[Title]			[Instructor]		
Advanced Analytical Chemistry			Susumu Kawakubo / Yasutada Suzuki		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416200	2	Engineering for Functional Material Systems	1st Semester	Mon.／II	English／Japanese*

[Outline and purpose]

Study of topical ultratrace analytical techniques in material sciences and environmental sciences. You can request an analytical technique according to your interest. Students will present current scientific literature.

[Objectives]

1. Proper interpretation of analysis data
2. Understanding of recent frontier analytical techniques; principle and instrumentation
3. Improvement of scientific communication skills

[Requirements]

This program requires you to be familiar with analytical techniques and methods studied in undergraduate programs and used in your doctor-course study.

[Evaluation]

report or midterm examination : 40%
presentation and scientific communication skills : 60%

[Textbooks]

None

[References]

None

[Schedule]

1. Introduction
2. Ultratrace analytical techniques in environmental sciences － speciation
3. Ultratrace analytical techniques in environmental sciences － on-site analysis
4. Ultratrace analytical techniques in matrial sciences
5. Choice of scientific article or monograph according to your interest
6. Preparation of 1st presentation I
7. Preparation of 1st presentation II
8. 1st presentation and discussion I
9. 1st presentation and discussion II
10. Preparation of 2nd presentation I
11. Preparation of 2nd presentation II
12. 2nd presentation and discussion I
13. 2nd presentation and discussion II
14. Future of modern analytical methods － requirement of new frontier techniques
15. Review for final

Working members of society can choose an intensive schedule.
*Foreign students can choose English lecture.

[Title]			[Instructor]		
Chemistry of Organic Functional Material			Yuichiro Haramoto / Tetsuo Kuwabara		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416210	2	Engineering for Functional Material Systems	1st Semester	Tue.／II	Japanese

[Outline and purpose]

Application of liquid crystalline materials.
To learn how to apply liquid crystalline materials to electrical and chemical industry.

[Objectives]

To understand how to apply liquid crystalline materials.

[Requirements]

Organic chemistry, Physical chemistry

[Evaluation]

Report 30%, attitude in lesson 40%, presentation 30%

[Textbooks]

[References]

液晶基礎編　培風館、ISBN4-563-03414-2

[Schedule]

1. Liquid Crystal
2,3. Liquid Crystalline Molecules and Syntheses
4,5. Liquid Crystalline Polymer and Syntheses
6,7. Ferroelectric Liquid Crystalline Molecules and Syntheses
8,9. Ionic Liquid Crystalline Molecules and Syntheses
10. Liquid Crystalline Semiconductor
11. Conductive Liquid Crystalline Memory
12. Ion Transport Liquid Crystal
13. Ionic Liquid Crystalline Lubricant
14. Possibility of Organic Functional Materials
15. Final Discussion

[Title]			[Instructor]		
Advanced Course of Applied Electronic Chemistry			Masami Shibata / Hiroshi Yanagi		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416221	2	Engineering for Functional Material Systems	2nd Semester	Wed.／II	English／Japanese

[Outline and purpose]

Students learn the following topics:
1. Electronic structure of solids and devices in related chemistry of solid
2. Decorative and functional plating

[Objectives]

To understand basics and application of electronic chemistry of solids and its evaluation techniques

[Requirements]

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

[Evaluation]

Quizzes and Examinations 50%
Attendance and class participation 50%

[Textbooks]

[References]

[Schedule]

1.Introduction
2.The electronic structure in solids
3.Spectrophotometric analysis (Basic)
4.Spectrophotometric analysis (Advanced)
5.The basics of functional transparent oxides
6.Film preparation and evaluation techniques
7.Application in actual devices
8.Outline of electrochemistry and surface finishing
9.Electroless plating (Basic)
10.Electroless plating (Advanced)
11.Electroplating (Basic)
12.Electroplating (Advanced)
13.Anodizing (Basic)
14.Anodizing (Advanced)
15.Summarization and Examination

[Title]			[Instructor]		
Advanced Course of Polymer Material Chemistry			Akihiro Suzuki / Hidenori Okuzaki		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416230	2	Engineering for Functional Material Systems	1st Semester	Wed.／II	Japanese

[Outline and purpose]

This course addresses the relation between structures and basis properties of various polymer materials, and their evaluation methods.

[Objectives]

To understand the relation between properties and structure of polymer materials.

[Requirements]

Basic knowledge of polymer synthesis and material properties.

[Evaluation]

Homework/Reports 70%
Class participation 30%

[Textbooks]

[References]

高分子化学序論，化学同人
高分子と複合材料の力学的性質
高分子のX線回折（上・下）

[Schedule]

1. Introduction
2. Polymer synthesis
3. Molecular weight and polydispersity
4. Glass transition
5. Conformation and configuration
6. Creep and relaxation
7. Theoretical model
8. Stress-strain curve, Young's modulus, strength, and elongation at break
9. Theoretical modulus and strength
10. Crystalline polymer
11. Amorphous polymer
12. Wide-angle X-ray diffraction and crystallinity
13. Dynamic mechanical properties and viscoelasticity
14. Drawing of polymer materials
15. Molecular orientation

[Title]			[Instructor]		
Functional Molecular Chemistry			Makoto Obata / Naoki Yoneyama		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416236	2	Engineering for Functional Material Systems	2nd Semester	Mon.／I	English／Japanese

[Outline and purpose]

To learn design, synthesis and properties of molecule-based functional materials, especially functional polymers and organic crystals.

[Objectives]

To understand design, syntheses and properties of molecule-based functional materials.

[Requirements]

Good groundings of polymer chemistry and physical chemistry are required.

