平 成 30 年 度

(April 2018－March 2019)

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)	2 Semester 2 Credits	稲葉　謙次 (Kenji INABA)	IMRAM, Laboratory of Biomolecular Structure

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 visit laboratories to attend seminars and be introduced to laboratory facilities 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 and reports

Remarks：

Course	Semester/Credits	Instructor	Affiliation
Special Class in Basic Chemistry Ⅰ (専門基礎化学Ⅰ)	3 Semester 2 Credits	(Kiyoshi UEDA) 上田　潔 奥西　みさき (Misaki OKUNISHI)	Institute of Multidisciplinary Research for Advanced Materials Laboratory of Electron and Molecular Dynamics

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 and 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：

We will cover the following themes.

1．Outline and introduction to elementally 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：

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

Preparation and review：

Read the text book for preparation.

Grading：

Attendance + Mid - term examination + Final examination（Additional examination）

Remarks：

Course	Semester/Credits	Instructor	Affiliation
Special Class in Basic Chemistry Ⅱ (専門基礎化学Ⅱ)	3 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：

breedlove@m.tohoku.ac.jp

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

Course code/number：SCH-ORG211E

Course Title：Basic Organic Chemistry I

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 ⅠA and ⅡA (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, 8th ed." by McMurry will be studied.

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)	3 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 practice problems

Grading：

Attendance, homework, and two exams

Remarks：

breedlove@m.tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
General Physical Chemistry A (物理化学概論A)	5 Semester 2 Credits	米田　忠弘 (Tadahiro KOMEDA)	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：

Homework quiz are assigned during class.

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)	4 Semester 2 Credits	組頭　広志 (Hiroshi KUMIGASHIRA)	Laboratory of Bioinspired Synthetic 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 mathematical tools of quantum mechanics; approximate methods; atomic structure; the chemical bond, valence bond; and molecular orbital theory.

Goal：

The aim of this course is 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) Approximation method in quantum mechanics: Perturbation theory
4) Structure of the helium atom
5) Multiple electron atoms and the Pauli principle
6) Multiple electron 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：

Questions are accepted at any time (after class, in particular).

Course	Semester/Credits	Instructor	Affiliation
General Physical Chemistry C (物理化学概論C)	5 Semester 2 Credits	荒木　保幸 (Yasuyuki ARAKI)	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. 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：

Textbook and References:
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 is 60 points), reports (perfect submission is 20 points) and scores of final examinations (full score is 20 points) are totally evaluated.

Person who gains over 80 ponts gets AA score.

Remarks：

Course	Semester/Credits	Instructor	Affiliation
General Physical Chemistry D (物理化学概論D)	5 Semester 2 Credits	髙岡　毅 (Takeshi TAKAOKA)	Advanced Scanning Probe Microscopy 走査プローブ計測技術研究分野

Course code/number：SCH-PCH224E

Course Title：Principles of spectroscopic methods in physical chemistry

Purpose/Abstract：

Starting from a lecture of the basic of spectroscopy, we try to survey modem spectroscopic methods used in physical chemistry.

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）Group theory
2）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：

No

Grading：

Score: Attendance + Mid-term exam + Final exam

Remarks：

Katahira Campus - South Multidisciplinary Research Laboratory Building 1 “E02” Room308
Email: takaoka@tagen.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)	4 Semester 1 Credits	(Tadahiro KOMEDA) 米田　忠弘 髙岡　毅 (Takeshi TAKAOKA)	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 quiz are assigned during class.

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)	5 Semester 1 Credits	米田　忠弘 (Tadahiro KOMEDA)	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 quiz are assigned during class.

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)	4 Semester 2 Credits	宇田　聡 (Satoshi UDA)	Laboratory of Crystal Chemistry

Course code/number：SCH-INO221E

Course Title：General Inorganic and Analytical Chemistry A　無機分析化学概論A

Purpose/Abstract：

Thermodynamics is a powerful tool to understand the equilibrium phase relationship that is needed for materials processing including materials synthesis and growth from the conventional to the most advanced one. It also gives an insight of the nonequilibrium process in terms of the deviation from the equilibrium state. It should be also noted that thermodynamics is a powerful mean to prove your developing theory.

