[Title]			[Instructor]		
Advanced Organic Chemistry			Yuichirou Haramoto/ Tetsuo Kuwabara		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTA501	2	Applied Chemistry	1st Semester	Fri.／I	English／Japanese

[Outline and purpose]

The course gives extended knowledge in the field of organic chemistry towards those who already finished to learn basic textbooks such as Jones, McMurry, Vollhardt-Schore and etc. This course mainly describes the fundamentals of organic chemistry involving syntheses, reactions, structural and physical organic chemistry, bio-organic chemistry and supramolecular chemistry. In addition, some of recently advanced subjects in the related fields are introduced.

[Objectives]

We will learn about fundamentals of organic chemistry involving syntheses, reactions, structural and physical organic chemistry, bio-organic chemistry and supramolecular chemistry

[Requirements]

Completion of undergraduate course covering basic organic chemistry.

[Evaluation]

Participation in class 50%
Term paper to be submitted at the end of the course 50%

[Textbooks]

Not specified

[References]

Not specified

[Schedule]

１．Liquid crystals
２．Synthesis of liquid crystals
３．Synthesis of polymer liquid crystals
４．Synthesis of ferroelectric liquid crystals
５．Synthesis of ionic liquid crystals
６．Liquid crystals semiconductor and conductive liquid crystals
７．Ion transport liquid crystal，ionic liquid crystal lubricant
８．Biomimetics
９．Molecular recognitions
１０．Supramolecules
１１．Self-assembly
１２．Rotaxane and catenane
１３. Nanostructure
１４．nanosensing
１５．Future of organic materials

[Title]			[Instructor]		
Advanced Inorganic Chemistry I			Hideto Sakane/ Naoya Miyajima		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTA502	2	Applied Chemistry	1st Semester	Mon.／II	

[Outline and purpose]

This program is a lecture on basic and structural characteristics, theory, nomenclature, and spectroscopic properties of metal complexes, in which molecules and ions coordinate to central metal ion(s). Students also learn the basic and application of surface/interface science of materials. They can deeply understand the field of surface adsorption technology for evaluating the surface/pore of materials such as carbons.

[Objectives]

Students are to be got learned in structure, bonding, and spectrochemical properties of transition metal complexes and to be able to name the coordination compounds. Students are also to be got understand fundamental principle and application of solid-surface modification and its evaluation.

[Requirements]

Expertise of general inorganic, physical, and quantum chemistry.
Basic knowledge of physical chemistry and electrochemistry.

[Evaluation]

Homework/Reports 90% (Reports to the questions given in several hours.)
Class participation 10%

[Textbooks]

日本化学会 命名法専門委員会 編, 化合物命名法 － IUPAC 勧告に準拠 － 第 2 版, 東京化学同人, ISBN:9784807908882 (in Japanese).

[References]

1. 平尾 一之、田中 勝久、中平 敦, 無機化学 その現代的アプローチ, 東京化学同人, ISBN:4807905511 (in Japanese).
2. 上村 洸、菅野 暁、田辺 行人, 配位子場理論とその応用, 裳華房, ISBN:478532404X (in Japanese).
3. 三吉 克彦, 金属錯体の構造と性質, 岩波書店, ISBN:400011042X (in Japanese).
4. 近藤 精一, 石川 達雄, 安倍 郁夫, 吸着の科学, 丸善, ISBN:461048430 (in Japanese).
5. 炭素材料学会編, 新・炭素材料入門, リアライズ, ISBN:4947655925 (in Japanese).
6. 近藤 正敏, 田嶋 和夫, 界面化学, 丸善, ISBN:4621049100 (in Japanese)

[Schedule]

1. Coordination bond and complex
2. Structure of mononuclear and polynuclear complexes
3. Structure of cluster, chelate, and isomerism complexes
4. Interpretations of electronic state by valence bond theory
5. Crystal and ligand field theory
6. Electronic states of multi d-electron systems
7. Nomenclature of coordination compound
8. Surface and interface
9. Surface modification and surface/pore control
10. Fundamental study of adsorption theory
11. Fundamental study of adsorption measurement method
12. Applications of surface modification and adsorption theory
13. Applications of adsorption measurement method
14. Adsorption and separation technology
15. Summative assessment for total score

[Title]			[Instructor]		
Advanced Inorganic Chemistry II			Satoshi Wada / Hiroshi Yanagi		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTA503	2	Applied Chemistry	2nd Semester	Thu.／I	

[Outline and purpose]

Students learn the basics and application of electron behavior in solids

[Objectives]

To understand fundamental principle of electronic and optical properties of solids

[Requirements]

A good grounding in Physical Chemistry, Inorganic Chemistry, and Quantum Chemistry.