[Evaluation]

presentations and reports : 70 %
attendance: 30 %

[Textbooks]

none

[References]

none

[Schedule]

1. Engineering plastics and elastomers
2. Polymers for optics and electronics
3. Polymers for separation technology and supports of chemical reagents
4. Biopolymers and medical polymers
5. Molecular crystals and organic conductors
6. Synthesis, structure, and electronic state of organic conductors
7. Physics and chemistry of strongly correlated systems
8. Physical properties of organic superconductors

[Title]			[Instructor]		
Advanced Chemical Analysis			Kazue Tani		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416240	2	Engineering for Functional Material Systems	1st Semester	Wed.／I	Japanese

[Outline and purpose]

This lecture presents the separation method for organic compounds, and the nature of ceramics and its application to HPLC packing materials. The knowledge of chemical analysis can be readily applied to evaluation of new materials.

[Objectives]

1. Understanding the theory and practice of modern chromatography in specially HPLC, Supercritical Fluid Chromatography and Capillary Electrophoresis
2. Mastering materials science from ceramics to HPLC new ceramics packing materials

[Requirements]

Basic knowledge of chromatography and spectrometric identification of organic compounds.
Basic understanding of inorganic, metallic and macromolecular materials.

[Evaluation]

By two Reports on the considerations of the lecture associated with Chromatography and Ceramics.

[Textbooks]

None

[References]

None

[Schedule]

1. Modern separation in HPLC
2. Modern detection in HPLC
3. Separation and detection in Supercritical Fluid Chromatography
4. Separation and detection in Capillary Electrophoresis
5. Read through academic papers related to chromatography
6. Ceramics treated as material
7. Genealogy and property of ceramics as inorganic material
8. Category of ceramics sensor
9. Electric properties of ceramics
10. Optical properties of ceramics
11. Explanation of ceramics sensor
12. Ceramics as HPLC packing materials
13. Separation properties of new ceramics packing materials
14. Chromatographic retention characteristic of new ceramics packing materials
15. Summarization

[Title]			[Instructor]		
Advanced Inorganic Material Chemistry I			Satoshi Wada		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416251	2	Engineering for Functional Material Systems	1st Semester	Mon.／IV	English／Japanese

[Outline and purpose]

In this lecture, basic science and application of inorganic material chemistry will be lectured.

[Objectives]

To understand basic science and application of inorganic material chemistry.

[Requirements]

[Evaluation]

Comprehensive evaluation

[Textbooks]

[References]

[Schedule]

1. Introduction
2. Functional inorganic materials
3. Dielectric inorganic materials
4. Piezoelectric inorganic materials
5. Application to electric devices
6. Ferroelectric phase transition phenomena
7. Evaluation of dielectric and ferroelectric properties
8. Ferroelectric domain configuration
9. Piezoelectricity
10. High-frequency dielectric property
11. Application of dielectrics and ferroelectrics
12. Piezoelectric effect
13. Pyroelectric effect
14. Future of dielectrics and ferroelectrics
15. Estimation and summary

[Title]			[Instructor]		
Advanced Inorganic Material Chemistry II			Hideto Sakane / Naoya Miyajima		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416252	2	Engineering for Functional Material Systems	1st Semester	Mon.／IV	Japanese

[Outline and purpose]

This lecture aims to learn research and development of characters and characterization for wide range of inorganic materials. As a local structural analysis method for inorganic materials XAFS is lectured from basic principles to applications. As an example of inorganic materials and industrial design and structural control of them, carbon material is also lectured in its science and applications.

[Objectives]

Students are to be wholly learned in characteristics design and analysis of a variety of inorganic materials.

[Requirements]

Expertise of solid state chemistry, molecular structure, and spectroscopies.

[Evaluation]

Report on the considerations of the lecture and student's own research problems.

[Textbooks]

none

[References]

Students are wanted to select proper references in their own.

[Schedule]

1. Interferences of X-ray and materials
2. Analytical methods for materials by X-ray
3. Core shell of atomic orbital
4. Absorptions of X-ray
5. Basic principles of XAFS (X-ray Absorption near-edge structures)
6. Analysis of XAFS
7. Measurements of XAFS
8. Applications of XAFS
9. Basic structures of carbon materials
10. Preparations of carbon materials (carbonizations and graphitization)
11. Chemical properties of carbon materials
12. Surface and spatial properties of carbon materials
13. Diversity of carbon materials
14. Applications of carbon materials
15. Reports

[Title]			[Instructor]		
Advanced Solid State Chemistry			Takahiro Takei / Satoshi Watauchi / Yoshinori Yonezaki		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416260	2	Engineering for Functional Material Systems	2nd Semester	Tue.／I	English／Japanese

[Outline and purpose]

The aim of this lecture is acquirement of the crystal chemistry which is significant for designing solid-state materials. Relationship between the structure of crystalline solid and its functions will be lectured with picking up of actual material. Preparation processes of crystalline materials with control of the structure will be also lectured.

[Objectives]

1. To acquire advanced knowledge of material design and the latest technology for measurement of physical/chemical properties
2. To acquire consideration competency for advanced material design via education of mechanisms for energy, information, mass transfer and conversion within crystal solid-state materials.

[Requirements]

Basic knowledge of inorganic chemistry and analytical chemistry

[Evaluation]

reporting assignment / mini-exam : 70%
attendance / attitude : 10%
presentation : 20%

[Textbooks]

C. N. R. Rao and J. Gopalakrishnan, New Directions in Solid State Chemistry, Second Edition, CAMBRIDGE UNIVIESITY PRESS, ISBN:0-521-49907-0

[References]

[Schedule]

1. Structures of crystalline solid I
2. Structures of crystalline solid II
3. Characterizations of crystal structure I
4. Characterizations of crystal structure I
5. Functions properties of crystal I
6. Functions properties of crystal II
7. Synthesis processes of crystal I
8. Synthesis processes of crystal II
9. Control of micro- and nano-structure I
10. Control of micro- and nano-structure II
11. Estications and characterizations of micro- and nanostructure I
12. Estications and characterizations of micro- and nanostructure II
13. Synthesis processes of micro- and nano-structured materials I
14. Synthesis processes of micro- and nano-structured materials II
15. Final evaluation

[Title]			[Instructor]		
Advanced Course in Crystal Science and Engineering			Yoichi Nabetani / Tsutomu Muranaka		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416410	2	Engineering for Functional Material Systems	1st Semester	Mon.／II	English／Japanese

[Outline and purpose]

Functions of optical/electronic devices utilize electronic, optical and magnetic properties which results from interaction between electron, photon and phonon in semiconductor and artificial crystals. We study electronic, optical and magnetic properties in bulk or low-dimensional quantum structure, and discuss fabrication and characterization of such structures, relating them with advanced optical/electronic devices.

