[Title]			[Instructor]		
Advanced Quantum Science			Hiroshi Irie /ToshihiroTakashima		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG502	2	Special Educational Program for Green Energy Conversion Science and Technology	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 about the quantum chemistry learned in the Faculty

[Evaluation]

Attendance 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 Physical Chemistry			Kenji Miyatake / Shinji Nohara		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG503	2	Special Educational Program for Green Energy Conversion Science and Technology	2nd Semester	Fri.／I	English／Japanese

[Outline and purpose]

Physical chemistry is one of the most important basic subjects in the field of green energy conversion technology. In this class, basics of physical chemistry will be studied in preparation for the advanced classes.

[Objectives]

To understand physical properties of gases, thermodynamics, phase equilibrium, electrochemistry, and reaction kinetics

[Requirements]

Basic knowledge on physical chemistry

[Evaluation]

Report and examination: 60%
Mark given for class participation: 40%

[Textbooks]

None

[References]

Physical Chemistry (Gordon M. Barrow), ISBN-10: 0070051119

[Schedule]

1. The properties of gases
2. Thermodynamics and the first law
3. Thermochemistry
4. Entropy, the second and the third law
5. Free energy and chemical equilibrium
6. Temperature and pressure dependence of phase equilibrium
7. Thermodynamics of solutions
8. Colligative properties of solutions
9. Phase and surface properties
10. Electrolytes in solutions
11. Electrochemical cells
12. Kinetics of chemical reactions
13. Reaction rate and mechanism
14. Spectroscopies and diffractions
15. Summary

[Title]			[Instructor]		
Advanced Inorganic Chemistry			Satoshi Wada / Hiroshi Yanagi		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG504	2	Special Educational Program for Green Energy Conversion Science and Technology	2nd Semester	Thu.／I	English／Japanese

[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 Materials Physics			Hiroyuki Uchida / Manuel E. Brito / Katsuyoshi Kakinuma		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG505	2	Special Educational Program for Green Energy Conversion Science and Technology	1st Semester	Mon.／I	English／Japanese

[Outline and purpose]

Solid state chemistry is one of the most important basic subjects in the field of green energy conversion technology. Many of the properties and applications of crystalline inorganic materials revolve around a surprisingly small number of structure types. We will study the basics of solid state chemistry to understand crystal structures, bonding types, and electronic structures that affect the various properties of solid materials. In addition, characteristics of the crystal structures and bonding types in solid oxide materials will be studied.

[Objectives]

1. To understand the crystal structures and bonding in solids.
2. To acquire competency in correlating various properties of materials (magnetic, electric, optic, etc.) with the crystal structures, bonding types, and constituent elements.

[Requirements]

Basic knowledge of inorganic chemistry (periodic table trends, crystal structures)

[Evaluation]

Examinations: 30%
Reports (homework) & Quizzes : 30%
Class participation & Engagement : 30%
Presentation : 10%

[Textbooks]

Anthony R. West, “Basic Solid State Chemistry and Its Applications, Second Edition”,
JOHN WILEY & SONS, LTD, ISBN:978-1-119-94294-8

[References]

None

[Schedule]

1. Crystal system, symmetry, and Bravais lattices
2. Lattice plane, Miller indices, and d-spacing
3. Crystal structures (CCP, HCP and FCC)
4. Materials with closed packed structure
5. Structures built of space-filling polyhedra
6. Rock salt, zinc blend, sphalerite, diamond, wurtzite and other AX structures
7. Rutile, cadmium iodide, cadmium chloride, perovskite, tungsten bronze, spinel and silicates
8. Ionic bonding and ionic radii
9. Lattice energy of ionic crystals
10. Exercises using the questions at the end of the textbook
11. Partial covalent bonding / Bond valence and bond length
12. Non-bonding electron effects
13. Metallic bonding
14. Band structure of metal, insulator and semiconductors / Band structure of inorganic solids
15. Term-end examination and commentaries

[Title]			[Instructor]		
Advanced Materials Chemistry			Nobuhiro Kumada / Isao Tanaka / Takahiro Takei		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG506	2	Special Educational Program for Green Energy Conversion Science and Technology	1st Semester	Tue.／II	English／Japanese

[Outline and purpose]

Synthesis and crystal growth techniques for solid state materials are acquired on the base of phase equilibrium in this course. Also crystal chemistry, X-ray crystal structure analysis, characterization for solid state materials are acquired. For various synthesis processes, the mechanism and their theories are acquired.