[Evaluation]

1 Midterm examination　30%
2 homework　30%
3 class participation　40%

[Textbooks]

[References]

[Schedule]

1. Introduction
2. Crystal Structure
3. Chemical bonding and band structure
4. Spectroscopic methods
5. Other evaluation method
6. The essence of electronic structure
7. Material design based on electronic structure
8. Midterm examination
9. Mechanism of electric polarization
10. Complex dielectric constant and dielectric relaxation
11. Evaluation of dielectric properties
12. Ferroelectrics and ferroelectric domain configuration
13. Piezoelectricity
14. Application of dielectrics and ferroelectrics
15. Summative assessment for total score

[Title]			[Instructor]		
Advanced Analytical Chemistry			Susumu Kawakubo / Kazue Tani		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTA504	2	Applied Chemistry	1st Semester	Thu.／I	

[Outline and purpose]

This lecture covers understanding of principles, instrumentations and applications of surface analyses, chromatography and NMR spectroscopy. You will increase the level of understanding of them to take midterm examinations and make presentation of spectral analysis.

[Objectives]

1. Understanding of typical surface analytical techniques; principles, instrumentations and applications
2. Proper interpretation of analysis data and appropriate choice of analytical technique for different types of analytical samples
3. Understanding of Chromatography; principles, instrumentations and applications
4. Understanding the principle of NMR spectroscopy to be able to attribute the structure of simple compounds from the NMR spectrum and molecular formulas

[Requirements]

This program requires you to be familiar with physical, analytical and organic chemistry studied in undergraduate programs.
You should do homework on textbooks and reference books used in undergraduate programs at need.

[Evaluation]

report and/or midterm examination：60%
presentation skill and scientific understanding of scientific literature：40%

[Textbooks]

Prints

[References]

Analytical Chemistry, 6th edition　Gary D. Christian (ISBN4-621-07555-1)
田中誠之、飯田芳男, 基礎化学選書 7　機器分析, 裳華房 (ISBN:9784785331337)
有機化合物のスペクトルによる同定法　第 7 版　-MS、IR、NMR の併用-, 東京化学同人 (ISBN:9784807906338)

[Schedule]

1. Introduction
2. Electron probe technique: Electron microscope, Electron Probe Microanalysis,
3. Electron probe technique: Auger electron Spectroscopy, Electron diffractometry
4. X-ray technique: X-ray Photoelectron Spectroscopy
5. First midterm examination
6. Ion probe technique: Secondary Ion Mass Spectroscopy
7. Ion probe technique: Rutherford Back Scattering Spectroscopy
8. Second midterm examination
9. Principle of Separation in Chromatography
10. High Performance Liquid Chromatography
11. Capillary Electrophoresis
12. ^{1}H-NMR spectroscopy: theory and apparatus
13. ^{1}H-NMR spectroscopy: chemical shift, spin-spin coupling, coupling constants
14. ^{13}C NMR spectroscopy: theory and analysis
15. Presentation of spectral analysis

[Title]			[Instructor]		
Advanced Physical Chemistry			Masami Shibata/ Naoki Yoneyama		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTA505	2	Applied Chemistry	2nd Semester	Tue.／I	

[Outline and purpose]

We first explain the crystal structure and its electronic state of solid state materials to deepen expertise in physical chemistry, which is indispensable to research functional materials. Second, we describe the coating and corroding processes of metals on the basis of the surface physics and chemistry.

[Objectives]

Students will obtain further understanding of the solid state physical chemistry such as space group, crystal structure, and band structure. Furthermore, the students will learn the chemical reaction process on the metallic surface based on basic knowledge of electrochemistry.

[Requirements]

All the contents concerned with physical chemistry in the undergraduate course.

