

[Title]			[Instructor]		
Advanced Inorganic Materials Chemistry			Hideto Sakane/Naoya Miyajima		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTA701	2	Energy Materials Science Course	1st Semester	Mon./IV	Japanese
[Outline and purpose]					
<p>As a local structural analysis method for inorganic materials XAFS is lectured from basic principles to applications.</p> <p>As an example of inorganic materials and industrial design and structural control of them, carbon material is also lectured in its science and applications.</p> <p>This lecture aims to learn research and development of characters and characterization for wide range of inorganic materials.</p>					
[Objectives]					
Students are expected to apply the knowledges learned to 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]					
<ol style="list-style-type: none"> 1. Interferences of X-ray and materials 2. Analytical methods for materials utilizing X-ray 3. Core shell of atomic orbitals 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 Course of Inorganic Material Property			Satoshi Wada / Shintaro Ueno		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTA702	2	Energy Materials Science Course	2nd Semester	Mon./II	Japanese/ English
[Outline and purpose]					
Students learn the basics and characteristics of inorganic materials, dielectrics, piezoelectrics and optical materials, and their applications. Students also try to understand the relationship between the unique microstructures of these materials and physical properties, and the essence of material design.					
[Objectives]					
Students can explain the fundamentals and principles of electronic and optical properties of inorganic materials, and also explain the origins of physical properties of materials and physical phenomena.					
[Requirements]					
A good grounding in Physical Chemistry, Inorganic Chemistry, and Quantum Chemistry.					
[Evaluation]					
1. examination 45%					
2. examination [midterm] 30%					
3. term papers 25%					
[Textbooks]					
Lecture slides will be provided.					
[References]					
[Schedule]					
1. Introduction 2. The essence of electronic structures and crystal structures 3. Mechanism of electric polarization 4. Complex dielectric constant and dielectric relaxation, Evaluation of dielectric properties 5. Ferroelectrics and ferroelectric domain configuration 6. Application of dielectrics and ferroelectrics 7. Piezoelectricity and pyroelectricity 8. Midterm examination 9. Characteristics of electromagnetic waves and refraction 10. Light scattering and light absorption of materials 11. Mechanisms of luminescence, luminescent materials and applications 12. Characteristics of LASER, LASER materials and applications 13. Metal oxide nanoparticles and optical applications 14. Wet processes for material design 15. Examination and term paper submission					

[Title]			[Instructor]		
Advanced Course of Functional Organic Molecular Chemistry			Tetsuo Kuwabara / Naoki Yoneyama		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTA703	2	Energy Materials Science Course	1st Semester	Tue./II	Japanese/ English
[Outline and purpose]					
Functional organic molecules with unconventional physical and chemical properties have been widely used in the field of electronic devices and medical treatments. They are one of the most important advanced technologies now and in the future. In the present lecture, the students will learn the basic acknowledgment and application of the functional organic molecules.					
[Objectives]					
The students will learn the leading edge to design the molecular structure of the functional organics and to measure the physical and chemical properties.					
[Requirements]					
The students will need to have a basic understanding of organic chemistry, crystal chemistry, and chemical bond theory. It is very fine to be interested in the supermolecular chemistry and/or solid state chemistry.					
[Evaluation]					
attitude 30% documentary survey and presentation 70 %					
[Textbooks]					
[References]					
[Schedule]					
<ol style="list-style-type: none"> 1. guidance: functional organic molecules from the view of material science 2. biomimetic materials 3. supermolecule and molecular recognition 4. self-assembly and molecular aggregation 5. rotaxane, catenane and molecular machines 6. knots and dendrimers 7. analysis and sensing of nanostructures 8. interim evaluation 9. molecular based organic conductors 10. synthesis and crystal structure of organic conductors 11. electronic structure of organic conductors 12. how to measure the electronic properties of organic conductors 13. physics and chemistry in strongly correlated electron system 14. physical properties of organic superconductors 15. summary and comprehensive evaluation 					

