on analytical chemistry learnt in Special Class in Basic Chemistry IV.

Goal :
The purpose of this course is to help students explain principles, appratuses, and applications of the analytical methods from the viewpoint of selectivity and sensitivity.

Contents :
This is a lecture-centered course with short quiz and homework report. The contents and schedule are as shon below:
1) Introduction
2) Electrochemistry
3) Potentiometry and coulometry
4) Ion selective electrode and other sensors
5) Two-phase equilibrium and extracrtion
6) Principle of chromatography
7) Partition chromatography
8) Ion chromatography and size exclusion chromatography
9) Review of electroanalytical chemistry, extraction, and chromatography
10) States of atoms
11) Atomic absorption spectroscopy
12) Inductively-coupled plasma optical emission and mass spectroscopies
13) X-ray generation and detection
14) X-ray fluorescence
15) Review of atomic and x-ray spectroscopies

Books required/referenced :
References are handed out at every class.

Preparation and review :
Students are expected to do homework (review).

Grading :
Quizzes in class, homework reports, and examination(s)

Remarks :
Bring your scientific calculator.
E-mail: hibara@tohoku.ac.jp
Lab homepage: http://www2.tagen.tohoku.ac.jp/lab/hibara/
Office hour: weekday 13:00-18:00, IMRAM West Building 1 RoomS211

Course	Semester/Credits	Instructor	Affiliation
Exercises in Inorganic and Analytical Chemistry B (無機分析化学演習B)	5th Semester 1 Credit	芳野　遼 福山　真央	Laboratory of Solid-State Metal-Complex Chemistry Laboratory of Nano/Micro Chemical Measurements

Course code/number : SCH-INO252E

Course Title : Exercises in Inorganic and Analytical Chemistry: From Basic Inorganic Chemistry to Coordination Chemistry and Ligand-Field Theory

Purpose/Abstract :
Conduct exercises in inorganic and analytical chemistry, in particular an area from basic inorganic chemistry to coordination chemistry related to the solid-state molecular chemistry, by explaining their fields.

Goal :
To gain a deeper understanding of the course. And we hope that you may be interested in the field of the solid-state molecular chemistry.

Contents :
Conduct exercises and explanation for the fields.
* Basic of quantum chemistry
* Molecular orbital and Molecular electronic state
* Periodic table and crystal structure
* Acid-base and Oxidation-reduction
* Thermodynamics and crystal structure
* Molecular symmetry
* Ligand-field theory
* Crystal-field theory
* Coordination chemistry 1
* Coordination chemistry 2
* Analytical chemistry 1 (Titration)
* Analytical chemistry 2 (Electrochemistry)
* Analytical chemistry 3 (Introduction to image analysis)
* Analytical chemistry 4 ((Quantification using image analysis 1)
* Analytical chemistry 5 (Quantification using image analysis 2)

Books required/referenced :
The problem set will be given at each class hour, but the following texts may be useful for your study :
Shriver & Atkins' Inorganic Chemistry, by P. Atkins et al., Oxford University Press.
D- and F-Block Chemistry, by C. Jones, RSC publisher.
Quantitative Chemical Analysis, by D. C. Harris, W. H. Freeman and Company.

Preparation and review :
The problems given at each class hour should be solved.

Grading :
Evaluation will be performed by your attendance records and results of the exercises.

Remarks :
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maofukuyama@tohoku.ac.jp 022-217-5640

Course	Semester/Credits	Instructor	Affiliation
General Organic Chemistry A (有機化学概論A)	4th Semester 2 Credits	水上　進	Institute of Mulidisciplinary Research for Advanced Materials (IMRAM), Laboratory of Cell Functional Molecular Chemistry

Course code/number：SCH-ORG221E

Course Title：General Organic Chemistry A

Purpose/Abstract：

Objective and Summary of Class:

This class is part of organic chemistry classes, including Special Class in Basic Chemistry III, and General Organic Chemistry A, C, and D. The lecture covers the following topics:

(1) Basic chemistry of organic halides.
(2) Nucleophilic substitution reactions and reaction theory
(3) Diene and allylic systems
(4) Conjugated and aromatic compounds
(5) Aromatic substitution reactions
(6) Properties of alcohols, phenols, ethers, and thiols.

This class will provide the broad fundamentals of organic chemistry that are essential for students to be a chemist.