Although thermodynamics is one of the classic academics, it is not easy to learn. This is because the 'practical state' is often far different from the 'ideal' and only ideal-gas case with mathematical expressions are simply demonstrated in teaching without showing its applications to the 'real world'. In this class, students will have an exciting learning experience of the thermodynamics through its practical applications with simple math forms. In addition, this class is linked to the 'Exercises in Inorganic and Analytical Chemistry A' and students will learn about the practical use of thermodynamics by solving a few kinds of problems associated with chemical equilibrium or chemical reactions.

Goal：

・Learn 1st law and 2nd law of Thermodynamics.
・Learn different kinds of free energy and how they are related by the Legendre transformation.
・Learn the basic concepts of Gibbs free energy, partial molar quantity.
・Learn the derivation of chemical potentials to understand the phase relationship.
・Learn how to read equilibrium phase diagrams.
・To get the idea how to apply the thermodynamics to phase equlibria and reaction process in materials synthesis and growth process.

Contents：

Ⅰ. Scope of Thermodynamics
Ⅱ. 1st law and 2nd law of Thermodynamics
Ⅲ. Equilibrium
Ⅳ. Chemical Potentials and Activities
Ⅴ. Phase Diagrams
Ⅵ. The Kinetics of Phase Transformations

Books required/referenced：

Handout will be given before the class begins.

Preparation and review：

Assignments will be given.

Grading：

The results of class attendance, quizes and examination will be used for evaluation.

Remarks：

Contact address: uda@imr.tohoku.ac.jp　Tel: 022-215-2100

Course	Semester/Credits	Instructor	Affiliation
General Inorganic and Analytical Chemistry B (無機分析化学概論B)	4 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 Shriver and Atkins' 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

Grading :

Attendance and two exams

Remarks :

breedlove@m.tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
General Inorganic and Analytical Chemistry C (無機分析化学概論C)	5 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@m.tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
General Inorganic and Analytical Chemistry D (無機分析化学概論D)	6 Semester 2 Credits	火原　彰秀 (Akihide HIBARA)	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 A (無機分析化学演習A)	4 Semester 1 Credits	宇田　聡 (Satoshi UDA)	Laboratory of Crystal Chemistry

Course code/number：SCH-INO251E

Course Title：Exercises in Inorganic and Analytical Chemistry A　無機分析化学演習A

Purpose/Abstract：

Obtain basic understanding of the thermochemistry and its practical approach in inorganic chemistry by solving various problem sets.

Goal：

To manipulate and solve the thermochemistry-related problems that students may encounter during their inorganic research works.

Contents：

Solve practical problems associated with basic thermochemistry after the short lecture is given at each class.

Books required/referenced：

A problem set will be given at every class hour.

Reprint from Dickerson, Gray, Darensbourg, Darensbourg（Chemical Principles）

Preparation and review：

Assignments are given as needed.

Grading：

Evaluation will be performed on the basis of attendance and results of the exercises.

Remarks：

Contact address：uda@imr.tohoku.ac.jp, 022-215-2100

Course	Semester/Credits	Instructor	Affiliation
Exercises in Inorganic and Analytical Chemistry B (無機分析化学演習B)	5 Semester 1 Credit	(Wataru KOHSAKA) 高坂　亘 関根　良博 (Yoshihiro SEKINE) 福山　真央 (Mao FUKUYAMA)	Laboratory of Solid-State Metal-Complex Chemistry

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.

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.

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 :

w-kosaka@imr.tohoku.ac.jp, y-sekine@imr.tohoku.ac.jp 022-215-2033
maofukuyama@tohoku.ac.jp 022-217-5640

Course	Semester/Credits	Instructor	Affiliation
General Organic Chemistry A (有機化学概論A)	4 Semester 2 Credits	水上　進 (Shin MIZUKAMI)	Institute of Multidisciplinary Research for Advanced Materials

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 :

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 :

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)	5 Semester 2 Credits	GRIDNEV ILYA	AMC Course

Course code/number : SCH-ORG223E

Course Title : Chemistry of Carbonyl Compounds

Purpose/Abstract :

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

Goal :

Understanding by the students 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 in writing mechanisms

Grading :

Attendance of the class, activity in the discussions, tets results

Remarks :

Course	Semester/Credits	Instructor	Affiliation
General Organic Chemistry D (有機化学概論D)	5 Semester 2 Credits	永次 史 (Fumi NAGATSUGI)	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 :

Record and Evaluation Method: 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)	4 Semester 1 Credits	(Fumi NAGATSUGI) 永次　史 水上　進(Shin MIZUKAMI) 和田　健彦 (Takehiko WADA)	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)	5 Semester 1 Credits	(Fumi NAGATSUGI) 永次　史 和田　健彦 (Takehiko WADA)	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 1 st 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）	3 Semester 2 Credits	稲葉　謙次 (Kenji INABA)	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 mechanisms of operations 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：

A short test will be given as a homework in the end of every class.

