Course number	U-ENG20 42105 LJ77		
Course title (and course title in English)	工学倫理 Engineering Ethics	Instructor's name, job title, and department of affiliation	Graduate School of Informatics Professor,KANDA TAKAYUKI Graduate School of Engineering Professor,MATSUBARA ATSUSHI Graduate School of Engineering Senior Lecturer,KANEKO KENTAROU Graduate School of Engineering Professor,SHIRAISHI MASASHI Graduate School of Engineering Professor,KAGEYAMA HIROSHI Graduate School of Letters Associate Professor,KODAMA SATOSHI Graduate School of Letters Associate Professor,ISEDA TETSUJI Graduate School of Engineering Professor,MATSUSAKA SHUJI Graduate School of Informatics Professor,UMENO KEN Graduate School of Engineering Professor,ITOH SADAHIKO Graduate School of Engineering Professor,KAWAI JIYUN Office of Society-Academia Collaboration for Innovation NAKAGAWA MASAYUKI Graduate School of Management Professor,YAMADA TADASHI Graduate School of Engineering Associate Professor,NAGAKI AIICHIROU Graduate School of Engineering Professor,MIURA KEN Graduate School of Energy Science Professor,HIRATO TETSUJI
Target year	4th year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Thu.3	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

Modern ethics based on engineering aspect are becoming essential to present engineers and scientists.
Instructors from various faculties give lectures about ethics in their research fields.

[Course objectives]

The goal of this class is to understand engineering ethics, and to develop the ability to judge by yourself when you encounter ethical issues.

[Course schedule and contents]

(4/8) The central topic is what is ethics for engineers and what is significance of studying ethics for engineers.
(4/15) "General research ethics"
Lectures on the concept of writing academic papers with ethics.
(4/22)" Ethical Theories for Engineering Ethics"

Continue to 工学倫理(2)↓↓↓

工学倫理(2)

This lecture focus on various ideas in ethics (utilitarianism, deontology, virtue ethics, professional ethics etc.) which will be useful for thinking about particular ethical problems in engineering ethics. This Lecture will be conducted online by using zoom.
(5/6) "Engineering Ethics as a Professional Ethics:"
This lecture discusses basic ideas of engineering ethics in comparison with other fields of applied ethics. In particular, it discusses the characteristics of engineering ethics as professional ethics and what engineers as professionals are required to do.
(5/13) "Ethics for Engineers"
Engineers have to go through some ethical issues about research, development, design, manufacturing, and maintenance. In particular, the ethical decisions of engineers need to be considered for society and environment.
(5/20) Press Release is an essential process for introducing the research to our society through various medias. In this lecture, issues related to Press Release will be addressed and discussed with several examples including SNS release. Lecture will be conducted by Zoom.
(5/27) "Ethics in Water Supply."
It is a basic right in a society that a person can receive and use safe water in sufficient quantity. In addition, a person of water supply utility is recognized to be an essential worker. Taking drinking water supply as a topic, ethics required for a water supplier and an engineer is discussed. It is given by Zoom.
(6/3) "Forensic Analysis"
Forensic repots are sometimes requested by the court in order to clarify the charge of incidents. The nylon rope incident, the Wakayama curry poisoning incident, and the pig iron incident are explained as examples. How to write the forensic report is explained in order to avoid the ethical problems. (Zoom&Youtube)
(6/10) "Patents and Ethics (Part 1)"
This course will teach the students about 1) patent systems which protect inventions and research results and 2) ethical issues in patents. The first class, in preparation for the next subject of patent ethics, introduces Japan's patent system with comparisons to the patent systems in the world's major countries and international framework.
(6/17) "Patents and Ethics (Part 2)"
Students, equipped with the basic knowledge of patent systems by the previous lecture, will get familier with actual case studies on ethical and legal issues in patents.
(6/24) "Urban Planning and Ethics"
The lecture focuses on the norms regulating the actions of the engineers involved in planning and designing urban areas, as well as on the normative consciousness required to facilitate such planning and design, demonstrating some examples on urban transport planning. This will be given via Zoom.
(7/1) "General research ethics of synthetic chemistry"
Lectures on the concept of writing academic papers and patents of synthetic chemisty with ethics.
(7/8) Architecture has developed by imitating beautiful buildings, but in recent years there has been an increase in the number of cases where copyright disputes have arisen. In addition, the appearance of architecture often causes landscape controversy because of its influence on the surrounding environment. Issues concerning the ethics and sociality of architecture are discussed while introducing overseas lawsuits and design processes.
(7/15) The materials engineer may stand on the side using materials as well as a side supplying materials. Some examples are introduced and, by this lecture, are argued about an ethic found from each situation by materials engineer. Note that this lecture is going to be carried out in ZOOM, but may be changed to the on-demand on account of the speaker.
(7/29) "Engineer ethics in mechanical design"
Engineer ethics is not a passive and passive thinking that issues the action of simply following existing norms, but a more active and creative thinking to decide and design one's own actions. It requires the logical thinking and ethical thinking necessary for engineers. This is explained with past cases in mechanical design.

Continue to 工学倫理(3)↓↓↓

工学倫理(3)

[Course requirements]

None

[Evaluation methods and policy]

Class participation and reports.

[Textbooks]

Lecture materials will be distributed.

[References, etc.]

(**Reference books**)
『Omnibus Engineering Ethics』(Kyoritsu Shuppan Co., Ltd.) ISBN:978-4320071964
『Practical Engineering Ethics - A Short Course, New Edition』(Kagaku-Dojin Publishing Company,INC) ISBN:9784759811551
『Engineering Ethics (Revised Edition)』(CORONA PUBLISHING CO.,LTD.) ISBN:978-4-339-07798-8
『World of Engineering Ethics (3rd Edition)』(Morikita Publishing Co., Ltd.) ISBN:978-4-627-97303-9

[Study outside of class (preparation and review)]

The assignment of the report will be given for each lesson.

(Other information (office hours, etc.))

The class order is subject to change.

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number	U-ENG20 12108 LJ77		
Course title (and course title in English)	工学序論 Introduction to Engineering	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Senior Lecturer,TAKATSU HIROSHI Graduate School of Engineering Senior Lecturer,KANEKO KENTAROU Graduate School of Engineering Senior Lecturer,YOROZU KAZUAKI Graduate School of Engineering Professor,TAJI TAKAHIRO Graduate School of Engineering Professor,MIKADA HITOSHI Graduate School of Engineering Professor,OOSAKI MAKOTO Graduate School of Energy Science Professor,HIRATO TETSUJI Graduate School of Engineering Professor,HIKIHARA TAKASHI Graduate School of Engineering Professor,KAWASE MOTOAKI Graduate School of Informatics Professor,YAMASHITA NOBUO
Target year	1st year students or above	Number of credits	1
Year/semesters	2021/Intensive, First semester		
Days and periods	Intensive	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

Engineering is to inquire after truth, to develop useful technologies, and to establish ways how to give back development results of technology to the society.
First, we offer special lectures regarding the basic knowledge that students in faculty of engineering are expected to have.
Then, we offer a series of intensive lectures about how engineering can suggest solutions of current and future problems of our society, the value of technology, and the responsibilities that researchers and engineers are expected to fulfill.

[Course objectives]

Students learn basic matters such as attitudes and responsibilities they are expected to take as a member of social community. They find value in studying engineering and become to consider what they do in future by understanding technology can suggest solutions of problems our society is facing, especially problems about safety and security.

[Course schedule and contents]

Special lectures,1time, About basic knowledge and attitude as students who start to learn engineering, and the role of engineering in society.
Intensive lectures,6times, A series of lectures offered by special lecturers playing on global stages of science and technology. Lectures are for understanding the role that technology is playing in modern society, for reconfirming importance to study engineering and to work as a researcher and engineer in society, and are to be opportunities to consider own future path. Essays are assigned in every lecture to summarize the lecture content and opinions of other students.
Schedule of the lectures are announced later.

Continue to 工学序論(2)↓↓↓

工学序論(2)

[Course requirements]

None

[Evaluation methods and policy]

Evaluation will be based on participation and essays assigned in every intensive lecture.

[Textbooks]

Specify if necessary.

[References, etc.]

（**Reference books**）

Specify if necessary.

[Study outside of class (preparation and review)]

Specify if necessary.

（Other information (office hours, etc.)）

Information about lecturers and contents of lectures are announced on electric bulletin boards.
Please confirm to your department office that the credit of this course is admitted to graduation requirements.

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG20 32402 SE77				
Course title (and course title in English)	工学部国際インターンシップ 1 Faculty of Engineering International Internship 1	**Instructor's name, job title, and department of affiliation**	Approved		
Target year	3rd year students or above	**Number of credits**	1	**Year/semesters**	2021/Intensive, year-round
Days and periods	Intensive	**Class style**	Seminar	**Language of instruction**	Japanese and English

[Overview and purpose of the course]

Acquisition of international skills with the training of foreign language through the internship programs hosted by the University, the Faculty of Engineering, or the undergraduate school the applicant belongs to.

[Course objectives]

The acquisition of international skills with the training of foreign language through the to internship programs hosted by the University is the major expectation to the students.

[Course schedule and contents]

Overseas Internship,1time,The contents to be acquired should be described in the brochure of each internship program.
Final Presentation,1time,A presentation by the student is required followed by discussion among participants.

[Course requirements]

Described in the application booklet for each internship program. The registrant is requested to have enough language skills for the participation.

[Evaluation methods and policy]

Marit rating is done based on the presentation or reports after each internship program. Each Department responsible to identify if the credit earned by this subject to be included as mandatory ones or not. If the credit is not included in the undergraduate school in which the participant belongs to, the credit is granted by the Global Leadership Education Center as a optional credit. The number of credits, either 1 or 2, will be determined depending on the contents and the duration of the program that the participant has participated in.

[Textbooks]

Continue to 工学部国際インターンシップ 1 (2)↓↓↓

工学部国際インターンシップ 1 (2)

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

It is required for students to check if the internship program to participate in could be evaluated as part of mandatory credits or not and could earn how many credits before the participation to the undergraduate school or educational program the student in enrolled. If the credit could not be treated as mandatory ones, get in touch with the Global Leadership Engineering Education Center.

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course that includes off-campus training classes.

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number	U-ENG20 22403 SJ77				
Course title (and course title in English)	グローバル・リーダーシップセミナー I (企業調査研究) Global Leadership Seminar I (Study for methodology in a company)	**Instructor's name, job title, and department of affiliation**	Graduate School of Engineering Senior Lecturer,YOROZU KAZUAKI Graduate School of Engineering Senior Lecturer,KOMIYAMA YOSUKE		
Target year	2nd year students or above	**Number of credits**	1	**Year/semesters**	2021/Intensive, year-round
Days and periods	Intensive	**Class style**	Seminar	**Language of instruction**	Japanese

[Overview and purpose of the course]

The purpose of this course is to study about how worldwide leading company, institute, etc. make proposals and find solutions for expanding their own technologies to the international market. Throughout hands-on training on their laboratory, students investigate the methodology of team organization, proposal, market prediction and conception ability by group works. After the investigation, students are expected to improve their comprehension and explanation capability. As extended exersice subject of this course, the Global Leadership Seminar II is opened in the second semester.

[Course objectives]

The goal of this course is to improve student's comprehension and explanation capability for processes of proposal and expansion on the international market invesitigating worldwide leading companies by group work.

[Course schedule and contents]

Week 1, Guidance
Week 2-13, Hands-on training
Week 14, Pre-presentation
Week 15, Final presentation

[Course requirements]

How to register will be announced later. Students who want to join this course is requested to attend the first class.

[Evaluation methods and policy]

Students are prohibited to skip hands-on training. Evaluation will be based on presentation.

[Textbooks]

Not used

Continue to グローバル・リーダーシップセミナー I (企業調査研究) (2)↓↓↓

グローバル・リーダーシップセミナーI(企業調査研究) (2)

[References, etc.]

（**Reference books**）

（**Related URLs**）

http://www.glc.t.kyoto-u.ac.jp/ugrad

[Study outside of class (preparation and review)]

Investigating companies in advance. Analyzing the result from hands-on training. Preparing presentation.

（**Other information (office hours, etc.)**）

How to register will be announced later. Students who want to join this course is requested to attend the first class. Students are prohibited to skip hands-on training. Evaluation will be based on presentation.

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
An omnibus course delivered by invited lecturers and guest speakers from different companies, etc.

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG20 32502 SE77				
Course title (and course title in English)	工学部国際インターンシップ２ Faculty of Engineering International Internship 2	Instructor's name, job title, and department of affiliation	Approved		
Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/Intensive, year-round
Days and periods	Intensive	Class style	Seminar	Language of instruction	Japanese and English

[Overview and purpose of the course]

Acqusition of international skills with wth the training of foreign language through the participation to the international internship programs held by the Faculty of Engineering or its subsidiary bodies.

[Course objectives]

The acquisition of international and foreign language skills through the participation to international programs is expected. Detailed objectives of the participation should be identified by each program.

[Course schedule and contents]

Overseas Internship,1time,The contents to be acquired should be described in the brochure of each internship program.
Final Presentation,1time,A presentation by the student is required followed by discussion among participants.

[Course requirements]

Described in the application booklet for each internship program. The registrant is requested to have enough language skills for the participation.

[Evaluation methods and policy]

Marit rating is done based on the presentation or reports after each internship program. Each Department responsible to identify if the credit earned by this subject to be included as mandatory ones or not. If the credit is not included in the undergraduate school in which the participant belongs to, the credit is granted by the Global Leadership Education Center as a optional credit. The number of credits, either 1 or 2, will be determined depending on the contents and the duration of the program that the participant has participated in.

[Textbooks]

Continue to 工学部国際インターンシップ２(2)↓↓↓

工学部国際インターンシップ２(2)

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（**Other information (office hours, etc.)**）

It is required for students to check if the internship program to participate in could be evaluated as part of mandatory credits or not and could earn how many credits before the participation to the undergraduate school or educational program the student in enrolled. If the credit could not be treated as mandatory ones, get in touch with the Global Leadership Engineering Education Center.

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course that includes off-campus training classes.

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number	U-ENG20 22503 SJ77				
Course title (and course title in English)	グローバル・リーダーシップセミナーII(イノベーションとその事業化) Global Leadership Seminar II (Innovation and its commercialization)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Senior Lecturer,KANEKO KENTAROU Graduate School of Engineering Senior Lecturer,TAKATSU HIROSHI		
Target year	2nd year students or above	Number of credits	1	Year/semesters	2021/Intensive, Second semester
Days and periods	Intensive	Class style	Seminar	Language of instruction	Japanese

[Overview and purpose of the course]

This course is a small-group workshop program where students are supposed to extract or set up challenges by themselves aiming at creating new social values. In concrete, abilities of planning and problem-solving are trained through group works in residential training and skills of presentation and communication are enhanced through oral presentations regarding contents of the proposal at each step of the process from a preliminary draft to its completion.

[Course objectives]

Ability of planning, from extraction or setting up challenges to proposal of solutions aiming at creating new social values, is trained through group works.

[Course schedule and contents]

※Depending on the situation of COVID-19 pandemic, all lectures will be given online and residential training will be canceled.

Orientation,1time,A brief overview and a schedule of the course are explained and working groups are organized.
Lectures,2times,Lectures by experts are given.
Group works,3times,Setting up challenges, extraction of problems, collecting information, and group works are done.
Residential training,7times,Through intensive group works based on discussion, a proposal for solving problems is planned, a draft report is made, and a few presentations are made.
Preliminary review meeting,1time,A preliminary review meeting is held and discussions are made.
Report meeting,1time,Final presentations are made and reports are submitted.

[Course requirements]

None

[Evaluation methods and policy]

※Depending on the situation of COVID-19 pandemic, all lectures will be given online and residential training will be canceled.

It is required to join the residential training. A report meeting is held and comprehensive evaluation concerning abilities in group discussion to extract or set up challenges and to propose solutions for achieving

Continue to グローバル・リーダーシップセミナーII(イノベーションとその事業化) (2)↓↓↓

a goal is made through presentation of the proposal as well as a submitted report.

[Textbooks]

Will be indicated as necessary.

[References, etc.]

（**Reference books**）
Will be indicated as necessary.

[Study outside of class (preparation and review)]

Will be indicated as necessary.

（Other information (office hours, etc.)）

Course open period: October to January

*It depends on divisions which students belong to whether the earned credits are admitted as credits required for graduation. Please refer to the syllabus of your division.

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number	U-ENG27 37028 LJ61 U-ENG27 37028 LJ76		
Course title (and course title in English)	有機工業化学 Industrial Organic Chemistry	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MAE KAZUHIRO Graduate School of Engineering Professor,TANAKA TSUNEHIRO Graduate School of Engineering Professor,OOE KOUICHI Graduate School of Engineering Professor,ATOMI HARUYUKI Graduate School of Engineering Professor,KAWASE MOTOAKI Graduate School of Engineering Professor,KONDOU TERUYUKI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Wed.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

In petrochemistry, organic intermediates are synthesized highly efficiently using a reaction that is completely different from that described in textbooks on organic chemistry. High efficiency means having low consumption of energy and resources, and a low environmental impact. Lectures will discuss the current state of industrial organic chemistry and reference manufacturing processes centered on petrochemistry and fermentation.

[Course objectives]

To understand the current state of the organic chemical industry based on the current economic climate, and to understand the characteristics of large-scale chemical product manufacturing and the basics needed to maintain its processes.

[Course schedule and contents]

Current state of carbon resources, history of the organic chemical industry, and the use of natural gas, 2 sessions
Students are given an overview on the current state of carbon resources such as petroleum, coal, natural gas, and biomass, as well as on the future outlook of energy supply and demand and the properties of carbon resources. Following this, the history of industrial organic chemistry is outlined alongside the chemical utilization of natural gas and utilization of biomass, which are expected to become increasingly important in the future. [Mae professor]

Petroleum products, petroleum refining, steam cracking, 2 sessions
The properties required for the safe use of petroleum products such as gasoline, kerosene, and light oil are outlined, along with chemical processes such as desulfurization, decomposition, and reforming, which are required to produce petroleum products. Following this, students are given an overview of the synthesis of ethylene, propylene, and BTX, which are the main materials in petrochemistry, and are taught the methods by which each product is isolated from complex mixtures (distillation, extraction, extractive distillation). [Professor Kondo]

Oxidation reactions and acid catalyst reactions, 3 sessions
Students are given a general overview of the characteristic reactions of petrochemistry that use air as an

Continue to 有機工業化学(2)↓↓↓

oxidant and are taught about the characteristics of catalysts that enable such reactions. In addition, special oxidation reactions such as ammoxidation, acetoxylation, and oxychlorination are explained, before briefly covering dehydrogenation reactions and oxidative dehydrogenation reactions. Following this, acid catalyst reactions such as esterification reactions, aromatic alkylation reactions, and hydration reactions are then outlined, alongside the characteristics of solid acid catalysts. [Professor Tanaka (Tsune)]

Chemistry of olefins, aromatic compounds and petrochemical secondary derivatives, 2 sessions
The conversion reactions of aromatic residues known as ethylene, propylene, C4 olefins, and BTX are explained using specific examples of each. In addition, students are taught industrial organic chemistry of secondary derivatives made from materials such as ethylene oxide, acetaldehyde, and acetone. Following this, the synthesis of chemical products from BTX secondary derivatives is summarized. [Professor Ohe]

Homogeneous catalytic reactions, 1 session
After giving an overview of complex catalysts, students are taught about processes of acetic acid synthesis using complex catalysts (Wacker process, oxo process, and Monsanto process). In addition, students briefly touch on the topic of complex-catalyzed asymmetric synthesis that uses cross-coupling reactions, alkene metathesis reactions, and chiral ligands. [Professor Ohe]

Bioprocesses, 2 sessions
An overview is given on the industrialized fermentation process and its principles. In addition, while using specific examples, students are taught basic strategies and methods for screening microorganisms and enzymes, enhancing activity, improving selectivity, regenerating coenzymes, and removing feedback inhibition, etc., which are needed for the commercialization of bioprocesses. [Professor Atomi]

Flow sheets and material balances, 2 sessions
Flow sheets and material balance sheets are the most important materials when it comes to chemical processes. Therefore, students are taught how to read outline flow sheets used in lectures and are given a brief explanation on detailed flow sheets. In addition, students are taught the basics of stoichiometry, as well as key points in reading and preparing detailed material balance sheets. [Professor Kawase]

Feedback lecture, 1 session
Lectures and examination contents are explained to students to improve their degree of learning (details are given during lecture or on KULASIS). [All professors]

[Course requirements]

Lectures are given under the assumption that students have taken "Organic Chemistry: Fundamentals and Exercises" and "Fundamentals of Chemical Process Engineering," which are offered in the first half of the second year.

[Evaluation methods and policy]

Questions on an end-of-term examination are given by all professor, with marks alloted to the questions being proportional to the total lecture time of each professor. The final grade is determined mainly by students' results on the end-of-term examination, and to a smaller degree, their performance in teaching sessions.

Continue to 有機工業化学(3)↓↓↓

[Textbooks]

Others; materials are distributed during each lecture.

[References, etc.]

（**Reference books**）
The following are to be distributed during the first lecture: Kambe, N., Yasuda, M. (ed.), Gendai yuuki kougyou kagaku, (Kagaku-Dojin Publishing, 2020) ISBN: 978-4-7598-2025-6; Tajima, K., Fukawa, I. (trans.), Kougyou yuuki kagaku, (Tokyo Kagaku Dojin, 2016) ISBN: 978-4-8079-0876-9; Wittcoff, H.A., Reuben, B., Plotkin, J.S., Industrial Organic Chemicals, 3rd Ed., (Wiley, 2012) ISBN: 9780470537435; Konishi, S., Nenryou kougaku gairon, (Shokabo, 1991) ISBN: 00097241; Japan Petrochemical Industry Association (ed.), Sekiyu kagaku kougyou no genjou 2021-nen, (Japan Petrochemical Industry Association, 2021)

[Study outside of class (preparation and review)]

Before attending teaching sessions, it would be advisable for students to read reference books to acquire knowledge on the formation and current state of the petrochemical industry in 2021. In addition, students will deepen their comprehensive understanding of industrial organic chemistry and their knowledge on process technology and other matters by reviewing materials distributed during teaching sessions and answering questions on short tests conducted in each teaching session. It would also be advisable for students to devote twice the amount of time spent in teaching sessions to review and prepare for the next session.

（Other information (office hours, etc.)）

A small test may be given before the end of lectures.

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG27 37030 LJ61		
Course title (and course title in English)	生物化学工学 Biochemical Engineering	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,ATOMI HARUYUKI Graduate School of Engineering Professor,HAMACHI ITARU Graduate School of Engineering Program-Specific Associate Professor,TAKAHASHI NOBUAKI Graduate School of Engineering Senior Lecturer,TAMURA TOMONORI
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/Second semester		
Days and periods	Fri.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,4times,
,3times,
,3times,
,4times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

Continue to 生物化学工学(2)↓↓↓

生物化学工学(2)

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG27 37042 LJ61		
Course title (and course title in English)	環境保全概論 Introduction to Environment Preservation	Instructor's name, job title, and department of affiliation	Agency for Health, Safety and Environment Professor,HASHIMOTO SATOSHI Graduate School of Engineering Associate Professor,NAKAGAWA HIROYUKI Agency for Health, Safety and Environment Professor,HIRAI YASUHIRO
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Mon.1	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

This course is designed for students specializing in chemistry.
Students will study basic examples of environmental issues and their effects on society from the perspective of preservation of the environment at the university, the air environment, the aquatic environment, and a sound material-cycle society. We will help develop students' understanding of environmental preservation for their future research and social activities.

[Course objectives]

The major course objectives:
(1) To learn the background and basic mechanisms of environmental problems, specifically as they relate to air and water, as well as how to establish a sound material-cycle society.
(2) To understand relationships between various activities and their environmental impacts on campus.

[Course schedule and contents]

1. Environmental Issues of Our Time, 3 times
With a particular focus on chemicals, we will study the background and current status of environmental issues and discuss possible future problems. We will also examine how environmental issues are related to human activities and resource/energy consumption.

2. Environment Preservation at Kyoto University, 2 times
Students will learn about environmental protection systems at Kyoto University. We will explain systems for water quality control, liquid waste treatment, and specially controlled waste management. We will also detail systems and regulations for proper use and management of chemical substances.

3. Air Environment, 5 times
We will discuss the current status of global air pollution. We will learn about a variety of regulations and the relevant background of rules created based on the Air Pollution Control Law. We will discuss in detail air pollutants emitted by factories and automobiles in urban areas and look closely at their chemical reactions in the air, with a particular focus on radical reactions.

4. Aquatic Environment, 2 times
Students will study the conservation of water quality, specifically (1) water contamination by organic substances and related purification methods, (2) water contamination by heavy metals and related treatment methods, and (3) management of environmentally persistent substances. They will also learn about environmental criteria, effluent standards, and environmental protection technologies for water quality

Continue to 環境保全概論(2)↓↓↓

環境保全概論(2)

control.

5. Waste Management and a Sound Material-Cycle Society, 2 times
Students will develop a better understanding of waste treatment/management and a sound material-cycle society by studying (1) mass balance and indexes on the macro level, (2) definitions of waste and the current status of waste treatment, (3) waste and dioxin problems, and (4) approaches toward establishing a sound material-cycle society.

6. Confirmation of students' levels of understanding, 1 time
Students' level of understanding of course topics will be checked.

[Course requirements]

None

[Evaluation methods and policy]

Evaluation: test scores + attendance rates.

[Textbooks]

Not specified. Materials and references will be distributed in class when needed.

[References, etc.]

（**Reference books**）
To be announced in class.