Goal：

Goal of Study:

To understand

(1) Properties of alkyl halides and related compounds, synthetic methods, radical reactions, principles of the stability of allyl radicals, the characteristics of Grignard reactions
(2) Reactions of organic compounds, especially the characteristics and reaction mechanisms of nucleophilic substitutions and aliphatic reactions
(3) Stability of conjugated chains, electrophilic reactions, kinetic and thermodynamic control of reactions, and the characteristics of Diels-Alder reactions
(4) Structure of benzene and its derivatives, the principles of aromatic stability, heterocyclic aromatic compounds, the Huckel rule, and electrophilic substitution reactions
(5) Chemical properties and reactivity of alcohols, phenols, epoxides, and thiols

Contents：

Contents:

The class will involve chapters 10, 11, and 14–18 of Organic Chemistry 9th Ed. by John McMurry. However, the parts in chapter 14 covering spectroscopy will be omitted.

1. Introduction
2. Organohalides (Chapter 10)
3. Nucleophilic substitutions and eliminations (Chapter 11)
4. Conjugated compounds (Chapter 14)
5. Benzene and aromaticity (Chapters 15)
6. Electrophilic aromatic substitution (Chapter 16)
7. Alcohols and phenols (Chapter 17)
8. Ethers and epoxides; Thiols and Sulfides (Chapter 18)

Books required/referenced：

McMurry Organic Chemistry 9th Ed.

Preparation and review：

Problem-solving exercise

Grading：

Grading:

Evaluation will be performed on the basis of exams, class participation, and homework results.

Remarks：

Course	Semester/Credits	Instructor	Affiliation
General Organic Chemistry C (有機化学概論C)	5th Semester 2 Credits	鬼塚　和光	Synthetic Chemistry for Biofunctional Molecules

Course code/number：SCH-ORG223E

Course Title：General Organic Chemistry C (AMC, Chemistry of Carbonyl Compounds)

Purpose/Abstract：

Learning the chemistry of carbonyl compounds - main reactions, methods of synthesis, reaction mechanisms and synthetic applications.

Goal：

Understanding the chemistry of carbonyl compounds.

Contents：

Lectures based on the textbook, discussions in the class, tests.

Chapter 19 Aldehydes and Ketones: Nucleophilic Addition Reactions
Chapter 20 Carboxylic Acids and Nitriles
Chapter 21 Carboxylic Acid Derivatives
Chapter 22 Carbonyl Alpha-Substitution Reactions
Chapter 23 Carbonyl Condensation Reactions

Books required/referenced：

McMurry-Organic Chemistry: chapters 19-23

Preparation and review：

Reading the textbook, self-training to understand reaction mechanisms.

Grading：

Attendance of the class, activity in the discussions, test results.

Remarks：

It is desirable for students to take General Organic Chemistry D as well.
General Organic Chemistry C (April-June)
General Organic Chemistry D (June-July)

Course	Semester/Credits	Instructor	Affiliation
General Organic Chemistry D (有機化学概論D)	5th Semester 2 Credits	永次　史	Synthesis of Organic Functional Molecules

Course code/number : SCH-ORG224E

Course Title : General Organic Chemistry D

Purpose/Abstract :

Objective and Summary of Class:

This class is part of series of organic chemistry classes, including General Organic Chemistry A, C, and D.

This lecture will concersn the following topics:

(1) Basic chemistry of amines and helelocycles
(2) Chemistry of biomolecules
  2-1 Carbohydrates
  2-2 Aminoacids, Peptides and Proteins
  2-3 Lipids
  2-4 Nucleic acids
(3) The organic chemistry of metabolic pathway
(4) Pericyclic reactions : electrocyclic reactions, cyclo additions and sigmatropic rearrangements

Goal :

Goal of Study

(1) To understand the synthetic method of amines and reactions of amines
(2) To understand the chemical properties and reactivity of heterocyclic amines
(3) To understand the structures and biological functions of biomoecules (carbohydrates, amino acids, peptides, proteins, lipids and nucleic acids)
(4) To understand the organic chemistry of metabolic pathway in the cells of living organisms
(5) To understand the peicyclic reacitions by molecular orbital theory

Contents :

The class will involve chapters 24-30 of Organic Chemistry by John McMurry.

Books required/referenced :

Textbook and References:

"Organic Chemistry 8th ed." by John McMurry

Preparation and review :

They should do the homework, which is assigned in the class. In addition, they should do the exercise in the text book

Grading :

Evaluation will be performed on the basis of exam and the homework results.