[Evaluation]

Exam: 40%
Exam [intermediate]: 40%
Attitude: 20%

[Textbooks]

P. Atkins and J. de Paula, Atkins' Physical Chemistry

[References]

N. W. Ashcroft and N. D. Mermin, "Solid State Physics"
今野豊彦 "物質の対称性と群論" (Japanese text)
春山志郎 "表面技術者のための電気化学" (Japanese text)

[Schedule]

1. Guidance
2. Symmetry of molecules（Sec. 12）
3. Symmetry of crystals（Sec. 20.1-2,副教材）
4. Crystal structure analysis（Sec. 20.3-4）
5. Crystal structure and electronic states（Sec. 20.9）
6. Electronic states of solid state materials（Sec. 20.9）
7. Magnetic states of solid state materials（Sec. 20.11）
8. Interim summary
9. Growth and structures of solid surfaces (Sec. 25.1)
10. Catalysis at surfaces (Sec. 25.6-7)
11. Basic electrochemistry (Sec. 7.5～7.9, Sec. 25.8-9)
12. Electrolysis (Sec. 25.1)
13. Electrodeposition
14. Corrosion and electroless plating (Sec. 25.13)
15. Summary

[Title]			[Instructor]		
Advanced Polymer Chemistry			Akihiro Suzuki / Hidenori Okuzaki / Makoto Obata		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTA506	2	Applied Chemistry	2nd Semester	Thu.／II	Japanese

[Outline and purpose]

Polymer materials are used in aviation, space, electronics, communication, transportation, and medical care. In this lecture, you learn synthesis, characterization, and application of various functional polymers.

[Objectives]

To understand basic knowledge of synthesis, structure, and function of polymer materials.

[Requirements]

A grounding in organic chemistry, physical chemistry, and fundamental polymer chemistry.

[Evaluation]

Attendance and report: 50 %
Presentation: 50 %

[Textbooks]

[References]

[Schedule]

1. Chain polymerization 1 (radical polymerizations, copolymerizations, and kinetics)
2. Chain polymerization 2 (ionic polymerizations and ring-opening polymerizations)
3. Stepwise polymerization 1 (condensation polymerizations and kinetics)
4. Precise polymerization 1 (basics of living polymerizations and design of specific-structure polymers)
5. Precise polymerization 2 (reversible activation mechanism and controlled polymerizations)
6. Molecular weight and distributions, stereospecificity, and properties of polymers
7. Evaluation of polymer conformation by wide-angle X-ray diffraction
8. Evaluation of molecular orientation of polymer materials
9. Crystalline structure and crystallization kinetics of polymer materials
10. Dynamic viscoelastic properties of polymer materials
11. Characteristics of optical plastics
12. Optical plastics (optical lens, optical fibers, and optical disks)
13. Prescribed properties of adhesives.
14. Mechanism of adhesion (epoxy adhesives and superglues)
15. Final examination (presentation)

[Title]			[Instructor]		
Advanced Quantum Chemistry for Energy Conversion			Hiroshi Irie		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTA507	2	Applied Chemistry	1st Semester	Thu.／II	English/ Japanese

[Outline and purpose]

This class discusses the principles of quantum mechanics first and then uses these ideas in the molecular approach to science. In every class, the attendances have a lecture, and then solve some problems to deepen their knowledge.

[Objectives]

1. To understand the basic quantum mechanics.
2. To understand the hydrogen atom, multi-electron atoms and approximation methods.
3. To understand the chemical bond: Diatomic molecules and polyatomic molecules.
4. To understand the molecular spectroscopy.

[Requirements]

Knowledge on the quantum chemistry learned in the Faculty

[Evaluation]

Attitude toward the class and practice：60%
Final examination：40%

[Textbooks]

[References]

大岩正芳：初等量子化学 第 2 版、化学同人、2006 年（in Japanese）

[Schedule]

1. The dawn of the quantum chemistry
2. The classical wave function
3. The Schrodinger equation and a particle in a box
4. Some postulates and general principles of quantum mechanics
5. The harmonic oscillator and the rigid rotator
6. The hydrogen atom
7. Approximation methods 1
8. Approximation methods 2
9. Multi-electron atoms
10. The chemical bond: Diatomic molecules
11. Bonding in polyatomic molecules
13. Group theory: The exploitation of symmetry
14. Molecular spectroscopy
15. Final examination

[Title]			[Instructor]		
Advanced Course of Materials Design for Fuel Cells			Hiroyuki Uchida / Kenji Miyatake / Shinji Nohara		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTA508	2	Applied Chemistry	2nd Semester	Tue.／II	English／Japanese

[Outline and purpose]

Fuel cells are electric power supply devices, which convert chemical energy to electric energy directly and reciprocally. Among them, polymer electrolyte fuel cells (PEFCs) for electric vehicles, portable devices, and residential power supply and solid oxide fuel cells (SOFCs) as on-site power generation have attracted a considerable attention. In this class, principle, design and evaluation of these fuel cells and their component materials will be discussed.

