[Title]			[Instructor]		
Advanced Instrumental Analysis IA			Junji Yamanaka Chiaya Yamamoto		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTI501	1	For All Programs of "Division of Engineering"	Intensive	／	English／Japanese

[Outline and purpose]

We will learn practical knowledge how to operate Transmission Electron Microscopes (TEM).

[Objectives]

First, we will learn about basic mechanical structure of TEM.
Then we will learn how to operate the TEM in the "Center for Instrumental Analysis."

[Requirements]

1 (Mandatory): Completion of undergraduate course covering basic physics.
2 (Mandatory): Completion of undergraduate course covering basic chemistry.
3 (Mandatory): Completion of undergraduate course of laboratory class about science/engineering.
4 (Mandatory): Your supervisor must agree that you will use the TEMs in the "Center for Instrumental Analysis."
5 (Optional): If you have a specific purpose to use TEM for your thesis, it will be desirable.

[Evaluation]

Quizzes and /or Reports: 50%
Practical Skills Examination: 50%

[Textbooks]

[References]

[Schedule]

1. What can we do using Transmission Electron Microscope (TEM)?
2. Principle of Transmission Electron Microscopy.
3. Basic Mechanical Structure of TEM.
4. How to check the condition of TEM in the "Center for Instrumental Analysis."
5. Specimen Preparation and TEM Operation. Part 1.
6. Specimen preparation and TEM operation. Part 2.
7. Specimen preparation and TEM operation. Part 3.
8. Data Analysis. Part 1.
9. Data Analysis. Part 2.
10. Discussion and Summary.

*: It is required to receive the credit of this class in advance if you would like to use the TEMs in the "Center for Instrumental Analysis."

*: If you already have the credit of the "Instrumental Analysis 1A", which is for undergraduate, you don't have to receive this credit to use the TEMs in the "Center for Instrumental Analysis."

*: There are many options how to prepare the TEM specimens and how to operate the TEM. We can discuss which part should be learned precisely, at the beginning of this class.

[Title]			[Instructor]		
Advanced Instrumental Analysis IB			Ichiro Fujii Junji Yamanaka Satoki Shinozuka Masayo Katsumata Chiaya Yamamoto Ryunosuke Kawamura		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTI502	1	For All Programs of “Division of Engineering”	Intensive Course	／	English／Japanese

[Outline and purpose]

We will learn practical knowledge how to operate Scanning Electron Microscopes (SEM).

[Objectives]

First, we will learn about basic mechanical structure of SEM.
Then we will learn how to operate the SEM in the “Center for Instrumental Analysis.”

[Requirements]

1 (Mandatory): Completion of undergraduate course covering basic physics.
2 (Mandatory): Completion of undergraduate course covering basic chemistry.
3 (Mandatory): Completion of undergraduate course of laboratory class about science/engineering.
4 (Mandatory): Your supervisor must agree that you will use the SEMs in the “Center for Instrumental Analysis.”
5 (Optional): If you have a specific purpose to use SEM for your thesis, it will be desirable.

[Evaluation]

Quizzes and /or Reports: 50%
Practical Skills Examination: 50%

[Textbooks]

[References]

[Schedule]

1. What can we do using Scanning Electron Microscope (SEM)?
2. Principle of Scanning Electron Microscopy.
3. Basic Mechanical Structure of SEM.
4. How to check the condition of SEM in the "Center for Instrumental Analysis."
5. Specimen Preparation and SEM Operation. Part 1.
6. Specimen preparation and SEM operation. Part 2.
7. Specimen preparation and SEM operation. Part 3.
8. Data Analysis. Part 1.
9. Data Analysis. Part 2.
10. Discussion and Summary.

*: It is required to receive the credit of this class in advance if you would like to use the SEMs in the "Center for Instrumental Analysis."

*: If you already have the credit of the "Instrumental Analysis 1B", which is for undergraduate, you don't have to receive this credit to use the SEMs in the "Center for Instrumental Analysis."

*: There are many options how to prepare the SEM specimens and how to operate the SEM. We can discuss which part should be learned precisely, at the beginning of this class.