[Objectives]

(1) Understanding of the properties of semiconductor crystals and quantum structures.
(2) Understanding of the fabrication methods of semiconductor crystals and quantum structures.
(3) Understanding of the characterizations of semiconductor crystal and quantum structures.
(4) Understanding of the functions of advanced devices, based on crystals science and technology.

[Requirements]

Electromagnetism, quantum mechanics, semiconductor physics

[Evaluation]

Through the commentaries such as the latest specialty treatises about the associated item, presentation, consideration, discussion, we evaluate a basic scholastic ability, technical knowledge, application.

[Textbooks]

None

[References]

None

[Schedule]

Selected from the followings

1. Electric properties of semiconductor crystals
2. Optical properties of semiconductor crystals
3. Magnetic properties of semiconductor crystals
4. Basic properties of semiconductor quantum structures
5. Fabrication methods of semiconductor quantum structure
6. Characterization of semiconductor crystals –structures–
7. Characterization of semiconductor crystals –optical and electrical properties–
8. Device applications

[Title]			[Instructor]		
Semiconductor Device Engineering			Koji Yano / Norio Onojima		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416420	2	Engineering for Functional Material Systems	2nd Semester	Thu.／II	English／Japanese

[Outline and purpose]

1. The operational mechanism, technique of the analysis, and estimation of the performance for the advanced high-frequency semiconductor devices for power amplifiers and switching power devices are explained.
2. The operational mechanism of the organic semiconductor devices compared with that of inorganic ones are understood, and solution of the current issues and development in the organic devices are discussed.

[Objectives]

1. to explain the operation principle of semiconductor devices with relating to the potential and carrier profile in the devices.
2. to design the semiconductor devices using the analytical equation in the fundamental semiconductor engineering.

[Requirements]

Fundamental knowledge in semiconductor property and semiconductor devices

[Evaluation]

Examination / report 100%

[Textbooks]

[References]

1. Power semiconductor devices, PWS publishing company, ISBN:0534940986
2. S. M. Sze, Physics of Semiconductor Devices, John Wiley & Sons, ISBN:0471056618

[Schedule]

1. Electronic property of semiconductor
2. Variety and transition of semiconductor devices
3. Operational principle of high-frequency devices and power devices
4. Application of semiconductor devices to systems
5. Process of optical absorption in semiconductor
6. Physics and design of solar cell
7. Fabrication technique of high-efficiency solar-cell
8. Background and view in future of organic electronics
9. Chemical property of organic material and physics of organic devices
10. fabrication technique of organic semiconductor devices

[Title]			[Instructor]		
Quantum Electronic Device Engineering			Kiyoshi Kobayashi / Kaoru Ijima		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416430	2	Engineering for Functional Material Systems	2nd Semester	Thu.／I	English／Japanese

[Outline and purpose]

Modern electronic devices frequently require quantum mechanical knowledge and insights. The aim of this course is to introduce quantum mechanical phenomena employed in advanced electronics, and to understand physics behind them, as well as principles of operation of typical devices.

[Objectives]

To understand principles of operation of typical devices as well as related physics.
To understand basics of quantum electromagnetic fields.

[Requirements]

Fundamentals of quantum mechanics and concept of fields

[Evaluation]

Homework and report: 100%

[Textbooks]

None

[References]

Specified during the course

[Schedule]

- Review of quantum mechanics, especially harmonic oscillators
- Canonical quantization of electromagnetic fields
- Photon localization and optical near fields
- Optical near-field interaction and its application to nano devices
- Semiconductor nano structure and its application to quantum devices
- Observation and Measurement techniques supporting quantum devices

[Title]			[Instructor]		
Quantum Theory of Devices			Chikako Uchiyama		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416440	2	Engineering for Functional Material Systems	2nd Semester	Tue.／III	English／Japanese

[Outline and purpose]

In order to develop nanodevices, we need knowledge and understanding of concepts of quantum theory. This course provides an introduction to basic principles of quantum theory, quantum statistical mechanics and quantum information processing.

[Objectives]

To understand basic principles of quantum statistical mechanics
To understand basic principles of quantum information processing
To understand basic of decoherence

[Requirements]

Basic Statistics(252051)
Quantum Mechanics(262028)

[Evaluation]

Homeworks and reports 100%
Good question, Good answer, Hot discussion, ｅｔｃ

[Textbooks]

[References]

[Schedule]

1. **Basics of quantum mechanics:** quantum superposition principle, entanglement
2. **Quantum information processing:** quantum cryptography, quantum computing,quantum teleportation
3. **Decoherence：** effects of decoherence on quantum information processing, proposals to overcome decoherence

[Title]			[Instructor]		
Quantum Functional Engineering			Hirokazu Hori / Ichiro Shiraki		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416450	2	Engineering for Functional Material Systems	1st Semester	Mon.／III	English／Japanese

[Outline and purpose]

Quantum Functional Engineering is essential to break through the limitations of modern technologies. To understand this engineering, students will be provided with fundamental theory of interactions between electrons and electromagnetic fields, theoretical background of information transfer based on energy dissipation process, nano photonics, nano optics, fundamental concepts of spins, electronic spins and magnetism, and surface science. The forefront topic of each issue will be also provided to deepen understandings.