[Objectives]

1. to understand phase equilibrium and the application of the phase equilibrium for synthesis techniques of solid state materials
2. to understand techniques of crystal structure analysis
3. to understand formation mechanism in various synthesis processes for solid state materials

[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, Solid State Chemistry and Its Applications, Second Edition, JOHN WILEY & SONS, LTD, ISBN:978-1-119-94294-8

[References]

[Schedule]

1. Rule about phase equilibrium
2. Understanding and application of monocomponent systems
3. Understanding and application of two component systems
4. Thermal analysis for preparation of phase diagrams
5. Fundamentals and applications of crystal growth
6. Synthesis techniques for materials
7. Inorganic chemistry and basis of solid state chemistry 1
8. Inorganic chemistry and basis of solid state chemistry 2
9. Fundamentals of crystal chemistry
10. Sol-gel synthesis of inorganic materials
11. Synthesis by hydrothermal reactions
12. Soft chemical reaction
13. Thin film preparation by gas phase reaction
14. Synthesis by electrochemical reactions
15. Summary

[Title]			[Instructor]		
Advanced Catalytic Science			Toshihiro Miyao / Kazutoshi Higashiyama		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG507	2	Special Educational Program for Green Energy Conversion Science and Technology	1st Semester	Thu.／I	English／Japanese

[Outline and purpose]

Learning adsorption and catalysis of a solid surface, preparation and characterization of catalyst, industrial aspects and latest research of catalyst for understanding catalysis chemistry papers and for applying the knowledge to the present researches.

[Objectives]

1. Acquiring fundamental knowledge on adsorption.
2. Understanding catalysis of a solid surface.
3. Acquiring knowledge on characterization of catalyst.
4. Acquiring knowledge on industrial catalyst.

[Requirements]

Basic knowledge on physical chemistry, and inorganic chemistry.

[Evaluation]

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

[Textbooks]

[References]

Given suitably.

[Schedule]

1. Introduction to catalyst science (Historical aspects)
2. Introduction to catalyst science (Catalyst properties)
3. Reaction kinetics and thermodynamics (Fundamental of adsorption at solid surface)
4. Reaction kinetics and thermodynamics (Catalytic reaction)
5. Reaction kinetics and thermodynamics (Adsorption thermodynamics)
6. Catalyst preparation (Supported metal catalyst)
7. Catalyst preparation (Metal oxide catalyst)
8. Catalyst characterization (Physical properties)
9. Catalyst characterization (Chemical properties)
10. Industrial catalyst (Chemicals)
11. Industrial catalyst (Environmental catalyst: Automobiles)
12. Industrial catalyst (Environmental catalyst: Power plants)
13. Latest research of solid catalyst (Surface chemistry)
14. Latest research of solid catalyst (Catalyst preparation)
15. Latest research of solid catalyst (Applications)

[Title]			[Instructor]		
Advanced Environmental Science			Junji Inukai		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG508	2	Special Educational Program for Green Energy Conversion Science and Technology	This subject isn't offered.		English／Japanese

[Outline and purpose]

Over the years, environmental problems have become more serious, and signs of their mitigation are not in sight. The limits to growth have already been exceeded, and there are even concerns over the survival of humankind. In this lecture, students are required to research on environmental topics, discuss them, and understand the present situation for the solutions to the problems.

[Objectives]

In this lecture, students are expected to develop their abilities in:
1. Researches on environmental topics.
2. Preparation of reports.
3. Presentation in English.
4. Discussion in English.

[Requirements]

Interest in environmental science. English ability required.

[Evaluation]

Class participation 70%
Reports 15%
Quiz and examination 15%

[Textbooks]

Download files at http://www.af-info.or.jp/en/survival/index.html. The text "Conditions for Survival" is mainly used.

Misprints in the text:
p. 23, line 2, 6 and first from the bottom "square meters" should read " square kilometers"

[References]

Given when necessary.