[Title]			[Instructor]		
Advanced Instrumental Analysis IC			Satoshi Watauchi Satoki Shinozuka		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTI503	1	For All Programs of “Division of Engineering”	Intensive	／	English／Japanese

[Outline and purpose]

An electron probe microanalyzer (EPMA) is composed of a scanning electron microscope and an X-ray spectroscope. EPMA is useful for compositional analysis of solid surface with micrometer to centimeter size.
After understanding the principle and feature of EPMA, the measurement technique of electron microscope observation, X-ray qualitative analysis and quantitative analysis is acquired.

[Objectives]

1. Understanding principle and feature of EPMA
2. Mastering measurement technique of electron microscope observation
3. Mastering measurement technique of X-ray qualitative analysis
4. Mastering measurement technique of X-ray quantitative analysis

[Requirements]

Understanding X-ray diffraction method and spectroscopy

[Evaluation]

brief examination & homework: 50%
practice skill : 50%

[Textbooks]

[References]

[Schedule]

1. Purpose of measurement
2. Principle of EPMA measurement
3. Principle of EPMA analyzer
4. Maintenance of EPMA
5. Observation of scanning electron microscope (sample preparation and microscope operation)
6. Operation of X-ray qualitative analysis
7. Operation of X-ray quantitative analysis
8. Data analysis I (basic)
9. Data analysis II (application)
10. Summary

*1 You should get 1 credit for this class to use EPMA.
**2 If you have already gotten 1 credit for this class in undergraduate, you do not take this class.

[Title]			[Instructor]		
Advanced Instrumental Analysis ID			Tetsuya Sato Satoki Shinozuka		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTI504	1	For All Programs of “Division of Engineering”	Intensive	／	Japanese

[Outline and purpose]

X-ray photoelectron spectroscopy (XPS) is useful for chemical characterization of thin films and surfaces because it is capable of readily providing information on the nature of chemical bonding and valence states. XPS is true surface analytical techniques, since the detection electrons are emitted from surface layers less than ～15 Å deep. After understanding the principle and measurement technique of XPS, qualitative analysis and quantitative analysis is acquired.

[Objectives]

1. Understanding principle of X-ray photoelectron spectroscopy.
2. Mastering measurement technique of X-ray photoelectron spectrometer.
3. Mastering Analysis of XPS spectra.

[Requirements]

Understanding the fundamental of ultrahigh vacuum and electron spectroscopy techniques.

[Evaluation]

brief examination & homework: 50%
practice skill : 50%

[Textbooks]

[References]

[Schedule]

1. Purpose of measurement
2. Principle of XPS measurement
3. Principle of XPS analyzer
4. Maintenance of XPS
5. Operation of XPS equipment (sample preparation,)
6. Operation of sputter depth profiling.
7. Data analysis I (Qualitative analysis)
8. Data analysis II (Quantitative analysis)
9. Summary

*1 You should get 1 credit for this class to use XPS.
**2 If you have already gotten 1 credit for this class in undergraduate, you do not take this class.

[Title]			[Instructor]		
Advanced Instrumental Analysis IE			Eiichi Kondoh Satoki Shinozuka Kosuke Hara		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTI505	1	For All Programs of “Division of Engineering”	Intensive	／	Japanese

[Outline and purpose]

Learn the principles of Auger electron spectroscopy and the actual configuration and operation techniques of the instrument.

[Objectives]

(1) To understand the principle and features of Auger electron spectroscopy.
(2) To be able to obtain information from spectra.
(3) To understand the principles of point analysis, line analysis, and plane analysis.
(4) To understand the actual configuration and operation techniques of the equipment.

[Requirements]

Knowledge of physical chemistry, condensed matter physics, and solid-state physics.

[Evaluation]

Attitude of active participation: 50%
To evaluate whether or not the student has acquired the ability to safely and correctly obtain data by operating the Auger electron spectroscopy at the Center for Instrument Analysis and understand the meaning: 50%

[Textbooks]

[References]

[Schedule]

・Principles and features of auger electron spectroscopy
・How to read spectra and their meanings
・Principles of point analysis, line analysis, and plane analysis
・Actual equipment configuration and operation techniques (hands-on practice)

[Title]			[Instructor]		
Advanced Instrumental Analysis IF			Eiichi Kondoh		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTI506	1	For All Programs of “Division of Engineering”	Intensive	／	Japanese

[Outline and purpose]

A high-precision shape property measurement system consists of several devices, such as (1) 3D coordinate measurement unit, (2) cylindrical shape measuring unit, (3) 3D roughness measurement unit, (4) strain measuring instrument, (5) nano-indenter, (6) color laser microscope, and (7) compact universal testing machine. This course will cover the overall structure of the system, as well as the principles, features, and operation of the instruments. Note that lectures will not be given on discarded equipment at the time of lecture.