[Study outside of class (preparation and review)]

Review on the materials and references distributed. Specified points willbe announced in class.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 37043 LJ61		
Course title (and course title in English)	環境安全化学 Chemistry and Environmental Safety	Instructor's name, job title, and department of affiliation	Agency for Health, Safety and Environment Professor,HASHIMOTO SATOSHI Graduate School of Engineering Associate Professor,NAKAGAWA HIROYUKI Graduate School of Engineering Professor,ABE RYUU
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/Second semester		
Days and periods	Thu.1	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,2-3times,
,2-3times,
,2-3times,
,2-3times,
,2-3times,
,2-3times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

Continue to 環境安全化学(2)↓↓↓

環境安全化学(2)

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG27 37046 LJ61　U-ENG27 37046 LJ76		
Course title (and course title in English)	移動現象 Transport Phenomena	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,YAMAMOTO RYOICHI
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Tue.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,5times,
,5times,
,4times,
,1time,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 37048 LJ61　U-ENG27 37048 LJ76		
Course title (and course title in English)	プロセス制御工学 Process Control	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,OOSHIMA MASAHIRO Graduate School of Engineering Professor,SOTOWA KENICHIRO
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Wed.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

Process control is used for operating the production processes in chemical and the steel industries. Pressure, temperature, liquid level and flow rate are major process variables to be controlled automatically (i.e., computers). Understanding the process dynamics is the first step to develop a good control system. Then, as the second step, the optimal selection and manipulation of the process input variables has to be determined. The class teaches to derive the physico-chemical dynamic models of chemical processes and transfer function models, which are obtained by taylor expansion of the physico-chemical models. Then, the design scheme of controller is described. To make the understanding easier, computer simulation exercises using Matlab and Simulink are offered. 1.

[Course objectives]

The goal of the class is to educate the students to be able to develop the dynamic process model, design the process controller and to analyze the control performance so as to design the optimal process control systems.

[Course schedule and contents]

Introduction of Process Control,1time,Showing several examples, the necessity, objectives and importance of process control are described. Then, the concepts of feedback and feed-forward controls and technical terms on process control are explained. Some issues on process control design are explained. The basic design procedure of the control system for solving the issues is explained.
Development of Dynamic Models,1time,The first step for developing better process control systems is to understand the dynamic behaviors of the process to be controlled. The modeling method using the material and heat balance equations is lectured to construct the model showing the dynamic behavior of the process appropriately. Then, how to derive the linear transfer model using Taylor expansion of the first principle model is explained.
Laplace transform and Transfer function,1time,The Laplace transform is revisited first. Then, how to derive the transfer function from the linearized dynamic model among the input and the output variables is lectured. How to obtain the linear model from the step response is also taught.
Exercise with Matlab for learning dynamic behavior,1time,[Exercise] After learning the basics of Matlab and Simulink, the dynamic behaviors of some typical dynamic systems such as the first-order lag system and the second-order lag system are simulated. Then, for a given process, the exercise on developing the model and executing the simulation is executed.
PID Control,1time,The most popular controller in process industries is PID (Proportional, Integral, and Derivative) controller. The basic features of three elements (P, I, D) are explained. Then, after explaining the basic feature of PID controller, how to adjust the control parameters is taught.
Dynamics of controlled system,1time,The relationship between the pole of the transfer function and the stability is lectured. Then, the basic feature, the steady-state characteristics, and the stability of the feedback control system are explained.

Continue to プロセス制御工学(2)↓↓↓

プロセス制御工学(2)

Mid-term exam,1time,To know the level of understanding, the mid-term examination is conducted.
Frequency response,1time,The relationship between the sine wave input and the output (the frequency response), and how to detect the stability from the frequency response are lectured. The features of various filters are also explained.
PID control system design ,1time,The adjusting method of PID parameters based on the IMC control procedure is explained. Then, several revised controllers of the basic PID controller for improving the performance are lectured.
Exercise of control system design ,1time,[Exercise] For a given process, the exercise of tuning the control parameters and verifying the performance under the developed system using Matlab/Simulink is executed.
Cascade control and Multi-loop control,1time,The concept of cascade control is explained. Then, as a control system dealing with the two-input and two-output process, the multi-loop control system is introduced, and how to remove the interaction among the control loops is explained.
Exercise of multi-loop control,1time,[Exercise] For a given process, the exercise of developing a controller for a two-input and two-output process is executed.
Equipment for control,1time,The equipment used for the real process control system are explained. The concept of proportional band and the reason why non-dimensional system is used are explained.
Overall exercise of process control design,1time,[Exercise] Starting with the construction of the first principle model of a chemical/bio process, a two-input and two-output control system (multi-loop controller) is designed and the parameters are tuned by using Matlab and Simulink
Feed-back time, 1 times,The question and answer to the final exercise, and the whole of the lectures are conducted.

[Course requirements]

Basic understanding of linear algebra, ordinal differential equations and Laplace transform

[Evaluation methods and policy]

The score is determined by considering the quality of homeworks, midterm exam, term-end exam and final project.

[Textbooks]

Process Control Engineering, Hashimoto, Hasebe, Kano, Asakura book store, isbn{}{4254250312}

[References, etc.]

（**Reference books**）
Process Control System, Ohshima, CORONA Publishing isbn{}{4339033146}

[Study outside of class (preparation and review)]

The final term project will be given.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Continue to プロセス制御工学(3)↓↓↓

プロセス制御工学(3)

[Courses delivered by instructors with practical work experience]

(1) Category

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

未更新

Course number	U-ENG27 37052 LJ61				
Course title (and course title in English)	量子化学概論 Introduction to Quantum Chemistry	**Instructor's name, job title, and department of affiliation**	Graduate School of Engineering Professor,SATO HIROFUMI		
Target year	3rd year students or above	**Number of credits**	2	**Year/semesters**	2021/Second semester
Days and periods	Mon.2	**Class style**	Lecture	**Language of instruction**	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,1time,
,1time,
,2times,
,2times,
,3times,
,2times,
,2times,
,1time,
,4times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

Continue to 量子化学概論(2)↓↓↓

量子化学概論(2)

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 47056 LJ61		
Course title (and course title in English)	電気化学 Electrochemistry	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,ABE TAKESHI Graduate School of Engineering Associate Professor,MIYAZAKI KOUHEI Graduate School of Engineering Assistant Professor,宮原　雄人
Target year	4th year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Thu.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

Fundamental of electrochemical reaction,4times,
Kinetics of electrochemical reaction,4times,
Battery and fuel cell,4times,
Electrolysis,1time,
Corrosion,1time,
Evaluation,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 47059 LJ61		
Course title (and course title in English)	有機分光学 Spectroscopy for Organic Compounds	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,KURAHASHI TAKUYA Institute for Chemical Research Associate Professor,TAKAYA HIKARU Graduate School of Global Environmental Studies Professor,TANAKA KAZUO Institute for Chemical Research Associate Professor,HIROSE TAKASHI
Target year	4th year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Tue.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,1time,
,2times,
,2times,
,1time,
,8times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

Continue to 有機分光学(2)↓↓↓

有機分光学(2)

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number	U-ENG27 47061 LJ61		
Course title (and course title in English)	触媒化学 Catalyst Chemistry	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,TANAKA TSUNEHIRO Graduate School of Engineering Associate Professor,TERAMURA KENTARO Graduate School of Engineering Professor,ABE RYUU Center for the Promotion of Interdisciplinary Education and Research Program-Specific Senior Lecturer,ASAKURA HIROYUKI Graduate School of Engineering Senior Lecturer,MUROYAMA HIROKI
Target year	4th year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Wed.1	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

Lecture will be delivered by Prof. Tanaka and Abe. Fundamental concepts to understand catalytic chemistry, how to clarify mechanism of catalytic reactions, properties of representative sold catalysts and reactions taking place over them will be lectured and also catalyst preparation methods will be outlined.

[Course objectives]

Understanding fundamentals on catalyst and catalysis.

[Course schedule and contents]

1. Fundamental concepts in catalysis (2)
Reaction kinetics; activation energy; adsorption; kinetics in steady state; heat of adsorption; Linear free energy relationship; volcano shape order.

2. Metal oxides and catalytic oxidation (1)
Catalytic oxidation; reactor; EO synthesis; oxidation of paraffins; oxidation of aromatic ring; oxidation of side branch of aromatics.

3. Solid acids and bases (1)
What is solid acids and bases; factors to gover solid acid/base catalysis; generation mechanism of acid and base

4. Catalyst characterization (2)
Catalytic reaction mechanism elucidated by analysis of reaction, Elucidation of reaction mechanism using physical instruments; topics of catalyst characterization.

5. Summary of first half part of the lecture (1)
Solution of quizzes and summary

6. Catalysis by metals (2)
Metal wire mesh catalyst; metal nanoparticle catalyst; Raney-metal catakyst; supported metal catalyst; role of support; industrial metal atalyst

7. Photocatalysis and environmental catalysis (2)

Continue to 触媒化学(2)↓↓↓

触媒化学(2)

What is photocatalsys; principle of photocatalysis; photocatalysis in next generation; green chemistry; what is environmental catalyst?

8. Catalyst preparation mmethod (2)
Formation of precipitates; structural change in drying process; co-precipitation method; uniform precipitation method; hydrothermal method; sol-gel method; sorvothermal method.

9. Summary of last half part of the lecture (1)
Solution of quizzes and summary

10. Feedback (1)

[Course requirements]

None

[Evaluation methods and policy]

Total scores of quizzes performed after first and last half of the lecture are evaluated.

[Textbooks]

Not used

[References, etc.]

（**Reference books**）
Introduced during class

[Study outside of class (preparation and review)]

Review the documents supplied in lecture.

（Other information (office hours, etc.)）

First half of the lecture will be given by Prof. Tanaka and the rest by prof. Abe.

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG27 37064 LJ61		
Course title (and course title in English)	生化学II Basic Biochemistry II	**Instructor's name, job title, and department of affiliation**	Graduate School of Engineering Professor,ATOMI HARUYUKI Graduate School of Engineering Professor,MORI YASUO Graduate School of Engineering Professor,HAMACHI ITARU
Target year	3rd year students or above	**Number of credits**	2
Year/semesters	2021/Second semester		
Days and periods	Mon.1	**Class style**	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,3times,
,3times,
,2times,
,2times,
,2times,
,2times,
,1time,
,4times,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

Continue to 生化学II(2)↓↓↓

生化学II(2)

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number	U-ENG27 37070 LJ61　U-ENG27 37070 LJ76		
Course title (and course title in English)	微粒子工学 Fine Particle Technology	**Instructor's name, job title, and department of affiliation**	Graduate School of Engineering Professor,MATSUSAKA SHUJI Graduate School of Engineering Associate Professor,WATANABE SATOSHI
Target year	3rd year students or above	**Number of credits**	2
Year/semesters	2021/Second semester		
Days and periods	Tue.3	**Class style**	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

From raw materials to finished products, powders#8212particle aggregates#8212are often used in chemical processes. In this course, students will learn about the fundamental properties of particles, characteristics of powders, properties of dispersed particles in a gas (vapor) or liquid phase, particle dynamic behavior analysis, and the generation, separation, and collection of particles.

[Course objectives]

Students will acquire an understanding of the characteristics of particles and powders, and of methods of analyzing the dynamic behavior of fine particles. Students will also foster their abilities in applications and developments involving the manipulation of fine particles, including their generation, separation, and collection.

[Course schedule and contents]

Overview of fine-particle engineering (1 class)
Explanation is made of the role of fine engineering in chemical processes, with examples from classical processes and natural phenomena.

Particle properties and measurement (4 classes)
In these lectures, explanation is made regarding the following: particle diameter expression method, particle size distribution and related statistical processing methods, dynamic properties, especially the basic properties of elastic deformation and plastic deformation, physicochemical properties including droplet formation and capillary condensation, etc., electrostatic properties related to electrical charge, optical properties from the relationship between light wavelength and particle diameter, etc., as well as the properties of individual particles, and the characteristics of particle interactions and particle aggregates (assemblies). Measurement methods for these will also be discussed.

Gas (vapor)-phase particle systems (5 classes)
Lectures focus on the basics of microparticle generation via pulverization and nucleation, as well as motion of gas-phase dispersed particles. Explanation is made of analysis methods for basic phenomena such as wall-surface deposition, fine particle aggregation, etc. Using this as a foundation, discussion is then made of various operations, including dispersion, classification, solid-gas separation, materials processing, etc.

Liquid-phase particle systems (4 classes)
Explanation is made of interactions of liquid-phase dispersion particles, and this base is used to discuss unit operations including dispersion, aggregation, filtration, etc. Examples of ordered structure formation based on particle group interactions are explained next. Finally, confirmation is made of the extent that students have understood the contents of this course.

Continue to 微粒子工学(2)↓↓↓

微粒子工学(2)

General summary of course (1 class)
A summary, chiefly focused on dry powder operations.

[Course requirements]

None

[Evaluation methods and policy]

Evaluation is made on the basis of scores (results) in periodically given tests. Consideration will also be given to reports that may be assigned at any time during the course.

[Textbooks]

K. Okuyama, H. Masuda and S. Morooka 『Biryuushi Kougaku ndash Fine particle technology』 (Ohmsha) ISBN:4-274-12900-4

[References, etc.]

(**Reference books**)
K. Hashimoto, F. Ogino 『Gendai Kagaku Kogaku』 (Sangyo Tosho) ISBN:4-7828-2609-5

[Study outside of class (preparation and review)]

Students must prepare for classes, and review after classes.

(Other information (office hours, etc.))

Please visit KULASIS to find out about office hours.

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 37071 LJ61 U-ENG27 37071 LJ76		
Course title (and course title in English)	プロセスシステム工学 Process Systems Engineering	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,SOTOWA KENICHIRO Graduate School of Engineering Assistant Professor,TONOMURA OSAMU
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/Second semester		
Days and periods	Thu.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

The chemical processes consist of various unit operations. In this course, the concepts and the methods of optimal synthesis,optimal design and production management are described. The mathematical methods for optimization are also explained.

[Course objectives]

This course aims to understand the systematic modelling procedures of the design and operational problems for chemical processes. In addition, it is requested to understand the optimization methods for solving the problems which are formulated as the linear, non-linear or combinatorial programming problem.

[Course schedule and contents]

What is PSE?,1time,The concept of process systems engineering is explained.
Modelling of the processes -physical model,1time,The feature of physical models used in the process design and operation problems is explained.
Modelling of the processes - statistical model,1time,The least square method used in constructing the statistical model is explained.
Procedure of process design,1time,The procedure of process design and the solution method using input and output model are explained.
Process design using simulation,1time,The sequential modular approach which is commonly used in the process simulators is explained.
Process synthesis,1time,The combinatorial programming method and multi-step heuristic method which are used in the conceptual design are explained.
Heat exchanger network synthesis,2times,A systematic synthesis method using T-Q diagram is explained for the heat exchanger network synthesis problem.
Production management of chemical processes,1time,The concept of production management including supply chain problem is explained.
Solution procedure using LP,2times,The formulation of the production planning problem as a linear programming problem, and its solution method using the simplex method are explained.
Scheduling problem and BampB method, 2 times,The formulation of the scheduling problem of batch processes as a traveling salesman problem and its solution procedure using the branch and bound method are explained.
Various scheduling problems of batch processes,1time,Various scheduling problems which arise in batch processes and their solution methods are explained.
Evaluation of learning achievement, 1 times,The comprehensive review is executed, and the misunderstanding of the homework is explained.

Continue to プロセスシステム工学(2)↓↓↓

プロセスシステム工学(2)

[Course requirements]

The basic knowledge of chemical engineering such as the unit operation and reaction engineering, and that of differential and integral calculus are requested.

[Evaluation methods and policy]

Homework assigned in the lectures is treated as 30 points, and the final examination is treated as 70 points of the total score.

[Textbooks]

Lecture materials are distributed in the class.

[References, etc.]

(**Reference books**)
Introduced during class

[Study outside of class (preparation and review)]

Students must be familiar with material and energy balances. Understanding of linear algebra is also required.

(Other information (office hours, etc.))

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number	U-ENG27 47072 LJ76 U-ENG27 47072 LJ61		
Course title (and course title in English)	プロセス設計 Process Design	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,SOTOWA KENICHIRO Faculty of Engineering
Target year	4th year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Fri.3	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

Students will learn fundamental skills of designing chemical processes which consist of various unit operations. A conceptual design exercise of a chemical process is carried out using the knowledge of chemical engineering and process simulation system.

[Course objectives]

It is requested to understand the way of conceptual design, and to have the skill of designing chemical processes by applying the knowledge of chemical engineering and related field.

[Course schedule and contents]

Concept of process design,1time,The concept of process design and the procedure of conceptual design are explained.
Evaluation methods,1time,After explaining the fundamental terms on economical efficiency evaluation, a single-year evaluation method and a multi-year evaluation method are explained.
How to use process simulators,1time,The sequential modular approach that is commonly used in the process simulators is explained. Then, how to use process simulator is explained using the demonstration.
Reality of process design,6times,According to the procedure of process design, some important points and available methods on market research, acquisition of data, process synthesis and equipment design are explained. (Intensive course)
Practice of a chemical process design,17times,The exercise on process design is performed by group consisting of 2 or 3 students.
Oral presentation,4times,The final design of each group is presented at the workshop where all members of the faculty attend.

[Course requirements]

The basic knowledge on chemical engineering such as unit operation is requested.

[Evaluation methods and policy]

The results are evaluated by the contents of the final report and the oral presentation.

Continue to プロセス設計(2)↓↓↓

プロセス設計(2)

[Textbooks]

The reference materials are prepared by teachers.

[References, etc.]

（**Reference books**）
Introduced during class

（**Related URLs**）
(http://www.cheme.kyoto-u.ac.jp/processdesign/)

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

Since the exercise is supervised by faculty members in each laboratory, the registration is restricted to senior students belonging to Chemical Process Engineering Course.

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
An omnibus course delivered by invited lecturers and guest speakers from different companies, etc.

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG27 37082 LJ76 U-ENG27 37082 LJ61		
Course title (and course title in English)	計算化学工学 Computers in Chemical Engineering	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,OOSHIMA MASAHIRO Graduate School of Engineering Associate Professor,NAGAMINE SHINSUKE Graduate School of Engineering Assistant Professor,HIKIMA YUUTA

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Tue.3	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Solving several Chemical Engineering problems with computer language, Visual Basic (VBA) in Excel, the students earn the basic computational skills for engineering calculations. They will be learing how to solve the linear and nonlinear algebraic equations, differential equations, integral and linear and nonlinear least square method for parameter fittings

[Course objectives]

The goals of this course is to write computer programming codes by students themselves for solving the simple Chemical Engineering Problems.

[Course schedule and contents]

1. Orientation
After the instruction on how to start the VBA Editor, the students write the programs for basic arithmetic calculation and unit conversion.
2. Algebraic equation
The simple chemical engineering problems that can be formulated by algebraic equations are assigned to solve with VBA.
3-4. Iterative calculation methods
After leaning the successive iteration and Newton iteration, the students write the programs to obtain the solutions of algebraic equations that are not analytically solvable.
5-6. Differential equation
After learning the Euler and RKG methods for solving the differential equations, the students work on the calculation of chemical reactor.
7-8. Numerical integration
After learning computer algorithm like trapezoidal method and Simpson method, the students write programs to integrate numerical data.
9. Partial differential equation
After learning the scheme of approximating the partial differential equation with difference equations, the students numerically solve the heat conduction equation and obtain the time evolution of temperature distribution.
10-11. Matrix calculation
First the programming codes for performing basic matrix calculations is taught. Then, the students learn Gaussian elimination to solve the simultaneous linear equation and develop a computer program to derive a linear regression model from the data.
12-14. Parameter fitting
The students learn the steepest descent method, Newton method and Marquardt method to seek local extremum of multivariable function, and write the program to determine the parameters to fit the model with

Continue to 計算化学工学(2)↓↓↓

計算化学工学(2)

data by non-linear least square method.
15. Term-end examination
16. Feedback

[Course requirements]

Excel is to be used. The basic operation of computer and excel is prerequisite.

[Evaluation methods and policy]

The submission of all homework assignments will be worth 40% of the final grade. The term end exam will be evaluated for the rest of the 60 % of the final grade.

[Textbooks]

Text will be prepared by the tutors

[References, etc.]

（**Reference books**）
Introduced during class

[Study outside of class (preparation and review)]

Writing program for the chemical engineering problem is assigned as homework every week.

（Other information (office hours, etc.)）

The first 30 minutes of the class will be devoted for explaining theory and basic computational scheme needed to solve the assignment of the day. Then, solve the assignment by using the computer.

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 47096 LJ61		
Course title (and course title in English)	化学実験の安全指針 Safty in Chemistry Laboratory	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,NAKAGAWA HIROYUKI Graduate School of Engineering Senior Lecturer,OOMAE MASASHI Graduate School of Engineering Professor,ABE RYUU Graduate School of Engineering Associate Professor,SUGASE KENJI Institute for Chemical Research Associate Professor,TOSAKA MASATOSHI Graduate School of Engineering Senior Lecturer,ISHIDA NAOKI

Target year	4th year students or above	Number of credits	1	Year/semesters	2021/Intensive, First semester
Days and periods	Intensive	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,1time,
,1time,
,1time,
,1time,
,1time,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

Continue to 化学実験の安全指針(2)↓↓↓

化学実験の安全指針(2)

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG27 37101 LJ61 U-ENG27 37101 LJ76		
Course title (and course title in English)	化学工学シミュレーション Simulations in Chemical Engineering	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,YAMAMOTO RYOICHI Graduate School of Engineering Associate Professor,WATANABE SATOSHI
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/Second semester		
Days and periods	Tue.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,3times,
,1time,
,2times,
,1time,
,2times,
,1time,
,4times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

Continue to 化学工学シミュレーション(2)↓↓↓

化学工学シミュレーション(2)

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG27 27102 LJ60		
Course title (and course title in English)	物理化学基礎及び演習［工化1］ Physical Chemistry: Fundamentals and Exercises	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,KOGA TSUYOSHI Graduate School of Engineering Assistant Professor,KOJIMA HIROYUKI
Target year	2nd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Tue.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,3times,
,3times,
,4times,
,2times,
,2times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（Reference books）

Continue to 物理化学基礎及び演習［工化1](2)↓↓↓

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number	U-ENG27 27102 LJ60		
Course title (and course title in English)	物理化学基礎及び演習［工化2］ Physical Chemistry: Fundamentals and Exercises	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,TANAKA TSUNEHIRO Graduate School of Engineering Associate Professor,TERAMURA KENTARO
Target year	2nd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Tue.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

In order to allow students to learn about the three fundamental laws of thermodynamics and apply them in physical chemistry, students are taught the fundamental matters and are given exercises (shorts tests) in the latter half of each teaching session to check their level of understanding.

[Course objectives]

The goal is to help students understand the fundamental laws of thermodynamics (especially the concept of entropy and the second law) and learn how to apply them to real physical chemistry systems.

[Course schedule and contents]

Physical chemistry systems (3 sessions), Tanaka
1) Systems and the surroundings, isolated systems, closed systems, open systems based on knowledge of the motion of material points/molecules, momentum and impulse, force and pressure, the kinetic theory of gas, gas state equations
2) Thermal equilibrium state of isolated systems, zeroth law of thermodynamics (transitivity of equilibrium), empirical temperature, state quantities and state variables (intensive properties and extensive properties), work, change of state (reversible, irreversible, quasi-static, minimal, cyclical)
3) State quantities and state variables (intensive properties and extensive properties), compressibility and coefficient of thermal expansion, infinitely small inrements and exact differentials

Energetics (3 sessions), Tanaka
4) Mechanical work driven by the motion of molecules and electrical work driven by the motion of electrons in an electric field, calorific value, internal energy, first law
5) Enthalpy, Joule-Thomson experiment, heat capacity (constant volume, constant pressure), enthalpy of phase changes
6) Heat of chemical reactions (Hess' law) (enthalpy of formation), heat of solution, atomic structure and chemical bonds, bond enthalpy

Entropy and free energy (4 sessions), Tanaka & Teramura
7) Heat balance and entropy, reversible processes, Thomson's principle, Clausius inequality (Tanaka)
8) Heat engine (cycle), Carnot cycle, thermodynamic temperature (absolute temperature) (Tanaka)
9) Entropy associated with state changes, entropy of compounds (standard entropy), irreversible processes and entropy increases (Teramura)
10) Helmholtz free energy, Gibbs free energy, thermodynamic potential, Maxwell relations (Teramura)

Third law of thermodynamics (2 sessions), Teramura
11) Nernst's heat theorem, the third law and entropy, residual entropy

Continue to 物理化学基礎及び演習［工化2］(2)↓↓↓

12) Adiabatic demagnetization method, approaching absolute zero

Thermodynamics of open systems (2 sessions), Teramura
13) Partial molar quantity, chemical potential
14) Equilibrium of mixed systems, Gibbs-Duhem equation

Feedback (1 session), Tanaka/Teramura
15) The learning achieved in teaching sessions will be checked and applied to physics and physicochemical phenomena in various ways.

[Course requirements]

None

[Evaluation methods and policy]

Evaluation is based on either method A or method B below, dependent on which one produces better results.

Method A: Regular examinations (100%)

Method B: Performance in teaching sessions (20%), mid-term test (30%), regular examinations (50%)
Performance in teaching sessions refers to the students' participation in teaching sessions.

・ 60 marks or above qualifies as a pass.
・ 59 marks or below qualifies as a fail.

[Evaluation policy]
Achievement targets are evaluated according to the grade evaluation policy of the Faculty of Engineering.

[Textbooks]

Others; students must follow instructions given by the professor-in-charge

[References, etc.]