[Title]			[Instructor]		
Advanced Chemical Analysis			Ikuo Ueta / Kumi Inoue		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTA704	2	Energy Materials Science Course	1st Semester	Wed./I	Japanese/ English
[Outline and purpose]					
This lecture presents the analytical methods using chromatography and biosensing for highly sensitive and specific quantification of organic compounds including bioactive molecules.					
[Objectives]					
Understanding the theory and recent progresses on chromatography in specially HPLC, and Gas chromatography, as well as on biosensors and biosensing especially using electrochemical methods.					
[Requirements]					
Basic knowledge of chromatography and biosensing for spectrometric identification of organic compounds.					
[Evaluation]					
By report on the considerations of the lecture associated with chromatography and biosensing.					
[Textbooks]					
None					
[References]					
None					
[Schedule]					
<ol style="list-style-type: none"> 1. Basic theory of HPLC 2. Modern separation in HPLC (1) 3. Modern separation in HPLC (2) 4. Modern detection in HPLC 5. Gas chromatography (1) 6. Gas chromatography (2) 7. Modern sample preparation in chromatography (1) 8. Modern sample preparation in chromatography (2) 9. Basic theory of biosensors 10. Recent progress on biosensors (1) 11. Recent progress on biosensors (2) 12. Electrochemical biosensors (history and theory). 13. Recent progress on electrochemical biosensors (1) 14. Recent progress on electrochemical biosensors (2) 15. Application of biosensors for bioimaging. 					

[Title]			[Instructor]		
Advanced Course of Polymer Materials Chemistry			Hidenori Okuzaki / Makoto Obata		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTA705	2	Energy Materials Science Course	2nd Semester	Thu./II	English/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]					
<ol style="list-style-type: none"> 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]		
Material Chemistry of Solids			Satoshi Watauchi / Yoshinori Yonesaki / Masanori Nagao		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTA707	2	Energy Materials Science Course	2nd Semester	Tue./II	Japanese
[Outline and purpose]					
For a better understanding of material properties, an elementary knowledge of group representation theory is lectured. For a better understanding of material preparation, crystal nucleation theory is lectured.					
[Objectives]					
To explain the influence of an electrostatic field symmetry on the energy shift of ion from the viewpoint of group representation theory. To understand the effects of thermodynamic parameters such as pressure and temperature on crystal nucleation phenomena.					
[Requirements]					
Basic knowledge on symmetry classification of molecular by sets of symmetry operations and on thermodynamics (lectured in Structure and Chemistry of Crystalline Solids).					
[Evaluation]					
Midterm examination: 50% Term-end examination : 50%					
[Textbooks]					
[References]					
[Schedule]					
1 Application of group theory to crystallography 2 Sets, Group 3 Crystallographic point groups 4 Representation matrices 5 Irreducible representation 6 Crystal field theory 7 Midterm examination 8 Midterm summary 9 Phase equilibrium 10 Crystal structure and atomic arrangement on crystal surface 11 Nucleation 12 Surface energy 13 Equilibrium form of crystal 14 Principle of crystal growth 15 Total summary					

[Title]			[Instructor]		
Advanced Quantum Materials Chemistry			Kazuya Ogawa/ Tetsuya Sato		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTA708	2	Energy Materials Science Course	1st Semester	Thu./I	Japanese
[Outline and purpose]					
<p>Nano-level structure control technology combining nanoscience and nanotechnology is required for creation of high-definition and high-performance materials to be the basis of next-generation electronics and photonics. We will explain how to control chemical reaction at the atomic / molecular level and create quantum dots and extremely thin films. Lecture on characteristics and physical properties of devices and photonics materials making use of quantum effect. Learn the process theory to grasp the thin film · surface from a micro viewpoint of atoms / molecules and create a new organic / inorganic material by physical and chemical methods. In addition, we will acquire molecular element / quantum device design method based on numerical analysis.</p>					
[Objectives]					
<ol style="list-style-type: none"> 1. To understand the electronic excitation and chemical reaction of the solid surface. 2. To understand nanostructure creation method using plasma / process principle. 3. To understand how to create energy related materials using quantum effects. 4. To understand understanding quantum chemistry of molecules. 5. To understand the principles and preparation methods of organic semiconductors. 					
[Requirements]					
Physical Chemistry, Quantum Chemistry, Electromagnetism					
[Evaluation]					
examination : 0 % homework : 40 % audit attitude : 40 % presentation : 20 %					
[Textbooks]					
[References]					
[Schedule]					