[Schedule]

1. Introduction.
2. Today's Global Environment I (Atmosphere, Biodiversity, Water resources)
3. Today's Global Environment II (Country gaps, Fossil Fuels, Energy Consumption, Droughts)
4. Limits to growth and Human Activities
5. Global Warming
6. Loss of Biodiversity
7. Concept of a Solar-Energy Based Society
8. Building a Solar-Energy Based Society
9. Building a Society that Values Nature Itself
10. Toward a Sustainable Use of Energy
11. Changing Lifestyles
12. Diversity and Cooperation between Areas
13. Social System and International Cooperation
14. New Ideas
15. Approaches to the "Blue Planet"

[Title]			[Instructor]		
Advanced Course of Materials Design for Fuel Cells			Hiroyuki Uchida / Kenji Miyatake /Hiroai Iiyama		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG510	2	Special Educational Program for Green Energy Conversion Science and Technology	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 Course of Catalyst Design for Electrodes			Shinji Nohara / Makoto Uchida / Katsuyoshi Kakinuma /Takao Tsuneda		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG511	2	Special Educational Program for Green Energy Conversion Science and Technology	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, エヌティーエス (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
3. Principles and development status of various fuel cells
4. Design for electrocatalysts in PEFCs (1)
5. Design for electrocatalysts in PEFCs (2)
6. Design for pore structure and catalyst effectiveness of the catalyst layer in PEFCs (1)
7. Design for pore structure and catalyst effectiveness of the catalyst layer in PEFCs (2)
8. Design guideline and evaluation methods of the catalyst layer in PEFCs
9. Environmental policy and industry-academia collaboration for fuel cells
10. Characteristics and development history of various PEFC systems
11. Challenges from the viewpoint of manufacturers in R & D of fuel cells for residential use
12. Present status and future prospects of social environments such an international standardization in fuel cells for residential use
13. Present status and future prospects of next-generation vehicles (1)
14. Present status and future prospects of next-generation vehicles (2)
15. Summary

[Title]			[Instructor]		
Advanced Course of Engineering for Solar Energy Conversion			Hiroshi Irie / Hiroshi Yanagi /ToshihiroTakashima		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG512	2	Special Educational Program for Green Energy Conversion Science and Technology	1st Semester	Wed.／II	Wed.／II

[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 Wurfel, 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 Science for Solid State Materials			Takahiro Takei / Satoshi Wada		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG514	2	Special Educational Program for Green Energy Conversion Science and Technology	2nd Semester	Mon.／I	English／Japanese

[Outline and purpose]

The behavior and mechanisms of electrical, magnetic and optical properties which are significant properties of solid materials will be lectured over from the basics. The aim of this lecture is acquisition of relationship between crystal structure and the electrical, magnetic and optical properties.

[Objectives]

1. To understand behavior and mechanism of electrical, magnetic and optical properties
2. To acquire consideration competency for correlation of electrical, magnetic and optical properties with the crystal structure, sorts of bond and composed elements of the solid

[Requirements]

Crystal structure of solid state materials

[Evaluation]

examinations: 30%
reporting assignment / mini-exam : 30%
attendance / attitude : 30%
presentation : 10%

[Textbooks]

Anthony R. West, Solid State Chemistry and Its Applications, Second Edition, JOHN WILEY & SONS, LTD, ISBN:978-1-119-94294-8

[References]

[Schedule]

1. Metallic conductivity
2. Superconductivity I
3. Superconductivity II
4. Semiconductivity
5. Ionic conductivity : metal halides
6. Ionic conductivity : solid electrolytes I
7. Ionic conductivity : solid electrolytes II
8. Ionic conductivity : solid electrolytes III
9. Dielectric materials, Ferroelectricity, Pyroelectricity and Piezoelectricity
10. Magnetic properties : behavior substances in a magnetic field
11. Magnetic properties : superexchange interaction
12. Magnetic properties : examples of materials I
13. Magnetic properties : examples of materials II
14. Optical properties
15. Final examination

[Title]			[Instructor]		
Advanced Course of Design for Advanced Inorganic Materials			Isao Tanaka / Nobuhiro Kumada/ Takahiro Takei		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG515	2	Special Educational Program for Green Energy Conversion Science and Technology	2nd Semester	Tue.／I	English／ 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]

1. to explain non-stoichiometry and lattice defects in oxides, and to calculate the defect concentration
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]

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 and defect equilibrium
5. Relationship between defect concentration and electrical conductivity
6. Basis of crystalline materials
7. Basis of crystal chemistry
8. Concept of ionic radius
9. Concept of tolerance factor of perovskite-type compounds
10. Drawing of crystal structures of inorganic compounds
11. Metallic conductivity and Superconductivity
12. Semiconductivity
13. Ionic conductivity
14. Recent topics
15. Summary