[Objectives]

To understand principles of electronic system and electromagnetic interactions.
To understand basics of interaction between photon and electronic system.
To understand basics of spins.
To understand basics of surface science.

[Requirements]

None, the lectures will be given in various aspects that depend on the backgrounds of attendee. Fundamentals of quantum mechanics may deepen understandings.

[Evaluation]

Homework, report, oral examination, final examination: 100%

[Textbooks]

None

[References]

Specified during the course

[Schedule]

- Interplay between spin, charge, lattice and orbital degree of freedom in novel functional materials - fundamentals
- Interplay between spin, charge, lattice and orbital degree of freedom in novel functional materials - topics
- Application of quantum beam – neutron, muon, photon from synchrotron radiation and positron
- Electromagnetic interactions as the basis of information transfer. Mechanisms of probe microscopy.
- Near-field optics and application to measurements and control of nanometer-scale functional devices.
- Probe microscopy and functional evaluations. Coulomb blockade and photon-assisted tunneling.
- Optical and quantum optical processes of nanometer scales. Nano-optoelectronics functional devices.
- Surface science – Surface superstructures and surface states
- Surface science – Experimental techniques: surface diffractions and scanning probe microscopy for surface superstructure analysis
- Surface science – Experimental techniques: local multi-probe methods for electrical conductivity measurements in nano scale

[Title]			[Instructor]		
Physics for Solid State Materials			Kiyokazu Nakagawa / Junji Yamanaka / Keisuke Arimoto		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416460	2	Engineering for Functional Material Systems	2nd Semester	Mon.／II	English／Japanese

[Outline and purpose]

We will learn about the basics of crystal structures and experimental techniques for analyzing crystal structures. Then, we will focus on semiconductor physics which is a core field of electronics.

[Objectives]

Introduction for Structure Analysis of Solid State Materials
Introduction for Solid State Physics

[Requirements]

Completion of course covering Quantum Mechanics
Completion of course covering Electromagnetism

[Evaluation]

Activities, lectures, and discussions: 80%
Presentations: 20%

[Textbooks]

[References]

<References written in Japanese are shown in the Japanese syllabus.>
Transmission Electron Microscopy, David B. Williams and C. Barry Carter, ISBN-10: 030645324X, ISBN-13: 978-030645324
Electronic Structure and The Properties of Solids, Walter A. Harrison, ISBN-13: 978-0-486-66021-9, ISBN-10: 0-486-66021-4

[Schedule]

1. Introduction
2. Crystal Structure
3. Diffraction Theory I
4. Diffraction Theory II
5. Transmission Electron Microscopy I
6. Transmission Electron Microscopy II
7. Other Experimental Techniques of Crystal Structure Analyses
8. Band Theory
   8.1 Nearly Free Electron Model
   8.2 Tight Binding Model
9. Band Structure
10. Transport Properties of Solids
11. Optical Properties of of Solids
12. Physics for Semiconductor Devices
   12.1 pn Junction
   12.2 MOS Devices
   12.3 Heterostructure Devices

[Title]			[Instructor]		
Advanced Instrumentation and Measurement Engineering			CHEN LEE CHUIN/ Satoshi Ninomiya		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416470	2	Engineering for Functional Material Systems	1st Semester	Mon.／Ⅳ	English／Japanese

[Outline and purpose]

Measurement and analysis in the microscopic and nanoscopic scale is indispensable to the technological innovation and scientific discovery. In this course, the student will gain a deeper understanding on the fundamentals and the operating principle of scientific instruments used in the microscopic analysis. The major components, such as ion source, detector and the core technology behind them will also be reviewed.

[Objectives]

Explain the principles behind the analytical instruments used for the microscopic analysis.
Describe the basic components and their roles in the widely used analytical instruments
Introduce how the analytical and measurement instruments contribute to the basic research and commercial R&D.

[Requirements]

Undergraduate level physics and basic chemistry

[Evaluation]

Test and report
Attendance

[Textbooks]

Materials and references will be distributed

[References]

Nil

[Schedule]

1) General Introduction on the instrumental measurement and analysis
2) Electron beam Instruments
3) Optical/laser beam instruments
4) X-ray instruments
5) Ion beam instruments
6) Detectors
7) Ion sources for Mass spectrometry I
8) Ion sources for Mass spectrometry II
9) Fundamentals of Mass spectrometer
10-15) Recent advance in Instrumentation and Measurement Engineering (based on recent published literatures)

[Title]			[Instructor]		
Advanced Quantum Science of Light and Matter			Akira Ishikawa/ Masaru Sakai/ Atsushi Syouji		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416480	2	Engineering for Functional Material Systems	1st Semester	Tue.／II	Japanese/English

[Outline and purpose]

This course pursues understanding of light-matter interactions as they relate to forefront research of novel quantum-electronic nano-devices.

[Objectives]

1. To acquire the full-quantum-mechanical theory of interaction between matters and quantized electromagnetic fields.
2. To acquire basic knowledge of optics and photonics as they relate to photonic crystals, light localization, and plasmonics.
3. To acquire a long-wave approximation and that of adaptive limit, in addition the transition probability of the case of comparable scale between a wave function and light wavelength.

[Requirements]

Electromagnetics, Quantum mechanics, Solid state physics.

[Evaluation]

Homework / Examination : 60%
Audit attitude : 40%

[Textbooks]

[References]

K. Cho, Optical Response of Nano-structures: Microscopic Nonlocal Theory, (Springer Verlag, Heidelberg 2003).

[Schedule]

Fundamental knowledge and application of the full-quantum-mechanical theory of matters and quantized electromagnetic fields.

Photonic crystals and related physics, Anderson localization of light in disordered materials, plasmonics, and their applications.

Differences of absorption spectrum of excitons in the bulk semiconductor and in the quantum well. Radiation corrections of excitons in the single quantum well and cross-interaction between multi quantum well intermediating the radiation.