1. Electronic excitation of the surface
2. Electron excitation of solid surface by slow electron / photo excitation
3. Collision of slow ion and solid
4. Surface chemical reactions involving hydrogen atoms and radicals
5. Quantum device fabrication I
6. Quantum device fabrication II
7. Quantum chemistry of molecules
8. Electron correlation
9. Transport phenomenon
10. Superconductivity
11. Charge transfer complex
12. Organic EL
13. Organic transistor
14. Organic solar cell, Conductive polymer
15. Assessment and explanation

[Title]			[Instructor]		
Advanced Course of Solid-State Electronic Materials			Hiroshi Yanagi / Ichiro Fujii		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTA709	2	Energy Materials Science Course	1st Semester	Tue./I	Japanese / English
[Outline and purpose]					
Students learn the following topics: 1. Electronic structure of solids and devices in related chemistry of solid 2. Sintering methods used for the fabrication of electric ceramics such as dielectrics					
[Objectives]					
To understand basics and application of electronic chemistry of solids and its evaluation techniques, and to understand and explain sintering methods used for the fabrication of electric ceramics					
[Requirements]					
A good grounding in Physical Chemistry, Inorganic Chemistry, and Quantum Chemistry.					
[Evaluation]					
Quizzes and Examinations 50% Attendance and class participation 50%					
[Textbooks]					
[References]					
R.K. Bordia, S.-J. Kang, E.A. Olevsky, "Current understanding and future research directions at the onset of the next century of sintering science and technology", J. Am. Ceram. Soc., 100, 2314-2352 (2017). DOI: 10.1111/jace.14919					
[Schedule]					
<ol style="list-style-type: none"> 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. Summarization and Examination 9. Basic of sintering and development of microstructure 10. New sintering methods 1: spark plasma sintering, microwave sintering, and flash sintering 11. New sintering methods 2: two-step sintering, reactive atmosphere sintering, and cold sintering 12. Topics 1: fabrication of single crystals by solid-state crystal growth method 13. Topics 2: fabrication of transparent ceramics 14. Topics 3: fabrication of multilayer ceramic capacitors 15. Summarization and Examination <p>This schedule may be changed by an arrangement between instructors and students.</p>					

[Title]			[Instructor]		
Advanced Course in Crystal Science and Engineering			Yoichi Nabetani / Tsutomu Muranaka		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTB701	2	Energy Materials Science Course	1st Semester	Mon./II	Japanese
[Outline and purpose]					
Crystal science and engineering is a key technology for semiconductor devices used in various optical and electronic applications. This course provides the knowledge of fabrication and characterization of semiconductor quantum nanostructures. You will learn up-to-date information about fabrication and characterization of semiconductor quantum nanostructures from R&D phase to industrial product phase.					
[Objectives]					
By the end of the course, you will be able to understand and describe fabrication and characterization of semiconductor quantum nanostructures. Also you will be able to understand and describe many kinds of technology for semiconductor quantum nanostructures in today's world.					
[Requirements]					
Electromagnetism, quantum mechanics and semiconductor physics.					
[Evaluation]					
Activities, lectures, discussions and presentations: 100%					
[Textbooks]					
Original text will be used.					
[References]					
Simon M. Sze, Kwok K. Ng, Physics of Semiconductor Devices, Third Edition, Wiley-Interscience (ISBN:978-0471143239)					
[Schedule]					
<ol style="list-style-type: none"> 1. Electrical properties of semiconductors 2. Optical properties of semiconductors 3. Magnetic properties of semiconductors 4. Structural properties of semiconductors 5. Fabrication processes of semiconductor quantum nanostructures 6. Characterization: Structural properties of semiconductor quantum nanostructures 7. Characterization: Optical and electrical properties of semiconductor quantum nanostructures 8. Device applications of semiconductor quantum nanostructures 					