Remarks :

Course	Semester/Credits	Instructor	Affiliation
Exercises in Organic Chemistry A (有機化学演習A)	4th Semester 1 Credit	永次　史 水上　進 和田　健彦	Institute of Multidisciplinary Research for Advanced Materials

Course code/number : SCH-ORG251E

Course Title : Exercises in Organic Chemistry A

Purpose/Abstract :

Objective and Summary of Class:

Understanding of organic chemistry will be deepened by performing exercises based on the lecture contents of "Chemistry C" and "Special Class in Basic Chemistry III" and in parallel "General Organic Chemistry A" and "Laboratory Experiments in Chemistry A" (up to chapter 18 in McMurry, "Organic Chemistry", 8th ed.)

Goal :

It will be possible to explain basic organic chemistry in real terms. In particular, organic reaction mechanisms can be described with arrows showing the movement of electrons.

Contents :

The problems at the end of each chapter of McMurry's "Organic Chemistry", 8th ed. up to chapter 18 will be performed. Details will be explained during the 1st lecture.

Books required/referenced :

McMurry "Organic Chemistry", 8th ed. and 9th ed. References will be introduced accordingly.

Preparation and review :

You should study the exercise in the McMurry's "Organic Chemistry", 8th ed. (chapters 1-18)

Grading :

Evaluation will be based on attendance and the number of exercise answers given. Additional points will be given for answers written on the blackboard.

Remarks :

Course	Semester/Credits	Instructor	Affiliation
Exercises in Organic Chemistry B (有機化学演習B)	5th Semester 1 Credit	永次　史 和田　健彦	Institute of Multidisciplinary Research for Advanced Materials

Course code/number：SCH-ORG252E

Course Title：Exercises in Organic Chemistry B

Purpose/Abstract：

Understanding of organic chemistry will be deepened by performing exercises based on the lecture contents of "General Organic Chemistry C" and "General Organic Chemistry D" (from chapter 19 up to chapter 29 in McMurry, "Organic Chemistry", 8th ed.)

Goal：

It will be possible to explain basic organic chemistry in real terms. In particular, organic reaction mechanisms can be described with arrows showing the movement of electrons.

Contents：

The problems at the end of each chapter of McMurry's "Organic Chemistry", 8th ed. (chapters 19-29) will be performed. Details will be explained during the 1st lecture.

Books required/referenced：

McMurry "Organic Chemistry", 8th ed. References will be introduced accordingly.

Preparation and review：

You should study the exercise in the McMurry's "Organic Chemistry", 8th ed. (chapters 19-29).

Grading：

Evaluation will be based on attendance and the number of exercise answers given. Additional points will be given for answers written on the blackboard.

Remarks：

Course	Semester/Credits	Instructor	Affiliation
General Biochemistry (生物化学概論)	3rd Semester 2 Credits	稲葉　謙次	IMRAM, Laboratory of Biomolecular Structure

Course code/number：SCH-BIC211E

Course Title：General Biochemistry (生物化学概論)

Purpose/Abstract：

To study the basic knowledge of molecular biology, biochemistry and structural biology and to understand biological phenomena at the molecular level, students will learn the following contents.

1) Structures and chemical properties of nucleic acids
2) Structures and chemical properties of amino acids and proteins
3) Biochemical methods for analyzing DNA sequence, amino acid sequence, protein structures and functions
4) Mechanisms of enzyme catalysis

Goal：

Students will gain deep insights into structures and physiological functions of nucleic acids, proteins and other important biomolecules. Also, students will understand molecular mechanisms of several important enzymes.

Contents：

Lectures will follow a textbook indicated below.
Especially, we will learn Chapters 1-9 of the textbook.

Books required/referenced：

Berg, Tymoczko and Stryer, Biochemistry, 7th international edition.

Preparation and review：

Preparation is not necessary, but review is recommended.

Grading：

Attendance, attitude in class and results of examinations will be taken into consideration for grading.

Remarks：

Course	Semester/Credits	Instructor	Affiliation
Biochemistry IA （生物化学ＩＡ）	4th Semester 2 Credits	髙橋　聡	Laboratory of Biological and Molecular Dynamics

Course code/number：SCH-BIC221E

Course Title：The Molecular Design of Life and Biological Energy Transduction

Purpose/Abstract：

To learn the biological phenomena at the molecular level and to gain a deeper understanding of biochemistry, molecular biology and biophysics.