[Title]			[Instructor]		
Advanced Course of Science for Surfaces and Interfaces			Junji Inukai / Toshihiro Miyao / Kazutoshi Higashiyama		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG516	2	Special Educational Program for Green Energy Conversion Science and Technology	1st Semester	Fri.／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]

16. Introduction to surface and interface science
17. Surface crystallography I: Single crystal surfaces
18. Surface crystallography II: Surface reconstruction and adlayers
19. Surface crystallography III: Surface structure notation
20. Surface crystallography IV: Reciprocal space
21. Surface Spectroscopy I. Interactions between photon/electron and surface
22. Surface Spectroscopy II. Photoelectron spectroscopy
23. Surface Spectroscopy III. Infrared/X-ray absorption spectroscopy
24. Surface Spectroscopy IV. Electron diffraction and ion scattering
25. Surface Spectroscopy V. Analyses of electrocatalyst surfaces
26. Adsorption at surface I: Introduction to adsorption at the solid-gas interface
27. Adsorption at surface II: Interpretation of adsorption isotherms
28. Adsorption at surface III: Adsorption in porous materials
29. Adsorption at surface IV: Characterization of porous materials by adsorption
30. Adsorption at surface V: Chemisorption and surface catalysis

[Title]			[Instructor]		
Advanced Course of Renewable Energy Science					
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG518	2	Special Educational Program for Green Energy Conversion Science and Technology	This subject isn't offered.		English／Japanese

[Outline and purpose]

The first half of this lecture overviews the status quo of renewable energies such as solar, wind, biomass, wave, ocean thermal and their conversion technologies, and examine their road map into the future. In the latter half is focused on biomass energy, and the details of its potential and its energy conversion technologies are examined.

[Objectives]

1) Understand the status quo of the renewable energy conversion technologies and their potential in the near future.
2) Understand technological details of biomass energy conversion and their application to bio-refinery.

[Requirements]

Knowledge on chemistry and physics at undergraduate level. Basic understanding of chemical thermodynamics.

[Evaluation]

Examination: midterm 50%, final 50%.

[Textbooks]

[References]

1. NEDO White Book on Renewable Energy Technology (in Japanese) (Downloadable from http://www.nedo.go.jp/library/ne_hakusyo_index.html)
2. 清水幸丸, 再生型自然エネルギー利用技術, パワー社, ISBN:978-4-8277-2267-3
3. 横山伸也、芋生憲司, バイオマスエネルギー, 森北出版, ISBN:978-4-627-94721-4
4. 木谷収, バイオマスー生物資源と環境ー, コロナ社, ISBN:978-4-339-06733-0

[Schedule]

1st - 7th week: The status quo of renewable energy (solar, wind, biomass, wave, ocean thermal, etc.) conversion technologies and their road map.
8th – 11th week: Potential of biomass energy and its energy conversion technologies.
12th – 15th week: Bio-refinery technologies and their applications.

[Title]			[Instructor]		
Advanced Course of Polymer Material Chemistry			Hidenori Okuzaki		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG519	2	Special Educational Program for Green Energy Conversion Science and Technology	This subject isn't offered.		English／Japanese

[Outline and purpose]

Polymer is one of three major materials together with metals and ceramics, which has been widely utilized in the fields of aerospace, electronics, telecommunication, transportation, and medicines. In this class, basic and advanced technologies in structure and function of various functional polymer materials such as gels, liquid crystals, conducting polymers, piezoelectric polymers, and intelligent materials will be discussed.

[Objectives]

To understand advanced technology in structure and function of various functional polymer materials.

[Requirements]

Basic knowledge on organic chemistry, physical chemistry, and polymer chemistry.