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）	4 Semester 2 Credits	髙橋　聡 (Satoshi TAKAHASHI)	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　Chap 11 Carbohydrates Ⅰ
2nd lecture　Chap 11 Carbohydrates Ⅱ
3rd lecture　Chap 12 Lipids and cell membranes Ⅰ
4th lecture　Chap 12 Lipids and cell membranes Ⅱ
5th lecture　Chap 13 Membrane Channels and Pumps Ⅰ
6th lecture　Chap 13 Membrane Channels and Pumps Ⅱ
7th lecture　Chap 14 Signal Transduction Pathways
8th lecture　Chap 15 Metabolism: Basic concepts and Design
9th lecture　Chap 16 Glycolysis and Glugoneogengesis Ⅰ
10th lecture　Chap 16 Glycolysis and Glugoneogengesis Ⅱ
11th lecture　Chap 17 The Citric Acid Cycle
12th lecture　Chap 18 Oxidative Phospholylation Ⅰ
13th lecture　Chap 18 Oxidative Phospholylation Ⅱ
14th lecture　Epilogue：Lives of Warburg, Mayerhoff and Krebs

Books required/referenced：

Berg, Tymoczko and Stryer, Biochemistry, 7th international edition（Freeman and Co. NY）. 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 addresses of Satoshi Takahashi are as follows：
Office：IMRAM, east building 1, room 307（Katahira Campus）.
Office hour：Tuesday from 4:00pm to 6:00pm.　Email：st@tagen.tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
Basic Experiments in Chemistry (基礎化学実験)	6 Semester 1 Credits	豊田　耕三 (Kozo TOYOTA)	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: toyota@m.tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
Laboratory Experiments in Chemistry A (化学一般実験A)	6 Semester 5 Credits	豊田　耕三 (Kozo TOYOTA)	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: toyota@m.tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
Laboratory Experiments in Chemistry B (化学一般実験Ｂ)	7 Semester 6 Credits	豊田　耕三 (Kozo TOYOTA)	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: toyota@m.tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
Analytical Chemistry A (分析化学Ａ)	5 Semester 1 Credits	BREEDLOVE BRIAN	Laboratory of Nanomaterials

Course code/number：SCH-INO301E

Course Title：Analytical Chemistry A (AMC)

Purpose/Abstract：

This class is designed to give a survey of analytical techniques, including theory and instrumentation, used to anaylyze and characterize compounds and their properties. This is by no means an in-depth or comprehensive course in analytical chemistry.

Goal：

Students will gain an understanding of the analytical techniques and their instrumentation.

Contents：

1. Background, including basic definitions
2. Spectroscopic methods
3. Spectrometry
4. Chromatography (if time permits)

Books required/referenced：

Holler, Skoog and Crouch “Principles of Instrumental Analysis 6th Ed.”

Skoog, West, Holler and Crouch “Fundamentals of Analytical Chemistry”, 9th Ed.

Preparation and review：

Reading appropriate chapters in the textbook

Grading：

Attendance and final exam

Remarks：

email: breedlove@m.tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
Inorganic Chemistry I A （無機化学Ｉ A）	6 Semester 1 Credits	谷口　耕治 (Koji TANIGUCHI)	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 I B （無機化学Ｉ B）	6 Semester 1 Credits	岡田　純平 (Junpei OKADA)	Laboratory of Crystal Chemistry

Course code/number：SCH-INO304E

Course Title：Inorganic Chemistry I B

Purpose/Abstract：

When we synthesize materials, we should refer to phase diagrams. Phase diagrams are one of the most important sources of information concerning the behavior of elements, compounds and solutions. They give us information of phase composition and phase stability as a function of temperature, pressure and composition. The course is intended to understand the principles of phase diagrams.

Goal：

The goal of this class is to understand and familiarize with binary phase diagrams.