[Title]			[Instructor]		
Advanced Physical Chemistry			Hiroshi Irie / Tetsuya Sato		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416730	2	Engineering for Functional Material Systems	1st Semester	Thu.／I	English／Japanese

[Outline and purpose]

A light-related system is one of the candidate technologies for sustainable energy conversion and environmental preservation. We will learn such light-related systems based on mainly physical chemistry as well as quantum chemistry and solid state physics.

[Objectives]

1. To understand the interaction of light with solids, and successive phenomena
2. To understand the excited-state properties of solids.

[Requirements]

Physical Chemistry, Quantum chemistry, Solid state physics

[Evaluation]

Report: 50%
Attendance: 50%

[Textbooks]

[References]

1. 魚崎浩平、米田龍、高橋誠、金子晋（共訳）：固体の電子構造と化学、技報堂出版、1989 年（in Japanese）
2. 塚田捷　編：表面の電子励起、丸善、1996 年（in Japanese）

[Schedule]

1. Introduction
2. Light, wave-particle durability
3. Band theory
4. Interaction of light with solids
5. Excited-state spectroscopy in solids.
6. Applications I-1: Solar cells, fundamentals
7. Applications I-2: Solar cells, Si, semiconductor and organic solar cells
8. Applications II-1: Photocatalysis, fundamentals
9. Applications II-2: Photocatalysis for environmental purification,
10. Applications III-1: Hydrogen Energy
11. Applications III-2: Photocatalysis for hydrogen production
12. Applications IV: Theory for surface wettability
13. Applications V-1: Energy conversion, fundamentals
14. Applications V-2: Energy conversion, heat to electricity
15. Evaluations

[Title]			[Instructor]		
Advanced Chemistry for Design			Shinji Nohara		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416740	2	Engineering for Functional Material Systems	2nd Semester	Wed.／I	Japanese

[Outline and purpose]

Pollution-free energy conversion is the most important subject of the 21st century, and the role of chemical engineers in this area is extremely important. In this class, energy problems and necessary research and development will be firstly explained. Next, fundamental knowledge of principles and mechanisms of various conventional and future energy conversions will be learned. Especially, conversion of chemical to electrical energy in fuel cells will be explained in detail, and deductive and inductive functional design methods will be also studied through the practical research examples.

[Objectives]

1. to learn fundamental knowledge of principles and mechanisms of fuel cells
2. to learn advanced research and technology of fuel cells
3. to understand deductive and inductive functional design methods through studies as mentioned above

[Requirements]

Physical chemistry, electrochemistry, and materials chemistry

[Evaluation]

Report and examination: 50%
Attendance and attitude: 20%
Presentation: 30%

[Textbooks]

[References]

[Schedule]

1. Overview and significance of energy and global environmental issues
2. Characteristics and uses of various devices for energy conversion (1)
3. Characteristics and uses of various devices for energy conversion (2)
4. Characteristics and uses of various fuel cells (1)
5. Characteristics and uses of various fuel cells (2)
6. Electrochemistry of fuel cells (1)
7. Electrochemistry of fuel cells (2)
8. Design for constituent materials of fuel cells (1)
9. Design for constituent materials of fuel cells (2)
10. Design for constituent materials of fuel cells (3)
11. Characteristics of various fuel cell systems
12. Current status and future prospects of various fuel cells
13. Discussion (1)
14. Discussion (2)
15. Summary

[Title]			[Instructor]		
Advanced Course of Processing			Shinichiro Hira		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416750	2	Engineering for Functional Material Systems	2nd Semester	Thu.／III	English／Japanese

[Outline and purpose]

Mechanical Processing focuses on the design, manufacture and operation of products that have moving parts. Aircraft, automobiles, more fuel efficient systems and cheaper electricity all come to mind. Manufacturing Engineering meanwhile concentrates on converting materials from one form to another.
This course also prepares you for the traditional challenges of mechanical processing using the most sophisticated computer tools.

[Objectives]

To use general information of Materials for Metal forming.
To predict possibility of forming processes by using general information of Materials.

[Requirements]

Strength of material
Material
Metal forming

[Evaluation]

final examination：100%

[Textbooks]

N.A.

[References]

N.A.

[Schedule]

1. General Introduction
2. Structure of Metals
3. Mechanical Behavior
4. Physical Properties of Materials
5. Metal Alloys
6. Fundamentals of Metal Casting
7. Metal rolling Processes
8. Metal Forging Processes
9. Metal Extrusion Processes
10. Sheet metal Forming Processes
11. Powder Metal Processes
12. Fundamentals of Machining
13. Cutting Tools Materials
14. Machining Processes
15. Final examination

[Title]			[Instructor]		
Advanced Science on Electrochemistry			Hiroyuki Uchida / Kenji Miyatake		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416760	2	Engineering for Functional Material Systems	2nd Semester	Tue.／II	Japanese

[Outline and purpose]

Electrochemical materials, which convert chemical energy to electric energy directly and reciprocally, are important in the field of information technology such as sensors and memory devices as well as in the field of energy conversion. Among them, fuel cells have attracted a great attention because fuel cells are highly efficient and environmentally benign energy conversion devices. Polymer electrolyte fuel cells for electric vehicles, portable devices, and residential power supply and solid oxide fuel cells as on-site power generation have been developed extensively. In this class, basics, design, and research trend of component materials are discussed.