（Reference books）
Others; Moore, W.J. (translated by Fujishiro, R.), Mooa butsuri kagaku (ue) dai 4-ban, (Tokyo Kagaku Dojin, 1974), parts of chapters 1, 2, 3 and 6, isbn {} {4807900021};
Atkins, P. (translated by Chihara, H., and Nakamura, N.), Atokinsu butsuri kagaku (ue) dai 8-ban, (Tokyo Kagaku Dojin, 2009), chapters 1-3 and parts of chapters 4 and 5, isbn {} {9784807906956}

[Study outside of class (preparation and review)]

Students must review exercises given during teaching sessions.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Continue to 物理化学基礎及び演習［工化2］(3)↓↓↓

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 27102 LJ60		
Course title (and course title in English)	物理化学基礎及び演習［工化3］ Physical Chemistry: Fundamentals and Exercises	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MIYAHARA MINORU Graduate School of Engineering Associate Professor,ＴＡＮＡＢＥ　ＫＡＴＳＵＡＫＩ
Target year	2nd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Tue.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,3times,
,3times,
,4times,
,2times,
,2times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

Continue to 物理化学基礎及び演習［工化3］(2)↓↓↓

[Study outside of class (preparation and review)]

（**Other information (office hours, etc.)**）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number	U-ENG27 27102 LJ60		
Course title (and course title in English)	物理化学基礎及び演習［工化4］ Physical Chemistry: Fundamentals and Exercises	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,UMEYAMA TOMOKAZU Graduate School of Engineering Associate Professor,SUGASE KENJI
Target year	2nd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Tue.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

Students are divided into four classes and each class is assigned a professor who conducts teaching sessions during the same time slot. The exercises given are sampled from questions appearing at the end of chapters in the reference book. However, the specific questions used and the way in which the exercises are given may differ from class to class. In order to allow students to learn about the three fundamental laws of thermodynamics and apply them in physical chemistry, students are also taught the fundamental matters and are given exercises to check their level of understanding.

[Course objectives]

The goal is to help students understand the fundamental laws of thermodynamics (especially the concept of entropy and the second law) and to learn how to apply them to real physical chemistry systems.

[Course schedule and contents]

Physical chemistry systems, 3 sessions
Systems and the external world (environment), isolated systems, closed systems, and open systems based on knowledge of the motion of point mass/molecules, momentum and impulse, force and pressure, the kinetic theory of gas and gas state equations, thermal equilibrium state of isolated systems, zeroth law of thermodynamics (transitivity of equilibrium), empirical temperature, state quantities and state variables (intensive properties and extensive properties), work, change of state (reversible, irreversible, quasi-static, minimal, cyclical), compressibility and coefficient of thermal expansion, minute changes and exact differentials

Energetics, 3 sessions
Mechanical work driven by the motion of molecules and electrical work driven by the motion of electrons in an electrical field, calorific value, internal energy, first law, enthalpy, Joule-Thomson experiment, heat capacity (constant volume, constant pressure), enthalpy of phase changes, heat of chemical reactions (Hess' law) (enthalpy of formation), heat of solution, atomic structure and chemical bonds, bond enthalpy

Entropy and free energy, 4 sessions
Heat fluctuations and entropy, reversible processes, Thomson's principle, Clausius inequality, heat engine (cycle), Carnot cycle, thermodynamic temperature (absolute temperature), entropy associated with state changes, entropy of compounds (standard entropy), irreversible processes and entropy increases
Helmholtz free energy, Gibbs free energy, thermodynamic potential, Maxwell relations

Third law of thermodynamics, 2 sessions
Nernst's heat theorem, the third law and entropy, residual entropy, adiabatic demagnetization method, approaching absolute zero

Continue to 物理化学基礎及び演習［工化4］(2)↓↓↓

Thermodynamics of open systems, 2 sessions
Partial molar quantity, chemical potential, equilibrium of mixed systems, Gibbs-Duhem equation

Entirety of thermodynamics, 1 session
The learning achieved in teaching sessions will be checked and applied to physics and physicochemical phenomena in various ways

[Course requirements]

None

[Evaluation methods and policy]

Performance in teaching sessions (20%), regular examinations (80%)
Student's performance in teaching sessions encompasses their participation in these sessions, marks on short tests taken during sessions, and marks from assigned reports.
Obtaining at least 60 out of 100 marks is considered passing, while obtaining 59 or below out of 100 marks is considered a fail.

[Evaluation policy]
Achievement targets are evaluated according to the grade evaluation policy of the Faculty of Engineering.

[Textbooks]

Atkins, P., Paula, J. (translated by Nakano, M., Ueda, T., Okumura, M., and Kitagawa, Y.), Atkins butsuri kagaku (jou) dai 10-pan, (Tokyo Kagaku Dojin, 2017) ISBN: 978-4-8079-0909-4, chapters 1-3 and parts of chapters 4 and 5

[References, etc.]

（**Reference books**）
Moore, W.J. (translated by Fujishiro, R.), Moore butsuri kagaku (jou) dai 4-han, (Tokyo Kagaku Dojin, 1974) ISBN: 978-4-8079-0002-2, chapters 1, 2, 3, and parts of chapter 6

[Study outside of class (preparation and review)]

Students must review exercises given during teaching sessions.

（**Other information (office hours, etc.)**）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

Continue to 物理化学基礎及び演習［工化4］(3)↓↓↓

物理化学基礎及び演習［工化4］(3)

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG27 27103 LJ60		
Course title (and course title in English)	有機化学基礎及び演習［工化1］ Exercises in Basic Organic Chemistry	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,NAGAKI AIICHIROU Graduate School of Engineering Associate Professor,FUJIHARA TETSUAKI
Target year	2nd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Mon.1	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

This course systematically studies the basic concepts and principles of organic chemistry through lectures and exercises. Particular attentions are focused on the chemistry of carbonyl group, which is one of the most important functional group in organic chemistry. The organic chemistry of amines and heterocyclic compounds are also studied.

[Course objectives]

Acquire the basic concept and knowledge, especially physical properties and reactions, of organic chemistry of carbonyl compounds, amines, and heterocycles.

[Course schedule and contents]

1. Aldehydes and ketones (2)
Study on the structures, properties, syntheses, and reactions of aldehydes and ketone.

2. Nucleophilic addition reactions (3)
Study on the reactions and reaction mechanisms of the nucleophilic addition reactions to aldehydes and ketones.

3. Carboxylic acids and nitriles (1)
Study on the structure, properties, syntheses, and reactions of carboxylic acids and nitriles

4. Carboxylic acid derivatives (2)
Study on the structure, properties, syntheses, and reactions of carboxylic acid derivatives, such as esters and acid halides.

5. Nucleophilic acyl substitution reactions (2)
Study on the reactions and reaction mechanisms of the nucleophilic acyl substitution reactions of carboxylic acid derivatives.

6. alpha-Substitution and condensation reactions of carbonyl group (2)
Study on the reactions and reaction mechanisms involving enolate anions of ketons and esters, such as alkylations and aldol reactions.

7. Amines and heterocycles (2)
Study on the structure, properties, syntheses, and reactions of amines and heterocycles.

8. Feedback (1)

Continue to 有機化学基礎及び演習［工化1］(2)↓↓↓

有機化学基礎及び演習［工化1］(2)

[Course requirements]

Desirable to take Basic Organic Chemistry A and B.

[Evaluation methods and policy]

Evaluate based on a final written examination and exercises and tests during the lecture.

[Textbooks]

マクマリー『有機化学　生体反応へのアプローチ』（東京化学同人）ISBN:9784807906918

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

Preparation and reviewing the textbook are needed.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 27103 LJ60		
Course title (and course title in English)	有機化学基礎及び演習［工化2］ Exercises in Basic Organic Chemistry	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,KURAHASHI TAKUYA
Target year	2nd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Mon.1	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

This course systematically studies the basic concepts and principles of organic chemistry through lectures and exercises. Particular attentions are focused on the chemistry of carbonyl group, which is one of the most important functional group in organic chemistry. The organic chemistry of amines and heterocyclic compounds are also studied.

[Course objectives]

Acquire the basic concept and knowledge, especially physical properties and reactions, of organic chemistry of carbonyl compounds, amines, and heterocycles.

[Course schedule and contents]

1. Aldehydes and ketones (2)
Study on the structures, properties, syntheses, and reactions of aldehydes and ketone.

2. Nucleophilic addition reactions (3)
Study on the reactions and reaction mechanisms of the nucleophilic addition reactions to aldehydes and ketones.

3. Carboxylic acids and nitriles (1)
Study on the structure, properties, syntheses, and reactions of carboxylic acids and nitriles

4. Carboxylic acid derivatives (2)
Study on the structure, properties, syntheses, and reactions of carboxylic acid derivatives, such as esters and acid halides.

5. Nucleophilic acyl substitution reactions (2)
Study on the reactions and reaction mechanisms of the nucleophilic acyl substitution reactions of carboxylic acid derivatives.

6. alpha-Substitution and condensation reactions of carbonyl group (2)
Study on the reactions and reaction mechanisms involving enolate anions of ketons and esters, such as alkylations and aldol reactions.

7. Amines and heterocycles (2)
Study on the structure, properties, syntheses, and reactions of amines and heterocycles.

8. Feedback (1)

Continue to 有機化学基礎及び演習［工化2］(2)↓↓↓

有機化学基礎及び演習［工化2］(2)

[Course requirements]

Desirable to take Basic Organic Chemistry A and B.

[Evaluation methods and policy]

Evaluate based on a final written examination and exercises and tests during the lecture.

[Textbooks]

マクマリー『有機化学　生体反応へのアプローチ』（東京化学同人）ISBN:9784807906918

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

Preparation and reviewing the textbook are needed.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 27103 LJ60		
Course title (and course title in English)	有機化学基礎及び演習［工化3］ Exercises in Basic Organic Chemistry	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,HAMACHI ITARU

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Mon.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

This course systematically studies the basic concepts and principles of organic chemistry through lectures and exercises. Particular attentions are focused on the chemistry of carbonyl group, which is one of the most important functional group in organic chemistry. The organic chemistry of amines and heterocyclic compounds are also studied.

[Course objectives]

Acquire the basic concept and knowledge, especially physical properties and reactions, of organic chemistry of carbonyl compounds, amines, and heterocycles.

[Course schedule and contents]

1. Aldehydes and ketones (2)
Study on the structures, properties, syntheses, and reactions of aldehydes and ketone.

2. Nucleophilic addition reactions (3)
Study on the reactions and reaction mechanisms of the nucleophilic addition reactions to aldehydes and ketones.

3. Carboxylic acids and nitriles (1)
Study on the structure, properties, syntheses, and reactions of carboxylic acids and nitriles

4. Carboxylic acid derivatives (2)
Study on the structure, properties, syntheses, and reactions of carboxylic acid derivatives, such as esters and acid halides.

5. Nucleophilic acyl substitution reactions (2)
Study on the reactions and reaction mechanisms of the nucleophilic acyl substitution reactions of carboxylic acid derivatives.

6. alpha-Substitution and condensation reactions of carbonyl group (2)
Study on the reactions and reaction mechanisms involving enolate anions of ketons and esters, such as alkylations and aldol reactions.

7. Amines and heterocycles (2)
Study on the structure, properties, syntheses, and reactions of amines and heterocycles.

8. Feedback (1)

Continue to 有機化学基礎及び演習［工化3］(2)↓↓↓

有機化学基礎及び演習［工化3］(2)

[Course requirements]

Desirable to take Basic Organic Chemistry A and B.

[Evaluation methods and policy]

Evaluate based on a final written examination and exercises and tests during the lecture.

[Textbooks]

マクマリー『有機化学　生体反応へのアプローチ』（東京化学同人）ISBN:9784807906918

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

Preparation and reviewing the textbook are needed.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG27 27103 LJ60		
Course title (and course title in English)	有機化学基礎及び演習［工化4］ Exercises in Basic Organic Chemistry	Instructor's name, job title, and department of affiliation	Institute for Chemical Research Professor,YAMAGO SHIGERU Institute for Chemical Research Assistant Professor,KAYAHARA EIICHI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Mon.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

This course systematically studies the basic concepts and principles of organic chemistry through lectures and exercises. Particular attentions are focused on the chemistry of carbonyl group, which is one of the most important functional group in organic chemistry. The organic chemistry of amines and heterocyclic compounds are also studied.

[Course objectives]

Acquire the basic concept and knowledge, especially physical properties and reactions, of organic chemistry of carbonyl compounds, amines, and heterocycles.

[Course schedule and contents]

1. Aldehydes and ketones (2)
Study on the structures, properties, syntheses, and reactions of aldehydes and ketone.

2. Nucleophilic addition reactions (3)
Study on the reactions and reaction mechanisms of the nucleophilic addition reactions to aldehydes and ketones.

3. Carboxylic acids and nitriles (1)
Study on the structure, properties, syntheses, and reactions of carboxylic acids and nitriles

4. Carboxylic acid derivatives (2)
Study on the structure, properties, syntheses, and reactions of carboxylic acid derivatives, such as esters and acid halides.

5. Nucleophilic acyl substitution reactions (2)
Study on the reactions and reaction mechanisms of the nucleophilic acyl substitution reactions of carboxylic acid derivatives.

6. alpha-Substitution and condensation reactions of carbonyl group (2)
Study on the reactions and reaction mechanisms involving enolate anions of ketons and esters, such as alkylations and aldol reactions.

7. Amines and heterocycles (2)
Study on the structure, properties, syntheses, and reactions of amines and heterocycles.

8. Feedback (1)

Continue to 有機化学基礎及び演習［工化4］(2)↓↓↓

有機化学基礎及び演習［工化4］(2)

[Course requirements]

Desirable to take Basic Organic Chemistry A and B.

[Evaluation methods and policy]

Evaluate based on a final written examination and exercises and tests during the lecture.

[Textbooks]

マクマリー『有機化学　生体反応へのアプローチ』（東京化学同人）ISBN:9784807906918

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

Preparation and reviewing the textbook are needed.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 27104 LJ60		
Course title (and course title in English)	基礎無機化学［T17，T18］ Basic Inorganic Chemistry	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,ABE RYUU Graduate School of Energy Science Associate Professor,TAKAI SHIGEOMI Institute for Liberal Arts and Sciences Professor,TANAKA KATSUHISA
Target year	2nd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Fri.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

Students are taught the structure of atoms and molecules, and the chemical bonds and structures of inorganic solids, which are basics of inorganic chemistry needed in order to work as researchers and engineers in all fields related to chemistry.

[Course objectives]

To understand atomic structure, ionic bonds, covalent bonds, electronegativity, molecular structure, and basic crystal structures, which together form the foundations of inorganic chemistry.

[Course schedule and contents]

Atomic structure (Chapter 1), 4 sessions
After receiving an overview of the origin, abundance ratio, and classification of chemical elements, students are given a general outline on the quantum mechanical method of expression for the orbitals of electrons in an atom and atomic orbitals, and are taught the orbital approximation method and the building-up principle for dealing with many-electron atoms. Additionally, students are given an explanation on atomic parameters such as the atomic radius and ionic radius that characterize the properties of an atom, ionization energy, electron affinity, and electronegativity, and are taught how these atomic parameters are related to the periodicity of properties of chemical elements.

Molecular structure and bonding (Chapter 2), 5 sessions
Based on the idea of bonding electron pairs, students are taught about Lewis structures, formal charge, oxidation number, resonance, and the relationship between the molecular structure and the characteristics of a bond (length and strength of a bond). Following this, the valence bond theory is explained, then concepts in the molecular orbital theory such as the bonding mode, expression of bond order, resonance, orbital overlap, and hybrid orbitals are explained for diatomic molecules and polyatomic molecules.

The structures of simple solids (Chapter 3), 5 sessions
The structures of many inorganic crystals are well explained by models that atoms and ions are regarded as spheres and they are closely packed. Here, the concepts of the crystal lattice and the close-packed structure of spheres that are needed for describing the structure of a crystal are explained. Following this, students are given an explanation about the structures of metal elements and alloys, and are taught about the characteristic structure of ionic solids, the effect of the cation to anion size ratio on the crystal structure, the concept of lattice enthalpy and the method of calculation using ionic models and thermodynamic data, and the various results derived from lattice enthalpy, among other matters concerning ionic solids in particular. Furthermore, students are also taught about the relationship between the electronic structure and the electrical/electronic properties of solids.

Continue to 基礎無機化学［T17，T18］(2)↓↓↓

基礎無機化学［T17，T18］(2)

Confirmation of learning achieved, 1 session
Here, the students' understanding of the lecture contents is confirmed.

[Course requirements]

Students must have introductory knowledge on physics and chemistry.

[Evaluation methods and policy]

Evaluation is based on results from regular examinations.
[Evaluation policy]
Achievement targets are evaluated according to the grade evaluation policy of the Faculty of Engineering.

[Textbooks]

Weller, M., et al. (translated by Tanaka, K., Takahashi, M., Abe, T., Hirao, K., Kitagawa, S.)『Shuraibaa atokinsu muki kagaku dai 6-ban (jyoukan)』（Tokyo Kagaku Dojin, 2016）ISBN:9784807908981

[References, etc.]

（**Reference books**）
Nothing in particular

[Study outside of class (preparation and review)]

Before attending a lecture, students must prepare by reading the textbook; after attending a lecture, students will review the material by solving exercises in the textbook.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number	U-ENG27 27104 LJ60		
Course title (and course title in English)	基礎無機化学［T19，T20］ Basic Inorganic Chemistry	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MIURA KIYOTAKA Graduate School of Engineering Associate Professor,MATSUI TOSHIAKI Institute for Liberal Arts and Sciences Professor,TANAKA KATSUHISA
Target year	2nd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Fri.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

Students are taught the structure of atoms and molecules, and the chemical bonds and structures of inorganic solids, which are basics of inorganic chemistry needed in order to work as researchers and engineers in all fields related to chemistry.

[Course objectives]

To understand atomic structure, ionic bonds, covalent bonds, electronegativity, molecular structure, and basic crystal structures, which together form the foundations of inorganic chemistry.

[Course schedule and contents]

Atomic structure (Chapter 1), 4 sessions
After receiving an overview of the origin, abundance ratio, and classification of chemical elements, students are given a general outline on the quantum mechanical method of expression for the orbitals of electrons in an atom and atomic orbitals, and are taught the orbital approximation method and the building-up principle for dealing with many-electron atoms. Additionally, students are given an explanation on atomic parameters such as the atomic radius and ionic radius that characterize the properties of an atom, ionization energy, electron affinity, and electronegativity, and are taught how these atomic parameters are related to the periodicity of properties of chemical elements.

Molecular structure and bonding (Chapter 2), 5 sessions
Based on the idea of bonding electron pairs, students are taught about Lewis structures, formal charge, oxidation number, resonance, and the relationship between the molecular structure and the characteristics of a bond (length and strength of a bond). Following this, the valence bond theory is explained, then concepts in the molecular orbital theory such as the bonding mode, expression of bond order, resonance, orbital overlap, and hybrid orbitals are explained for diatomic molecules and polyatomic molecules.

The structures of simple solids (Chapter 3), 5 sessions
The structures of many inorganic crystals are well explained by models that atoms and ions are regarded as spheres and they are closely packed. Here, the concepts of the crystal lattice and the close-packed structure of spheres that are needed for describing the structure of a crystal are explained. Following this, students are given an explanation about the structures of metal elements and alloys, and are taught about the characteristic structure of ionic solids, the effect of the cation to anion size ratio on the crystal structure, the concept of lattice enthalpy and the method of calculation using ionic models and thermodynamic data, and the various results derived from lattice enthalpy, among other matters concerning ionic solids in particular. Furthermore, students are also taught about the relationship between the electronic structure and the electrical/electronic properties of solids.

Continue to 基礎無機化学［T19，T20］(2)↓↓↓

基礎無機化学［T19，T20］(2)

Confirmation of learning achieved, 1 session
Here, the students' understanding of the lecture contents is confirmed.

[Course requirements]

Students must have introductory knowledge on physics and chemistry.

[Evaluation methods and policy]

Evaluation is based on results from regular examinations.
[Evaluation policy]
Achievement targets are evaluated according to the grade evaluation policy of the Faculty of Engineering.

[Textbooks]

Weller, M., et al. (translated by Tanaka, K., Takahashi, M., Abe, T., Hirao, K., Kitagawa, S.) 『Shuraibaa atokinsu muki kagaku dai 6-ban (jyoukan)』 （Tokyo Kagaku Dojin, 2016）ISBN:9784807908981

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

Before attending a lecture, students must prepare by reading the textbook; after attending a lecture, students will review the material by solving exercises in the textbook.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 27104 LJ60		
Course title (and course title in English)	基礎無機化学［T21，T22］ Basic Inorganic Chemistry	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,FUJITA KOJI Institute for Liberal Arts and Sciences Professor,TANAKA KATSUHISA
Target year	2nd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Fri.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

Students are taught the structure of atoms and molecules, and the chemical bonds and structures of inorganic solids, which are basics of inorganic chemistry needed in order to work as researchers and engineers in all fields related to chemistry.

[Course objectives]

To understand atomic structure, ionic bonds, covalent bonds, electronegativity, molecular structure, and basic crystal structures, which together form the foundations of inorganic chemistry.

[Course schedule and contents]

Atomic structure (Chapter 1), 4 sessions
After receiving an overview of the origin, abundance ratio, and classification of chemical elements, students are given a general outline on the quantum mechanical method of expression for the orbitals of electrons in an atom and atomic orbitals, and are taught the orbital approximation method and the building-up principle for dealing with many-electron atoms. Additionally, students are given an explanation on atomic parameters such as the atomic radius and ionic radius that characterize the properties of an atom, ionization energy, electron affinity, and electronegativity, and are taught how these atomic parameters are related to the periodicity of properties of chemical elements.

Molecular structure and bonding (Chapter 2), 5 sessions
Based on the idea of bonding electron pairs, students are taught about Lewis structures, formal charge, oxidation number, resonance, and the relationship between the molecular structure and the characteristics of a bond (length and strength of a bond). Following this, the valence bond theory is explained, then concepts in the molecular orbital theory such as the bonding mode, expression of bond order, resonance, orbital overlap, and hybrid orbitals are explained for diatomic molecules and polyatomic molecules.

The structures of simple solids (Chapter 3), 5 sessions
The structures of many inorganic crystals are well explained by models that atoms and ions are regarded as spheres and they are closely packed. Here, the concepts of the crystal lattice and the close-packed structure of spheres that are needed for describing the structure of a crystal are explained. Following this, students are given an explanation about the structures of metal elements and alloys, and are taught about the characteristic structure of ionic solids, the effect of the cation to anion size ratio on the crystal structure, the concept of lattice enthalpy and the method of calculation using ionic models and thermodynamic data, and the various results derived from lattice enthalpy, among other matters concerning ionic solids in particular. Furthermore, students are also taught about the relationship between the electronic structure and the electrical/electronic properties of solids.

Continue to 基礎無機化学［T21，T22］(2)↓↓↓

基礎無機化学［T21，T22］(2)

Confirmation of learning achieved, 1 session
Here, the students' understanding of the lecture contents is confirmed.

[Course requirements]

Students must have introductory knowledge on physics and chemistry.

[Evaluation methods and policy]

Evaluation is based on results from regular examinations.
[Evaluation policy]
Achievement targets are evaluated according to the grade evaluation policy of the Faculty of Engineering.

[Textbooks]

Weller, M., et al. (translated by Tanaka, K., Takahashi, M., Abe, T., Hirao, K., Kitagawa, S.) 『Shuraibaa atokinsu muki kagaku dai 6-ban (jyoukan)』 （Tokyo Kagaku Dojin, 2016）ISBN:9784807908981

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

Before attending a lecture, students must prepare by reading the textbook; after attending a lecture, students will review the material by solving exercises in the textbook.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 27105 LJ60　U-ENG27 27105 LJ76		
Course title (and course title in English)	化学プロセス工学基礎［T17，T18］ Fundamental Chemical Process Engineering	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MAE KAZUHIRO Graduate School of Engineering Professor,YAMAMOTO RYOICHI Graduate School of Engineering Associate Professor,MAKI TAISUKE
Target year	2nd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Thu.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,2times,
,2times,
,2times,
,1time,
,1time,
,0.5times,
,1time,
,1.5times,
,1time,
,2times,
,1time,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

Continue to 化学プロセス工学基礎［T17，T18］(2)↓↓↓

化学プロセス工学基礎［T17，T18］(2)

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number	U-ENG27 27105 LJ60　U-ENG27 27105 LJ76		
Course title (and course title in English)	化学プロセス工学基礎［T19，T20］ Fundamental Chemical Process Engineering	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,KAWASE MOTOAKI Graduate School of Engineering Professor,SANO NORIAKI Graduate School of Engineering Senior Lecturer,ASHIDA RIYUUICHI Graduate School of Engineering Professor,YAMAMOTO RYOICHI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Thu.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Transport phenomenon of materials, energy, and momentum are important not only in chemical processes but also in environmental problems and energy problems which include diffusion of pollutants and efficient utilization of heat. In this course, beginning with material and energy balances, momentum transport, energy transport, and material transport are explained. As well, fundamentals of chemical reaction engineering which aims to analyze and design chemical reactors are lectured. Categorization of reactor operation and shapes of reactors is explained from engineering viewpoint and methods for formulating reaction rate equations from experimental data and for designing reactors are then explained.

[Course objectives]

To learn fundamentals of chemical process engineering particularly transport phenomena and chemical reaction engineering.

[Course schedule and contents]

Weeks 1 and 2: Fluid dynamics (momentum transport)--- Basic concepts of transport phenomena, momentum transport in fluids as well as Newton's law of viscosity, laminar flow of Newtonian fluid, turbulent flow and friction factor, and macroscopic flow and application of balance equation to actual processes are lectured.