Students will learn:

1．Structures and properties of sugars and lipids,
2．Structures and properties of biological membranes,
3．Biological energy transduction.

It is desirable to consistently attend the discussions in Biochemistry IIA concerning the DNA and RNA synthesis and metabolism of biomolecules.

Goal：

Students will gain an understanding of the functions of sugars, polysaccharides, lipids and membranes on the basis of their structures and thermodynamics. In addition, students will understand the process in which glucose is converted into ATP as energy currency.

Contents：

1st lecture Carbohydrates I
2nd lecture Carbohydrates II
3rd lecture Lipids and cell membranes I
4th lecture Lipids and cell membranes II
5th lecture Membrane Channels and Pumps I
6th lecture Membrane Channels and Pumps II
7th lecture Signal Transduction Pathways
Mid term test
8th lecture Metabolism: Basic concepts and Design
9th lecture Glycolysis and Glugoneogengesis I
10th lecture Glycolysis and Glugoneogengesis II
11th lecture The Citric Acid Cycle
12th lecture Oxidative Phospholylation I
13th lecture Oxidative Phospholylation II
FInal test
14th lecture Epilogue: Lives of Warburg, Mayerhoff and Krebs

Books required/referenced：

Berg, Tymoczko, Gatto and Stryer, Biochemistry, 9th edition (WH Freeman). The lectures will cover chapters 10 to 18 of the textbook.

Preparation and review：

Students will be asked to submit homework every week.

Grading：

The results of examinations and attendance will be taken into consideration for evaluation.

Remarks：

The contact address of Satoshi Takahashi is as follows:
IMRAM, east building 1 in Katahira campus, room 208.
Email: satoshi.takahashi.a6@tohoku.ac.jp
Students are welcomed to visit my office. Please make an appointment by email.

Course	Semester/Credits	Instructor	Affiliation
Basic Experiments in Chemistry （基礎化学実験）	6th Semester 1 Credit	豊田　耕三	Laboratory of Fundamental Chemistry

Course code/number：SCH-OCH251E

Course Title：Laboratory Experiments in Basic Chemistry

Purpose/Abstract：

You learn experimental operations of basic inorganic chemistry, basic analytical chemistry, basic physical chemistry, and basic organic chemistry.

Goal：

You can make fundamental experiments of basic inorganic chemistry, basic analytical chemistry, basic physical chemistry, and basic organic chemistry.

Contents：

(1) Basic operations
　Calibration of volumetric measuring instruments
(2) Titrations
　Neutralization titration
　Precipitation titration
　Oxidation-reduction titration
　Complexometric titration
　Neutralization titration curves and acid dissociation constants of weak acids
(3) Analyses of absorption spectra using UV-vis spectrophotometer
(4) Measurement of enthalpy changes in neutralization and dissolving salts
(5) Syntheses of organic compounds
　Synthesis of 6,6-nylon from cyclohexene
　Synthesis of Aspirin

Books required/referenced：

Textbooks (directions for the experiments) will be given in the class; other references are shown in the directions.

Preparation and review：

Read the textbook and draw a flow chart of the experiment, in advance.

Grading：

Evaluation will be performed by your attendance records and laboratory reports.

Remarks：

Telephone: 022-795-6606 (staff room): E-mail: kozo.toyota.d3@tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
Laboratory Experiments in Chemistry A (化学一般実験A)	6th Semester 5 Credits	豊田　耕三	Laboratory of Fundamental Chemistry

Course code/number : SCH-OCH252E

Course Title : Laboratory Experiments in Chemistry

Purpose/Abstract :

You learn fundamental experimental operations of inorganic chemistry, analytical chemistry, and the related fields.

Goal :

You can make fundamental experiments of inorganic chemistry, analytical chemistry, and the related fields.

Contents :

(1) Inorganic experiments
- Synthesis of chemicals used for measurements
- Complex synthesis
- X-ray crystal structure analysis
- UV-visible absorption spectra of metal complexes
- Complex formation reaction rates
- Cyclic voltammetry of metal complexes

(2) Analytical experiments
- Determination of the composition of an iron phenanthroline complex by using spectrophotometry
- Determination of fluoride ion contents by using an iron-selective electrode

(3) Optional experiments and exercises

Books required/referenced :

Textbooks (directions for the experiments) will be given in the class; other references are shown in the directions.