[Title]			[Instructor]		
Physics for Solid State Materials			Junji Yamanaka/ Keisuke Arimoto		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTB705	2	Energy Materials Science Course	2nd Semester	Mon./II	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]					
<ol style="list-style-type: none"> 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 <ol style="list-style-type: none"> 8.1 Nearly Free Electron Model 8.2 Tight Binding Model 9. Band Structure 10. Transport Properties of Solids 11. Optical Properties of Solids 12. Physics for Semiconductor Devices <ol style="list-style-type: none"> 12.1 pn Junction 12.2 MOS Devices 12.3 Heterostructure Devices 					

[Title]			[Instructor]		
Advanced Quantum Science of Light and Matter			Akira Ishikawa / Masaru Sakai/ Atsushi Syouji		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTB706	2	Energy Materials Science Course	1st Semester	Tue./II	Japanese
[Outline and purpose]					
In this course, we explain: (1) theory on the interaction between light and nano materials and optical response of nano materials; (2) optical properties in interaction between light and nanosized materials; (3) optical responses in a semiconductor microstructure on the interaction through a radiation field performed by the coherent transition radiation function. In order to realize innovative nanodevices, it is essential to understand and apply those new aspects of interaction between light and matter.					
[Objectives]					
<ol style="list-style-type: none"> 1. to understand optical response of nano materials 2. to understand interaction between light and nanosized materials. 3. to understand longwave approximation and limitation of that, and transition probability of nano-scale materials. 					
[Requirements]					
Electromagnetics, quantum mechanics, and optics.					
[Evaluation]					
Attendance, Attitude: 100%					
[Textbooks]					
None					
[References]					
Cho, Kikuo, Optical Response of Nanostructures, Springer-Verlag Tokyo (ISBN:4431710752)					
[Schedule]					
<ol style="list-style-type: none"> 1. Classical theory of optical response (A. Ishikawa) 2. Semiclassical theory of optical response (A. Ishikawa) 3. Nonlocal response theory (A. Ishikawa) 4. Nonlocal response theory (A. Ishikawa) 5. Applications (A. Ishikawa) 6. Optical pulse propagation in exciton resonant region (M. Sakai) 7. Development of enhanced SNOM (M. Sakai) 8. Light localization in GaN nanocolumns (M. Sakai) 9. Random laser (M. Sakai) 10. WGM laser in GaN microdisk (M. Sakai) 11. Exciton polariton (A. Syouji) 12. Confined exciton (A. Syouji) 13. Longwave approximation (A. Syouji) 14. Exciton creation and annihilation (A. Syouji) 15. Radiation correction of confined exciton (A. Syouji) 					

[Title]			[Instructor]		
Advanced Photon Engineering			Tetuo Harimoto		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTB708	2	Energy Materials Science Course	2nd Semester	Mon./IV	Japanese
[Outline and purpose]					
Emphases of this course are on the development of ultrahigh intensity laser science and interaction of laser and materials. In addition, some numerical methods on the photon engineering, especially involving the UV laser generation using the second-harmonic generation and the optical chirped pulse parametric amplification. It meets the needs of many students with interests in the modern physics and provides students with a general feel for the subject of ultrahigh intensity laser science.					
[Objectives]					
To introduce students to the concept of photon and ultrahigh intensity laser science. To introduce students to the generation mechanism of ultrashort laser pulses. To allow students to learn the numerical method of the photon engineering. To introduce students to the interaction of laser and materials.					
[Requirements]					
Electromagnetics, optics, and quantum mechanics.					
[Evaluation]					
Report: 80% Attendance: 20%					
[Textbooks]					
[References]					
Amnon Yariv, Optical Electronics, Saunders College Publishing, 1991, ISBN:0030474442 Amnon Yariv, Quantum Electronics, John Wiley & Sons Inc., 1989, ISBN:0471609978					
[Schedule]					
1. Generation of ultrashort and ultrahigh intensity laser pulses 2. Wavelength conversion of ultrahigh intensity laser pulses 3. Amplification of a cycle pulse 4. Measurement for ultra-broadband laser pulses 5. Design of photonics devices 6. Interaction of laser and materials 7. Simulation of photon engineering					