[Objectives]

1. To acquire advanced knowledge and cutting edge technology on electrochemical devices and their component materials
2. To acquire advanced knowledge and cutting edge technology on sustainable energy devices

[Requirements]

Basic knowledge on electrochemistry, physical chemistry, and materials chemistry

[Evaluation]

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

[Textbooks]

None

[References]

None

[Schedule]

1. Polymer electrolyte fuel cells (PEFCs)
2. Component materials of PEFCs 1
3. Component materials of PEFCs 2
4. Design of component materials for PEFCs 1
5. Design of component materials for PEFCs 2
6. Research trend of PEFCs 1
7. Research trend of PEFCs 2
8. Solid oxide fuel cells (SOFCs)
9. Component materials of SOFCs 1
10. Component materials of SOFCs 2
11. Design of component materials for SOFCs 1
12. Design of component materials for SOFCs 2
13. Research trend of SOFCs 1
14. Research trend of SOFCs 2
15. Summary

[Title]			[Instructor]		
Advanced Color Image Technology			Shinji Kotani / Kazumi Fujima		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416775	2	Engineering for Functional Material Systems	1st Semester	Wed.／IV	English／Japanese

[Outline and purpose]

Starting with how our eyes recognize color, we will explain important issues such as color space, measurement of color and their practical applications for engineering design.

[Objectives]

1. Being able to explain how our eyes recognize colors.
2. Understand several color systems and difference between them.
3. Instrument of measuring color
4. translate Analog figures to digital ones
5. Get used to tools for handling color and simulate color images on PC.

[Requirements]

Fundamental knowledge about spectra of light and some mathematical skill for vector space

[Evaluation]

final examination: 50%
presentation: 50%

[Textbooks]

Not Specified.

[References]

Not Specified.

[Schedule]

We will go through following issues. The order of explanation may be subjected to change.

1.Structure of our eyes and how they recognize colors
2. Difference of spectra of light and color space.
3..How we measure color and Color models
4..Representation of color, i.e. Munsell color system, RGB and CMYK are color models and so on
5. Conversion analog color to digital representation
6 . Composition and decomposition of colors using image manipulation tools on PC.

[Title]			[Instructor]		
Advanced Course of Creation of Functional Materials			Nobuhiro Kumada / Isao Tanaka		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416780	2	Engineering for Functional Material Systems	1st Semester	Mon.／III	English／Japanese

[Outline and purpose]

An up-to-date synthesis method of functional materials is acquired on the bases of crystal chemistry, electric structure and phase equilibrium in this course. Students are required to submit the report of the scientific paper on up-to-date functional materials and to represent it and to discuss on synthesis method of functional materials.

[Objectives]

To understand an uptodate synthesis method of functional materials

[Requirements]

Inorganic chemistry, solid state chemistry, materials science, physical chemistry, electronic physical properties

[Evaluation]

Homework/ examination：40%
Audit attitude：20%
Presentation：40%

[Textbooks]

Original prints

[References]

Anthony R. West, Solid State Chemistry and its Applications, 2nd Edition, John Wiley & Sons Ltd., ISBN:978-1-119-94294-8

[Schedule]

1-2. Basic inorganic chemistry and solid state chemistry
3-5. Phase equilibrium
6-8. Crystal structural analysis
9-10. Basic band theory
11-12. Functions of materials
13-14. Up-to-date synthesis method of functional materials
15. Summary

[Title]			[Instructor]		
Advanced Crisis Management			Takeyasu Suzuki		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416790	2	Human Oriented Engineering	2nd Semester	Fri.／III	Japanese

[Outline and purpose]

The aim of this course is to learn knowledge on crisis management required in all business activities in the real world. As Crisis management is not only knowledge but also practical response capacity, discussion with teachers and students, and discussion based exercises are done for learning basis on crisis management.

[Objectives]

1. to acquire fundamental knowledge on crisis management
2. to understand basis on BCP (Business Continuity Plan) and to illustrate it
3. to understand crisis communication and to illustrate it

[Requirements]

Nothing in particular

[Evaluation]

Report: 50 %
Presentation: 50%

[Textbooks]

[References]

[Schedule]

1. Introduction
2. Cases on crisis management
3. Disaster management and crisis management
4. Civil protection and crisis management
5. Crisis management on public authority
6. Crisis management on private company
7. Business Continuity Plan (BCP)
8. Crisis communication
9. Information management
10. Discussion based exercise on BCP
11. Discussion based exercise on crisis communication
12. Summary

[Title]			[Instructor]		
Advanced Course of Catalyst Materials Science			Kazutoshi Higashiyama / Toshihiro Miyao		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416800	2	Engineering for Functional Material Systems	2nd Semester	Mon.／I	English／Japanese

[Outline and purpose]

Learning important topics of industrial catalytic process and understanding methodologies of research and development of realistic industrial catalyst for applying the knowledge to the present researches.

[Objectives]

Understanding the following topics.
1. Fundamentals of industrial catalytic processes.
2. Design concepts of industrial catalysts.
3. Methodologies of research and development for industrial catalyst.
4. Latest topics for industrial catalytic process.

[Requirements]

Basic knowledge on catalysis chemistry, physical chemistry, and inorganic chemistry.

[Evaluation]

Class participation: 50%
Report and presentation: 50%

[Textbooks]

[References]

Given

[Schedule]

One theme will be chosen from the following topics; environmental catalyst, hydrogen production catalyst, oil refining catalyst, chemical production catalyst; Research the literature related to the theme and make report and presentation.

Lectures relates to general topics of industrial catalyst will be given; introduction of industrial catalytic process, designing of industrial catalytic process, methodologies of catalyst characterization, latest topics for industrial catalytic process.

[Title]			[Instructor]		
Surface Science			Junji Inukai / Toshihiro Miyao / Mitsuru Wakisaka		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416805	2	Engineering for Functional Material Systems	1st Semester	Tue.／I	English／Japanese

[Outline and purpose]

Comprehending basic surface crystallography, surface analytical methods, and surface reactions to be applied to students' researches.

[Objectives]

Understanding basic ideas of the following topics.
1) Surface and interface science.
2) Surface crystallography at the atomic level.
3) Surface analytical methods.
4) Surface reactions on model and real surfaces.

[Requirements]

Basic knowledge on solid crystallography and quantum chemistry.

[Evaluation]

Class participation 40%
Reports, quiz, and examination 60%

[Textbooks]

[References]

Atkins' Physical Chemistry, Peter Atkins.