Preparation and review :

Read the textbook and draw a flow chart of the experiment, in advance.

Grading :

Evaluation will be performed by your attendance records and laboratory reports.

Remarks :

Telephone: 022-795-6606 (staff room): E-mail: kozo.toyota.d3@tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
Laboratory Experiments in Chemistry B (化学一般実験B)	7th Semester 6 Credits	豊田　耕三	Laboratory of Fundamental Chemistry

Course code/number : SCH-OCH253E

Course Title : Laboratory Experiments in Chemistry

Purpose/Abstract :

You learn fundamental experimental operations of physical chemistry, organic chemistry, and biochemistry.

Goal :

You can make fundamental experiments of physical chemistry, organic chemistry, and biochemistry.

Contents :

(1) Physical chemistry experiments
- Optics and molecular spectroscopy
- Molecular spectroscopy in solutions
- Electronics
- Computer calculation experiments

(2) Organic experiments
- Basic procedures for the organic chemistry experiments
- Grignard synthesis of triphenylmethanol
- Benzoin condensation and synthesis of hexaphenylbenzene
- Molecular modeling and various spectroscopic measurements

(3) Biochemical experiments
- Enzyme Reaction kinetics
- Basic gene cloning

Books required/referenced :

Textbooks (directions for the experiments) will be given in the class; other references are shown in the directions.

Preparation and review :

Read the textbook and draw a flow chart of the experiment, in advance.

Grading :

Evaluation will be performed by your attendance records and laboratory reports.

Remarks :

Telephone : 022-795-6606 (staff room) : E-mail : kozo.toyota.d3@tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
Analytical Chemistry A （分析化学A）	5th Semester 1 Credit	福山　真央	Laboratory of Nano-Micro Chemical Measurements

Course code/number：SCH-INO301E

Course Title：Statistics and coding for chemical analysis

Purpose/Abstract：

Students will learn statistics and coding to obtain the conclusion from chemical experimental data correctly.

Goal：

Student will understand the basics for quantitative analysis, multivariate analysis and machine learning which can be applied to chemical researches.

Contents：

Contents and Schedule：

1．Guidance（Instruction of python coding）
2．Experimental error & Gaussian distribution
3．Hypothesis testings（t test and Grubbs test）
4．Quantification using calibration curves
5．Multivariate analysis（lecture）
6．Multivariate analysis（coding）
7．Introduction to machine learning

Books required/referenced：

“Qantitative Chemical Analysis” by Daniel C. Harris, W. H. Freeman and Company.

Preparation and review：

The problems given at each class hour should be solved.

Grading：

Class attendance & quiz in class（40%）, Homework（30%）and Final repoort（30%）

Remarks：

maofukuyama@tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
Inorganic Chemistry ＩA （無機化学ＩA）	6th Semester 1 Credit	高坂　亘	Solid-State Metal-Complex Chemistry

Course code/number：SCH-INO303E

Course Title：Electronic Properties of Inorganic Materials

Purpose/Abstract：

Properties of solid are mainly dominated by an electronic structure of material. In this class, we will learn how to understand the atomic bonds, which form a crystal structure, and electric properties such as electrical conductivity of materials based on the electronic structure.

Goal：

The goal of this class is to understand the relationship between electronic structure and atomic bond/electrical conductivity of solid. One will understand the classification of atomic bonds and the definition of metal and insulatorthat based on an electronic structure.

Contents：

1．Introduction
（crystal structure, X-ray diffraction）
2．Bonding character in crystal
（Relationship between atomic bonding character and crystal structure）
3．Quantum-mechanical treatment of atomic bond
（Molecular orbital, LCAO-approximation, Hückel method）
4．Band Theory
（Expansion of molecular orbital to crystal）

Books required/referenced：

The Electronic Structure and Chemistry of Solids（P.A. Cox, OXFORD）, Transition Metal Oxides（P. A. Cox, OXFORD）, Electronic Structure and The Properties of Solids（W. A. Harrison, Dover）, etc.

Preparation and review：

The session time is limited and therefore self-directed learning is important. Students are required to review for each class.