[Objectives]

Learn what kind of high-precision shape property measurement systems are available, how they differ from each other, and understand the principles, features, and operation of the devices.

[Requirements]

Knowledge of materials

[Evaluation]

Attitude of active participation: 50%

To evaluate whether or not the student has acquired the ability to safely and correctly obtain data by operating the system and understand the meaning of the data: 50%

[Textbooks]

[References]

[Schedule]

The principle, configuration, features, and operation of each high-precision shape property measurement system will be explained.

[Title]			[Instructor]		
Advanced Instrumental Analysis IG			Tsutomu Muranaka Masayo Katsumata Satoki Shinozuka Chiaya Yamamoto Ryunosuke Kawamura		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTI507	1	For All Programs of "Division of Engineering"	Intensive	／	Japanese

[Outline and purpose]

Liquid nitrogen is nitrogen in a liquid state at an extremely low temperature (< 77K). The extreme cold of liquid nitrogen makes handling it very dangerous because it can cause very serious burns that irreparably destroy skin or eyes. Professionals who use it must undergo training to properly learn about its reactivity and thus take appropriate precautions. Liquid nitrogen is stored, shipped and handled in several types of containers, depending upon the quantity required by the user.

After understanding the feature of liquid nitrogen and associated hazards, the safe handling of liquid nitrogen (and container) is shown.

[Objectives]

1. Understanding feature of liquid nitrogen and associated hazards
2. Safe handling of liquid nitrogen and equipment
3. Transferring liquid nitrogen from primary container

[Requirements]

Basic understanding of chemistry and physics

[Evaluation]

brief examination & homework: 50%
practice skill : 50%

[Textbooks]

[References]

[Schedule]

01. User guidance of "Center for Instrumental Analysis"
02. Outline and purpose
03. Characteristics of liquid nitrogen and associated hazards
04. Handling liquid nitrogen and containers
05. Transferring liquid nitrogen from primary container (Lecture)
06. Transferring liquid nitrogen from primary container (Training)
07. Summary

*1 You should get 1 credit for this class to use liquid nitrogen.
**2 If you have already gotten 1 credit for this class in undergraduate, you do not take this class.

[Title]			[Instructor]		
Advanced Instrumental Analysis ⅡA			Keisuke Arimoto Satoki Shinozuka		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTI508	1	For All Programs of “Division of Engineering”	Intensive	／	Japanese

[Outline and purpose]

To learn how to use X-ray diffractometers and analyze X-ray patterns.

[Objectives]

To understand the fundamentals of X-ray diffraction measurement methods.

To acquire the ability to operate the X-ray diffractometer.

[Requirements]

1. The student should have a third-year level of physics and chemistry at the undergraduate level.
2. The student must have completed some student laboratory courses and earned credits in the science department of a university.
3. The student's thesis advisor must agree to the use of the X-ray diffractometer at the Instrumental Analysis Center.

[Evaluation]

The student's basic knowledge of X-ray diffractometry will be evaluated by a quiz (including oral examination) and a report. (50%)

The students will be evaluated on their ability to operate the X-ray diffraction apparatus and to obtain correct data safely. (50%)

[Textbooks]

[References]

[Schedule]

1. Purpose of measurement
2. Principle of measurement
3. Instrument principle
4. Inspection and maintenance of equipment
5. Measurement method 1 (sample preparation and operation 1)
6. Measurement method 2 (sample preparation and operation 2)
7. Measurement method 3 (sample preparation and operation 3)
8. Data Analysis Method 1 (Basic)
9. Data Analysis Method 2 (Advanced)
10. Summary

Note: Students who wish to use the Center's equipment must take courses related to the equipment they wish to use and obtain credits in advance.

[Title]			[Instructor]		
Advanced Instrumental Analysis IIC			Tetsuo Kuwabara Masayo Katsumata		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTI510	1	For All Programs of “Division of Engineering”	Intensive	／	Japanese

[Outline and purpose]

Nuclear magnetic resonance spectrometry (NMR) is a typical analytical technique for structural analysis of organic compounds. It determines the physical and chemical properties of atom or molecules. The principle, feature and practical analytical technique of NMR are lectured and trained in this lecture.