[Objectives]

To understand principle and evaluation of PEFCs and SOFCs and their component materials

[Requirements]

Basic knowledge on electrochemistry and physical chemistry

[Evaluation]

Report and examination: 50%
Mark given for class participation: 50%

[Textbooks]

None

[References]

Denkikagakugairon (co-authored by Matsuda and Iwakura), Maruzen, ISBN: 4621039962

[Schedule]

1. Electrochemistry of fuel cells 1
2. Electrochemistry of fuel cells 2
3. Principle and research trend of fuel cells 1
4. Principle and research trend of fuel cells 2
5. Design of fuel cell electrocatalysts: cathode catalysts 1
6. Design of fuel cell electrocatalysts: cathode catalysts 2
7. Design of fuel cell electrocatalysts: anode catalysts 1
8. Design of fuel cell electrocatalysts: anode catalysts 2
9. Methanol oxidation catalysts 1
10. Methanol oxidation catalysts 2
11. Design of highly dispersed catalysts 1
12. Design of highly dispersed catalysts 2
13. Design of functional materials 1
14. Design of functional materials 2
15. Summary

[Title]			[Instructor]		
Advanced Special Lecture in Applied Chemistry			Yoshitoki Iijima		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTA601	1	Applied Chemistry	Intensive	／	Japanese

[Outline and purpose]

You acquire research technology, product development, and dynamics of market based on the recent cases from the view point of applied chemistry. In this lecture, you obtain skills of (1) gathering information, (2) problem-solving and making proposals, (3) communication, (4) logical thinking, and (5) conception necessary for your future research through discussions with lecturer and other students.

[Objectives]

[Requirements]

This lecture requires basic knowledge of chemistry studied in the undergraduate program.

[Evaluation]

Final report: 30 %
Attendant and contribution: 40 %
Homework: 30 %

[Textbooks]

Handout is distributed as necessary.

[References]

伊丹敬之、イノベーションを興す、日本経済新聞出版社(ISBN:9784532314927)
伊丹敬之、日本企業は何で食っていくのか、日本経済新聞出版社(ISBN:9784532262020)
宮田親平、「科学者の楽園」をつくった男　大河内正敏と理化学研究所、河出文庫(ISBN:9784309412948)
小野晃　編、最新ナノテクノロジーの国際標準化、日本規格協会(ISBN:9784542301900)

[Schedule]

1. Guidance
2. To be a chemical engineer with high technology, development ability, and competitiveness – making an innovation with chemical technologies.
3. Standardization in Japan – mainly on nanotechnology.
4. Fusion technology of different fields – horizontal development in the fields of energy and environment.
5. Technology and market dynamics induced by globalization – elemental technology development.
6. Measuring instruments supporting chemical technology – development to measuring instrument industry.
7. Chemical technologies save Japan.
8. Summary

[Title]			[Instructor]		
Seminar in Applied Chemistry IA			all academic supervisors		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTA602	1	Applied Chemistry	1st Semester		Japanese

[Outline and purpose]

Students assigned to each laboratory acquire experimental and analysis methods to accomplish their master's thesis with skills in literature search, data collection, and utilization of international journals. Furthermore, the students obtain communication and presentation skills by studying how to approach the wide field and subject from the international viewpoints to cultivate the problem-solving ability and creative mind.

[Objectives]

To acquire analysis method required for professional engineers with advanced expertise.
To obtain communication and presentation skills by studying how to approach the wide field and subject from the international viewpoints.

[Requirements]

This seminar requires basic knowledge of each courses obtained in your undergraduate program.

[Evaluation]

Your academic supervisors evaluate your degree of attainment.

[Textbooks]

[References]

Textbooks, reference books, and articles related to your master's thesis prescribed by your supervisors.