Grading：

Class attendance and examination

Remarks：

Course	Semester/Credits	Instructor	Affiliation
Inorganic Chemistry ⅡA （無機化学ⅡA）	6th Semester 1 Credit	宮坂　等	Division of Solid-State Metal-Complex Chemistry

Course code/number：SCH–INO305E

Course Title：Inorganic Chemistry IIA

Purpose/Abstract：

Topics will include the structure and mechanical and physical properties of supramolecular complexes and multi-dimensional framework systems. Each topic assigned to you should be pre-investigated before your presentation. We will get various knowledes on the basic science in the field of supramolecular complexes and multi-dimensional framework systems through our presentation and discussion.

Goal：

The goal of this course is to gain an understanding of supramolecular chemistry and multi-dimensional framework systems and related chemistry.

Contents：

After discussion about the basics of supramolecular chemistry and its related chemistry, students will present a topic involving supramolecular chemistry or other related chemistry for discussion by the class.

Books required/referenced：

Steed and Atwood, Supramolecular Chemistry, 2nd Ed. Wiley, and others

Preparation and review：

Prepare a lecture and discussion on a topic supramolecular chemistry and related chemistry such as multi-dimensional networks and their physical properties（we mainlly use ppt for the presentation）

Grading：

Attendance and in-class discussions will be used to evaluate the students' progress.

Remarks：

E-mail : miyasaka@imr.tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
Physical Chemistry ⅡA （物理化学ⅡA）	6th Semester 1 Credit	鎌形　清人	Biological and Molecular Dynamics Laboratory

Course code/number：SCH–PCH303E

Course Title：Physical chemistry IIA

Purpose/Abstract：

This course focuses on physical chemistry hidden in life sciences. Biomolecules function obeying some rules based on physical chemistry. These physical chemistry bases are deeply discussed while introducing Nobel Prize stories and hot research topics.

Goal：

This course is designed to help students understand what kind of physical chemistries are utilized in the life sciences using many schematic diagrams and movies.

Contents：

The contents are as follows.

1．Molecular Dynamics Simulation –Visualizing Molecules on Computer–
2．Fluorescent Proteins and Probes in Life Science
3．Microscopy and Single-Molecule Analysis –Visualizing Molecules in Experiment–
4．Watching Protein Action on DNA
5．Liquid-Liquid Phase Separation –Condensation Magic–
6．Rational and Experiment-Guided Peptide Design for Disease-Related Proteins

This course is centered on a lecture.

Books required/referenced：

Slides which I prepared are used in this class.

Preparation and review：

The session time is limited and therefore self-directed learning is important.

Grading：

A minute paper with attendance in each class is evaluated.

Remarks：

Course	Semester/Credits	Instructor	Affiliation
Polymer Chemistry Ⅰ （高分子化学Ⅰ）	6th Semester 1 Credit	和田　健彦	Laboratory of Nanobio Functional Materials/Chemical Biology & Supramolecular Photochirogenesis

Course code/number：SCH-OCH301E

Course Title：Polymer Chemsitry I

Purpose/Abstract：

The category of polymer (or macromolecular) materials is so wide, for example, familiar fiber (or textile), rubber, plastics, and photo-resist to fabricate semiconductor integrated circuit (IC). Protein and nucleic acid are also a kind of polymer, so-called biopolymer.

In this lecture, synthesis, structure, and properties of polymers will be first introduced, which is considerably different from the case of ordinary organic low-molecular weight compounds. Next, high-performance and functional polymers, and hybrid polymer meterials will be explained in detail. In addition, biopolymer will be summarized from the viewpoint of biophysics.

Goal：

Aiming at making the backbone in the specific fields of advanced materials science in nano-science and nano-technology through basic understanding for polymer material chemistry.

Contents：

(1) Basic Principles
(2) Molecular Weight and Polymer Solutions.
(3) Chemical Structure and Polymer Morphorogy
(4) Chemical Structure and Polymer Properties
(5) Evaluation, Characterization and analysis of Polymers.

Books required/referenced：

"Polymer Chemistry -An Introduction-" (3rd Ed.) by Malcolm P. Stevens, Oxford Univ., Press, NY, 1999.

Preparation and review：

The session time is limited and therefore self-directed learning is important. Students are required to review for each class.

Grading：

Attendance and regular examination

Remarks：

Course	Semester/Credits	Instructor	Affiliation
Organic Chemistry Ⅰ A （有機化学Ⅰ A）	6th Semester 1 Credit	BREEDLOVE BRIAN	Laboratory of Nanomaterials

Course code/number：SCH-ORG301E

Course Title：Organic Chemistry IA（AMC）

Purpose/Abstract：

Since organic, coordination , inorganic, bio and materials chemistries all require the ability to use spectroscopy to characterize molecules. This course will provide students tools needed to interpret spectra from different spectroscopic techniques.