[Evaluation]

Mark given for class participation and report: 50%
Presentation and examination: 50%

[Textbooks]

None

[References]

Zukai Kobunshi zairyou saizensen (Kunihiro Ozaki and Kazuo Matsuura), Kogyotyosakai, ISBN:476934161X

[Schedule]

1. Polymer materials chemistry (introduction)
2. Research and development of polymer materials
3. Structure of polymer materials (molecular weight and distribution)
4. Structure of polymer materials (tacticity)
5. Structure of polymer materials (crystallinity, crystallite size, and crystalline orientation)
6. Structure of polymer materials (cross-linking and gels)
7. Function of polymer materials (high modulus and high strength polymers)
8. Function of polymer materials (biocompatibility and medical polymers)
9. Function of polymer materials (polymer gels)
10. Function of polymer materials (semiconducting polymers)
11. Function of polymer materials (conducting polymers)
12. Function of polymer materials (plastic electronics)
13. Function of polymer materials (intelligent polymer materials)
14. Function of polymer materials (biomimetic polymers)
15. Summary

[Title]			[Instructor]		
Advanced Course of System Engineering for Energy Storage			Tsuneji Kameda		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG520	1	Special Educational Program for Green Energy Conversion Science and Technology	This subject isn't offered.		Japanese

[Outline and purpose]

Renewable energy is thought to play an increasingly significant role in reducing the environmental load and reinforcing the energy securities. Concerning a promotion of the large amounts of fluctuating electricity from renewable energy into the grid, the electricity storage system is necessary in both meanings of load-leveling and demand- supply adjustment.

The energy storage technologies are reviewed in terms of cost efficiency, and some application examples are studied in this course.

[Objectives]

1. to understand the general view of the energy storage technologies, especially focused on the load-leveling and demand- supply adjustment of the renewable energy generation.
2. to study some actual approaches in the world.

[Requirements]

an interest and a basic knowledge for the renewable energy

[Evaluation]

final examination：100%

[Textbooks]

to be determined

[References]

「国家戦略会議」,「基本問題委員会」資料（2012 年 7 月 5 日）(in Japanese)、他

[Schedule]

1. Introduction
2. Technologies for energy storage
3. Technologies for energy transport
4. Electrical power storage systems
5. Renewable energy generation and power storage　part 1
6. Renewable energy generation and power storage　part 2
7. Specific case study
8. Summary

[Title]			[Instructor]		
Advanced Course of Science for Energy Materials			Tetsu Kiyobayashi		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG521	1	Special Educational Program for Green Energy Conversion Science and Technology	Intensive	／	English／Japanese

[Outline and purpose]

The energy materials mainly addressed in this intensive course are hydrogen storage materials and battery electrode materials. Physical chemistry lying behind these materials is dealt with.

[Objectives]

To acquire the knowledge on hydrogen storage materials and battery electrode materials

[Requirements]

General knowledge on physical chemistry in the undergraduate course

[Evaluation]

Attendance 60%
Report 40%

[Textbooks]

N.A.

[References]

N.A.

[Schedule]

1. Overview of hydrogen energy
2. Hydrogen storage technologoes
3. Physical chemistry of hydrogen storage materials
4. Hydrogen storage alloys, complex hydrides, carbons...
5. Problems and prospects
6. Materials in battery electrodes
7. Environmental issues
8. Summary

[Title]			[Instructor]		
Advanced Course of Chemistry for Solar Cells			Masatoshi Yanagida		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG522	1	Special Educational Program for Green Energy Conversion Science and Technology	Intensive	／.	English／Japanese

[Outline and purpose]

Solar cells convert inexhaustible solar-light energy to electrical energy, being most promising renewable and sustainable energy. Solar cells are now prevailing as subsidized photovoltaic power plants in developed countries. However, solar cells should become prevailed as subsidiary-free and personalizing solar cells in near future. Such next generation solar cells must have not only high efficiency and long durability but also low cost efficiency and environment-friendliness. Basic knowledge of solar cells will be lectured to discuss about the next generation solar cells.

[Objectives]

An understanding of the basic mechanism of photovoltaics, and acquisition of the knowledge about a future subject of solar cells

[Requirements]

Basic knowledge about the electrochemistry and the physical chemistry which were learned in the undergraduate class

[Evaluation]

Homework & report：40%
Calculation & discussion on this lecture：60%

[Textbooks]

Power Point of Instructor

[References]

桑野幸徳：「太陽電池はどのように発明され、成長したのか」 ―太陽電池開発の歴史―、オーム社、2011 年 (in Japanese)

[Schedule]

1. Introduction of photovoltaics
2. Status of solar cells
3. Silicon based solar cells(single and ploy crystalline silicon solar cells)
4. Thin layered Si based solar cells
5. CIGS based solar cells
6. Dye-sensitized solar cells
7. Organic thin film solar cells
8. Other new photovoltaics (Quantum dot solar cells)

[Title]			[Instructor]		
Advanced Course of Applied Electrochemistry			Hiroshi Senoh		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG523	1	Special Educational Program for Green Energy Conversion Science and Technology	This subject isn't offered.		Japanese

[Outline and purpose]

The importance of electrochemistry is undeniable – we cannot live without electrochemistry. There are various applications of electrochemical systems, like battery, fuel cell, super capacitor, electroplating and sensor.