[Schedule]

1. Introduction to surface and interface science
2. Surface crystallography I: Single crystal surfaces
3. Surface crystallography II: Surface reconstruction and adlayers
4. Surface crystallography III: Surface structure notation
5. Surface crystallography IV: Reciprocal space
6. Surface Spectroscopy I. Interactions between photon/electron and surface
7. Surface Spectroscopy II. Photoelectron spectroscopy
8. Surface Spectroscopy III. Infrared/X-ray absorption spectroscopy
9. Surface Spectroscopy IV. Electron diffraction and ion scattering
10. Surface Spectroscopy V. Analyses of electrocatalyst surfaces
11. Adsorption at surface I: Introduction to adsorption at the solid-gas interface
12. Adsorption at surface II: Interpretation of adsorption isotherms
13. Adsorption at surface III: Adsorption in porous materials
14. Adsorption at surface IV: Characterization of porous materials by adsorption
15. Adsorption at surface V: Chemisorption and surface catalysis

[Title]			[Instructor]		
Advanced Engineering for Fuel Cell Systems			Makoto Uchida		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416810	2	Engineering for Functional Material Systems	2nd Semester	Wed.／I	Japanese

[Outline and purpose]

These lectures are focusing on a system using the PEFCs. Professors and external lecturers give lectures on the comparison of the products, components, characteristics, and distributed generation systems etc., respectively, based on search of latest literature, discussion, and practical science with development experience in the enterprise.

[Objectives]

Students can learn the state-of-the-art technology and knowledge of devices, constituent materials of the cogeneration system and fuel cell vehicles, and system design technology. In addition, they will get a better understanding of energy and environmental issues and the background of the development of fuel cells. This class is aimed to develop advanced human resources to lead the technology development to build a sustainable society on a global scale.

[Requirements]

Basic knowledge of electrochemistry, physical chemistry, materials chemistry, and thermodynamics.

[Evaluation]

Report: 60%
Class attendance and attitude: 40%

[Textbooks]

[References]

1.（監修）田村英雄,（編著）内田裕之, 池田宏之助, 岩倉千秋, 高須芳雄, 「固体高分子形燃料電池のすべて」, エヌティーエス（in Japanese)
2.（財）電気科学技術奨励会編, 「現代電力技術便覧」, オーム社（in Japanese)
3.（監修）石田正義, 「家庭用燃料電池の開発と課題」, シーエムシー出版 (in Japanese)

[Schedule]

1. Overview and significance of energy and global environmental issues
2. Principles and classification of fuel cell power generation
3. Operation principles of polymer electrolyte fuel cell and characteristics of constituent materials for the stacks
4. Development history and current status of the constituent materials for polymer electrolyte fuel cell stacks
5. Design for pore structure and catalyst effectiveness of the catalyst layer in polymer electrolyte fuel cells
6. Design guidelines and evaluation method of the catalyst for polymer electrolyte fuel cells
7. Characteristics and development history of various polymer electrolyte fuel cell systems
8. Challenges of R & D from the manufacturer perspective
9. Future R & D from the manufacturer perspective
10. Characteristics of fuel cells and various cogeneration systems
11. Current status of fuel cells and various cogeneration systems
12. Consumer energy demand with a focus on home
13. Operation results from actual sites with a focus on home
14. Future prospects and challenges from viewpoints of fuel cell market and social infrastructure
15. Summary

Subjects as mentioned above, etc. will be discussed, searching latest related literature.

[Title]			[Instructor]		
English for Fuel Cell Technologies, Advanced Level			D. A. Tryk / M. E. Brito		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416815	2	Engineering for Functional Material Systems	1st Semester	Wed.／III	Japanese

[Outline and purpose]

This course will cover all aspects of scientific and engineering English, including reading, writing, speaking and listening. All are important for today's fuel cell engineer. Oral skills are particularly important, including presentation and discussion skills. Such skills will benefit engineers throughout their careers. There will be an emphasis on learning general chemical and engineering vocabulary, in addition to fuel cell-specific terms.
In addition, there will be three classes on more advanced topics, which could include either advanced data analysis or simple density functional theory (DFT) calculations, depending on the interest of the student.

[Objectives]

The specific achievements or "milestones" will include: (1) ability to read a technical paper and summarize it briefly in English; (2) ability to write a short paper; (3) ability to confidently give a short technical presentation in English; (4) ability to listen to an oral technical presentation; (5) ability to use EndNote software to organize important background literature; (6) ability to use plotting software; (7) ability to do either more advanced data analysis or simple DFT calculations.

[Requirements]

D1 status

[Evaluation]

Reports 40 %
Presentation 40 %
Attendance 20 %

[Textbooks]

[References]

[Schedule]

1. Introduction; overview; basic pronunciation;
2. Pronunciation of general chemical terms, specific terms for student research theme; self-introductions;
3. Introduction to EndNote
4. Brief reports on papers related to student research 1
5. Brief reports on papers related to student research 2
6. Using EndNote (bibliographic software)
7. How to write a brief report on your research topic;
8. How to use Kaleidagraph 1 (plotting software)
9. How to use Kaleidagraph 2
10. Data analysis or DFT calculations 1
11. Data analysis or DFT calculations 2
12. Data analysis or DFT calculations 3
13. Final presentations 1
14. Final presentations 2
15. Final presentations 3

[Title]			[Instructor]		
Advanced Nano-Materials For Fuel Cells			Katsuyoshi Kakinuma		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416820	2	Engineering for Functional Material Systems	2nd Semester	Thu.／I	Japanese

[Outline and purpose]

In order to improve the performance of fuel cells, the development of new electrocatalysts based on nano materials is needed. The program focuses both on the synthesis of nano materials (build-up process, etc.) and on characterization (XRD, TEM, EELS, etc.), and introduces students to the advanced synthesis and characterization of nano materials for energy materials.