Goal：

Students should be able to characterize organic compouds from the spectra from various techniques, including NMR, IR, UV-vis, etc.

Contents：

The course will contain the following:

1．IR and UV-vis spectroscopy and mass spectrometry
2．1H NMR spectroscopy
3．13C NMR spectroscopy
4．2D NMR techniques

Books required/referenced：

Texts will be discussed in class.

Preparation and review：

do the practice problems

Grading：

practice problems and one exam

Remarks：

breedlove.brian.b1@tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
Biochemistry Ⅱ A （生物化学Ⅱ A）	6th Semester 1 Credit	鎌形　清人	Biological and Molecular Dynamics Laboratory

Course code/number：SCH-BIC301E

Course Title：Biochemistry of nucleic acid and protein synthesis.

Purpose/Abstract：

To learn the biological phenomena at the molecular level and to gain a deeper understanding of biochemsity, molecular biology and biophysics.

Goal：

Students will gain an understanding of the various biological phenomenon related to synthesis of nucleic acids and proteins.

Contents：

The lectures will cover chapters 28 to 32 of the textbook.

1st class　DNA replication, repair and recombination Ⅰ
2nd class　DNA replication, repair and recombination Ⅱ
3rd class　RNA synthesis and processing Ⅰ
4th class　RNA synthesis and processing Ⅱ
5th class　Protein synthesis
6th class　The control of gene expression in prokaryotes
7th class　The control of gene expression in eukaryotes
including practical approach for heterologous protein expression

Books required/referenced：

Berg, Tymoczko and Stryer, Biochemistry (Freeman and Co. NY). The 8th edition is available but the chapter numbers are based on the 7th edition.

Preparation and review：

Students are required not only to submit class assignments but also to review each class using handouts. If there remain any parts they cannot understand, they should ask questions in the next class.

Grading：

The results of examinations and attendance will be taken into consideration for evaluation.

Remarks：

Email: kiyoto.kamagata.e8@tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
Polymer Chemistry Ⅱ （高分子化学Ⅱ）	6th Semester 1 Credit	和田　健彦	Laboratory of Nanobio Functional Materials/Chemical Biology & Supramolecular Photochirogenesis

Course code/number：SCH-OCH302E

Course Title：Polymer Chemsitry Ⅱ

Purpose/Abstract：

The category of polymer (or macromolecular) materials is so wide, for example, familiar fiber (or textile), rubber, plastics, and photo-resist to fabricate semiconductor integrated circuit (IC). Protein and nucleic acid are also a kind of polymer, so-called biopolymer.

In this lecture, synthesis, structure, and properties of polymers will be first introduced, which is considerably different from the case of ordinary organic low-molecular weight compounds. Next, high-performance and functional polymers, and hybrid polymer meterials will be explained in detail. In addition, biopolymer will be summarized from the viewpoint of biophysics.

Goal：

Aiming at making the backbone in the specific fields of advanced materials science in nano-science and nano-technology through basic understanding for polymer material chemistry.

Contents：

(1) Free Radical Polymerization
(2) Ionic Polymerization
(3) Vinyl Polymerization with Complex Coordination Catalysts
(4) Step-reaction and Ring-opening Polymerization

Books required/referenced：

"Polymer Chemistry -An Introduction-" (3rd Ed.) by Malcolm P. Stevens, Oxford Univ., Press, NY, 1999.

Preparation and review：

The session time is limited and therefore self-directed learning is important. Students are required to review for each class.

Grading：

Attendance and regular examination

Remarks：

List of Frequently Used Academic Terms

学科	Department
数学	Mathematics
物理学	Physics
宇宙地球物理学	Astronomy and Geophysics
化学	Chemistry
地圏環境科学	GeoEnvironmental Science（a division of Earth Science）
地球惑星物質科学	Earth and Planetary Materials Science（a division of Earth Science）
生物学	Biology

教授	Professor
准教授	Associate Professor
講師	Lecturer
助教	Assistant Professor

学期	Semester
１セメスター ３セメスター ５セメスター ７セメスター	Spring Semesters
２セメスター ４セメスター ６セメスター ８セメスター	Fall Semesters

単位	Credit
授業	Course, Class
時間割	Schedule, Timetable