[Objectives]

1. Understanding principle and feature of NMR
2. Training analytical technique of NMR
3. Understanding principle and feature of NMR
4. Training analytical technique of NMR

[Requirements]

Basic knowledge of organic compounds and NMR spectroscopy

[Evaluation]

Participation in class 50%
Practice skill : 50%

[Textbooks]

None

[References]

None

[Schedule]

1. Principle of NMR
2. Instrumentation of NMR
3. Analytical procedure of NMR
4. Sample preparation, operation and data analysis of NMR
5. Principle of NMR
6. Instrumentation of NMR
7. Analytical procedure of NMR
8. Sample preparation, operation and data analysis of NMR
9. Applications
10. Summary

[Title]			[Instructor]		
Advanced Instrumental Analysis IIIA			Makoto Obata Masayo Katsumata		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTI511	1	For All Programs of “Division of Engineering”	Intensive	／	Japanese

[Outline and purpose]

The purpose of this course is to learn the principles and practical methods of LC-MS and/or elemental analysis (carbon, hydrogen, and nitrogen). Students must take at least one analytical technique from each lecture.

[Objectives]

To learn and understand data analysis methods used in LC-MS and/or elemental analysis.

[Requirements]

Good understanding of basic organic chemistry is required in all courses
Basic understandings of liquid and gas chromatography are beneficial in LC-MS and/or elemental analysis courses, respectively.

[Basis of Evaluation]

Reports (30%)
Practical Exam (70%)

[Textbooks]

Title: 役に立つ有機微量元素分析
Author: (社)日本分析学会 有機微量分析研究懇談会
Publisher: みみずく舎
ISBN: 978-4-87211-905-3

[References]

Not specified

[Schedule]

1. Guidance
2. Principles of measurement
3. Principles of instrumentation
4. Maintenance and inspection of equipment
5. Instrumental measurement 1
6. Instrumental measurement 2
7. Instrumental measurement 3
8. Data analysis 1
9. Data analysis 2
10. Review

*1 You should take at least one analytical technique course from each lecture to get 1 credit for this class.
**2 If you have already gotten 1 credit for this class in undergraduate, you do not take this class.
***3 If you are going to use LC-MS or elemental analysis, you should take all corresponding courses to get user license.

[Title]			[Instructor]		
Advanced Instrumental Analysis IIIB			Ikuo Ueta Masashi Hisamoto		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTI512	1	For All Programs of “Division of Engineering”	Intensive	／	English／Japanese

[Outline and purpose]

Theory and application of GC-MS for analyzing organic compounds.

[Objectives]

1. Understanding principle of GC-MS.
2. Mastering qualitative analysis by GC-MS.

[Requirements]

Understanding principle of gas chromatography

[Evaluation]

Practical Skills Examination: 100%

[Textbooks]

[References]

[Schedule]

1. Object of GC-MS measurement.
2. Principle of GC-MS measurement.
3. Instrumental principle of GC-MS.
4 Maintenance and inspection of GC-MS.
5. Practice (sample preparation).
6. Practice1 (measurement method).
7. Practice2 (measurement method).
8. Data analysis (basic).
9. Data analysis (application).
10. Summary.

*1 You should get 1 credit for this class to use GC-MS.

[Title]			[Instructor]		
Advanced Instrumental Analysis ⅢC			Takahiro Takei Hideto Sakane Masayo Katsumata Ryunosuke Kawamura		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTI513	1	For All Programs of “Division of Engineering”	Intensive	／	Japanese

[Outline and purpose]

The course will cover the principles, structure, and applications of inductively coupled plasma optical emission spectrometry (ICP-OES) and X-ray fluorescence spectrometry (XRF), which are analytical instruments for inorganic components, as well as practical training in sample preparation and analytical operations.

[Objectives]

To understand the principle and structure of ICP-OES and XRF.
To be able to select appropriate analytical equipment according to sample, target component, concentration, etc.
To be able to select and implement appropriate pretreatment and concentration method, according to sample, target component, and concentration.
To master the operation of analyzers.