The purpose of this course is to consider the application of electrochemical system for green energy conversion science and technology.

[Objectives]

1. to understand the importance of electrochemical devices in our lives
2. to propose some methods for solving the environmental problem by the application of electrochemistry

[Requirements]

a grounding in chemistry, electricity and industry

[Evaluation]

examination : 50%
report : 50%

[Textbooks]

[References]

[Schedule]

1. Introduction - electrochemical devices
2. Corrosion and plating
3. Sensor with high sensitivity
4. Electrolysis to produce chemical substances
5. Battery as an energy storage
6. Approach for electric vehicle
7. Expectation of applied electrochemistry
8. Examination

[Title]			[Instructor]		
Advanced Course of Engineering for Electrode Nano-Materials			Yoshimi Kubo		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG524	1	Special Educational Program for Green Energy Conversion Science and Technology	This subject isn't offered.		English／Japanese

[Outline and purpose]

Structures and properties of nanocarbon materials will be reviewed in connection with electrodes of fuel cells and secondary batteries. Recent application of nanocarbons to the air electrode in lithium-air battery will also be discussed in detail.

[Objectives]

To acquire knowledge and understanding of structures and properties of nanocarbon materials used in fuel cells and secondary batteries. To acquire knowledge and understanding of the principle and structure of lithium-air secondary battery as well as current status of the technology.

[Requirements]

Undergraduate level of physics, chemistry and electrochemistry

[Evaluation]

-Class attendance (50%)
-Report (50%)

[Textbooks]

None

[References]

None

[Schedule]

1. Introduction to nanocarbon materials
2. Structures and properties of nanocarbon materials
3. Application of nanocarbons to batteries and fuel cells
4. Introduction to lithium-air secondary battery
5. Electrochemistry of lithium-air secondary battery
6. Comparison of lithium-air battery and fuel cells
7. Structural design of air electrodes
8. Promise and challenges of lithium-air secondary battery

[Title]			[Instructor]		
Advanced Course of English for Green Energy Science and Technology, Elementary Level			D. A. Tryk / M. E. Brito		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG525	2	Special Educational Program for Green Energy Conversion Science and Technology	1st Semester	Wed.／I	English／Japanese

[Outline and purpose]

This course will cover reading, writing, speaking and listening for scientific and engineering English, including special emphasis on green energy and technology. Presentation and discussion skills will be particularly emphasized.

[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 ask questions at an oral technical presentation.

[Requirements]

M1 status

[Evaluation]

Attendance: 20%; presentations: 40%; reports: 40%

[Textbooks]

None

[References]

None

[Schedule]

1. Introduction; overview; basic pronunciation;
2. Pronunciation of general chemical terms, specific terms for student research themes; self-introductions;
3. Brief self-introductions
4. Short, informal oral presentations 1
5. Short, informal oral presentations 2
6. Short, informal oral presentations 3
7. Brief oral introduction to your research field for non-specialists 1
8. Brief oral introduction to your research field for non-specialists 2
9. Brief oral introduction to your research field for non-specialists 3
10. Brief oral introduction to your research field for non-specialists 4
11. Final oral presentations 1
12. Final oral presentations 2
13. Final oral presentations 3
14. Final oral presentations 4
15. Final oral presentations 5

[Title]			[Instructor]		
Advanced Course of Innovation Management			Hiroshi Osada		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG526	1	Special Educational Program for Green Energy Conversion Science and Technology	This subject isn't offered.		Japanese

[Outline and purpose]

To understand an indispensable innovation to the sustainable growth for Japanese manufacturing industry in global economy is expected. Especially management necessary to align product/business and technological development by the innovation and to accomplish the development of business is studied through the case. Moreover, the methodology of such innovation management is acquired

[Objectives]

The content of Management of Technology (MOT) to develop the product and business by innovation is understood, and the management methodology of planning and developing new products is studied
In addition, the method of how to advance the group discussion and presentation is learnt through the case study.