Weeks 3 and 4: Heat transfer (energy transport)--- Types of heat transfer, heat conduction and Fourier's law, heat transfer at fluid--solid interface and heat transfer coefficient, convective heat transfer, and principles of heat exchanger are lectured.

Weeks 5 and 6: Diffusion (material transport)--- Diffusion and Fick's laws, analogy between momentum transport, energy transport, and material transport, equimolar counter diffusion and one-directional diffusion, and application to diffusion problems are lectured.

Week 7: Review of transport phenomena--- Comprehensive lecture of fluid dynamics, heat transfer, and diffusion which were taught previous weeks is given.

Week 8: Confirmation of understanding of transport phenomena--- Intermediate examination on transport phenomena as practice.

Week 9: Classification of chemical reactions and chemical reactors--- Basic concept of chemical reaction engineering is lectured and categorization of reactions and reactors from engineering viewpoint is explained.

Continue to 化学プロセス工学基礎［T19，T20］(2)↓↓↓

Weeks 9 and 10: Reaction rate equation--- Definition of reaction rate and its dependency on temperature are explained. Steady-state approximation and partial equilibrium approximation fro formulation of overall reaction are lectured.

Weeks 10 and 11: Fundamental equations of designing and operating reactors--- Stoichiometry during reaction and kinetic balance equations of batch reactor, continuous tank reactor, and tubular reactor are explained.

Week 12: Kinetic analysis of simple reaction--- Measuring data in experiments using batch reactor, tubular reactor, or continuous tank reactor, analyzing those data, and formulating reaction rate as a function of concentrations and temperature are explained.

Weeks 13 and 14: Design and operation of reactors--- Design and operation of reactors are taught and exercised.

Week 15: Comprehensive lecture on chemical reaction engineering which were lectured in previous weeks is given.

[Course requirements]

None

[Evaluation methods and policy]

Absolute evaluation of intermediate and final examinations. Take-home assignments and in-class quizzes are imposed and evaluated if necessary.

[Textbooks]

K. Hashimoto and F. Ogino ed. 『Gendai Kagakukogaku (2001).』 （Sangyo Tosho）ISBN:4782826095

[References, etc.]

（**Reference books**）
F. Ogino 『Ido Gensho.』 （Sangyo Tosho）ISBN:478282520X
R. Bird, W. Stewart and E. Lightfoot 『Transport Phenomena (2nd Ed.).』 （Wiley）ISBN:9780470115398
K. Hashimoto 『Han'no Kogaku (revised and augmented).』 （Baifukan）ISBN:9784563046347

[Study outside of class (preparation and review)]

Read through a corresponding part of the textbooks before the lecture. Assignments are usually taken from the textbooks.

（Other information (office hours, etc.)）

All registered students are divide into 3 classes. The 3 classes run separately though the contents are shared. Fundamental knowledge on ordinary differential equations is needed. Be sure to take two examinations on the former part (transport phenomena) and the latter part (chemical reaction engineering).

Continue to 化学プロセス工学基礎［T19，T20］(3)↓↓↓

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 27105 LJ60　U-ENG27 27105 LJ76		
Course title (and course title in English)	化学プロセス工学基礎［T21，T22］ Fundamental Chemical Process Engineering	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MIYAHARA MINORU Graduate School of Engineering Associate Professor,NAKAGAWA HIROYUKI Graduate School of Engineering Professor,YAMAMOTO RYOICHI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Thu.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Transport phenomenon of materials, energy, and momentum are important not only in chemical processes butalso in environmental problems and energy problems which include diffusion of pollutants and efficient utilization of heat. In this course, beginning with material and energy balances, momentum transport, energy transport, and material transport are explained. As well, fundamentals of chemical reaction engineering which aims to analyze and design chemical reactors are lectured. Categorization of reactor operation and shapes of reactors is explained from engineering viewpoint and methods for formulating reaction rate equations from experimental data and for designing reactors are then explained.

[Course objectives]

To learn fundamentals of chemical process engineering particularly transport phenomena and chemical reaction engineering.

[Course schedule and contents]

Weeks 1 and 2: Fluid dynamics (momentum transport)--- Basic concepts of transport phenomena, momentum transport in fluids as well as Newton's law of viscosity, laminar flow of Newtonian fluid, turbulent flow and friction factor, and macroscopic flow and application of balance equation to actual processes are lectured.
Weeks 3 and 4: Heat transfer (energy transport)--- Types of heat transfer, heat conduction and Fourier's law, heat transfer at fluid--solid interface and heat transfer coefficient, convective heat transfer, and principles of heat exchanger are lectured.
Weeks 5 and 6: Diffusion (material transport)--- Diffusion and Fick's laws, analogy between momentum transport, energy transport, and material transport, equimolar counter diffusion and one-directional diffusion, and application to diffusion problems are lectured.
Week 7: Review of transport phenomena--- Comprehensive lecture of fluid dynamics, heat transfer, and diffusion which were taught previous weeks is given.
Week 8: Confirmation of understanding of transport phenomena--- Intermediate examination on transport phenomena as practice.
Week 9: Classification of chemical reactions and chemical reactors--- Basic concept of chemical reaction engineering is lectured and categorization of reactions and reactors from engineering viewpoint is explained.
Weeks 9 and 10: Reaction rate equation--- Definition of reaction rate and its dependency on temperature are explained. Steady-state approximation and partial equilibrium approximation fro formulation of overall reaction are lectured.
Weeks 10 and 11: Fundamental equations of designing and operating reactors--- Stoichiometry during reaction and kinetic balance equations of batch reactor, continuous tank reactor, and tubular reactor are explained.
Week 12: Kinetic analysis of simple reaction--- Measuring data in experiments using batch reactor, tubular reactor, or continuous tank reactor, analyzing those data, and formulating reaction rate as a function of

Continue to 化学プロセス工学基礎［T21，T22］(2)↓↓↓

concentrations and temperature are explained.
Weeks 13 and 14: Design and operation of reactors--- Design and operation of reactors are taught and exercised.
Week 15: Comprehensive lecture on chemical reaction engineering which were lectured in previous weeks is given.

[Course requirements]

None

[Evaluation methods and policy]

Absolute evaluation of intermediate and final examinations. Take-home assignments and in-class quizzes are imposed and evaluated if necessary.

[Textbooks]

K. Hashimoto and F. Ogino ed. 『Gendai Kagakukogaku (2001)』（Sangyo Tosho）ISBN:4782826095

[References, etc.]

（**Reference books**）
F. Ogino 『Ido Gensho』（Sangyo Tosho）ISBN:478282520X
R. Bird, W. Stewart and E. Lightfoot 『Transport Phenomena (2nd Ed.)』（Wiley）ISBN:9780470115398
K. Hashimoto 『Han'no Kogaku (revisedand augmented)』（Baifukan）ISBN:4563045187

[Study outside of class (preparation and review)]

Read through a corresponding part of the textbooks before the lecture. Assignments are usually taken from the textbooks.

（Other information (office hours, etc.)）

All registered students are divide into 3 classes. The 3 classes run separately though the contents are shared. Fundamental knowledge on ordinary differential equations is needed. Be sure to take two examinations on the former part (transport phenomena) and the latter part (chemical reaction engineering).

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG27 27111 LJ60		
Course title (and course title in English)	有機化学Ⅰ（創成化学） Organic Chemistry I (Frontier Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,NAKAO YOSHIAKI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Mon.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,4times,
,3times,
,3times,
,2times,
,2times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 27112 LJ60		
Course title (and course title in English)	物理化学Ⅰ（創成化学） Physical Chemistry I (Frontier Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,KOGA TSUYOSHI Graduate School of Engineering Associate Professor,NISHIDA KOUJI Graduate School of Engineering Assistant Professor,KOJIMA HIROYUKI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Wed.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,2times,
,3times,
,3times,
,3times,
,3times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

Continue to 物理化学Ⅰ（創成化学）(2)↓↓↓

物理化学 I （創成化学）**(2)**

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

未更新

Course number	U-ENG27 27113 LJ60		
Course title (and course title in English)	無機化学（創成化学） Inorganic Chemistry (Frontier Chemistry)	**Instructor's name, job title, and department of affiliation**	Graduate School of Engineering Professor,MIURA KIYOTAKA Graduate School of Engineering Associate Professor,SHIMOTSUMA YASUHIKO
Target year	2nd year students or above	**Number of credits**	2
Year/semesters	2021/Second semester		
Days and periods	Mon.2	**Class style**	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,3times,
,3times,
,4times,
,4times,
, 1 times,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

Continue to 無機化学（創成化学）(2)↓↓↓

無機化学（創成化学）**(2)**

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

Course number	U-ENG27 27114 LJ60		
Course title (and course title in English)	分析化学（創成化学） Analytical Chemistry (Frontier Chemistry)	**Instructor's name, job title, and department of affiliation**	Graduate School of Engineering Professor,OTSUKA KOJI Graduate School of Engineering Associate Professor,OYAMA MUNETAKA Graduate School of Engineering Associate Professor,KUBO TAKUYA
Target year	2nd year students or above	**Number of credits**	2
Year/semesters	2021/Second semester		
Days and periods	Fri.2	**Class style**	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

As an introduction to analytical chemistry, basic subjects related to the underlying chemical equilibrium in solution, including acid-base, complex formation, redox, dissolution, and partition equilibrium, will be given and some exercises will also be conducted.

[Course objectives]

Learn important matters related to in-solution chemical equilibrium, which is the basis of analytical chemistry.

[Course schedule and contents]

1. Outline of chemical equilibrium (2): Explain the basics of chemical equilibrium as the basis for dealing with in-solution chemical equilibrium, such as acid-base, complex formation, precipitation, and redox reactions.

2. Acid-base equilibrium (4): Based on the Bronsted's definition of acids and bases, the pH calculation methods for various solutions are shown, and the estimation of the neutralization titration curve, selection of indicators, and buffer solutions are explained. The acid-base equilibrium in complex systems containing polyprotic acids will also be shown.

3. Complex formation equilibrium (4): Mainly for chelatometric titration, the condition formation constant is evaluated in consideration of side reactions, such as the protonation of ligands and the complexing effect of metal ions. And discuss the feasibility of complex titration. The prediction of titration curves and metal indicators will be discussed.

4. Redox equilibrium (4): The electrode potential and Nernst equation, which are the basis for understanding the redox equilibrium, are explained. The relationship between the electrode potential and the redox equilibrium in an aqueous solution is discussed. The relationship between the amount of the titrant and potential in a redox titration is shown. The actual titration is will be given.

5. Confirmation of learning achievement (1): Confirm (comment) the achievement of the contents of this lecture.

[Course requirements]

None

Continue to 分析化学（創成化学）(2)↓↓↓

分析化学（創成化学）**(2)**

[Evaluation methods and policy]

Evaluation will be based on assignments (80%) and class performance (20%).

[Textbooks]

Daniel C. Harris 『Quantitative Chemical Analysis, 10th Ed.』 （W. H. Freeman, 2020）ISBN: 9781319324506

[References, etc.]

（**Reference books**）

Introduced during class

[Study outside of class (preparation and review)]

Introduced during class if necessary.

（**Other information (office hours, etc.)**）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 27115 LJ61 U-ENG27 27115 LJ62		
Course title (and course title in English)	高分子化学基礎Ⅰ（創成化学） Elements of Polymer Chemistry I (Frontier Chemistry)	**Instructor's name, job title, and department of affiliation**	Graduate School of Engineering Associate Professor,NISHIDA KOUJI Graduate School of Engineering Associate Professor,MATSUOKA HIDEKI
Target year	2nd year students or above	**Number of credits**	2
Year/semesters	2021/Second semester		
Days and periods	Thu.2	**Class style**	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,2times,
,1time,
,2times,
,1time,
,1time,
,1time,
,2times,
,2times,
,2times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

Continue to 高分子化学基礎Ⅰ（創成化学）(2)↓↓↓

高分子化学基礎Ⅰ（創成化学）**(2)**

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（**Other information (office hours, etc.)**）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 37117 LJ60		
Course title (and course title in English)	有機化学II（創成化学） Organic Chemistry II (Frontier Chemistry)	**Instructor's name, job title, and department of affiliation**	Graduate School of Engineering Professor,MATSUBARA SEIJIROU
Target year	3rd year students or above	**Number of credits**	2
Year/semesters	2021/First semester		
Days and periods	Wed.2	**Class style**	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,3times,
,3times,
,3times,
,3times,
,2times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（**Other information (office hours, etc.)**）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 37118 LJ61		
Course title (and course title in English)	生体関連物質化学（創成化学） Biorelated Material Chemistry	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,NUMATA KEIJI Graduate School of Engineering Senior Lecturer,OOMAE MASASHI
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Tue.1	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

, 4 times,
,4times,
,4times,
,3times,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

Continue to 生体関連物質化学（創成化学）(2)↓↓↓

生体関連物質化学（創成化学）(2)

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG27 37119 LJ60		
Course title (and course title in English)	物理化学II（創成化学） Physical Chemistry II (Frontier Chemistry)	Instructor's name, job title, and department of affiliation	Institute for Chemical Research Associate Professor,OONO KOUJI Institute for Chemical Research Professor,TSUJII YOSHINOBU
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Wed.1	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,3times,
,2times,
,2times,
,4times,
,3times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 37120 LJ61　U-ENG27 37120 LJ62		
Course title (and course title in English)	高分子化学基礎II（創成化学） Elements of Polymer Chemistry II (Frontier Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,HORINAKA JIYUNICHI Graduate School of Engineering Associate Professor,TERASHIMA TAKAYA
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Tue.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,2times,
,2times,
,3times,
,3times,
,4times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 37121 LJ61		
Course title (and course title in English)	統計熱力学入門（創成化学） Introduction to Statistical Thermodynamics (Frontier Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,IDA DAICHI
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Mon.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,2times,
,3times,
,3times,
,3times,
,3times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 37122 LJ60		
Course title (and course title in English)	機器分析化学（創成化学） Instrumental Analytical Chemistry (Frontier Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,OTSUKA KOJI Graduate School of Engineering Associate Professor,OYAMA MUNETAKA Graduate School of Engineering Associate Professor,KUBO TAKUYA
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Fri.1	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

As an introduction to instrumental analysis, chromatography, spectral analysis and electrochemical analysis are shown.

[Course objectives]

Learn the principles and applications of typical instrumental analysis methods.

[Course schedule and contents]

1. Chromatography (4): The basic theory and principle of chromatography, including the plate and kinetic theory and parameters related to retention and separation, are explained. Then equipment and separation characteristics of both gas chromatography and high performance liquid chromatography will be introduced.

2. Spectral analysis (5): After explaining the properties of electromagnetic waves and their interaction with substances, derivation of the Beer's law, which is important in light absorption measurement, as well as its use in quantitative analysis are shown. In addition, the principles, equipment, and measurement methods of ultraviolet-visible absorption spectrophotometry, and fluorescence/phosphorescence spectrophotometry are discussed.

3. Electrochemical analysis (5): Regarding the potentiometric method (potentiometric), the details of the electrodes that are the basis of the measurement and the measurement principle are explained. The response principle of ion-selective electrodes and pH measurement using glass electrodes will also be explained. In addition, electrolytic gravimetric analysis and coulometry will be introduced.

4. Confirmation of learning achievement (1): Confirm (comment) the achievement of the contents of this lecture.

[Course requirements]

Completed or learned "Analytical Chemistry (Frontier Chemistry)" is recommended.

[Evaluation methods and policy]

Evaluation will be based on assignments (80%) and class performance (20%).

[Textbooks]

Daniel C. Harris 『Quantitative Chemical Analysis, 10th Ed.』（W. H. Freeman, 2020）ISBN: 9781319324506

Continue to 機器分析化学（創成化学）(2)↓↓↓

機器分析化学（創成化学）(2)

[References, etc.]

（**Reference books**）
Introduced during class

[Study outside of class (preparation and review)]

Introduced during class if necessary.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 37123 LJ60		
Course title (and course title in English)	有機化学III（創成化学） Organic Chemistry III (Frontier Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,KURAHASHI TAKUYA Graduate School of Engineering Associate Professor,YOSHIHIRO SASAKI
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/Second semester		
Days and periods	Tue.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,2times,
,2times,
,2times,
,2times,
,2times,
,4times,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 37124 LJ60		
Course title (and course title in English)	物理化学III（創成化学） Physical Chemistry III (Frontier Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,OOKITA HIDEO

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Tue.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

In Physical Chemistry III (frontier chemistry), lectures will focus on quantum chemstry, which is one of the core subjects in physical chemistry as well as thermodynamics and statistical thermodynamics: quantum chemistry describe the dynamics and properies of microscopic systems such as electrons and molecules, thermodynamics provides systematic description of macroscopic properties and characteristics, and statistical thermodynamics makes links between microscopic and macroscopic properties. The lectures will also focus on how quantum theory serves as a basis for understanding electron configuration in atoms, chemical bonds, molecular structure, and various spectroscopic properties.

[Course objectives]

Students will understand quantum theory systematically, which provides the fundamental laws of the molecular world. Students will also become able to explain, on the basis of quantum theory, electron configuration in atoms, chemical bonds, molecular structures, and various spectroscopic properites.

[Course schedule and contents]

(1) Quantum theory (5 classes)
・ Origins of quantum mechanics and microscopic system dynamics
・ Quantum-mechanical principles
・ Translational motion, vibrational motion
・ Rotational motion

(2) Atomic structure and atomic spectra (2 classes)
・ Structure and spectra of the hydrogen atom
・ Structure and complex atomic spectra of multielectron atoms

(3) Molecular structure (2 classes)
・ Valence bond method, molecular orbital method
・ Polyatomic molecular system orbitals

(4) Molecular spectroscopy 1 (2 classes)
・ Rotational spectrum
・ Vibrational spectrum

(5) Molecular spectroscopy 2 (1 class)
・ Electron transition

(6) Molecular spectroscopy 3 (1 class)

Continue to 物理化学III（創成化学）(2)↓↓↓

・ Magnetic resonance

(7) Intermolecular interactions (1 class)
・ Electrical properties
・ Intermolecular interactions

Final examination/ Confirmation of extent of student learning

Feedback (1 class)

[Course requirements]

Prerequisites for this course are completion of the following courses: Fundamentals of Physical Chemistry and Practical Exercises, Physical Chemistry I (Frontier Chemistry), and Physical Chemistry II (Frontier Chemistry).

[Evaluation methods and policy]

【Evaluation method】
Evaluation will be based on an examination (80%) and class performance (20%).
Evaluation for Participation in class includes attendance and evaluations of short reports.
【Evaluation policy】
Achievement of goals is evaluated according to the grade evaluation policy of the undergraduate.

[Textbooks]

Peter Atkins, Julio de Paula 著, 中野元裕・上田貴洋・奥村光隆・北河康隆 訳 『アトキンス「物理化学」第１０版（上）』（東京化学同人）ISBN:978-4-8079-0908-7（アトキンス「物理化学」第８版（上）でも構いません）
Peter Atkins, Julio de Paula 著, 中野元裕・上田貴洋・奥村光隆・北河康隆 訳 『アトキンス「物理化学」第１０版（下）』（東京化学同人）ISBN:978-4-8079-0909-4（アトキンス「物理化学」第８版（下）でも構いません）

[References, etc.]

（**Reference books**）
Introduced during class
To be introduced during the course

[Study outside of class (preparation and review)]

Lectures will proceed on the assumption that students have read carefully and thoroughly assigned textbook pages before each class period. Therefore, students should be sure to perform such study before and after each class.

Continue to 物理化学III（創成化学）(3)↓↓↓

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 37126 LJ60		
Course title (and course title in English)	最先端機器分析（創成化学） Advanced Instrumental Analysis (Frontier Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,OTSUKA KOJI Graduate School of Engineering Associate Professor,OYAMA MUNETAKA Graduate School of Engineering Associate Professor,KUBO TAKUYA

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Fri.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Principles and methodologies of new chromatography, separation analysis methods, and some methods which were not dealt with in "Instrumental Analysis (Frontier Chemistry)" are discussed. In addition, the advanced instrumental analysis methods will be introduced as a topic.

[Course objectives]

Understand the principles and applications of advanced instrumental analysis methods as well as the cutting-edge analysis technology.

[Course schedule and contents]

1. High-performance separation analysis (4): Outlines the basic theory, principle, equipment, and applications of micro/nano-scale separation analysis methods, which have been rapidly developing in recent years, focusing on capillary electrophoresis and microchip electrophoresis

2. Electrochemical analysis (4): Principles, measurement methods, and response behavior of electrochemical analysis methods for electrolytic redox reactions, such as potential and current measurement methods (voltammetry) and current measurement methods (amperometry).

3. Spectral analysis I (1): Principles and measurement methods of atomic spectroscopy and inductively coupled plasma spectroscopy.

4. Spectral analysis II (4): Basic theory, principle, equipment and applications of infrared spectrophotometry, Raman spectrophotometry, mass spectrometry, and nuclear magnetic resonance spectroscopy.

5. Topics (1): Advanced instrumental analysis method.

6. Confirmation of learning achievement (1): Confirm (comment) the achievement of the contents of this lecture.

[Course requirements]

Completed or learned both "Analytical Chemistry (Frontier Chemistry)" and "Advanced Instrumental Analysis (Frontier Chemistry)" is highly recommended.

Continue to 最先端機器分析（創成化学）(2)↓↓↓

[Evaluation methods and policy]

Evaluation will be based on assignments (80%) and class performance (20%).

[Textbooks]

Daniel C. Harris 『Quantitative Chemical Analysis, 10th Ed.』 （W. H. Freeman, 2020）ISBN: 9781319324506

[References, etc.]

（**Reference books**）
Introduced during class

[Study outside of class (preparation and review)]

Introduced during class if necessary.

（**Other information (office hours, etc.)**）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 47127 LJ61		
Course title (and course title in English)	化学のフロンティア（創成化学） Frontier Chemistry (Frontier Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,OOUCHI MAKOTO Graduate School of Engineering Professor,OTSUKA KOJI Graduate School of Engineering Professor,NAKAO YOSHIAKI Graduate School of Engineering Professor,NAKAMURA YOU Institute for Liberal Arts and Sciences Professor,TANAKA KATSUHISA Graduate School of Engineering Professor,MIURA KIYOTAKA Graduate School of Engineering Professor,TAKENAKA MIKIHITO Institute for Chemical Research Associate Professor,OONO KOUJI Graduate School of Engineering Professor,NUMATA KEIJI Faculty of Engineering

Target year	4th year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Fri.4	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Advanced research being performed in frontier chemistry research labs will be explained in an easy-to-understand way by researchers themselves. This is a concentrated course: Two classes will be held one after the other on Friday afternoons at 13:00-14:30 and 14:45-16:15, for a total of seven class days. Course dates are posted separately elsewhere.

[Course objectives]

Students will gain knowledge of frontier research as currently practiced in representative chemistry research areas, as well as of likely future trends. Students will also understand the role that chemistry plays in society.

[Course schedule and contents]

Frontlines of polymer properties (2 classes)
As macromolecules form a variety of molecular assembly structures, they display superior properties. In these lectures, an overview explanation is provided on how block copolymers and graft copolymers form, via self-organization, regular micro-phase separated structures on nanometer orders. These nano-patterns are then used in the development of devices and new materials.

Frontlines of polymer synthesis (2 classes)
An overview explanation is provided of basic chain polymerization functions, methods of precise synthesis of macromolecules via chain polymerization, and the characteristics of polymers thus precisely synthesized.

Frontlines of macromolecular design (2 classes)
Chemistry for the rational design and synthesis of macromolecules is indispensable to activities that aim to proactively grant new functions to polymers. Students will gain a deeper understanding of the fundamentals

Continue to 化学のフロンティア（創成化学）(2)↓↓↓

of living radical polymerization, which has undergone remarkable developments in recent times, and surface-graft polymerization; an overview of applications and related items will also be presented from the viewpoint of material design, especially applications in surface graft polymerization.

Frontlines of polymer characterization (2 classes)
An overview explanation is provided of light scattering in polymer solutions and of methods for determining molecular parameters from intrinsic viscosity measurement. Also discussed are application examples for each type of macromolecule (polymer).

Frontlines of organic chemistry and analytical chemistry (2 classes)
Fine organic synthesis using organometallic compounds has become the most powerful tool of molecular architecture. An overview is made of the theories of fine organic synthesis, and concrete advanced research cases are introduced. Micro- and nanoscale high-performance separation and analysis techniques are introduced to showcase the frontlines of novel topics.

Frontlines of inorganic materials chemistry (2 classes)
Discussion will be made of the synthesis and function of novel inorganic materials synthesis for applications involving spin electronics and photonics materials.

Frontlines of polymer materials chemistry (2 classes)
Explanation will be made of recent issues associated with the characteristics and properties of such things as elastomers and polymer gels. Lectures discuss the flow of development from supramolecular assembly to supramolecular organization, trends in molecular architecture such as catenane and rotaxane, and the development of nanomaterials.

Feedback (1 class)
Evaluation is made of the extent of learning achieved in the course overall, and in regards to the degree that students have achieved course goals.

[Course requirements]

Students are recommended to have finished fundamental courses in organic chemistry, physical chemistry, inorganic chemistry, analytical chemistry, and polymer chemistry.

[Evaluation methods and policy]

Grades will be determined based on an overall evaluation of attendance and scores (results) on reports.

[Textbooks]

No textbook will be used. Materials and PowerPoint presentations will be distributed and/or used during classes.

[References, etc.]

（**Reference books**）

Continue to 化学のフロンティア（創成化学）(3)↓↓↓

[Study outside of class (preparation and review)]

Assignments and individual reports will be appropriately instructed during classes.