[Requirements]

1. Knowledge of basic chemistry and reagents.
2. Knowledge of the sample to be measured (composition, physical properties, etc.)
3. Experience in basic chemistry experiments such as solution preparation and dilution.

[Evaluation]

Submit a report on the results of the practical training. Determine if the operation is at a feasible level. (80%)
The evaluation will be based on the student's attitude in lectures and practical training. (20%)

[Textbooks]

[References]

[Schedule]

1. Structure and principle of Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES)

The structure and principles of ICP-OES will be explained, including an overview of atomic spectrum analysis methods.

2. Principles and structure of X-ray fluorescence spectrometer (XRF)

The structure and principles of the X-ray fluorescence spectrometer (XRF) will be explained, including an overview of other X-ray analysis methods.

3. Preparation of standard solutions

The preparation of standard solutions necessary for calibration curves will be explained.

4. Solution preparation methods such as acid digestion

Perchloric acid decomposition, hydrofluoric acid decomposition, microwave decomposition, etc., which are widely used as methods to prepare solutions of solid samples, mainly required for ICP-OES measurements, will be explained.

5. Solid sample preparation

The glass bead method and high-pressure pressing method for solidifying powder samples will be explained as sample preparation methods for XRF analysis.

6. Sample preparation

Students will prepare samples to be used in their research by themselves and prepare standard solutions necessary for measurement. (Hands-on practice)

7. Measurement

Using the samples prepared in step 6, students will actually perform measurements.

8. Summary

Summarize the results of 6 and 7 in a report and submit it.

[Title]			[Instructor]		
Advanced Instrumental Analysis IIID			Makoto Obata Masayo Katsumata Satoki Shinozuka Ryunosuke Kawamura		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTI514	1	For All Programs of “Division of Engineering”	Intensive	／	Japanese

[Outline and purpose]

The purpose of this course is to learn the principles and practical methods of Fourier Transform Infrared Spectroscopy.

[Objectives]

1. To understand the principle Infrared spectrometry
2. Be familiar with aspect of FTIR operation

[Requirements]

A grounding in infrared spectrometry

[Evaluation]

Participation in lecture class (30%)
Practice skill (70%)

[Textbooks]

[References]

G. D. Christian, Analytical Chemistry (6th Ed)
II Instrumental Analysis (Japanese TR), Maruzen

[Schedule]

1. Object of IR measurement
2. Principle of IR measurement
3. Principle of FTIR instrument
4. Check and maintenance of FTIR instrument
5. Method of measurement 1 (sample preparation and practice)
6. Method of measurement 2 (sample preparation and practice)
7. Method of measurement 3 (sample preparation and practice)
8. Basic data analysis
9. Advanced data analysis
10. Summary

[Title]			[Instructor]		
Advanced Instrumental Analysis IIIE			Tetsuya Sato Keisuke Arimoto Masayo Katsumata		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTI515	1	For All Programs of “Division of Engineering”	Intensive	／	Japanese

[Outline and purpose]

Laser Raman Scattering Spectroscopy (LRSS) is used to characterize materials and crystallographic orientation of a sample. LRSS offers several advantages for microscopic analysis. Since it is a scattering technique, specimens do not need to be fixed or sectioned. Raman spectra can be collected from a very small volume (< 1 μm in diameter); these spectra allow the identification of species present in that volume.

After understanding the principle and measurement technique of LRSS, qualitative analysis and quantitative analysis is acquired.

[Objectives]

1. Understanding principle and feature of LRSS
2. Mastering measurement technique of LRSS
3. Mastering measurement technique of LRSS qualitative analysis
4. Mastering measurement technique of LRSS quantitative analysis

[Requirements]

Understanding the fundamental of Raman effect, laser, light scattering.

[Evaluation]

brief examination & homework: 50%
practice skill : 50%

[Textbooks]

[References]

[Schedule]

1. Purpose of measurement
2. Principle of LRSS measurement
3. Principle of LRSS analyzer
4. Maintenance of LRSS
5. Operation of LRSS equipment (sample preparation,)
6. Operation of LRSS qualitative analysis
7. Operation of LRSS quantitative analysis
8. Data analysis I (basic)
9. Data analysis II (application)
10. Summary

*1 You should get 1 credit for this class to use LRSS.
**2 If you have already gotten 1 credit for this class in undergraduate, you do not take this class.