[Requirements]

No preliminary knowledge on management and the innovation is needed.

[Evaluation]

Attendance(20) , One Report(50), Discussion and Presentation by group work(30) : Total Score(100)

[Textbooks]

Akio Yamanouchi "New Management of Technology", Nikkei News Paper(1992) ISBN:4-532-13015-8
Hiroshi Osada ed. " Strategic Management by Policy in TQM Age", JUSE(1996) ISBN:4-8171-0288-8

[References]

Hirshi Osad "Best Practice Company", JUSE(2003) ISBN:4-8171-0100-8
Hiroshi Osada ed. " Self Assessment of Management System" ,JSA(2001) ISBN:978-4-542-70138-0
Hiroshi Osada ed. " Innovative Problem Solving Method", JUSE(2011) ISBN:978-4-8171-9410-7

[Schedule]

(1) Introduction to Innovation
(2) Management of development of Technology, product and business
(3) Case study 1: Innovation by Linear motion system of THK Co .Ltd (Explanation and DVD)
(4) Case study 2: Group exercise- Analysis and discussion
(5) Case study 3: Group exercise- Making presentation material and preparation for presentation
(6) Case study 4: Group exercise- Presentation by group and discussion, Wrapping up
(7) Management of dissemination of new products in the market
(8) Strategic planning and operations management, Wrapping up

[Title]			[Instructor]		
Advanced Course of Economics for Energy and Environment			Hisaaki Gyoten		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG527	1	Special Educational Program for Green Energy Conversion Science and Technology	Intensive	／.	Japanese

[Outline and purpose]

Under the growing interest in global environmental issues, the new energy technologies such as fuel cells, solar cells, thermoelectric elements, energy management technology, or the environmental technologies such as purification technology, green technology, are expected as core technologies which could solve those issues. In this lecture, present status of those technologies will be explained briefly. At the final part, we will think together about how to contribute to the establishment of the sustainable future society by the full use and fusion of those technologies.

[Objectives]

In addition to acquire the basic knowledge about the each environmental energy technologies, the ability to envision the ideal future society with strong ambitions should be cultivated.

[Requirements]

Basic knowledge regarding to energy conversion, such as physical chemistry and semiconductor physics learned in undergraduate

[Evaluation]

Attendance and participation to discussion (40%): evaluated by comprehension of lecture and daily efforts.
Short test and report (60%):evaluated by the ability to extract the essential issue and to solve them through theoretical thinking. The ability to describe your own opinions and persuade others also required.

[Textbooks]

non

[References]

non

[Schedule]

(1)Introduction to Energy Technology
1. Fuel Cell(No1, No2)
2.Solar Cells (No1,No2)
3.Thermoelectric Elements
4.Other Energy Technologies (No1, No2)
(2)Introduction to Environmental Technologies
1.Purification Technology (No1, No2)
(3)Recent Topics(No1, No2)
(4)Discussions (how to contribute the establishment of sustainable future society)
(5)Summary and Evaluation

[Title]			[Instructor]		
Advanced Course of Science and Technology			Akihiro Iiyama		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG528	1	Special Educational Program for Green Energy Conversion Science and Technology	Intensive	／.	English／Japanese

[Outline and purpose]

Automobile has been developed by applying advanced technology. Currently to respond to energy and environmental issues, the wave of electrification has come, such as Battery EV, HEV,PHEV and FCEV. This course is to introduce current status and future issues on those advanced technology application to automobiles.

[Objectives]

To get understanding and knowledge on the application of advanced science and technology into automotives, especially fuel cell.

[Requirements]

Undergraduate level of electrochemistry.