（**Other information (office hours, etc.)**）

Course contents may be changed as necessary.

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 37129 LJ61		
Course title (and course title in English)	化学生物学 Chemical Biology	Instructor's name, job title, and department of affiliation	Institute for Frontier Life and Medical Sciences Professor,TABATA YASUHIKO Institute for Frontier Life and Medical Sciences Professor,EIRAKU GENJI Institute for Frontier Life and Medical Sciences Associate Professor,OHGUSHI MASATOSHI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Thu.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

It is important in the field of life science to understand biochemistry and biological medicine in terms of organic material chemistry. The way to think and view the biological system and bioprocess at the molecular level can make clear the academic knowledge of life science and contribute to the development of engineering-medicine-pharmacy interdisciplinary research area. In this lecture, proteins, polysaccharides, and lipids of bio-related substances as well as cells, cell membrane, extracellular matrix of biological system are explained in terms of chemical biology. As a representative of engineering-medicine-pharmacy interdisciplinary research area, drug delivery system (DDS) and regenerative medicine are introduced. In addition, some topics in the field of life science, including stem cells, body defense and immunology, and endocrine disruptor, are also covered.

[Course objectives]

The objective of the lecture is to obtain the fundamental knowledge of proteins, polysaccharides, lipids, cells, and extracellular matrix and understand stem cells, body defense, DDS, regenerative medicine, and endocrine disruptor of life science application.

[Course schedule and contents]

Proteins and enzymes,2times,Structure and function of proteins and enzymes
Polysaccharides and lipids,1time,Structure and function of polysaccharides and lipids
Cell and cell membrane,1time,Structure and function of cells and membrane transportation
Signal transduction,1time,Signal transduction at cell membrane
Energy conversion,1time,Oxidative phosphorylation to generate ATP
Cytoskeleton,1time,Cellular biomechanics and biochemistry of cytoskeleton
Body defense and immunology,1time,System and function of body defense and immunology
Stem cells,1time,System, function, and medical application of stem cells
Cell and extracellular matrix,1time,Structure and function of extracellular matrix
Regenerative medicine and material science,2times,Overview of regenerative medicine based on material science
Drug delivery system (DDS),1time,Overview of DDS based on material science
Endocrine disruptor,1time,Overview of endocrine disruptor based on material science
Achievement evaluation,1time,Credit evaluation based on the understanding level of lecture contents

Continue to 化学生物学(2)↓↓↓

化学生物学(2)

[Course requirements]

None

[Evaluation methods and policy]

The credit is judged by the scheduled examination and the attendant rate.

[Textbooks]

[References, etc.]

（**Reference books**）
Fundamentals of Biochemistry: Life at the Molecular Level；Wiley isbn{}{9780470547847}、
Molecular biology of the Cell ；Garland Science isbn{}{9780815344322}、
ますます重要になる細胞周辺環境（細胞ニッチ）の最新科学技術；株式会社メディカルドゥ isbn{}{9784944157846}、
Immunology；Saunders isbn{}{9780323080583}、
生物薬剤学；株式会社南江堂 isbn{}{9784524403059}、
絵で見てわかるナノDDS；株式会社メディカルドゥ isbn{}{9784944157884}

[Study outside of class (preparation and review)]

（**Other information (office hours, etc.)**）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 37130 LJ62　U-ENG27 37130 LJ61		
Course title (and course title in English)	高分子化学 I Polymer Chemistry I	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,OOUCHI MAKOTO

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Wed.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Based on the courses quotFundamental Polymer Science I and IIquot (covering polycondensation and radical polymerization), this course is to discuss the concepts and the characteristics of coordination, stereospecific, ionic (anionic and cationic), ring-opening, and living polymerizations. Examples are provided for initiators, monomers, reaction mechanism, polymerization intermediates, and produced polymers.

[Course objectives]

To discuss fundamental aspects of polymer chemistry, particularly the fundamental nature of polymers and their synthesis (polymerization reactions).

[Course schedule and contents]

Coordination Polymerization,2times,To discuss: The fundamentals of coordination and Ziegler-Natta polymerizations, including ring-opening metathesis polymerization, and the relation between catalyst design and polymerization mechanism.
Stereospecific Polymerization,2times,To discuss: The fundamentals of stereospecific polymerization, polymer characterization therein, and the relation between polymer steric structure and polymerization mechanism.
Study Achievement Test (1),1time,To examine as quotfeed-backquot: The achievement of studying in the subjects that have already been discussed (coordination and stereospecific polymerizations).
Anionic Polymerization,3times,To discuss: The fundamental of anionic polymerization, including initiators, monomers, their structurendashreactivity relationships, elementary reactions, kinetics. and reaction mechanisms.
Cationic Polymerization,3times,To discuss: The fundamental of cationic polymerization, including initiators, monomers, their structurendashreactivity relationships, elementary reactions, kinetics. and reaction mechanisms.
Ring-Opening Polymerization,1time,To discuss: The fundamental of ring-opening polymerization, including initiators, monomers, their structurendashreactivity relationships, elementary reactions, kinetics. and reaction mechanisms.
Living Polymerization,2times,To discuss: The definition and examples of quotlivingquot polymerization, including initiators, catalysts, monomers, their structure-reactivity relationships, elementary reactions, kinetics, and reaction mechanisms
Study Achievement Test (2),1time,To examine as quotfeed-backquot: The achievement of studying in the subjects that have already been discussed (ionic and living polymerizations).

[Course requirements]

Fundamental Polymer Science I (2nd year, 2nd term) and Fundamental Polymer Science II (3rd year, 1st term)

Continue to 高分子化学 I (2)↓↓↓

高分子化学 I (2)

[Evaluation methods and policy]

Written Examination

[Textbooks]

None in particular. PDF files of slides that are to be shown at the course lectures will be uploaded into the course website, and it is strongly recommended for students to download these materials for review and self-learning.

[References, etc.]

（**Reference books**）
quotFundamentals in Polymer Sciencequot, Tokyo Kagaku Dojin: isbn{}{9784807906352}

[Study outside of class (preparation and review)]

（**Other information (office hours, etc.)**）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG27 27132 LJ55　U-ENG27 27132 LJ61		
Course title (and course title in English)	化学数学（創成化学） Mathematics of Chemistry(Frontier Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,NAKAMURA YOU Institute for Chemical Research Associate Professor,OGAWA HIROKI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Tue.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,1time,
,1time,
,1time,
,1time,
,1time,
,2times,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

Continue to 化学数学（創成化学）(2)↓↓↓

化学数学（創成化学）(2)

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 37133 LJ60		
Course title (and course title in English)	錯体化学（創成化学） Coordination Chemistry (Frontier Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,FUJITA KOJI Institute for Liberal Arts and Sciences Professor,TANAKA KATSUHISA

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Mon.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Students are given an explanation of acids and bases, and oxidation and reduction, which are basic concepts of inorganic chemistry. Following this, students are taught about coordination chemistry, one of the core fields in inorganic chemistry. In order to prepare students to understand coordination chemistry, an introduction to group theory is given and the structure and properties of complexes are explained.

[Course objectives]

To understand acids and bases, as well as oxidation and reduction for inorganic compounds; to learn how group theory is used to describe molecular symmetry; and to understand the structure and electronic state of complexes, especially d-metal complexes.

[Course schedule and contents]

Acids and bases, 3 sessions
Students are given explanations of the Bronsted definition and Lewis definition of acids and bases, the concepts of hard acids and bases and soft acids and bases, specific examples of oxoacids, and acid‐base reactions in solvents.

Oxidation and reduction, 3 sessions
Explanations are given on basic concepts of oxidation-reduction reactions related to inorganic compounds, such as reduction potential, Nernst equation, Latimer diagrams, Frost diagrams, Pourbaix diagrams, the chemical extraction of simple substances, and Ellingham diagrams.

Molecular symmetry, 3 sessions
Here, the symmetry of molecules and the basics of group theory are explained. In particular, students are taught about symmetry operations, symmetry elements, point groups, the application of symmetry, orbital symmetry, molecular vibrations and spectroscopy.

An introduction to coordination compounds, 2 sessions
Explanations are given on specific examples of the structure and symmetry of complexes, the nomenclature of complexes, and the isomers in complexes.

d-Metal complexes: electronic structure and properties, 3 sessions
Students are given an explanation on the crystal field theory and the ligand field theory, then are taught how to clarify the electronic structure of a complex based on spectroscopy. In particular, students are taught about the basic principles of optical absorption, luminescence, electron paramagnetic resonance and other techniques in spectroscopy, and are given a clear explanation on the electronic structure of a complex that could be clarified by using these techniques.

Continue to 錯体化学（創成化学）(2)↓↓↓

錯体化学（創成化学）(2)

Confirmation of learning achieved, 1 session
Here, the students' understanding of the lecture contents is confirmed.

[Course requirements]

Students are required to have knowledge obtained in Basic Inorganic Chemistry.

[Evaluation methods and policy]

Evaluation is based on results from regular examinations.

[Textbooks]

Others; Weller, M., et al. (translated by Tanaka, K., Takahashi, M., Abe, T., Hirao, K., Kitagawa, S.), Shuraibaa atokinsu muki kagaku dai 6-ban (ue), (Tokyo Kagaku Dojin, 2016), ISBN: 978-4-8079- 0898-1) isbn {} {9784807908981}; Weller, M., et al. (translated by Tanaka, K., Takahashi, M., Abe, T., Hirao, K., Kitagawa, S.), Shuraibaa atokinsu muki kagaku dai 6-ban (shita), (Tokyo Kagaku Dojin, 2017), ISBN:978-4-8079-0899-8） isbn{}{9784807908998}

[References, etc.]

（Reference books）
Others; Hirao, K., et al., Muki kagaku - sono gendai-teki apuroochi - dai 2-ban, (Tokyo Kagaku Dojin, 2013) isbn {} {9784807908240}

[Study outside of class (preparation and review)]

Before attending a lecture, students must prepare by reading the textbooks; after attending a lecture, students will review the material by solving exercises in the textbooks.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 37134 LJ61　U-ENG27 37134 LJ62		
Course title (and course title in English)	高分子化学II Polymer Chemistry II	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,TAKENAKA MIKIHITO Institute for Chemical Research Associate Professor,OGAWA HIROKI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Fri.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

Mastering at least the minimum knowledge of polymer physics necessary for starting research in polymer field

[Course schedule and contents]

polymer structure and characteristic property,3times,Definition of polymer, polymer characteristics, kinds of polymer, molecular structure, shape of a single-chain and its variety, molecular weight and molecular weight distribution will be discussed.
,4times,
,4times,
,3times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

Grading

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（**Other information (office hours, etc.)**）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 37135 EJ61		
Course title (and course title in English)	創成化学実験Ⅰ（創成化学） Frontier Chemistry Laboratory I(Frontier Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MATSUBARA SEIJIROU Graduate School of Global Environmental Studies Professor,TANAKA KAZUO Graduate School of Engineering Associate Professor,YOSHIHIRO SASAKI Graduate School of Engineering Associate Professor,KUBO TAKUYA Graduate School of Engineering Associate Professor,KURAHASHI TAKUYA Graduate School of Engineering Associate Professor,TERASHIMA TAKAYA Graduate School of Engineering Senior Lecturer,OOMAE MASASHI Graduate School of Engineering Professor,FUJITA KOJI Graduate School of Engineering Associate Professor,IDA DAICHI Graduate School of Engineering Assistant Professor,KOJIMA HIROYUKI Faculty of Engineering 創成化学実験関連教員

Target year	3rd year students or above	Number of credits	7	Year/semesters	2021/First semester
Days and periods	Tue.3,4,5,Wed.3,4,5,Thu.3,4,5	Class style	Experiment	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,6times,
,6times,
,12times,
,9times,
,3times,
,9times,
,15times,
,6times,

Continue to 創成化学実験Ⅰ（創成化学）(2)↓↓↓

創成化学実験Ⅰ（創成化学）**(2)**

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（**Other information (office hours, etc.)**）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG27 37136 EJ61		
Course title (and course title in English)	創成化学実験Ⅱ（創成化学） Frontier Chemistry Laboratory II(Frontier Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MATSUBARA SEIJIROU Graduate School of Engineering Associate Professor,KUBO TAKUYA Graduate School of Engineering Associate Professor,KURAHASHI TAKUYA Graduate School of Engineering Associate Professor,TERASHIMA TAKAYA Graduate School of Engineering Senior Lecturer,OOMAE MASASHI Graduate School of Engineering Professor,FUJITA KOJI Graduate School of Engineering Associate Professor,IDA DAICHI Faculty of Engineering 創成化学実験関連教員

Target year	3rd year students or above	Number of credits	7	Year/semesters	2021/Second semester
Days and periods	Tue.3,4,5,Wed.3,4,5,Thu.3,4,5	Class style	Experiment	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,6times,
,12times,
,9times,
,3times,
,9times,
,15times,
,6times,
,6times,

[Course requirements]

None

Continue to 創成化学実験Ⅱ（創成化学）(2)↓↓↓

創成化学実験 II（創成化学）(2)

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG27 37137 LE48　U-ENG27 37137 LE61		
Course title (and course title in English)	科学英語（創成化学） Scientific English	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MATSUBARA SEIJIROU Part-time Lecturer,John Pryce

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Mon.3	Class style	Lecture	Language of instruction	English

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,1time,
, 4 times,
, 4 times,
, 5 times,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

None

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 37137 LE48　U-ENG27 37137 LE61		
Course title (and course title in English)	科学英語（創成化学） Scientific English	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MATSUBARA SEIJIROU Part-time Lecturer,John Pryce

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Mon.4	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

This course aims to give students an opportunity to use and expand on their current English skills in a Scientific context, specifically within the field of Industrial Chemistry. In addition, since all instruction is in English, the course focuses on creating an environment where students can develop their overall skills in International Communication in both oral and written formats.

This is not a passive lecture course; students are expected to attend all online classes and actively participate in activities and discussion.

[Course objectives]

The goals of this course are: 1. To enable students to become conversant in English within various aspects of Industrial Chemistry. 2. To improve and expand student's specialized vocabulary and pronunciation skills. 3. To give students confidence in oral and presentation skills. 4. To develop student's overall ability in speaking, listening, reading, and writing, as well as critical thinking skills with regards to Industrial Chemistry topics. 5. To develop and contribute to the student's confidence and knowledge to be able to attend international conferences, conduct presentations and publish papers in English.

[Course schedule and contents]

1. Introduction / Unit 1 - 3D Printing Material Chemistry：Introduction to the course objectives, how it will be conducted and the first unit covering effective note taking.

2. Unit 1 - 3D Printing Material Chemistry：Continuation and completion of unit 1.

3. Unit 2 - Virology - Studying Viruses：Pronunciation, use of synonyms and effective summarisation methods using the 5W1H approach.

4. Unit 2 - Virology - Studying Viruses：Continuation and completion of unit 2.

5. Video Opinion 1 Assignment Preparation：Details will be given in class.

6. Unit 3 - Nanotechnology - Securing your Future / Video Opinion Assignment 1 Submission.：Pronunciation, use of collocations, and the using the 5W1H method for brainstorming and creating titles for

Continue to 科学英語（創成化学）(2)↓↓↓

科学英語（創成化学）(2)

presentations/papers/assignments.

7. Unit 3 - Nanotechnology - Securing your Future：Continuation and completion of unit 3.

8. Unit 4 - Genetics -What does the future Hold：Pronunciation, topic keywords and the resolution of dilemmas using ethical and moral issues in science and technology.

9. Video Opinion 2 Assignment Preparation / Final Presentation Topic Selection：Details will be given in class.

10. Unit 5- DNA and Cloning -Real Carbon Copies/Video Opinion 2 Assignment Submission：Pronunciation, word association, note-taking and summarizing.

11. Unit 5- DNA and Cloning - Real Carbon Copies / Practice Presentation：Continuation and completion of unit 5.

12. Unit 6 - Biomimicry - Nature as a solution：Pronunciation, topic keywords, Note-taking and Summarizing

13. Unit 6 - Biomimicry - Nature as a solution：Continuation and completion of unit 6.

14. Opinion 3 Assignment：This assignment will be conducted live in class.

15. Final Presentation：This assignment will be conducted live in class.

[Course requirements]

Students enrolled in the Industrial Chemistry Course of the School of Industrial Chemistry. All instruction will be in English, so students are advised to work on improving listening skills both before and during the course.

[Evaluation methods and policy]

Video Opinion 1-3 - 45%
Practice Presentation - 10%
Presentation Topic - 10%
Final Presentation - 35%

[Textbooks]

Handouts can be downloaded from the resources tab on Panda. Additional materials such as rubrics, lecture presentations and supplementary materials can also be found there.

Continue to 科学英語（創成化学）(3)↓↓↓

科学英語（創成化学）(3)

[References, etc.]

（**Reference books**）

Nothing specified.

[Study outside of class (preparation and review)]

Nothing specified.

（Other information (office hours, etc.)）

Nothing specified.

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 37211 LJ61		
Course title (and course title in English)	グリーンケミストリー概論 Introduction to Green Chemistry	Instructor's name, job title, and department of affiliation	Agency for Health, Safety and Environment Professor,HASHIMOTO SATOSHI Graduate School of Engineering Professor,EGUCHI KOUICHI Graduate School of Engineering Professor,OGOSHI TOMOKI
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Thu.1	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,5times,
,5times,
,5times,
,4times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 37220 LJ61 U-ENG27 37220 LJ55		
Course title (and course title in English)	化学数学II Mathematical Method in Chemistry II	Instructor's name, job title, and department of affiliation	Fukui Institute for Fundamental Chemistry Professor,SATOU TOORU Graduate School of Engineering Assistant Professor,NAKANO HIROSHI Institute for Chemical Research Professor,MIZUOCHI NORIKAZU
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Fri.1	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,2times,
,1time,
,3times,
,1time,
,4times,
,3times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 27300 LJ60		
Course title (and course title in English)	物理化学 I （化学工学） Physical Chemistry I (Chemical Engineering)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MAE KAZUHIRO Graduate School of Engineering Associate Professor,MAKI TAISUKE Graduate School of Engineering Associate Professor,TANABE KATSUAKI
Target year	2nd year students or above	Number of credits	2
Year/semesters	2021/Second semester		
Days and periods	Wed.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

Thermodynamics is an essential subject to learn chemical engineering. This class provides an elementaly level of chemical engineering thermodynamics.

[Course objectives]

The goal is to learn the way to apply the basics of thermodynaaics to chemical process caluculations.

[Course schedule and contents]

Introduction,0.5times,
The First Low of Thermodynamics and Other Basic Concepts,0.5times,
Volumetric Properties of Pure Fluids,1.5times,
Thermochemistry,1.5times,
The Second Low of Thrmodynamics,2times,
Confirmation of the Level of Attainment 1,1time,
Balance for Open Systems,2times,
Thermodynamic Properties of Fluids,2times,
Phase Equilibrium,1time,
Application of Thermodynamics to Industrial Processes ,2times,
Confirmation of the Level of Attainment 2,1time,

[Course requirements]

The basic knowledge of physical chemistry is required.

[Evaluation methods and policy]

The score is evaluated by reports (homeworks) and examinations.

[Textbooks]

J. M. Smith and H. C. Van Ness : Introduction to Chemical Engineering Thermodynamics, Eighth Edition (McGraw-Hill International) isbn{}{9781259696527}

Continue to 物理化学 I （化学工学）(2)↓↓↓

物理化学Ⅰ（化学工学）**(2)**

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

For lectures using English textbooks, prepare in advance and understand the outline of the contents.
Since we pose homework of 1-3 problems from the end of the chapter every week, please submit the report at the bigining of next lecture.

（Other information (office hours, etc.)）

Implement as many exercises as possible according to the progress of the lecture and try to acquire the content of the lecture. Impose tasks every week. Bring a scientific calculator.

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course
A lecture derived from an instructor's practical work experience outside of academia

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG27 27301 LJ60		
Course title (and course title in English)	無機化学Ⅰ（化学工学） Inorganic Chemistry I (Chemical Engineering)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,SAKKA TETSUO Institute of Advanced Energy Professor,NOHIRA TOSHIYUKI Graduate School of Engineering Professor,ABE TAKESHI Graduate School of Engineering Associate Professor,MATSUI TOSHIAKI Graduate School of Engineering Program-Specific Associate Professor,HOSOKAWA SABUROU Graduate School of Engineering Professor,ABE RYUU Graduate School of Engineering Associate Professor,MIYAZAKI KOUHEI
Target year	2nd year students or above	Number of credits	2
Year/semesters	2021/Second semester		
Days and periods	Mon.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

In quotInorganic Chemistry I (Chemical Engineering)quot, following five topics will be explained: 1) Acids and bases of inorganic compounds 2) Oxidation and reduction 3) Concept of group theory, which is necessary for the understanding of molecular structures 4) Fundamentals of coordination compounds, 5) Corrosion

[Course objectives]

[Course schedule and contents]

Asids and Bases,4times,
Oxidation and Reduction,4times,
Corrosion,3times,
Molecular Symmetry,4times,
Coordination compounds,2times,
Evaluation,1time,

[Course requirements]

Based on the understanding of quotFundamental Inorganic Chemistryquot, lectures will be done.

[Evaluation methods and policy]

Grading is based on the examination held at the end of the semester. The attendance rate and the reports submitted during the course may be counted in evaluation.

Continue to 無機化学Ⅰ（化学工学）(2)↓↓↓

無機化学Ⅰ（化学工学）**(2)**

[Textbooks]

Inorganic Chemistry (4th edition) P. Atkins、T. Overton、J. Rourke、M. Weller、F. Armstrong isbn{}{0199264635}

[References, etc.]

（**Reference books**）
Supplemental explanation will be delivered at the first class.

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number	U-ENG27 27302 LJ55　U-ENG27 27302 LJ76		
Course title (and course title in English)	化学工学数学Ⅰ（化学工学） Mathematics for Chemical Engineering I (Chemical Engineering)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,NAGAMINE SHINSUKE Graduate School of Engineering Associate Professor,TANIGUCHI TAKASHI
Target year	2nd year students or above	Number of credits	2
Year/semesters	2021/Second semester		
Days and periods	Thu.1	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

The aim of this class is to learn the fundamental mathematics commonly used in Chemical Process Engineering, Chemical System Engineering, such as ordinary differential equations, Laplace transformation, methods to solve differential equations by using Laplace transformation, and vector analysis. The style of the class is mainly lecture style.

[Course objectives]

To attain the mathematical knowledge and skill how to calculate a line, surface and volume integrals, and to calculate differentiations
of scalar and vector fields, and to solve ordinal differential equations by using Laplace transformations.

[Course schedule and contents]

Vector Analysis, (7-times)
We learn the following items:
1. Vector Analysis (including differentiation of vectors)
2. Integration of vectors Integral Theorem (Gauss divergence Theorem, Stokes Theorem)

Ordinary differential Equation, (4-times)
We learn that various physical phenomena seen in our daily life can be described by ordinary differential equations.
As a method to solve 1st and 2nd order ordinary differential equation, the following methods will be learned :
1. Method of separation of variables
2. Method of variation of parameters

Laplace Transformation, (3-times)
After learning the historical background and the discovery of Laplace transformation,
we learn how to solve ordinal differential equations and integral equations by using Laplace transformation, and also learn applications of Laplace transformation to definite integration.

Confirmation of the level of attainment, (1-time)
Confirmation of the level of attainment
Comments on the term-end Exam

Continue to 化学工学数学Ⅰ（化学工学）(2)↓↓↓

化学工学数学 I （化学工学）(2)

[Course requirements]

Basic knowledge on differentiation, integral, matrix operations

[Evaluation methods and policy]

Grade will be evaluated by (i) the examination at the end of semester and (ii) homework during semester.

[Textbooks]

戸田 盛和 『ベクトル解析 (理工系の数学入門コース 3)』（岩波書店）ISBN:4000077732
布川 昊 『ラプラス変換と常微分方程式』（昭晃堂）ISBN:4785670215

[References, etc.]

（**Reference books**）
佐藤 總夫 『自然の数理と社会の数理』（日本評論社）ISBN:4535603014
大岩 正芳 『化学者のための数学十講』（化学同人）ISBN:4759800085

[Study outside of class (preparation and review)]

After each class of vector analysis, homework is given to students, and their solution will be shown at the class in two weeks.
It is highly recommended that students solve them before the class.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 37303 LJ61 U-ENG27 37303 LJ76		
Course title (and course title in English)	流体系分離工学 Fluid-Phase Separation Engineering	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,SANO NORIAKI Graduate School of Engineering Associate Professor,NAKAGAWA KYUYA
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Thu.1	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

Chemical Processes consist of variety of units and operations. Here, distillation, gas absorption, extraction, and so forth which aim substance separation and purification will be lectured from basic principle and phenomena to kinetics and quantitative expression.

[Course objectives]

By taking typical separation operations as examples, mass balance, the students will understand the concept of mass transfer, and equilibrium, and they will master how to use them in quantitative manner. Additionally, they cultivate their ability to use differential contact operation and stage operation.

[Course schedule and contents]

Fundamental of mass separation and mass purification (3times): Principles and methods in substance separation and purity, which are important for chemical process, will be lectured. Fundamentals of molecular diffusion and mass transport will be explained.

Gas absorption(4times): Equilibrium of gas with liquid, diffusion in liquid phase, gas diffusion rate, and design of gas absorption will be lectured, and the students will understand the idea of differential contact operation.

Distillation (4times): Method to correlate the gas-liquid equilibrium will be lectured, and fundamental principle of distillation operation is explained as operation for purification of liquid mixture. The design method of continuous rectifying trays tower will be lectured as the most simple multi-stage contact operation method.