[Schedule]

1. Selection of research subject 1
2. Selection of research subject 2
3. Literature search
4. Previous research investigation 1
5. Previous research investigation 2
6. Previous research investigation 3
7. Acquisition of relevant information and knowledge 1
8. Acquisition of relevant information and knowledge 2
9. Acquisition of relevant information and knowledge 3
10. Reading of international journals to obtain the relevant information and knowledge 1
11. Reading of international journals to obtain the relevant information and knowledge 2
12. Reading of international journals to obtain the relevant information and knowledge 3
13. Reading of international journals to obtain the relevant information and knowledge 4
14. Reading of international journals to obtain the relevant information and knowledge 5
15. Reading of international journals to obtain the relevant information and knowledge 6

[Title]			[Instructor]		
Seminar in Applied Chemistry IB			all academic supervisors		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTA603	1	Applied Chemistry	2nd Semester		Japanese

[Outline and purpose]

Students assigned to each laboratory propose experimental design and conduct preliminary research study under the guidance of their supervisors. Furthermore, the students obtain communication and presentation skills by studying how to approach the wide field and subject from the international viewpoints to cultivate the problem-solving ability and creative mind.

[Objectives]

To carry out a novel research based on the study of Seminar in Applied Chemistry IA.

[Requirements]

This seminar requires basic knowledge of each courses obtained in your undergraduate program.

[Evaluation]

Your academic supervisors evaluate your degree of attainment.

[Textbooks]

[References]

Textbooks, reference books, and articles related to your master's thesis prescribed by your supervisors.

[Schedule]

1. Previous research investigation 1
2. Previous research investigation 2
3. Previous research investigation 3
4. Experimental design 1
5. Experimental design 2
6. Experimental design 3
7. Preparation of preliminary research 1
8. Preparation of preliminary research 2
9. Preparation of preliminary research 3
10. Preliminary research study 1
11. Preliminary research study 2
12. Preliminary research study 3
13. Preparation of interim presentation 1
14. Preparation of interim presentation 2
15. Preparation of interim presentation 3

[Title]			[Instructor]		
Research Work in Applied Chemistry IA			all academic supervisors		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTA606	2	Applied Chemistry	1st Semester		Japanese

[Outline and purpose]

Students assigned to each laboratory acquire experimental and analysis methods to accomplish their master's thesis with skills in literature search, data collection, and utilization of international journals. Furthermore, the students obtain communication and presentation skills by studying how to approach the wide field and subject from the international viewpoints to cultivate the problem-solving ability and creative mind.

[Objectives]

To acquire analysis method required for professional engineers with advanced expertise.
To obtain communication and presentation skills by studying how to approach the wide field and subject from the international viewpoints.

[Requirements]

This seminar requires basic knowledge of each courses obtained in your undergraduate program.

[Evaluation]

Your academic supervisors evaluate your degree of attainment.

[Textbooks]

[References]

Textbooks, reference books, and articles related to your master's thesis prescribed by your supervisors.

[Schedule]

1. Selection of research subject 1
2. Selection of research subject 2
3. Literature search
4. Previous research investigation 1
5. Previous research investigation 2
6. Previous research investigation 3
7. Acquisition of relevant information and knowledge 1
8. Acquisition of relevant information and knowledge 2
9. Acquisition of relevant information and knowledge 3
10. Reading of international journals to obtain the relevant information and knowledge 1
11. Reading of international journals to obtain the relevant information and knowledge 2
12. Reading of international journals to obtain the relevant information and knowledge 3
13. Reading of international journals to obtain the relevant information and knowledge 4
14. Reading of international journals to obtain the relevant information and knowledge 5
15. Reading of international journals to obtain the relevant information and knowledge 6

[Title]			[Instructor]		
Research Work in Applied Chemistry IB			all academic supervisors		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTA607	2	Applied Chemistry	2nd Semester		Japanese

[Outline and purpose]

Students assigned to each laboratory propose experimental design and conduct preliminary research study under the guidance of their supervisors. Furthermore, the students obtain communication and presentation skills by studying how to approach the wide field and subject from the international viewpoints to cultivate the problem-solving ability and creative mind.

[Objectives]

To carry out a novel research based on the study of Research Work in Applied Chemistry IA.

[Requirements]

This seminar requires basic knowledge of each courses obtained in your undergraduate program.

[Evaluation]

Your academic supervisors evaluate your degree of attainment.

[Textbooks]

[References]

Textbooks, reference books, and articles related to your master's thesis prescribed by your supervisors.

[Schedule]

1. Previous research investigation 1
2. Previous research investigation 2
3. Previous research investigation 3
4. Experimental design 1
5. Experimental design 2
6. Experimental design 3
7. Preparation of preliminary research 1
8. Preparation of preliminary research 2
9. Preparation of preliminary research 3
10. Preliminary research study 1
11. Preliminary research study 2
12. Preliminary research study 3
13. Preparation of interim presentation 1
14. Preparation of interim presentation 2
15. Preparation of interim presentation 3