[Evaluation]

40%; Report (Competency for logical thinking, task setting, and task solving)
60%; Class attendance (Competency of understanding and daily efforts)

[Textbooks]

None

[References]

None

[Schedule]

No.1 ; Circumstances of Automobile (History, Future perspectives, Energy trend)
No.2 ; Safety technology for Automobile
No.3 ; Environmental technology for Automobile
　　Development history and issues
　　Internal Combustion Engine vehicle
No.4 : Battery Electric Vehicles
No.5 ; FuelCell Electric Vehicles
No.6 ; Fuel Cell Technology
　　History of development and application
　　Features of FC for automobile
No.7 ; Structure and Parts of Fuel Cell
　　Code and Standard trend
No.8 : Issues for commercialization of FCEV
　　And summary

[Title]			[Instructor]		
Internship			Each staff		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG602	2	Special Educational Program for Green Energy Conversion Science and Technology	Intensive	／	English／Japanese

[Outline and purpose]

A long-term (one month or more) internship in either industry or institute is a requirement in the second year of the Master's program. All students learn at the front lines of industrial R&D at our collaborating companies or companies engaged in the energy, or at the national institutes.

[Objectives]

To nurture a sense of green innovation through an actual job in industry or institute and to make a carrier path in either of them.

[Requirements]

[Evaluation]

Attendance and job practice : 90%
Presenrarion : 10%

[Textbooks]

[References]

[Schedule]

1. A long-term (one month or more) internship is required.
2. After the internship, an oral presentation of it is required.

[Title]			[Instructor]		
Exercises for Green Energy Conversion I			all academic supervisors		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG603	1	Special Educational Program for Green Energy Conversion Science and Technology	2nd Semester	／	English／Japanese

[Outline and purpose]

The purpose is to acquire knowledge about the green energy conversion science and technology.

[Objectives]

Students will have will have acquired the ability to address following issues through our instructional approach, which integrates basic and practical studies; Fuel cells, Solar energy conversion, Energy-conversion materials, New energy technology

[Requirements]

Physical chemistry, Materials Physics and Chemistry, Catalyst Science, Environmental Science, etc.

[Evaluation]

Laboratory work, Technical report

[Textbooks]

[References]

[Schedule]

・Students have opportunities to present the results of their studies in monthly research meetings.
・Subjects of interactive discussion between students and faculty are provided. A particular focus is on developing debate skills in English through interactive discussion subjects presented by foreign faculty.
・The number of faculty is large enough to maintain a student to faculty ratio of 1.5 to 1, creating small-group instruction, with close attention to each student.

[Title]			[Instructor]		
Professional Research for Green Energy Conversion IA			all academic supervisors		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG605	2	Special Educational Program for Green Energy Conversion Science and Technology	1st Semester	／	English／Japanese

[Outline and purpose]

The purpose is to acquire knowledge about the green energy conversion science and technology.

[Objectives]

Students will have accomplished the following general and specific learning objectives.
・Develop innovative technology in order to efficiently and economically convert and store green energy to establish a low-carbon, sustainable society.
・Achieve the best balance of various energy conversion devices and through these studies

[Requirements]

Physical chemistry, Materials Physics and Chemistry, Catalyst Science, Environmental Science, etc.

[Evaluation]

Laboratory work, Technical report

[Textbooks]

[References]

[Schedule]

・Students are required to research green energy conversion-related issues in each laboratory.
・Students have opportunities to present the results of their studies in monthly research meetings.
・Subjects of interactive discussion between students and faculty are provided. A particular focus is on developing debate skills in English through interactive discussion subjects presented by foreign faculty.
・The number of faculty is large enough to maintain a student to faculty ratio of 1.5 to 1, creating small-group instruction, with close attention to each student.

[Title]			[Instructor]		
Professional Research for Green Energy Conversion IB			all academic supervisors		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTG606	2	Special Educational Program for Green Energy Conversion Science and Technology	2nd Semester	／	English／Japanese

[Outline and purpose]

The purpose is to acquire knowledge about the green energy conversion science and technology.

[Objectives]

Students will have accomplished the following general and specific learning objectives.
・Develop innovative technology in order to efficiently and economically convert and store green energy to establish a low-carbon, sustainable society.
・Achieve the best balance of various energy conversion devices and through these studies

[Requirements]

Physical chemistry, Materials Physics and Chemistry, Catalyst Science, Environmental Science, etc.

[Evaluation]

Laboratory work, Technical report

[Textbooks]

[References]

[Schedule]

・Students are required to research green energy conversion-related issues in each laboratory.
・Students have opportunities to present the results of their studies in monthly research meetings.
・Subjects of interactive discussion between students and faculty are provided. A particular focus is on developing debate skills in English through interactive discussion subjects presented by foreign faculty.
・The number of faculty is large enough to maintain a student to faculty ratio of 1.5 to 1, creating small-group instruction, with close attention to each student.