Contents：

1．Introduction
（Basics for thermodynamics）
2．Phase equilibria and phase diagrams
（One component phase diagram, Phase rule and equilibrium）
3．Phase diagrams of two-component systems
（Solid solutions, Construction of equilibrium phase diagrams of two-component systems, Cooling curves）
4．Interpretation of phase diagrams
（Phase composition, The Lever rule）

Books required/referenced：

1．Introduction to Metallurgical Thermodynamics, D.R. Gaskell, McGraw-Hill, 1980
2．Thermodynamics of Solids, R.A. Swalin, John Wiley, 1968

Preparation and review：

Printed materials for review will be distributed.

Grading：

Class attendance and examination

Remarks：

Course	Semester/Credits	Instructor	Affiliation
Inorganic Chemistry Ⅱ A （無機化学Ⅱ A）	6 Semester 1 Credits	宮坂　等 (Hitoshi MIYASAKA)	Division of Solid-state metal-complex chemistry

Course code/number：SCH-INO305E

Course Title：Inorganic Chemistry Ⅱ A

Purpose/Abstract：

Topics will include the structure and mechanical and physical properties of supramolecular complexes and multi-dimensional framework systems

Goal：

The goal of this courseis 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

Grading：

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

Remarks：

miyasaka@imr.tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
Physical Chemistry Ⅱ A （物理化学Ⅱ A）	6 Semester 1 Credits	大庭　裕範 (Yasunori OBA)	Institute of Multidisciplinary Research for Advanced Materials

Course code/number：SCH-PCH303E

Course Title：Physical Chemistry Ⅱ A

Purpose/Abstract：

To understand basic principles of electron paramagnetic resonance（EPR）and to learn its application to studies of molecular science（structures, electronic states, dynamics and etc.）.

Goal：

Subjects to be learned

1．Properties of a spin angular momentum.
2．How magnetism is explained by electron spin.
3．Basic principles of magnetic resonance phenomenon
4．Magnetic interactions and its relation to molecular structures, electronic states and dynamics.
5．Microwave techniques used in EPR.
6．Some of advanced techniques in EPR：pulse method, double resonances, high-field and high-frequency methods, and time resolved measurements

Contents：

1．Properties of a spin angular momentum.
2．Several types of magnetism and role of electron spin.
3．Basic principles of magnetic resonance phenomenon
4．Magnetic interactions of electron spin: Interactions with static field, nuclear spins and electron spins
5．Microwave techniques used in EPR.
6．Some of advanced techniques in EPR：pulse method, double resonances, high-field and high-frequency methods, and time resolved measurements

90 minutes for each subject.

Books required/referenced：

References：J. A. Weil, J. R. Bolton and J. E. Wertz, "Electron Paramagnetic Resonance", John Wiley and Sons, 1994

Preparation and review：

none

Grading：

Attendance

Remarks：

Course	Semester/Credits	Instructor	Affiliation
Polymer Chemistry I （高分子化学Ⅰ）	6 Semester 1 Credits	及川　英俊 (Hidetoshi OIKAWA)	IMRAM, Tohoku Univetsity

Course code/number：SCH-OCH301E

Course Title：Polymer Chemistry 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：

Students are strongly expected to review enough the lectures.

Grading：

Attendance and regular examination

Remarks：

Course	Semester/Credits	Instructor	Affiliation
Organic Chemistry ⅠA （有機化学ⅠA）	6 Semester 1 Credit	GRIDNEV ILYA	AMC Course

Course code/number：SCH-ORG301E

Course Title：Spectral identification of organic compounds

Purpose/Abstract：

Learning to elucidate structures of organic compounds from the data of MS, IR and NMR spectroscopy

Modern spectral techniques make possible elucidation of structures of organic compounds from spectral data. These skills will be trained via lectures on the priciples of the spectral methods and practical exercises for solving the structures.

Goal：

Train students to identify organic compounds from spectra

Contents：

Lectures, discussions in the class, joint solution of problems, tests.

MS spectroscopy
GC spectroscopy
1H and 13 NMR spectroscopy
Multinuclear NMR spectroscopy
2D NMR spectroscopy

Books required/referenced：

Silverstein. Spectroscopic identification of organic compounds

Preparation and review：

Reading textbook, solving problems

Grading：

Attendance of the class, activity in the discussions, tests results

Remarks：

Course	Semester/Credits	Instructor	Affiliation
Organic Chemistry ⅠB （有機化学ⅠB）	6 Semester 1 Credits	(Fumi NAGATSUGI) 永次　史 和田　健彦 (Takehiko WADA)	Institute of Multidisciplinary Research for Advanced Materials

Course code/number：SCH-ORG302E

Course Title：Organic Chemistry ⅠB

Purpose/Abstract：

Objective and Summary of Class：

This class is the former part of series of organic chemistry classes, Organic Chemistry ⅠB and ⅡB. This class provides a thorough introduction to the current topis of organic chemistry. Fundamental knowledge and cutting-edge research in organic chemistry and related area will be presented by each professor.