[Title]			[Instructor]		
Advanced Course of Catalyst Design for Electrodes			Makoto Uchida / Katsuyoshi Kakinuma / Hiroshi Yano		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTC702	2	Energy Materials Science Course	2nd Semester	Wed./I	Japanese
[Outline and purpose]					
Fuel cells have attracted much attention as key technologies of energy conversion to solve the energy and global environment issues. Especially, polymer electrolyte fuel cells (PEFCs) have been intensively developed for the extensive spread as residential cogeneration systems and automotive power sources. In this course, design guideline, preparation and evaluation methods and development trend of electrocatalysts and catalyst layers with important roles in the PEFCs will be studied. Furthermore, lectures on fuel cell systems will be given, accompanied with practical science based on progressive experience in companies.					
[Objectives]					
To learn expert knowledge and advanced technology on electrocatalysts and catalyst layers in PEFCs, and fuel cell systems					
[Requirements]					
Basic knowledge on electrochemistry, physical chemistry, materials chemistry, and thermodynamics					
[Evaluation]					
Report and examination: 60% Attendance: 40%					
[Textbooks]					
None					
[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, エヌティエス (in Japanese) 2. 松田好晴、岩倉千秋共著, 電気化学概論, 丸善 (in Japanese)					
[Schedule]					
1. Overview and significance of energy and global environmental issues 2. Electrochemistry of fuel cells (1) 3. Electrochemistry of fuel cells (2) 4. Principles and development status of various fuel cells (1) 5. Principles and development status of various fuel cells (2) 6. Design for electrocatalysts in PEFCs (1) 7. Design for electrocatalysts in PEFCs (2) 8. Design for practical electrocatalysts in PEFCs (1) 9. Design for practical electrocatalysts in PEFCs (2) 10. Design for pore structure and catalyst effectiveness of the catalyst layer in PEFCs (1) 11. Design for pore structure and catalyst effectiveness of the catalyst layer in PEFCs (2) 12. Design guideline and evaluation methods of the catalyst layer in PEFCs (1) 13. Design guideline and evaluation methods of the catalyst layer in PEFCs (2) 14. Current status and future prospects of PEFC systems 15. Summary					

[Title]			[Instructor]		
Advanced Course of Engineering for Solar Energy Conversion			Hiroshi Irie / Toshihiro Takashima		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTC703	2	Energy Materials Science Course	1st Semester	Mon./II	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. Students also learn the fundamental principle of standard and new concept solar cells.					
[Objectives]					
1. To understand the interaction of light with solids, and successive phenomena 2. To understand the fundamental principle of standard and new concept solar cells					
[Requirements]					
Physical Chemistry, Quantum chemistry, Solid state physics, Inorganic Chemistry, and Semiconductor Physics					
[Evaluation]					
1 final examination 20% 2 midterm examination 20% 3 homework / reports 20% 4 class participation / presentation 40%					
[Textbooks]					
[References]					
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） 山口 真史・M・A・グリーン・大下 祥雄・小島 信晃，太陽電池の基礎と応用，丸善（in Japanese） Martin A. Green, Solar Cells, University of New South Wales Peter Würfel, 太陽電池の物理，丸善（in Japanese） Peter Würfel, Physics of Solar Cells: From Basic Principles to Advanced Concepts, Wiley-VCH					
[Schedule]					
1.Introduction 2. Light energy conversion, Basic theory 3. Solar energy conversion : To chemical energy 1 4. Solar energy conversion : To chemical energy 2 5 Solar energy conversion : To hydrogen energy 6. Thermal energy conversion : Basic theory 7. Thermal energy conversion : To electricity 8. Solar cells and sunlight 9. Semiconductor properties 10. Carrier generation and recombination 11. Si based solar cells 12. Compound-semiconductor Solar cells 13. Organic solar cells 14. Future view 15. Final examination / presentation					