[Objectives]

1) To introduce students to the synthesis of nano materials (build-up process, break-down process, etc.)
2) To introduce students to the use of X-ray analysis for nano materials (XRD, SAXS, XPS, etc.)
3) To introduce students to the use of electron probe analysis for nano materials (TEM-EDX, STEM-EELS)
4) To introduce students to the use of thermal analysis for nano materials (TG-DTA, DSC, TMA)

[Requirements]

A basic knowledge of inorganic chemistry and physical chemistry.

[Evaluation]

Attendance 40%
Small test and report 60%

[Textbooks]

Leite, E. R. (Ed): Nanostructured Materials for Electrochemical Energy Production and Storage, Springer, New York, 2009

[References]

[Schedule]

1. Introduction
2. Synthesis of nano materials : build-up process, break-down process, etc.
3. Properties of nano materials 1: electronic and optical properties
4. Properties of nano materials 2: thermal property
5. Design of nano materials for fuel cells
6. Characterization of nano materials 1:XRD, SAXS, Rietveld analysis
7. Characterization of nano materials 2:TEM-EDX, STEM-EELS
8. Characterization of nano materials 3: Thermal analysis
9. Characterization of nano materials 5:XPS, UPS

[Title]			[Instructor]		
Advanced Analyses for Fuel Cell Reactions			Hiroshi Yano / Shigehito Deki		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416825	2	Engineering for Functional Material Systems	Intensive	／	Japanese

[Outline and purpose]

Synthesis of electrocatalysts and application. To understand the behavior and analyzing method of anodic and cathodic reactions in the fuel cells.

[Objectives]

1. To understand preparation methods of materials for the electrocatalysts of fuel cells.
2. To understand the analytical methods of electrochemical data

[Requirements]

1. Basic electrochemical kinetics
2. Advanced inorganic chemistry.

[Evaluation]

Test and reports:100%

[Textbooks]

Prints

[References]

J. O'M. Bockris and S. U.M Kahn: "Surface Electrochemistry –A Molecular Level Approach" Plenum Press, N.Y.(1993)

[Schedule]

1. Various kinds of electrocatalysts and applications
2. Selection and fabrication of catalytic materials
3. Catalytic properties of metal nanoparticles
4. Coordination chemistry of catalysts
5. Characterization of catalysis
6. Application of catalysis
7. Electrochemical process and kinetics on catalysis
8. Cathodic reactions and catalytic activities in fuel cells
9. Anodic reactions and catalytic activities in fuel cells
10. Effects of particle size and interparticle distance on catalytic activities

[Title]			[Instructor]		
Advanced Exercises for Functional Materials System I			Each academic supervisor		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416900 C	2	Engineering for Functional Material Systems Dept. of Functional Materials Creation Technology		Fri.／I	English／Japanese

[Outline and purpose]

Items related deeply with student's own research subject in the field of the functional material systems engineering is exercised under each academic supervisor, and understood deeply.

[Objectives]

1. to read and understand the literature about student's own research subject
2. to understand the world-leading research about the scientific fields

[Requirements]

None

[Evaluation]

audit attitude : 50%
presentation : 50%

[Textbooks]

[References]

[Schedule]

Presentation and discussion about student's own research under each academic supervisor

[Title]			[Instructor]		
Advanced Exercises for Functional Materials System I			Each academic supervisor		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416900 F	2	Engineering for Functional Material Systems Dept. of Functional Materials Creation Technology		Fri.／I	English／Japanese

[Outline and purpose]

Items related deeply with student's own research subject in the field of the functional material systems engineering is exercised under each instructor, and understood deeply.

[Objectives]

1. to read and understand the literature about student's own research subject
2. to understand the world-leading research about the scientific fields

[Requirements]

None

[Evaluation]

audit attitude : 50%
presentation : 50%

[Textbooks]

[References]

[Schedule]

Presentation and discussion about student's own research under each academic supervisor

[Title]			[Instructor]		
Advanced Exercises for Functional Materials System II			Each academic supervisor		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416910 C	2	Engineering for Functional Material Systems Dept. of Functional Materials Creation Technology		Fri.／II	English／Japanese

[Outline and purpose]

Items related deeply with student's own research subject in the field of the functional material systems engineering is exercised under each academic supervisor, and understood deeply.

[Objectives]

1. to read and understand the literature about student's own research subject
2. to understand the world-leading research about the scientific fields

[Requirements]

None

[Evaluation]

audit attitude : 50%
presentation : 50%

[Textbooks]

[References]

[Schedule]

Presentation and discussion about student's own research under each academic supervisor

[Title]			[Instructor]		
Advanced Exercises for Functional Materials System II			Each academic supervisor		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416910 F	2	Engineering for Functional Material Systems Dept. of Functional Materials Creation Technology		Fri.／II	English／Japanese

[Outline and purpose]

Items related deeply with student's own research subject in the field of the functional material systems engineering is exercised under each academic supervisor, and understood deeply.

[Objectives]

1. to read and understand the literature about student's own research subject
2. to understand the world-leading research about the scientific fields

[Requirements]

None

[Evaluation]

audit attitude : 50%
presentation : 50%

[Textbooks]

[References]

[Schedule]

Presentation and discussion about student's own research under each academic supervisor

[Title]			[Instructor]		
Field Research for Functional Materials System			Each academic supervisor		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
416920 C	2	Engineering for Functional Material Systems Dept. of Functional Materials Creation Technology		／	English／Japanese

[Outline and purpose]

Productive activity and research development are exercised in a company, and understanding the relation between the student's own research and the valuable experiences are deepened.

[Objectives]

to acquire technology and the point of view required to transfer technology of laboratory level to the industry

[Requirements]

None

[Evaluation]

audit attitude : 70%
presentation : 30%

[Textbooks]

[References]

[Schedule]

Research work in laboratory and factory of the company related with student's own research subject