Goal：

Goal of Study：

To gain an understanding of the cutting-edge research fields of organic chemistry, bioorganic chemistry, and organic materials.

Contents：

Contents and Progress Schedule of the Class：

Topics of Chemical Biology and Bio-Nano&Medical-Biopolymers
Advanced Synthetic Organic Chemistry
The Chemical Reactions in the Biological Systems
Advanced Polymer Materials
Biomimetic and Supramolecular Chemistry
Some of these contents are included in Organic Chemistry ⅡB

Books required/referenced：

Textbook and References：
They will be announced in the class.

Preparation and review：

Students should review what they learned in the class.

Grading：

Record and Evaluation Method：
Attendance and Reports.

Remarks：

This course will not be held in this semester (2018).

Course	Semester/Credits	Instructor	Affiliation
Organic Chemistry ⅡA （有機化学ⅡA）	6 Semester 1 Credit	GRIDNEV ILYA	AMC Course

Course code/number：SCH-ORG303E

Course Title：Spectral identification of organic compounds

Purpose/Abstract：

Learning to elucidate structures of organic compounds from the data of MS, IR and NMR spectroscopy

Modern spectral techniques make possible elucidation of structures of organic compounds from spectral data. These skills will be trained via lectures on the priciples of the spectral methods and practical exercises for solving the structures.

Goal：

Train students to identify organic compounds from spectra

Contents：

Lectures, discussions in the class, joint solution of problems, tests.

MS spectroscopy
GC spectroscopy
1H and 13 NMR spectroscopy
Multinuclear NMR spectroscopy
2D NMR spectroscopy

Books required/referenced：

Silverstein. Spectroscopic identification of organic compounds

Preparation and review：

Reading textbook, solving problems

Grading：

Attendance of the class, activity in the discussions, tests results

Remarks：

Course	Semester/Credits	Instructor	Affiliation
Organic Chemistry ⅡB （有機化学ⅡB）	6 Semester 1 Credits	(Fumi NAGATSUGI) 永次　史 和田　健彦 (Takehiko WADA)	Institute of Multidisciplinary Research for Advanced Materials

Course code/number：SCH-ORG304E

Course Title：Organic Chemistry ⅡB

Purpose/Abstract：

Objective and Summary of Class：

This class is the formar part of series of organic chemistry classes, Organic Chemistry ⅡB and ⅡB. This class provides a thorough introduction to the current topis of organic chemisrtry. Fundamental knowledge and cutting-edge research in organic chemistry and related area will be presented by each professor.

Goal：

Goal of Study：

To gain an understanding of the cutting-edge research fields of organic chemistry, bioorganic chemistry, and organic materials.

Contents：

Contents and Progress Schedule of the Class：

Topics of Chemical Biology and Bio-Nano&Medical-Biopolymers
Advanced Synthetic Organic Chemistry
The Chemical Reactions in the Biological Systems
Advanced Polymer Materials
Biomimetic and Supramolecular Chemistry
Some of these contents are included in Organic Chemistry ⅠB

Books required/referenced：

They will be announced in the class.

Preparation and review：

Students should review what they learned in the class.

Grading：

Attendance and Reports.

Remarks：

This course will not be held in this semester (2018).

Course	Semester/Credits	Instructor	Affiliation
Biochemistry ⅡA （生物化学ⅡA）	6 Semester 1 Credits	松井　敏高 (Toshitaka MATSUI)	Laboratory of Cell Functional Molecular Chemistry, Institute of Multidisciplinary Research for Advanced Materials

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.

It is desirable to consistently attend the discussions in Biochemistry ⅡB concerning the photosynthesis, protein turnover and protein trafficking.