Extraction (3times): Method to correlate the gas-liquid equilibrium will be lectured, and fundamental principle of distillation operation is explained as operation for purification of liquid mixture. The design method of continuous rectifying trays tower will be lectured as the most simple multi-stage contact operation method.

Feedback class (1time): A supplementary lecture or exercise class will be conducted as an additional class to give advanced knowledge or to confirm the attainment level of the course goals on diffusion, gas absorption and distillation.

Continue to 流体系分離工学(2)↓↓↓

流体系分離工学(2)

[Course requirements]

Introduction to Industrial Chemistry (Material and energy balances), Fundamentals of Chemical Process Engineering,

[Evaluation methods and policy]

Evaluation will be made based on midterm exam, routine exam at the end of semester, and reports often given in lectures.

[Textbooks]

K. Hashimoto and F. Ogino 『Gendai Kagaku Kogaku』 （Sangyo Tosho）

[References, etc.]

（**Reference books**）
Introduced during class

[Study outside of class (preparation and review)]

Students should check the contents of lecture beforehand and deepen their understanding by using text book and reference book.

（Other information (office hours, etc.)）

Lecture will be given basen on the textbook. Exercise problems will be given to students to deepen understanding in due course.

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 37304 LJ60		
Course title (and course title in English)	物理化学II（化学工学） Physical Chemistry II (Chemical Engineering)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,TANABE KATSUAKI Graduate School of Engineering Assistant Professor,SUZUKI TETSUO
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Fri.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

Based on the contents of Physical Chemistry I, you learn the phase transition and separation for multi-component systems, etc. Also, you learn molecular and solid-state physical chemistry in the view of quantum theory.

[Course objectives]

Understand the phase-separation phenomenon of multi-component systems, and master how to read the phase diagrams. Further, understand the quantum theory, its difference and relation to the physical chemistry of macroscopic systems.

[Course schedule and contents]

Physical chemistry of multi-component liquids and gases: 8 times

Physical chemistry of molecules and solids: 6 times

Feedback lecture: 1 time

[Course requirements]

Assume the completion of Physical Chemistry I (Chemical Engineering)

[Evaluation methods and policy]

Final (end-term) exam score, etc.

[Textbooks]

Atkins 『Physical Chemistry』 （10th edition, Chaps. 4-10）

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

Remind the contents of Physical Chemistry I (Chemical Engineering).

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 37305 LJ55　U-ENG27 37305 LJ76		
Course title (and course title in English)	化学工学数学II Mathematics for Chemical Engineering II	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,NAGAMINE SHINSUKE Graduate School of Engineering Associate Professor,TANIGUCHI TAKASHI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Fri.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

We will give a series of lectures on necessary mathematical knowledge and skills when students will learn subjects in the chemical engineering course, especially on Probability and Statistics, Fourier Transformation, Partial Differential Equations.

[Course objectives]

Goal of the class is that students attain necessary mathematical knowledge that is needed when students learn subjects in the chemical engineering course.

[Course schedule and contents]

Probability and Statistics (fundamentals) (5-times)
1-1. Definition and properties of probability
1-2. Conditional probability
1-3. Stochastic variable and its properties
　(a) Probability distribution function,
　(b) Average, Expectation value, Moment,
　(c) Moment generating function
1-4. Multi-stochastic variable case
　(a) simultaneous distribution function
　(b) marginal and conditional probability
　(c) covariance, correlation coefficient

Probability and Statistics, (2-times)
1-5. Various distribution function
　(a) binomial distribution functions
　(b) Poisson distribution functions
　(c) Gauss distribution functions
1-6. Law of large numbers
　Central limit theorem
　Normal distribution

Fourier Transformation, (4-times)
3-1. Fourier integral
3-2. Fourier transformation

Partial Differential Equation (3-times)
4. Fundamentals to solve partial differential equations

Continue to 化学工学数学II(2)↓↓↓

化学工学数学II(2)

Equation of wave
Diffusion equation,
Multi-dimensional problem
Confirmation of the level of attainment (1-time),
Confirmation of the level of attainment

[Course requirements]

It is required that students have already had the lecture : Mathematics for Chemical Engineering I in the former semester.

[Evaluation methods and policy]

Grading will be determined by a test at the end of series of lectures, and reports and short tests in class, if necessary.

[Textbooks]

薩摩順吉 『理工系の数学入門コース 7. 確率・統計』（岩波書店）ISBN:4000077775
阿部寛治 『フーリエ解析と偏微分方程式』（培風館）ISBN:9784563011178

[References, etc.]

（**Reference books**）
薩摩順吉 『岩波基礎物理シリーズ　10. 物理の数学』（岩波書店）ISBN:4000079301

[Study outside of class (preparation and review)]

After each class of Probability and Statistics, homework is given to students, and their solution will be shown at the class in two weeks.
It is highly recommended that students solve them before the class.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 37307 LJ61　U-ENG27 37307 LJ76		
Course title (and course title in English)	反応工学II Chemical Reaction Engineering II	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,NAKAGAWA HIROYUKI Graduate School of Engineering Professor,KAWASE MOTOAKI Graduate School of Engineering Senior Lecturer,ASHIDA RIYUUICHI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Mon.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Kinetic analysis and reactor design of heterogeneous chemical reactions and nonideal flow reactors are described.

[Course objectives]

Knowledge on the kinetic description of heterogeneous reactions.
Knowledge on the design and operation of various reactors, including non-ideal flow reactors.
Ability to perform such calculations for designing reactors.

[Course schedule and contents]

Homogeneous and heterogeneous reactions,1time,
Complicated reaction rate equations,1time,
Macromixing and micromixing in nonideal flow,3times,
Gas-solid reactions and reactors,3.5times,
Solid-catalyst reactions and reactors,3.5times,
Gas-liquid and gas-liquid-solid-catalyst reactions and reactors,2times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

Evaluation will be based on a mark of the final written exam, submission of quizzes conducted in class, and reports on assignments conducted.

[Textbooks]

K. Hashimoto 『Han'no Kogaku (revised and augmented)』 （Baifukan）ISBN:9784563046347

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

Read through the chapter of the textbook by the class starts and learn by yourself if understanding is insufficient after the class.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 37308 LJ61　U-ENG27 37308 LJ76		
Course title (and course title in English)	固相系分離工学 Solid-Phase Separation Engineering	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,SANO NORIAKI Graduate School of Engineering Associate Professor,NAKAGAWA KYUYA

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Wed.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

To understand various separation operations used in industrial chemical processes, multiphase transport phenomena, transport properties, and methods to design separation operations will be lectured. Especially, drying, adsorption, membrane separation and crystallization will be taken as practical examples.

[Course objectives]

The present course aims at achieving the following three goals by taking some types of solid-phase separation operations for example: (1) understanding mass balance, heat balance, and simultaneous transport phenomena of mass and heat, (2) cultivating the ability to design and develop separation units and materials used for multi-phase separations, and (3) developing knowledge on recent trends of separation techniques.

[Course schedule and contents]

Adsorption Operations (4times): Adsorption equilibrium as dynamic equilibrium, adsorption isotherm, diffusion in pores and at surface, adsorption rate, and so forth will be explained. In addition, how to design adsorption operation and how to calculate breakthrough curve in fixed bed type adsorbing column will be lectured.

Humidification Operations (1time): Humidification operation will be lectured as example of simultaneous transport of heat and mass at gas-liquid interface. The students will understand the idea of wet-bulb temperature and how to use humidity chart.

Drying Operations (4times): The mechanisms and kinetics of drying and expertise to select and design the drying unit type will be lectured, relating operation conditions with properties of the dried products.

Membrane Separation Operations (3times): With the main focus on the gas separation, permeability equations and process designs of membrane separation processes will be lectured.

Crystallization Operations (2times): The mechanism of the crystallization and kinetic analysis of the crystal growth will be lectured, followed by the explanation on the population balance required for the design of apparatuses. Finally, students' understanding on the course will be tested.

Feedback class (1time): A supplementary lecture or exercise class will be conducted as an additional class to give advanced knowledge or to confirm the attainment level of the course goals.

[Course requirements]

Introduction to Industrial Chemistry (Material and energy balances),
Fundamentals of Chemical Process Engineering,

Continue to 固相系分離工学(2)↓↓↓

固相系分離工学(2)

Fluid-Phase Separation Engineering

[Evaluation methods and policy]

Evaluation will be made based on midterm exam, routine exam at the end of semester, and reports often given in lectures.

[Textbooks]

K. Hashimoto and F. Ogino 『Gendai Kagaku Kogaku』 (Sangyo Tosho)
H. Tamon 『Kanso Gijutu Jitsumu Nyumon』 (Nikkan Kogyo Shinbun)

[References, etc.]

(**Reference books**)
Introduced during class

[Study outside of class (preparation and review)]

Students should check the contents of lecture beforehand and deepen their understanding by using text book and reference book.

(Other information (office hours, etc.))

Lecture will be given basen on the textbook. Exercise problems will be given to students to deepen understanding in due course.

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 37309 LJ60		
Course title (and course title in English)	物理化学III（化学工学） Physical Chemistry III (Chemical Engineering)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MIYAHARA MINORU
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/Second semester		
Days and periods	Tue.1	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

Thermodynamics is an important foundation of chemical engineering that is difficult to understand intuitively. To understand thermal phenomena intrinsically, observing them on a microscopic level is effective and provides indispensable knowledge for various advanced technologies such as nanotechnology. In this subject, students are taught the basics of statistical thermodynamics and are given the chance to deeply understand and apply entropy and free energy, which are difficult to comprehend through macroscopic theory alone.

[Course objectives]

To understand the relationship between number of states and the probability of the emergence of states that lie behind entropy and free energy, and to acquire the ability to formulate molecular models for simple systems, such as lattice systems, using various ensembles

[Course schedule and contents]

Fundamental laws of classical thermodynamics, 3 sessions
The "difficulty" of the second law, entropy, and free energy, in particular, are again recognized.

Probability, distribution of states, and thermodynamic limit, 1 session
Students are given an explanation of how the random motion of each molecule is connected to the thermodynamic state observed using a simple continuous system as an example.

Microcanonical ensembles and entropy, 1 session
Distribution of the number of states under a constant gross energy, S=klnW, dS/dE=1/T and its interpretation

Entropy of ideal gas, Boltzmann distribution, and velocity distribution, 1.5 sessions
Phase spaces and quantity of states, deriving the entropy of ideal gas via S=klnW, distribution of energy states

Canonical ensembles and partition function, 1.5 sessions
Study of the energy distribution of subsystems connected to a heat bath, partition function, Helmholtz free energy in a system at constant (V, T), Gibbs free energy in a system at constant (p, T)

Exercises, 1 session
For microcanonical ensembles and canonical ensembles, students will work on the formulation of thermodynamic states based on molecular physical properties. Students must attend this session as it is important for their evaluation. Depending on the progress made in this session, an additional session may be held for exercises.

Continue to 物理化学III（化学工学）(2)↓↓↓

Grand canonical ensembles and chemical potential, 2 sessions
Study of open systems, grand partition function, chemical potential, examples of application

Classical statistical approximation and configuration integral, 1 session
Students are given an explanation of the configuration integral and expression of partition functions, which are formulated via classical approximation of the number of states in a phase space. In addition, students are taught about the relationship between the configuration integral and thermodynamic quantity.

Non-ideal systems and intermolecular interactions, 2 sessions
In real systems, non-ideality is expressed through intermolecular interactions. As a result of these interactions, imperfect gas is produced and the gas-liquid transition occurs. Hence, the approach to handling such outcomes is explained to students in these sessions. In addition to the typical interaction potential function, students are taught that molecular simulation is significant as it allows the configuration integral to be obtained directly, and are given an outline on how to obtain thermodynamic quantities via molecular simulation.

Confirmation of learning achieved, 1 session
Here, the students' understanding of the contents of lectures will be evaluated and confirmed.

[Course requirements]

Physical Chemistry: Fundamentals and Exercises & Physical Chemistry I (Chemical Engineering)

[Evaluation methods and policy]

In addition to the end-of-term examination, students are also evaluated based on exercises and short tests conducted when necessary.

[Textbooks]

Others; none

[References, etc.]

(**Reference books**)
Others; Nagaoka, Y., Iwanami kiso butsuri shiriizu: Toukei rikigaku, (Iwanami Shoten, 1994) isbn {} {9784000079273}; Fujiwara K., Hyodo, T., Netsu-gaku nyuumon: Makuro kara mikuro he, (University of Tokyo Press, 1995) isbn {} {4130626019}; Toda, M., Butsurigaku 30-kou shiriizu: Netsu genshou 30-kou, (Asakura Shoten, 1995) isbn {} {425413634X};
Kubo, R., Shinsou-ban: Toukei rikigaku, (Kyoritsu Shuppan, 2003) isbn {} {9784320034235};
Widom, B. (translated by Koga, K.), Kagaku-kei no toukei rikigaku nyuumon, (Kagaku-Dojin, 2005) isbn {} {4759809503};
Doi, M., Butsuri no kangaekata 2: Toukei rikigaku, (Asakura Shoten, 2006) isbn {} {9784254137422}

[Study outside of class (preparation and review)]

After a teaching session, students must review it to deepen their understanding. In addition, students must prepare any questions that they may have and ask them at the beginning of the next teaching session.

Continue to 物理化学III（化学工学）(3)↓↓↓

(Other information (office hours, etc.))

Students are given many short tests (quizzes). Exercises are also important for the students' evaluation. Hence, they must attend the session where exercises are given.

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number	U-ENG27 37312 EJ61　U-ENG27 37312 EJ76		
Course title (and course title in English)	化学プロセス工学実験Ⅰ（化学工学） ChemicalProcessEngineeringLaboratoryI(Chemical Engineering)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,SANO NORIAKI Graduate School of Engineering Associate Professor,NAKAGAWA KYUYA Graduate School of Engineering Assistant Professor,SUZUKI TETSUO Graduate School of Engineering Senior Lecturer,ASHIDA RIYUUICHI Graduate School of Engineering Assistant Professor,HIRAIDE SYOTARO Graduate School of Engineering Assistant Professor,MOLINA LOPEZ, John Jairo Graduate School of Engineering Assistant Professor,HIKIMA YUUTA Graduate School of Engineering Assistant Professor,TONOMURA OSAMU Graduate School of Engineering Assistant Professor,MURANAKA YOSUKE Graduate School of Engineering Assistant Professor,MARUYAMA HIROYUKI Faculty of Engineering 化学工学実験関連教員

Target year	3rd year students or above	Number of credits	5	Year/semesters	2021/First semester
Days and periods	Thu.3,4,5,Fri.3,4,5	Class style	Experiment	Language of instruction	Japanese

[Overview and purpose of the course]

Experimental training on chemical analyses (gravimetric analysis, titration analysis) and fundamentals of chemical engineering (physical chemistry, transport phenomena, reaction engineering, etc.)

[Course objectives]

This course will enhance studentsrsquo understanding of quantitative chemical analysis and chemical engineering.

[Course schedule and contents]

Fundamentals on chemical analyses,15times,training regarding glass tools, electric balance, condensation, filtration, volumetric measurement, titration, etc. Student will also learn safety and waste management in chemical experiments.
Chemical Engineering I/Physical Chemistry,14times,freezing point drop, Liquid-liquid equilibrium, gas-liquid equilibrium, measurement of gas diffusivity, fabrication of pH meter, surface tension and wettability
Chemical Engineering I/Transport Phenomena,4times,viscosity and flow dynamics, pressure drop in liquid flow
Chemical Engineering I/Reaction Engineering,4times,kinetic analysis in batch reactor, characterization of flow reactor
Chemical Engineering I/Apparatus Setup,2times,electric-cooling temperature-controlled batch,

Continue to 化学プロセス工学実験Ⅰ（化学工学）(2)↓↓↓

化学プロセス工学実験Ⅰ（化学工学）(2)

[Course requirements]

Fundamentals of Chemical Process Engineering, Physical Chemistry I (Chemical Engineering), Fundamental Fluid Mechanics, Chemical Reaction Engineering I are recommend to take in advance.

[Evaluation methods and policy]

Attendance, performance in experiments, reports will be evaluated.

[Textbooks]

Textbook edited by teaching staff in department of chemical engineering

[References, etc.]

（**Reference books**）
Bird, Stewart, Lightfoot, Transport Phenomena, 2nd Ed. (Wiley) isbn{}{9780470115398}
Hashimoto and Ogino, Gendai Kagaku Kogaku (Sangyo Tosyo) isbn{}{4782826095}
Hashimoto, Hanno Kogaku (Baifukan)isbn{}{4563045187}
Smith, Van Ness, Abbott, Introduction to Chemical Engineering Thermodynamics, 7th Ed.(McGraw Hill) isbn{}{0071247084}

[Study outside of class (preparation and review)]

Preparation of each lecture is highly recommended.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 37313 EJ76　U-ENG27 37313 EJ61		
Course title (and course title in English)	化学プロセス工学実験II（化学工学） ChemicalProcessEngineeringLaboratoryII(Chemical Engineering)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,SANO NORIAKI Graduate School of Engineering Associate Professor,NAKAGAWA KYUYA Graduate School of Engineering Assistant Professor,SUZUKI TETSUO Graduate School of Engineering Senior Lecturer,ASHIDA RIYUUICHI Graduate School of Engineering Assistant Professor,HIRAIDE SYOTARO Graduate School of Engineering Assistant Professor,MOLINA LOPEZ, John Jairo Graduate School of Engineering Assistant Professor,HIKIMA YUUTA Graduate School of Engineering Assistant Professor,TONOMURA OSAMU Graduate School of Engineering Assistant Professor,MURANAKA YOSUKE Graduate School of Engineering Assistant Professor,MARUYAMA HIROYUKI Faculty of Engineering 化学工学実験関連教員

Target year	3rd year students or above	Number of credits	5	Year/semesters	2021/Second semester
Days and periods	Wed.3,4,5,Thu.3,4,5	Class style	Experiment	Language of instruction	Japanese

[Overview and purpose of the course]

Experimental training of chemical engineering fundamentals(transport phenomena, separation engineering, reaction engineering, powder technology, process control)

[Course objectives]

This course will enhance studentsrsquo understanding of chemical engineering, and the students will learn typical operations in the experiments.

[Course schedule and contents]

Chemical Engineering II/Transport phenomena,9times,unsteady state heat transfer, heat transfer with forced flow, mass transport through interface
Chemical Engineering II/Separation Engineering,9times,continuous distillation, pressure drop and gas absorption in packed bed tower, cyclone characteristics for particle sizes
Chemical Engineering II/Reaction Engineering and Process Control,9times,gas-solid reaction, gas-solid catalytic reaction, , dynamic characteristics in process control

Continue to 化学プロセス工学実験II（化学工学）(2)↓↓↓

化学プロセス工学実験II（化学工学）(2)

[Course requirements]

Physical Chemistry I, II (Chemical Engineering), Fundamental Fluid Mechanics, Transport Phenomena, Chemical Reaction Engineering I, II, Fluid Phase Separation Engineering, Fine Particle Technology, Process Control are recommend to take in advance.

[Evaluation methods and policy]

Attendance, performance in experiments, reports will be evaluated.

[Textbooks]

Textbook edited by teaching staff in department of chemical engineering

[References, etc.]

（**Reference books**）
Bird, Stewart, Lightfoot, Transport Phenomena, 2nd Ed. (Wiley) isbn{}{9780470115398}
Hashimoto and Ogino, Gendai Kagaku Kogaku (Sangyo Tosyo) isbn{}{4782826095}
Hashimoto, Hanno Kogaku (Baifukan)isbn{}{4563045187}
Smith, Van Ness, Abbott, Introduction to Chemical Engineering Thermodynamics, 7th Ed.(McGraw Hill) isbn{}{0071247084}

[Study outside of class (preparation and review)]

Preparation of each lecture is highly recommended.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 27314 LJ61　U-ENG27 27314 LJ76		
Course title (and course title in English)	化学工学量論 Material and energy balances	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MAE KAZUHIRO Graduate School of Engineering Professor,KAWASE MOTOAKI Graduate School of Engineering Associate Professor,MAKI TAISUKE Graduate School of Engineering Associate Professor,TANABE KATSUAKI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Wed.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Balances of mass, volume, mole amount, and elements of substances as well as balance of energy is a fundamental of chemical engineering. Physical and chemical principles which are required for taking material and energy balance in problems about chemical processes are lectured. How to calculate the mass, component (element), and energy balance as for application processes is explained and practiced.

[Course objectives]

To acquire capability to analyze complicated chemical industrial processes from balance point of view as well as to cope with design and operation of chemical processes quantitatively.

[Course schedule and contents]

Week 1: Dimensions and units--- How to express dimensions and units, which are basic concept of measurement, and importance of dimensions and units is lectured.

Weeks 2--4: Fundamentals of material balance--- Flow system (closed and open), steady and unsteady operations, expression of composition of mixture, material balance over a single apparatus, and their exercises.

Weeks 5--6: Fundamentals of energy balance--- Forms of energy, calculation of apparent and latent heats, energy balance with no chemical reactions, and their exercises.

Weeks 7--8: Process flow diagram and unit operations--- Various unit operations, principles of separation processes, and process flow diagram are lectured.

Weeks 9--10: Material and energy balance of complicated processes--- Calculation of balance of processes including chemical reactions or phase changes is lectured. As well, how to understand material balance in case of many apparatus connected, merging, splitting, and recycling included is explained.

Weeks 11--13: Practice of taking balance in chemical processes--- Calculation of material and energy balance in complicated chemical processes is exercised.

Weeks 14: Scale-up. Methodology of scaling up apparatus is generally explained as well as introduction to kinetics required for design is lectured.

Week 15: Learning achievement evaluation.

Continue to 化学工学量論(2)↓↓↓

化学工学量論(2)

[Course requirements]

Basic knowledge on thermodynamics lectured in Physical Chemistry: Fundamentals and Exercises, and Physical Chemistry I (Chemical Engineering) is required.

[Evaluation methods and policy]

Evaluation will be based on exercises at class, assignments, and an examination.

[Textbooks]

Masao Sudo ed. 『Kiso Kagakukogaku』 (Kyoritsu Shuppan) ISBN:9784320088702

[References, etc.]

(Reference books)

Some handouts are given at class.

[Study outside of class (preparation and review)]

As many exercises as possible will be imposed at class. Assignments will be imposed every week. Bring a scientific calculator to the class.

(Other information (office hours, etc.))

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category

A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number	U-ENG27 37315 LE48　U-ENG27 37315 LE61		
Course title (and course title in English)	科学英語（化学工学） Scientific English	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MATSUSAKA SHUJI Part-time Lecturer,John Pryce

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Mon.3	Class style	Lecture	Language of instruction	English

[Overview and purpose of the course]

This course aims to give students an opportunity to use and expand on their current English skills in a Scientific context, specifically within the field of Chemical Engineering. In addition, since all instruction is in English, the course focuses on creating an environment where students can develop their overall skills in International Communication in both oral and written formats.

[Course objectives]

The goals of this course are: 1. To enable students to become conversant in English within various aspects of Chemical Engineering. 2. To improve and expand student#039s specialized vocabulary and pronunciation skills. 3. To give students confidence in oral and written communication skills regarding technical data, unit operations, process design and technical descriptions in English. 4. To develop student#039s overall ability in speaking, listening, reading and writing, as well as, critical thinking skills with regards to Chemical Engineering topics. 5. To develop and contribute to the student#039s confidence and knowledge to be able to attend international conferences, conduct presentations and publish papers in English.

[Course schedule and contents]

Unit 1-15,times,The course is divided into 15 classes over 15 weeks and the topics have been selected and sequenced to take the students through key aspects of Chemical Engineering beginning with elementary specialized vocabulary and pronunciation, culminating in technical trouble shooting and presentation of a solution.

Week ： Theme
1 ： Unit 1 Nanotechnology
2 ： Unit 1 Nanotechnology
3 ： Unit 2 Materials Chemistry
4 ： Unit 2 Materials Chemistry
5 ： Video Opinion Assessment Preparation
6 ： Unit 3 Catastrophes in Chemical Engineering / Video Opinion Assignment 1
7 ： Unit 3 Catastrophes in Chemical Engineering
8 ： Unit 4 Virology
9 ： Unit 4 Virology
10 ： Presentation Assignment Preparation
11 ： Unit 5 Genetics / Video Opinion Assignment 2
12 ： Unit 5 Genetics
13 ： Unit 6 Biomimicry
14 ： Unit 6 Biomimicry / Presentation Assignment
15 ： Final Written Exam

Continue to 科学英語（化学工学）(2)↓↓↓

科学英語（化学工学）(2)

[Course requirements]

Students enrolled in the Chemical Process Engineering Course of the School of Industrial Chemistry.

[Evaluation methods and policy]

Assessment

Week 6 - Video Opinion Assignment 1 (10%)
Week 11 - Video Opinion Assignment 2 (10%)
Week 14 - Presentation Assignment (20%)
Week 15 - Final Written Exam (60%)

[Textbooks]

Handouts will be given each lesson.

[References, etc.]

(Reference books)

Nothing specified.

(Related URLs)

(Nothing specified.)

[Study outside of class (preparation and review)]

All instruction will be in English, so students are advised to work on improving listening skills both before and during the course.

(Other information (office hours, etc.))

Nothing specified.

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 37315 LE48　U-ENG27 37315 LE61		
Course title (and course title in English)	科学英語（化学工学） Scientific English	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MATSUSAKA SHUJI Part-time Lecturer,John Pryce

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Mon.4	Class style	Lecture	Language of instruction	English

[Overview and purpose of the course]

This course aims to give students an opportunity to use and expand on their current English skills in a Scientific context, specifically within the field of Chemical Engineering. In addition, since all instruction is in English, the course focuses on creating an environment where students can develop their overall skills in International Communication in both oral and written formats.