[Title]			[Instructor]		
Advanced Course of Design for Advanced Inorganic Materials			Isao Tanaka / Takahiro Takei		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTC705	2	Energy Materials Science Course	1st Semester	Tue./ II	Japanese
[Outline and purpose]					
Crystal structure, crystal defects, functions and property of functional inorganic compounds are acquired as combined with scientific research fields of inorganic industrial chemistry, crystal engineering, materials engineering. Also recent topics about properties, characterization and crystal structures of functional inorganic compounds are discussed.					
[Objectives]					
<ol style="list-style-type: none"> 1. to understand point group and non-stoichiometry of oxides 2. to understand drawing technique of crystal structure 3. to understand crystal chemistry 4. to understand X-ray diffraction analysis 					
[Requirements]					
inorganic chemistry, solid state chemistry, materials engineering, physical chemistry, electronic physical properties					
[Evaluation]					
Homework/ examination: 70% audit attitude: 10% presentation: 20%					
[Textbooks]					
Anthony R. West, Basic Solid State Chemistry, Second Edition, John Wiley & Sons Ltd., ISBN: 978-1-119-94294-8					
[References]					
[Schedule]					
<ol style="list-style-type: none"> 1. Lattice defects and its effects on functions and properties in materials 2. Non-stoichiometry of oxides 3. Lattice defects in oxides 4. Defect concentration of lattice defects 5. Defect concentration and defect equilibrium 6. Relationship between defect concentration and electrical conductivity 7. Recent topics I 8. Interim summary 9. Basics of crystal structure 10. Analysis method of crystal structure 11. Metallic conductivity and Superconductivity 12. Semiconductivity 13. Ionic conductivity 14. Recent topics II 15. Summary 					

[Title]			[Instructor]		
Advanced Course of Science for Surfaces and Interfaces			Junji Inukai / Akiyoshi Kuzume / Toshihiro Miyao		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTC706	2	Energy Materials Science Course	1st Semester	Fri./I	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. 5) Adsorption and reactions on solid 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 Surface crystallography I: Single crystal surfaces 2. Surface crystallography II: Notification of surface structures; adlayers 3. Surface crystallography III: Reciprocal lattice 4. Surface crystallography IV: Reciprocal lattice to real lattice 5. Quiz on surface crystallography 6. Surface analysis method I: Electrochemistry on Single crystal surfaces 7. Surface analysis method II: Morphological study with Scanning Probe Microscopy 8. Surface analysis method III: Infrared absorption spectroscopy 9. Surface analysis method IV: Surface enhanced Raman spectroscopy 10. Quiz on surface analysis method 11. Adsorption at solid surfaces I: (interpretation of adsorption isotherms) 12. Adsorption at solid surfaces II: (surface characterization using adsorption phenomena) 13. Adsorption at solid surfaces III: (chemisorption and surface catalysis) 14. Adsorption at solid surfaces IV: (catalytic reaction mechanisms at solid surfaces) Quiz on adsorption at solid surfaces					

[Title]			[Instructor]		
Advanced Course of English for Green Energy Science and Technology, Advanced Level			D. A. Tryk / M. E. Brito		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
PTC707	2	Energy Materials Science Course	1st Semester	Wed./III	English
[Outline and purpose]					
<p>This course will cover all aspects of scientific and engineering English, including reading, writing, speaking and listening. All are important for today's green energy scientist and engineer. Oral skills are particularly important, including presentation and discussion skills. Such skills will benefit you throughout your career. There will be an emphasis on learning general chemical and engineering vocabulary, in addition to specific terms for each student's own research. The course will complement the Green Program monthly presentations.</p>					
[Objectives]					
<p>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 and understand and answer questions; (4) ability to listen to an oral technical presentation and ask questions.</p>					
[Requirements]					
D1 status					
[Evaluation]					
Attendance: 20%; presentations: 40%; reports: 40%					
[Textbooks]					
None					
[References]					
None					
[Schedule]					
<ol style="list-style-type: none"> 1. Introduction; overview; basic pronunciation; online software; short self-introductions; 2. Self-introductions by students; online software; 3. Brief oral introduction to your research field for non-specialists 1 4. Brief oral introduction to your research field for non-specialists 2 5. Brief oral introduction to your research field for non-specialists 3 6. Brief oral introduction to your research field for non-specialists 4 7. Oral presentation of student's research 1 8. Oral presentation of student's research 2 9. Oral presentation of student's research 3 10. Oral presentation of student's research 4 11. Brief written reports on student's own research 1 12. Brief written reports on student's own research 2 13. Brief written reports on student's own research 3 14. Brief written reports on student's own research 4 15. Brief written reports on student's own research 5 					