Goal：

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

Contents：

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

1st class	chap 28	DNA replication, repair and recombination Ⅰ
2nd class	chap 28	DNA replication, repair and recombination Ⅱ
3rd class	chap 29	RNA synthesis and processing Ⅰ
4th class	chap 29	RNA synthesis and processing Ⅱ
5th class	chap 30	Protein synthesis
6th class	chap 31	The control of gene expression in prokaryotes
7th class	chap 32	The control of gene expression in eukaryotes including practical approach for heterologous protein expression

Books required/referenced：

Berg, Tymoczko and Stryer, Biochemistry, 7th international edition (Freeman and Co. NY).

Preparation and review：

Some assignments would be given for better understandings.

Grading：

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

Remarks：

The contact addresses of Toshitaka Matsui are as follows：

Office：South Multidisciplinary Research Laboratory Building 1, room 607 (Katahira Campus).
Office hour：Tuesday from 1：00pm to 3：00pm.
Email：toshitaka.matsui.d5@tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
Biochemistry ⅡB （生物化学ⅡB）	6 Semester 1 Credits	門倉　広 (Hiroshi KADOKURA)	Laboratory of Biomolecular Structure, IMRAM

Course code/number：SCH-BIC302E

Course Title：Biochemistry ⅡB

Purpose/Abstract：

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

Goal：

Students will gain an understanding of the principles and basic mechanisms of photosynthesis, protein turnover and protein trafficking.

Contents：

Handouts will be provided. The lectures will be interactive.

1. Light reactions of photosynthesis Ⅰ
2. Light reactions of photosynthesis Ⅱ
3. Calvin cycle and the pentose phosphate pathway
4. Protein turnover and amino acid metabolism
5. Intracellular compartments and transport Ⅰ
6. Intracellular compartments and transport Ⅱ
7. Final exam

Books required/referenced：

1. Berg, Tymoczko and Stryer, Biochemistry, international edition, 7th (Freeman and Co. NY) (chapters 19, 20, and 23).
2. Alberts, Bray, Hopkin, Johnson, Lewis, Raff, Roberts, and Walter, Essential Cell Biology, 4th edition (Garland Science, NY) (chapters 14 and 15)

Preparation and review：

Some assignments may be given for better understanding.

Grading：

The final grade in this course will be based on the final exam, quizzes, attendance, and active participation.

Remarks：

The contact address of Hiroshi KADOKURA
Office: Laboratory of Biomolecular Structure, IMRAM
South Multidisciplinary Research Laboratory Building 1, Room 508, Katahira Campus
Email: hiroshi.kadokura.b3@tohoku.ac.jp

Course	Semester/Credits	Instructor	Affiliation
Polymer Chemistry Ⅱ （高分子化学Ⅱ）	6 Semester 1 Credits	及川　英俊 (Hidetoshi OIKAWA)	IMRAM, Tohoku Univetsity

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：

Students are strongly expected to review enough the lectures.

Grading：

Attendance and regular examination

Remarks：

Course	Semester/Credits	Instructor	Affiliation
Science, Technology and Industry in Japan (日本の産業と科学技術)	4 Semester 1 Credit	渡邉　由美子 (Yumiko WATANABE)	Global Learning Center, Institute for Excellence in Higher Education

Course code/number : SCH-OAR801E

Course Title : The past, present, and future of industry, science, technology and their relationships and integration in Japan

Purpose/Abstract :

This class is a newly developed multidisciplinary course that was organized by the faculties of science, engineering, and agriculture. Except for the first class, each class will feature a talk by a specialist in his/her field. The topic of each talk will be the "past, present, and future of industry, science, and technology, and their relationships and integration in Japan."

Students will obtain fundamental problem-solving abilities, proactiveness, understanding of different cultures, and a multidisciplinary perspective. Registered students are expected to apply what they learn from this course in the newly developed class titled "Multidisciplinary Internship."

Goal :

The goal of this course is to give students a multidisciplinary perspective and open-minded attitude.

Contents :

Schedule of the course

＃1	Guidance
＃2－8	Lectures by guest speakers who are specialists in the fields of science, technology, and industry.
（＃9）	Group presentations and/or individual essay on "The project to integrate the fields of science, technology, and agriculture" by students

Books required/referenced :

Preparation and review :

10 hours

Grading :

Attendance and active participation (50%), a group presentation or an essay on "Our/My project: how we/I will integrate the fields of science, technology, and agriculture" (50%)

Remarks :

Th guest espeakers and topics will be announced in timely manner. This course is opened to Japanese students, too.

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