[Course objectives]

The goals of this course are: 1. To enable students to become conversant in English within various aspects of Chemical Engineering. 2. To improve and expand student#039s specialized vocabulary and pronunciation skills. 3. To give students confidence in oral and written communication skills regarding technical data, unit operations, process design and technical descriptions in English. 4. To develop student#039s overall ability in speaking, listening, reading and writing, as well as, critical thinking skills with regards to Chemical Engineering topics. 5. To develop and contribute to the student#039s confidence and knowledge to be able to attend international conferences, conduct presentations and publish papers in English.

[Course schedule and contents]

Unit 1-15,times,The course is divided into 15 classes over 15 weeks and the topics have been selected and sequenced to take the students through key aspects of Chemical Engineering beginning with elementary specialized vocabulary and pronunciation, culminating in technical trouble shooting and presentation of a solution.

Week ： Theme
1 ： Unit 1 Nanotechnology
2 ： Unit 1 Nanotechnology
3 ： Unit 2 Materials Chemistry
4 ： Unit 2 Materials Chemistry
5 ： Video Opinion Assessment Preparation
6 ： Unit 3 Catastrophes in Chemical Engineering / Video Opinion Assignment 1
7 ： Unit 3 Catastrophes in Chemical Engineering
8 ： Unit 4 Virology
9 ： Unit 4 Virology
10 ： Presentation Assignment Preparation
11 ： Unit 5 Genetics / Video Opinion Assignment 2
12 ： Unit 5 Genetics
13 ： Unit 6 Biomimicry
14 ： Unit 6 Biomimicry / Presentation Assignment
15 ： Final Written Exam

Continue to 科学英語（化学工学）(2)↓↓↓

[Course requirements]

Students enrolled in the Chemical Process Engineering Course of the School of Industrial Chemistry.

[Evaluation methods and policy]

Assessment

Week 6 - Video Opinion Assignment 1 (10%)
Week 11 - Video Opinion Assignment 2 (10%)
Week 14 - Presentation Assignment (20%)
Week 15 - Final Written Exam (60%)

[Textbooks]

Handouts will be given each lesson.

[References, etc.]

（**Reference books**）
Nothing specified.

（**Related URLs**）
(Nothing specified.)

[Study outside of class (preparation and review)]

All instruction will be in English, so students are advised to work on improving listening skills both before and during the course.

（Other information (office hours, etc.)）

Nothing specified.

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 27400 LJ76　U-ENG27 27400 LJ61		
Course title (and course title in English)	化学プロセス工学［Ｗ２０２（創成）］ Chemical Process Engineering	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MATSUSAKA SHUJI Graduate School of Engineering Professor,SANO NORIAKI Graduate School of Engineering Professor,SOTOWA KENICHIRO Graduate School of Engineering Associate Professor,MAKI TAISUKE Graduate School of Engineering Associate Professor,WATANABE SATOSHI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Wed.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Chemical processes are comprised of a combination of various operations (unit operations), and this course will discuss distillation, gas-absorption, and other fluid-based mass transfer unit operations for separating and purifying substances, as well as mechanical unit operations related to the production and processing of particulate matter (powders), beginning from an overview of their basic phenomena and operating principles together with the study of the related kinetic phenomena and their quantitative expression methods. Students will also learn methods for the safe operation and control of chemical processes.

[Course objectives]

Cultivate an understanding of the concepts of mass balance, mass transfer, equilibrium relationship, and control by studying examples of typical separation operations, particle-based separation operations, and process control in chemical processes. In addition, students will develop the ability to quantitatively analyze chemical processes.

[Course schedule and contents]

1. Basics of substance separation and purification, 2 sessions
These sessions will explain the principles and methods of separation and purification of important substances in chemical processes, as well as the fundamentals of molecular diffusion and mass transfer.

2. Gas absorption, 2 sessions
Students will learn the concept of the “differential contact method”, through lectures discussing equilibrium of gas dissolution in liquids, the diffusion phenomenon in the liquid phase, gas absorption rates, and design methods for gas absorption devices.

3. Distillation, 3 sessions
These sessions will describe the correlation method of vapor-liquid equilibria, explain the basic principles of various distillation operation methods for mixed liquid purification procedures, and explain the design method for a continuous rectification stage column, which is the simplest “multi-stage contact operation.”

4. Overview of particle system operation, 2 sessions
These sessions will describe the role of particle-based unit operations in chemical processes, the evaluation of particle characteristics, their methods of expression, and the behavior of particles.

Continue to 化学プロセス工学［Ｗ２０２（創成）］(2)↓↓↓

5. Gas-solid separation, 2 sessions
These sessions will describe the concept of partial separation efficiency, in addition to discussion of the principle of solid-gas separation and the methods for evaluating separation performance applicable under various conditions.

6. Process control, 3 sessions
These sessions will promote an understanding of the characteristics of systems characterized by dynamic input and parameter values and also briefly describe the control methods for compensating fluctuations by taking distillation column and reactors as examples.

7. Feedback, 1 session
Supplementary classes or exercises are conducted outside of the regular course schedule to confirm the achievement of learning objectives related to diffusion, gas absorption, and distillation.

[Course requirements]

Introduction to Industrial Chemistry (stoichiometry for chemical engineering), Foundations of Chemical Process Engineering

[Evaluation methods and policy]

Course grades will be based on the results of regular examinations and reports assigned as needed to improve understanding.

[Textbooks]

橋本，荻野 『現代化学工学』 (産業図書) ISBN:4782826095

[References, etc.]

（**Reference books**）
亀井編 『化学機械の理論と計算』 (産業図書)) ISBN:4782825099, 水科，桐榮 『化学工学概論』 (産業図書) ISBN:4782825102

[Study outside of class (preparation and review)]

Lectures will be conducted mainly using textbooks, and exercises will be assigned based on the pace of the lectures. Students should make efforts to acquire lecture content.

（Other information (office hours, etc.)）

Please visit KULASIS to find out about office hours.

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 27400 LJ76　U-ENG27 27400 LJ61		
Course title (and course title in English)	化学プロセス工学［ＮＳ（先端）］ Chemical Process Engineering	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MATSUSAKA SHUJI Graduate School of Engineering Professor,SANO NORIAKI Graduate School of Engineering Professor,SOTOWA KENICHIRO Graduate School of Engineering Associate Professor,MAKI TAISUKE Graduate School of Engineering Associate Professor,WATANABE SATOSHI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Wed.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Chemical processes are comprised of a combination of various operations (unit operations), and this course will discuss distillation, gas-absorption, and other fluid-based mass transfer unit operations for separating and purifying substances, as well as mechanical unit operations related to the production and processing of particulate matter (powders), beginning from an overview of their basic phenomena and operating principles together with the study of the related kinetic phenomena and their quantitative expression methods. Students will also learn methods for the safe operation and control of chemical processes.

[Course objectives]

Cultivate an understanding of the concepts of mass balance, mass transfer, equilibrium relationship, and control by studying examples of typical separation operations, particle-based separation operations, and process control in chemical processes. In addition, students will develop the ability to quantitatively analyze chemical processes.

[Course schedule and contents]

1. Basics of substance separation and purification, 2 sessions
These sessions will explain the principles and methods of separation and purification of important substances in chemical processes, as well as the fundamentals of molecular diffusion and mass transfer.

2. Gas absorption, 2 sessions
Students will learn the concept of the “differential contact method”, through lectures discussing equilibrium of gas dissolution in liquids, the diffusion phenomenon in the liquid phase, gas absorption rates, and design methods for gas absorption devices.

3. Distillation, 3 sessions
These sessions will describe the correlation method of vapor-liquid equilibria, explain the basic principles of various distillation operation methods for mixed liquid purification procedures, and explain the design method for a continuous rectification stage column, which is the simplest “multi-stage contact operation.”

4. Overview of particle system operation, 2 sessions
These sessions will describe the role of particle-based unit operations in chemical processes, the evaluation of

Continue to 化学プロセス工学［ＮＳ（先端）］(2)↓↓↓

化学プロセス工学［ＮＳ（先端）］(2)

particle characteristics, their methods of expression, and the behavior of particles.

5. Gas-solid separation, 2 sessions
These sessions will describe the concept of partial separation efficiency, in addition to discussion of the principle of solid-gas separation and the methods for evaluating separation performance applicable under various conditions.

6. Process control, 3 sessions
These sessions will promote an understanding of the characteristics of systems characterized by dynamic input and parameter values and also briefly describe the control methods for compensating fluctuations by taking distillation column and reactors as examples.

7. Feedback, 1 session
Supplementary classes or exercises are conducted outside of the regular course schedule to confirm the achievement of learning objectives related to diffusion, gas absorption, and distillation.

[Course requirements]

Introduction to Industrial Chemistry (stoichiometry for chemical engineering), Foundations of Chemical Process Engineering

[Evaluation methods and policy]

Course grades will be based on the results of regular examinations and reports assigned as needed to improve understanding.

[Textbooks]

橋本，荻野 『現代化学工学』 (産業図書) ISBN:4782826095

[References, etc.]

（**Reference books**）
亀井編 『化学機械の理論と計算』 (産業図書)) ISBN:4782825099, 水科，桐榮 『化学工学概論』 (産業図書) ISBN:4782825102

[Study outside of class (preparation and review)]

Lectures will be conducted mainly using textbooks, and exercises will be assigned based on the pace of the lectures. Students should make efforts to acquire lecture content.

（Other information (office hours, etc.)）

Please visit KULASIS to find out about office hours.

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 27401 LJ61　U-ENG27 27401 LJ76		
Course title (and course title in English)	基礎流体力学 Fundamental Fluid Mechanics	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,TANIGUCHI TAKASHI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Tue.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Lecture on fundamentals of fluid dynamics needed for Chemical Engineering

[Course objectives]

Goal of this class is to understand the fundamental pricipals in fluid dynamics.

[Course schedule and contents]

Introduction to fluid dynamics, (3-times)
0.　Example of flows
0-1. flow of ideal fluid
0-2. Laminar flow
0-3. Stability of flow
0-4. Turbulent
0-5. Computational fluid dynamics
1.　Properties of fluid
1-1. Viscosity
1-2. Compressibility
1-3. Laminar and turbulent flows
2.　Quiescent fluid
2-1. Pressure
2-2. Buoyancy
Dynamics of Ideal Fluid, (6-times)
3. Fundamentals on flows
3-1. Particles and continuum body
3-2. One dimensional flow
3-3. Three-dimensional flow (Preparation of Mathematics)
4-1. Mechanics in the ideal fluid
4-2. Equation of continuity
4-3. Euler’s equation of motion
4-4. Bernoulli’s theorem
4-5. Examples
4-6. Streaming function and potential flow
Dynamics of viscous fluid, (5-times)
5. Dynamics of viscous fluid
5-1. Viscosity
5-2. Stress tensor
5-3. Exact soluble problems described by Navier-Stokes equation

Continue to 基礎流体力学(2)↓↓↓

基礎流体力学(2)

Confirmation of the level of attainment, (1-time)
Confirmation of the level of attainment
Comments on the term-end Exam

[Course requirements]

It is highly recommended for students to take the class:
"Mathematics for Chemical Engineers I".

[Evaluation methods and policy]

Grade will be determined by (i) the examination at the end of semester and (ii) homeworks during semester.

[Textbooks]

日野幹雄 『流体力学』（朝倉書店）ISBN:4254200668

[References, etc.]

（**Reference books**）
Bird, Stewart, Lightfoot 『Transport Phenomena 2nd Ed.』（Wiley）ISBN:9780470115398

（**Related URLs**）
(http://www-tph.cheme.kyoto-u.ac.jp/p/taniguch/class.html)

[Study outside of class (preparation and review)]

Because the content of the class basically follows the textbook raised above,
it is recommended that the students look through before the class.
In addition, because the students need a fundamental knowledge of vector analysis as prerequisite knowledge, it is highly recommended for the students to parallelly take a class of "vector analysis".

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 27402 LJ61　U-ENG27 27402 LJ76		
Course title (and course title in English)	化学工学計算機演習 Computer Programming in Chemical Engineering	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,KAWASE MOTOAKI Graduate School of Engineering Senior Lecturer,ASHIDA RIYUUICHI
Target year	2nd year students or above	Number of credits	2
Year/semesters	2021/Second semester		
Days and periods	Tue.4	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

Lectures and practices of fundamentals of computer algorithms and programming using FORTRAN 77 and Visual Basic for Applications (VBA) for learning basic knowledge and skills of computation required for chemical engineers. FORTRAN 77 has been often employed for numerical calculation and VBA is practical on PCs.

[Course objectives]

To learn syntaxes of FORTRAN 77 and VBA, how to write programs, and how to execute program for solving basic chemical engineering problems.

[Course schedule and contents]

Weeks 1--3: Computer algorithms and programming I
1) Introduction to digital computers and programming languages as well as inputs, outputs, and simple programs, 2) Logical IF statement and GO TO statement, data types, 3) Array and DO loop, 4) Description of assignments

Weeks 4--5: Practice of computer algorithms and programming I
To write and execute 2 or 3 programs solving fundamental problems. e.g. Simple calculations, integration by the trapezoidal rule, Newton method, bisection method

Weeks 6--8: Computer algorithms and programming II
1) Built-in functions, function and subroutine subprograms, 2) Data format, input from and output to file, 3) Interpolation, numerical integration, 4) Description of assignments

Weeks 9--11: Practice of computer algorithms and programming II
To write and execute 2 or 3 programs solving fundamental chemical engineering problems. e.g. Statistics, linear least square

Week 12: VBA programming
Fundamentals of Visual Basic for Applications and some examples of VBA codes

Weeks 13--14: Practice of VBA programming
To write and execute some VBA programs solving problems, some of which are shared with FORTRAN practice

Week 15: Qualification

Continue to 化学工学計算機演習(2)↓↓↓

化学工学計算機演習(2)

To qualify achievement of the practices

[Course requirements]

None

[Evaluation methods and policy]

Absolute evaluation based on the assignments with taking into account participation in practice classes, quizzes, and examination.

[Textbooks]

Ken'ichi Harada 『Fortran 77 Programming』 （Saiensu (Science)）ISBN:9784781904610

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

Practice of programming and calculations are to be carried out by BYOD. Train yourself at home as well as at classes.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 27403 LJ76　U-ENG27 27403 LJ61		
Course title (and course title in English)	反応工学 I Chemical Reaction Engineering I	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,NAKAGAWA HIROYUKI Graduate School of Engineering Professor,KAWASE MOTOAKI
Target year	2nd year students or above	Number of credits	2
Year/semesters	2021/Second semester		
Days and periods	Fri.1	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

Homogeneous chemical reaction engineering including kinetic analysis, design and operation of reactors, complex reactions, recycle reactors, semibatch operation, and nonisothermal reactors.

[Course objectives]

To understand stoichiometry and kinetics of complex reactions and mathematical models for design, operation, and kinetic analysis of homogeneous reactors including nonisothermal conditions and to be acquainted with those calculations.

[Course schedule and contents]

Design equations of isochoric and nonisochoric reactors,1time,
Reactor systems,2times,
Complex reactions,4times,
Kinetic analysis of reactions and design and operation of reactors,2.5times,
Nonisothermal reactors,4.5times,
,1time,

[Course requirements]

It is required to learn Fundamentals of Chemical Process Engineering and to have basic knowledge of ordinary differential equations and matrix.

[Evaluation methods and policy]

Absolute evaluation based on the examination, assignments, and quizzes.

[Textbooks]

Kenji Hashimoto 『Han'no Kogaku (revised and augmented)』 （Baifukan）ISBN:9784563046347

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

Take home assignments almost every week.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 37404 LJ61		
Course title (and course title in English)	材料有機合成化学 Organic Material Synthetic Chemistry	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MATSUBARA SEIJIROU Graduate School of Engineering Associate Professor,KURAHASHI TAKUYA
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/Second semester		
Days and periods	Mon.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

,1time,
,2times,
,4times,
,4times,
,1time,
,2times,
,1time,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 17405 LJ60		
Course title (and course title in English)	工業化学概論［工化1］ Introduction to Industrial Chemistry	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,NAKAO YOSHIAKI Institute for Chemical Research Professor,KAJI HIRONORI Graduate School of Engineering Professor,KOGA TSUYOSHI Graduate School of Engineering Professor,MIURA KIYOTAKA Graduate School of Engineering Professor,ABE RYUU Graduate School of Engineering Professor,MATSUBARA SEIJIROU Graduate School of Engineering Professor,KONDOU TERUYUKI Graduate School of Engineering Professor,SUGINOME MICHINORI Graduate School of Engineering Professor,OGOSHI TOMOKI Institute for Chemical Research Professor,MURATA YASUJIROU Graduate School of Engineering Professor,ABE TAKESHI Graduate School of Engineering Professor,OTSUKA KOJI Graduate School of Global Environmental Studies Professor,TANAKA KAZUO Institute for Chemical Research Professor,WATANABE HIROSHI Graduate School of Engineering Professor,MORI YASUO Institute for Frontier Life and Medical Sciences Professor,EIRAKU GENJI Graduate School of Engineering Professor,KAWASE MOTOAKI Graduate School of Engineering Professor,SOTOWA KENICHIRO Graduate School of Engineering Professor,MAE KAZUHIRO Graduate School of Engineering Professor,MATSUSAKA SHUJI
Target year	1st year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Wed.1	Class style	Lecture
Language of instruction	Japanese		

Continue to 工業化学概論［工化1］(2)↓↓↓

工業化学概論［工化1］(2)

[Overview and purpose of the course]

In this subject, the leading topics in research conducted in the field of industrial chemistry are taken up in a series of lectures and explained in a simple manner.

[Course objectives]

To gain an interest in chemistry, to understand the role of chemistry in society, as well as basic knowledge that should be acquired as an industrial chemistry student.

[Course schedule and contents]

Lecture 1: Physical chemistry field: Professor Hironori Kaji: Shining molecules: Principles and applications of electroluminescence (EL)

Lecture 2: Physical chemistry field: Professor Tsuyoshi Koga: The discipline of physical chemistry: Centered on statistical thermodynamics

Lecture 3: Inorganic chemistry field: Professor Kiyotaka Miura: Manufacturing via lasers

Lecture 4: Inorganic chemistry field: Professor Ryu Abe: Artificial photosynthesis will open up a hydrogen-based society in the future: Solar water splitting via photocatalysts

Lecture 5: Organic chemistry field: Professor Seijiro Matsubara, Professor Yoshiaki Nakao, Professor Teruyuki Kondo, Professor Michinori Suginome: Constructing molecules via precise organic synthesis

Lecture 6: Organic chemistry field: Professor Seijiro Matsubara, Professor Yoshiaki Nakao, Professor Tomoki Ogoshi, Professor Yasujiro Murata: Constructing molecules via precise organic synthesis

Lecture 7: Analytical chemistry field: Professor Takeshi Abe, Professor Koji Otsuka: Storage batteries, the latest analytic technology, micro/nanoscale separation analysis

Lecture 8: Analytical chemistry field: Professor Takeshi Abe, Professor Koji Otsuka: Storage batteries, the latest analytic technology, micro/nanoscale separation analysis

Lecture 9: High polymer chemistry field: Professor Kazuo Tanaka: High-performance materials pioneered by high polymer chemistry - from familiar to advanced materials

Lecture 10: High polymer chemistry field: Professor Hiroshi Watanabe: Motion and relaxation of high polymers

Lecture 11: Biochemistry field: Professor Yasuo Mori: Life-likeness of matter

Lecture 12: Biochemistry field: Professor Mototsugu Eiraku: Organogenesis technology using stem cells

Lecture 13: Chemical engineering field: Professor Motoaki Kawase, Professor Kenichiro Sotowa, Professor Kazuhiro Mae, Professor Shuji Matsusaka: Quantitative relationship of matter in chemical processes, energy balance and global environmental conservation

Continue to 工業化学概論［工化1］(3)↓↓↓

工業化学概論［工化1］(3)

Lecture 14: Chemical engineering field: Professor Motoaki Kawase, Professor Kenichiro Sotowa, Professor Kazuhiro Mae, Professor Shuji Matsusaka: Quantitative relationship of matter in chemical processes, energy balance and global environmental conservation

Lecture 15: Feedback (planned)

[Course requirements]

Students are not required to have specialized prior knowledge of chemistry.

[Evaluation methods and policy]

Students are evaluated based on their performance in teaching sessions, as well as the submission status and content of their assignments and reports. (Achievement targets are evaluated according to grade evaluation policy of the Faculty of Engineering.)

[Textbooks]

Not used

[References, etc.]

（**Reference books**）

Others; materials are introduced in lectures when needed.

[Study outside of class (preparation and review)]

Students are given appropriate instructions during teaching sessions, and are required to review printouts and other materials distributed during these sessions.

（Other information (office hours, etc.)）

Students are required to submit reports when necessary. The order of items covered in lectures is subject to change.

*Please visit KULASIS to find out about office hours.

未更新

Course number	U-ENG27 17405 LJ60		
Course title (and course title in English)	工業化学概論［工化2］ Introduction to Industrial Chemistry	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,NAKAO YOSHIAKI Institute for Chemical Research Professor,KAJI HIRONORI Graduate School of Engineering Professor,KOGA TSUYOSHI Graduate School of Engineering Professor,MIURA KIYOTAKA Graduate School of Engineering Professor,ABE RYUU Graduate School of Engineering Professor,MATSUBARA SEIJIROU Graduate School of Engineering Professor,KONDOU TERUYUKI Graduate School of Engineering Professor,SUGINOME MICHINORI Graduate School of Engineering Professor,OGOSHI TOMOKI Institute for Chemical Research Professor,MURATA YASUJIROU Graduate School of Engineering Professor,ABE TAKESHI Graduate School of Engineering Professor,OTSUKA KOJI Graduate School of Global Environmental Studies Professor,TANAKA KAZUO Institute for Chemical Research Professor,WATANABE HIROSHI Graduate School of Engineering Professor,MORI YASUO Institute for Frontier Life and Medical Sciences Professor,EIRAKU GENJI Graduate School of Engineering Professor,KAWASE MOTOAKI Graduate School of Engineering Professor,SOTOWA KENICHIRO Graduate School of Engineering Professor,MAE KAZUHIRO Graduate School of Engineering Professor,MATSUSAKA SHUJI
Target year	1st year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Wed.1	Class style	Lecture
Language of instruction	Japanese		

Continue to 工業化学概論［工化2］(2)↓↓↓

工業化学概論［工化2］(2)

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

Guidance,2times,Guidance on how this class is operated, and how to use computing facility for this class.
Basic knowledge on the role of IDS in network security and how machine learning can help the intrusion detection.
Intrusion Detection by Signature-Based IDS,5times,Learn the mechanism of intrusion detection by signature-based IDS by studying open source signature-based IDS and attacks, such as correspondence between alarms issued from IDS and communications, and adding signatures to detect attacks.
Intrusion Detection by Machine Learning,7times,Learn the method of classifying normal and malicious traffic by machine learning algorithms and public dataset for benchmarking intrusion detection performance.
Presentation,1time,Based on the exercise, students presents their methods of intrusion detection using machine learning, and discuss it with other students and instructors.

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Continue to 工業化学概論［工化2］(3)↓↓↓

工業化学概論［工化2］(3)

未更新

Course number	U-ENG27 17405 LJ60		
Course title (and course title in English)	工業化学概論［工化3］ Introduction to Industrial Chemistry	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,NAKAO YOSHIAKI Institute for Chemical Research Professor,KAJI HIRONORI Graduate School of Engineering Professor,KOGA TSUYOSHI Graduate School of Engineering Professor,MIURA KIYOTAKA Graduate School of Engineering Professor,ABE RYUU Graduate School of Engineering Professor,MATSUBARA SEIJIROU Graduate School of Engineering Professor,KONDOU TERUYUKI Graduate School of Engineering Professor,SUGINOME MICHINORI Graduate School of Engineering Professor,OGOSHI TOMOKI Institute for Chemical Research Professor,MURATA YASUJIROU Graduate School of Engineering Professor,ABE TAKESHI Graduate School of Engineering Professor,OTSUKA KOJI Graduate School of Global Environmental Studies Professor,TANAKA KAZUO Institute for Chemical Research Professor,WATANABE HIROSHI Graduate School of Engineering Professor,MORI YASUO Institute for Frontier Life and Medical Sciences Professor,EIRAKU GENJI Graduate School of Engineering Professor,KAWASE MOTOAKI Graduate School of Engineering Professor,SOTOWA KENICHIRO Graduate School of Engineering Professor,MAE KAZUHIRO Graduate School of Engineering Professor,MATSUSAKA SHUJI
Target year	1st year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Wed.1	Class style	Lecture
Language of instruction	Japanese		

Continue to 工業化学概論［工化3］(2)↓↓↓

工業化学概論［工化3］(2)

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

Guidance,2times,Guidance on how this class is operated, and how to use computing facility for this class.
Basic knowledge on the role of IDS in network security and how machine learning can help the intrusion detection.
Intrusion Detection by Signature-Based IDS,5times,Learn the mechanism of intrusion detection by signature-based IDS by studying open source signature-based IDS and attacks, such as correspondence between alarms issued from IDS and communications, and adding signatures to detect attacks.
Intrusion Detection by Machine Learning,7times,Learn the method of classifying normal and malicious traffic by machine learning algorithms and public dataset for benchmarking intrusion detection performance.
Presentation,1time,Based on the exercise, students presents their methods of intrusion detection using machine learning, and discuss it with other students and instructors.

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Continue to 工業化学概論［工化3］(3)↓↓↓

未更新

Course number	U-ENG27 17405 LJ60		
Course title (and course title in English)	工業化学概論［工化4］ Introduction to Industrial Chemistry	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,NAKAO YOSHIAKI Institute for Chemical Research Professor,KAJI HIRONORI Graduate School of Engineering Professor,KOGA TSUYOSHI Graduate School of Engineering Professor,MIURA KIYOTAKA Graduate School of Engineering Professor,ABE RYUU Graduate School of Engineering Professor,MATSUBARA SEIJIROU Graduate School of Engineering Professor,KONDOU TERUYUKI Graduate School of Engineering Professor,SUGINOME MICHINORI Graduate School of Engineering Professor,OGOSHI TOMOKI Institute for Chemical Research Professor,MURATA YASUJIROU Graduate School of Engineering Professor,ABE TAKESHI Graduate School of Engineering Professor,OTSUKA KOJI Graduate School of Global Environmental Studies Professor,TANAKA KAZUO Institute for Chemical Research Professor,WATANABE HIROSHI Graduate School of Engineering Professor,MORI YASUO Institute for Frontier Life and Medical Sciences Professor,EIRAKU GENJI Graduate School of Engineering Professor,KAWASE MOTOAKI Graduate School of Engineering Professor,SOTOWA KENICHIRO Graduate School of Engineering Professor,MAE KAZUHIRO Graduate School of Engineering Professor,MATSUSAKA SHUJI
Target year	1st year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Wed.1	Class style	Lecture
Language of instruction	Japanese		

Continue to 工業化学概論［工化4］(2)↓↓↓

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

Guidance,2times,Guidance on how this class is operated, and how to use computing facility for this class.
Basic knowledge on the role of IDS in network security and how machine learning can help the intrusion detection.
Intrusion Detection by Signature-Based IDS,5times,Learn the mechanism of intrusion detection by signature-based IDS by studying open source signature-based IDS and attacks, such as correspondence between alarms issued from IDS and communications, and adding signatures to detect attacks.
Intrusion Detection by Machine Learning,7times,Learn the method of classifying normal and malicious traffic by machine learning algorithms and public dataset for benchmarking intrusion detection performance.
Presentation,1time,Based on the exercise, students presents their methods of intrusion detection using machine learning, and discuss it with other students and instructors.

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Continue to 工業化学概論［工化4］(3)↓↓↓

未更新

Course number	U-ENG27 27406 LJ60		
Course title (and course title in English)	高分子化学序論 Introduction of Polymer Chemistry	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,AKIYOSHI KAZUNARI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Wed.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

[Course objectives]

[Course schedule and contents]

, 1 times,
, 5 times,
, 3 times,
, 4 times,
, 1 times,

[Course requirements]

None

[Evaluation methods and policy]

[Textbooks]

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number	U-ENG27 27407 EJ61		
Course title (and course title in English)	Chem-E-Car設計・実験 Chemical-E-Car Design and Experiment	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,SANO NORIAKI Faculty of Engineering

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Fri.4,5	Class style	Practical training	Language of instruction	Japanese

[Overview and purpose of the course]

制御された化学反応を駆動力とする化学自動車模型（Chem-E-Car）を設計、製作する。設計開始前には電池や熱電効果等に関する実験を行い、Chem-E-Carに関する基礎を習得する。製作したChem-E-Carが、決められた荷重を搭載して目的とする距離を走行できるかをコンテスト形式で競う。走行コンテストのときには所要電力の測定も行い、省エネ走行の評価も行う。

[Course objectives]

電池における物理化学を理解し、その活用についての理解を深める。
電気化学、熱電効果、発熱・吸熱、ガス発生等を含む、様々な化学・物理的現象を利用する発想力を磨く。
目的とするChem-E-Carの走行性能を実現するための化学反応の選択、制御の工夫を通して創造性を養う。

[Course schedule and contents]

（1）安全講習【１週】：Chem-E-Car作製、走行実験に必要な安全に関する講習
（2）基礎実習【５週】：電気化学、熱電効果、等に関する講義；一次電池、燃料電池、熱電効果等を使用したモデルChem-E-Carの作製
（3）設計方針討論【１週】：Chem-E-Carの設計方針の討論
（4）工作実習【１週】：Chem-E-Carの製作に必要な工作技術や工作機械の使用方法の説明、実習
（5）Chem-E-Car製作、試運転【５週】：Chem-E-Carの設計、製作、走行実験、基本データの採取
（6）発表会【１週】：Chem-E-Carに関する発表（走行・停止の原理、特徴、等）
（7）コンテスト、講評会【１週】：Chem-E-Car走行コンテスト、Chem-E-Carの走行データに関する解説等

[Course requirements]

None

[Evaluation methods and policy]

Chem-E-Carの走行性能（コンテスト結果）、成果報告会における発表、レポートにより評価する。

Continue to Chem-E-Car設計・実験(2)↓↓↓

Chem-E-Car設計・実験(2)

[Textbooks]

教員が配布するプリント

[References, etc.]

（Reference books）
アトキンス『物理化学（上）　第10版』

[Study outside of class (preparation and review)]

授業中に指示する

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	無機化学Ⅰ（先端化学）［工化1・工化3］ Inorganic Chemistry I (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,SAKKA TETSUO Institute of Advanced Energy Professor,NOHIRA TOSHIYUKI Graduate School of Engineering Professor,ABE TAKESHI Graduate School of Engineering Associate Professor,MATSUI TOSHIAKI Graduate School of Engineering Program-Specific Associate Professor,HOSOKAWA SABUROU Graduate School of Engineering Professor,ABE RYUU Graduate School of Engineering Associate Professor,MIYAZAKI KOUHEI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Mon.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

無機化学Ⅰでは、様々なブレンステッド酸・塩基、ルイスの酸・塩基を解説する。次に、酸化と還元について、電気化学を中心に概説する。さらに、分子の形を理解する上で重要な群論の概念について解説し、分子の形と分子の反応性や化学的性質との関連について述べる。さらに、d-ブロック化合物の錯体について述べる。

[Course objectives]

酸・塩基、酸化還元、対称性、配位化合物について理解し、３学年開講の無機化学II、４学年開講の電気化学に繋げる。

[Course schedule and contents]

酸と塩基（4章）,4回
酸および塩基に属する化学種について講義する。まず、Bronstedの酸・塩基の定義を述べ、酸の強さを定量的に表現するための酸解離定数や、Bronsted酸性度の周期性について解説する。次にLewisによる酸塩基の定義を講義し、Peasonの硬い酸・軟らかい酸の概念を講義する。最後に、酸・塩基としての溶媒の性質を定量的に表現するための溶媒パラメーターを解説する。

酸化と還元（5章）,4回
一つの物質からもう一つの物質へ電子が移動して酸化と還元が生じる。この二つの過程をまとめて酸化還元反応という。この反応に関する熱力学的効果と速度論的効果について述べ、この両者が重要であることを示す。さらに、酸化還元反応の解析に用いられる電気化学的に重要な因子rdquo標準（電極）電位rdquoについて解説する。

分子の対称性（7章）,4回
分子の形を対称性の観点から捉え、その対称性を示す重要な概念である群論について述べる。また、分子の対称性に関する考察から分子が有する物理的な性質や分光学的な性質について予測できることを解説する。さらに、分子軌道の組み立てや、電子構造の考察、分子振動の議論を単純化する上で分子の対称性が重要となることを示す。

配位化合物　（8章）,2回

Continue to 無機化学Ⅰ（先端化学）［工化1・工化3］(2)↓↓↓

Lewisの酸・塩基およびそれらの組合わせである錯体の概念を用いてd-ブロック化合物の幾何学的な構造について概説する。

学習到達度の確認,1回,レポート問題に対する解答および解説を行い、学習到達度を確認する。

[Course requirements]

基礎無機化学を履修していることを前提に講義を進める。

[Evaluation methods and policy]

定期試験の成績が主であるが、これに平常点を加味して総合的に判断して評価する。

[Textbooks]

「シュライバー・アトキンス無機化学（上）第６版」
M.Weller、T.Overton、J.Rourke、F.Armstrong 著
田中　勝久、髙橋　雅英、安部　武志、平尾　一之、北川　進 訳
東京化学同人 (2016) ISBN 9784807908981

[References, etc.]

（**Reference books**）
第１回講義時に補足説明資料を配布する。

[Study outside of class (preparation and review)]

授業の前に該当の章を通読しておくこと。その週の講義に該当する問題を適宜選んで宿題として課し、毎週提出させる。

（Other information (office hours, etc.)）

受講生を２クラスに分け、クラス毎に定められた教員により同時間帯に授業が行われる。
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[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors’ practical work experience related to the course
独立行政法人産業技術総合研究所　4年

Continue to 無機化学Ⅰ（先端化学）［工化1・工化3］(3)↓↓↓

(3) Details of practical classes delivered based on instructors’ practical work experience
産業技術総合研究所において、基礎的な立場からのみならず、企業との共同研究など実用化に近い立場において無機化学関連の研究を実施した経験を活かした講義を実施する。

Course number			
Course title (and course title in English)	無機化学Ⅰ（先端化学）［工化2・工化4］ Inorganic Chemistry I (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,SAKKA TETSUO Institute of Advanced Energy Professor,NOHIRA TOSHIYUKI Graduate School of Engineering Professor,ABE TAKESHI Graduate School of Engineering Associate Professor,MATSUI TOSHIAKI Graduate School of Engineering Program-Specific Associate Professor,HOSOKAWA SABUROU Graduate School of Engineering Professor,ABE RYUU Graduate School of Engineering Associate Professor,MIYAZAKI KOUHEI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Mon.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

無機化学Iでは、様々なブレンステッド酸・塩基、ルイスの酸・塩基を解説する。次に、酸化と還元について、電気化学を中心に概説する。さらに、分子の形を理解する上で重要な群論の概念について解説し、分子の形と分子の反応性や化学的性質との関連について述べる。さらに、d-ブロック化合物の錯体について述べる。

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酸・塩基、酸化還元、対称性、配位化合物について理解し、３学年開講の無機化学II、４学年開講の電気化学に繋げる。

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酸と塩基　（4章）,4回
酸および塩基に属する化学種について講義する。まず、Bronstedの酸・塩基の定義を述べ、酸の強さを定量的に表現するための酸解離定数や、Bronsted酸性度の周期性について解説する。次にLewisによる酸塩基の定義を講義し、Peasonの硬い酸・軟らかい酸の概念を講義する。最後に、酸・塩基としての溶媒の性質を定量的に表現するための溶媒パラメーターを解説する。

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分子の形を対称性の観点から捉え、その対称性を示す重要な概念である群論について述べる。また、分子の対称性に関する考察から分子が有する物理的な性質や分光学的な性質について予測できることを解説する。さらに、分子軌道の組み立てや、電子構造の考察、分子振動の議論を単純化する上で分子の対称性が重要となることを示す。

配位化合物　（8章）,2回

Continue to 無機化学Ⅰ（先端化学）［工化2・工化4］(2)↓↓↓

Lewisの酸・塩基およびそれらの組合わせである錯体の概念を用いてd-ブロック化合物の幾何学的な構造について概説する。

学習到達度の確認,1回
レポート問題に対する解答および解説を行い、学習到達度を確認する。

[Course requirements]

基礎無機化学を履修していることを前提に講義を進める。

[Evaluation methods and policy]

定期試験の成績が主であるが、これに平常点を加味して総合的に判断して評価する。

[Textbooks]

「シュライバー・アトキンス無機化学（上）第６版」
M.Weller、T.Overton、J.Rourke、F.Armstrong 著
田中　勝久、髙橋　雅英、安部　武志、平尾　一之、北川　進 訳
東京化学同人 (2016) ISBN 9784807908981

[References, etc.]

（**Reference books**）
第１回講義時に補足説明資料を配布する。

[Study outside of class (preparation and review)]

授業の前に該当の章を通読しておくこと。その週の講義に該当する問題を適宜選んで宿題として課し、毎週提出させる。

（Other information (office hours, etc.)）

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*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors’ practical work experience related to the course

Continue to 無機化学Ⅰ（先端化学）［工化2・工化4］(3)↓↓↓

無機化学Ⅰ（先端化学）［工化2・工化4］(3)

独立行政法人産業技術総合研究所　4年

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Course number			
Course title (and course title in English)	分析化学Ⅰ（先端化学）［工化1・工化3］ Analytical Chemistry I (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,SAKKA TETSUO Institute of Advanced Energy Professor,NOHIRA TOSHIYUKI Institute for Integrated Radiation and Nuclear Science Associate Professor,OKI YUUICHI Graduate School of Engineering Professor,ABE TAKESHI Graduate School of Engineering Associate Professor,NISHI NAOYA

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Tue.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]
分析化学の入門として、また、化学一般の基礎として重要な、溶液中の化学平衡（酸塩基、錯形成、沈殿、酸化還元）の考え方を講述する。問題を解く力を身につけるための演習を行う。

[Course objectives]
溶液中の化学平衡の考え方を身につけ、問題を解く力を身につけるにとどまらず、それが、他の化学・科学にどのように関連しているか、また、現代の諸問題にどうかかわっているかを意識できるようになることを目標とする。

[Course schedule and contents]
化学平衡概説,2回
われわれがコントロールできる、あるいは正確に知りうる初期条件（量り取った試薬の量、測容器の体積など）から、溶液内における平衡状態（化学種の濃度や酸化還元状態）を求める時の考え方は、どの化学平衡でも共通である。その基本を解説する。

酸塩基平衡,5回
はじめに、溶液のpH の計算法を解説する。種々の近似的な計算法の基礎にある論理的な考え方、系統立てた理解に重点を置く。次に、滴定曲線の形と意味、緩衝作用の考え方、多段階の酸塩基平衡が関与するより複雑な場合について詳しく述べる。

沈殿生成,1回
沈殿平衡の基本（溶解度積や共通イオン効果）について概説した後、酸塩基平衡やイオン対生成平衡などの他の化学平衡が共存する場合の取り扱い方を解説する。

錯生成平衡,2回
錯生成反応の概説の後、代表的なキレート剤であるＥＤＴＡを例に取り上げてキレート滴定時における錯生成反応について解説する。pHや補助錯化剤の効果も含めて定量的なキレート滴定の取扱を講述する。

酸化還元平衡,4回
酸化還元平衡を理解するための基礎となる電気化学、特に電極電位やネルンスト式について解説する。さらに、酸化還元滴定中での電極電位と酸化還元平衡の関係について講述する。

Continue to 分析化学Ⅰ（先端化学）［工化1・工化3］(2)↓↓↓

分析化学Ⅰ（先端化学）［工化1・工化3］(2)

学習到達度の確認,1回
宿題として課した演習問題に対する解説を行い、学習到達度を確認する。

[Course requirements]
None

[Evaluation methods and policy]
評価は、定期試験（筆記）の成績による。

[Textbooks]
Daniel C. Harris 『Quantitative Chemical Analysis, 10th ed.』（Freeman (2020)）

[References, etc.]
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デイ・アンダーウッド『定量分析化学（改訂版）』（培風館、1982年）ISBN:4563041513
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岡田、垣内、前田『分析化学の基礎』（化学同人、2012）ISBN:9784759814651

[Study outside of class (preparation and review)]
講義内容に関する演習問題を宿題として課す。

（Other information (office hours, etc.)）
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Course number			
Course title (and course title in English)	分析化学Ⅰ（先端化学）［工化2・工化4］ Analytical Chemistry I (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,SAKKA TETSUO Institute of Advanced Energy Professor,NOHIRA TOSHIYUKI Institute for Integrated Radiation and Nuclear Science Associate Professor,OKI YUUICHI Graduate School of Engineering Professor,ABE TAKESHI Graduate School of Engineering Associate Professor,NISHI NAOYA

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
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Continue to 分析化学Ⅰ（先端化学）［工化2・工化4］(2)↓↓↓

学習到達度の確認,1回
宿題として課した演習問題に対する解説を行い、学習到達度を確認する。

[Course requirements]

None

[Evaluation methods and policy]

評価は、定期試験（筆記）の成績による。

[Textbooks]

Daniel C. Harris 『Quantitative Chemical Analysis, 10th ed.』（Freeman (2020)）ISBN:4563041513

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Course number			
Course title (and course title in English)	有機化学Ⅰ（先端化学）［工化1・工化3］ Organic Chemistry I (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,OOE KOUICHI Graduate School of Engineering Associate Professor,MIURA TOMOYA Institute for Chemical Research Professor,NAKAMURA MASAHARU
Target year	2nd year students or above	Number of credits	2
Year/semesters	2021/Second semester		
Days and periods	Mon.1	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

Organic Chemistry I-IV are taught over two years (from the second half of sophomore year to the first half of senior year) as subjects that systematically instill students with the basics of organic chemistry they will need to know in order to work as researchers and engineers in all fields related to chemistry in the industrial, academic, and public sectors. Among these subjects, Organic Chemistry I allows students to understand ideas of acids and bases, as well as concepts of delocalization and conjugation of electronic states in compounds and intermediates, while also teaching them about reactions involving carbonyl groups from the standpoint of molecular orbital theory. In addition, students are taught how to determine the structure of organic compounds by making full use of various spectral methods.

[Course objectives]

The goal is to understand organic reactions in a unified manner by considering mechanical similarities, rather than through mechanical memorization.

[Course schedule and contents]

Structure of molecules and method of expressing organic reactions (Chapter 4 and Chapter 5), 1 session
Atomic orbitals and molecular orbitals are explained to students to provide a deeper understanding of the relationship between the shape of organic molecules and electronic structures. In addition, students learn to depict the movement of electrons in organic reactions using curved arrows.

Nucleophilic addition reactions to carbonyl groups (Chapter 6), 2 sessions
Students are given an overview of reaction modes between carbonyl groups and nucleophiles.

Delocalization and conjugation (Chapter 7), 2 sessions
The concepts of “delocalization and conjugation,” which are important for understanding differences in reactivity and physical properties of organic molecules, are explained using molecular orbital theory. In addition, aromaticity is explained.

Acidity and basicity (Chapter 8), 2 sessions
Students develop an understanding of the structural characteristics of compounds related to acidity and basicity, and learn how to calculate and use pH and pKa. In addition, equilibrium theory and changes in the electronic structure of compounds in proton transfer reactions are explained. During the session, an examination is conducted to confirm how much students have learned to date.

Organometallic reagents for carbon-carbon bond formation (Chapter 9), 1 session
The method for preparing organometallic compounds and examples of carbon-carbon bond forming reactions that use organometallic compounds are explained.

Continue to 有機化学Ⅰ（先端化学）［工化1・工化3］(2)↓↓↓

Nucleophilic substitution reactions on the carbon in carbonyl groups (Chapter 10), 2 sessions
By showing examples of substitution reactions that occur on the carbon in carbonyl groups, students are able to gain an understanding about the reactivity of carbonyl compounds based on reaction mechanisms that go through tetrahedral intermediates and the properties of nucleophiles and leaving groups. Using such examples also allows synthesis reactions that involve carbonyl compounds to be explained in a systematic manner.

Nucleophilic substitution reactions at C=O, following loss of carbonyl oxygen (Chapter 11), 2 sessions
The mechanisms behind the formation of acetals, imines, and alkenes from carbonyl compounds and their applications in synthetic chemistry are explained.

How to determine the structure of organic compounds (Chapter 3 and Chapter 13), 2 sessions
Students are explained the principles and characteristics of infrared spectroscopy and nuclear magnetic resonance spectroscopy, and are taught for determining the structure of organic compounds by reading various spectra.

Feedback lecture, 1 session
The fourteen lectures and examination contents are explained to students to improve their degree of learning (details are given during the lecture or on KULASIS). [All professors]

[Course requirements]

None

[Evaluation methods and policy]

[Evaluation method]
Marks from (mid-term and end-of-term) examinations (90%); evaluation of performance in teaching sessions (10%)
Performance in teaching sessions is evaluated based on participation in sessions and the assessment of reports assigned in each teaching session.
[Evaluation policy]
Students must obtain a total of at least 60 (out of 100 marks) from the results of their (mid-term and end-of-term) examinations and their performance in teaching sessions.
60 marks or more: Pass
59 marks or less: Fail

[Textbooks]

J. Clayton, N. Greeves, and S. Warren 『Organic Chemistry, 2nd Ed.』（Oxford University Press）ISBN: 9780199270293

[References, etc.]

（**Reference books**）
McMurry, J. (translated by Shibasaki, M., Iwasawa, N., Owada, T., Mashino, T.,) 『McMurry Organic Chemistry』（Tokyo Kagaku Dojin, 2009）ISBN:9784807906918

Continue to 有機化学Ⅰ（先端化学）［工化1・工化3］(3)↓↓↓

[Study outside of class (preparation and review)]

Students should briefly glance over the handouts and textbook, and prepare for the contents of each unit before attending any lecture. In addition, students will actively work on report assignments given in each teaching session, while deepening their understanding of the contents of each unit. It would also be advisable for students to devote twice the amount of time spent in teaching session to review the material and prepare for the next session.

（Other information (office hours, etc.)）

Students are divided into two classes and each class is assigned a professor who will conduct teaching sessions in the same time slot.
* For details on office hours, please check KULASIS.

Note: If a student who has already completed “Organic Chemistry I (Basic Industrial Chemistry)” takes “Organic Chemistry I (Advanced Chemistry)” and earns credit, these will be treated as additional credits.

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	有機化学 I （先端化学）［工化2・工化4］ Organic Chemistry I (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,OOE KOUICHI Graduate School of Engineering Associate Professor,MIURA TOMOYA Institute for Chemical Research Professor,NAKAMURA MASAHARU

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Mon.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Organic Chemistry I-IV are taught over two years (from the second half of sophomore year to the first half of senior year) as subjects that systematically instill students with the basics of organic chemistry they will need to know in order to work as researchers and engineers in all fields related to chemistry in the industrial, academic, and public sectors. Among these subjects, Organic Chemistry I allows students to understand ideas of acids and bases, as well as concepts of delocalization and conjugation of electronic states in compounds and intermediates, while also teaching them about reactions involving carbonyl groups from the standpoint of molecular orbital theory. In addition, students are taught how to determine the structure of organic compounds by making full use of various spectral methods.

[Course objectives]

The goal is to understand organic reactions in a unified manner by considering mechanical similarities, rather than through mechanical memorization.

[Course schedule and contents]

Structure of molecules and method of expressing organic reactions (Chapter 4 and Chapter 5), 1 session
Atomic orbitals and molecular orbitals are explained to students to provide a deeper understanding of the relationship between the shape of organic molecules and electronic structures. In addition, students learn to depict the movement of electrons in organic reactions using curved arrows.

Nucleophilic addition reactions to carbonyl groups (Chapter 6), 2 sessions
Students are given an overview of reaction modes between carbonyl groups and nucleophiles.

Delocalization and conjugation (Chapter 7), 2 sessions
The concepts of "delocalization and conjugation," which are important for understanding differences in reactivity and physical properties of organic molecules, are explained using molecular orbital theory. In addition, aromaticity is explained.

Acidity and basicity (Chapter 8), 2 sessions
Students develop an understanding of the structural characteristics of compounds related to acidity and basicity, and learn how to calculate and use pH and pKa. In addition, equilibrium theory and changes in the electronic structure of compounds in proton transfer reactions are explained. During the session, an examination is conducted to confirm how much students have learned to date.

Organometallic reagents for carbon-carbon bond formation (Chapter 9), 1 session
The method for preparing organometallic compounds and examples of carbon-carbon bond forming reactions that use organometallic compounds are explained.

Continue to 有機化学 I （先端化学）［工化2・工化4］(2)↓↓↓

Nucleophilic substitution reactions on the carbon in carbonyl groups (Chapter 10), 2 sessions
By showing examples of substitution reactions that occur on the carbon in carbonyl groups, students are able to gain an understanding about the reactivity of carbonyl compounds based on reaction mechanisms that go through tetrahedral intermediates and the properties of nucleophiles and leaving groups. Using such examples also allows synthesis reactions that involve carbonyl compounds to be explained in a systematic manner.

Nucleophilic substitution reactions at C=O, following loss of carbonyl oxygen (Chapter 11), 2 sessions
The mechanisms behind the formation of acetals, imines, and alkenes from carbonyl compounds and their applications in synthetic chemistry are explained.

How to determine the structure of organic compounds (Chapter 3 and Chapter 13), 2 sessions
Students are explained the principles and characteristics of infrared spectroscopy and nuclear magnetic resonance spectroscopy, and are taught for determining the structure of organic compounds by reading various spectra.

Feedback lecture, 1 session
The fourteen lectures and examination contents are explained to students to improve their degree of learning (details are given during the lecture or on KULASIS). [All professors]

[Course requirements]

None

[Evaluation methods and policy]

[Evaluation method]
Marks from (mid-term and end-of-term) examinations (90%); evaluation of performance in teaching sessions (10%)
Performance in teaching sessions is evaluated based on participation in sessions and the assessment of reports assigned in each teaching session.
[Evaluation policy]
Students must obtain a total of at least 60 (out of 100 marks) from the results of their (mid-term and end-of-term) examinations and their performance in teaching sessions.
60 marks or more: Pass
59 marks or less: Fail

[Textbooks]

Clayden, J., Greeves, N., Warren S. 『Organic Chemistry, 2nd Ed.』 （Oxford University Press, 2012）
ISBN:9780199270293

[References, etc.]

（**Reference books**）
McMurry, J. (translated by Shibasaki, M., Iwasawa, N., Owada, T., Mashino, T.,) 『McMurry Organic Chemistry』 （Tokyo Kagaku Dojin）ISBN:9784807906918

Continue to 有機化学 I （先端化学）［工化2・工化4］(3)↓↓↓

[Study outside of class (preparation and review)]

Students should briefly glance over the handouts and textbook, and prepare for the contents of each unit before attending any lecture. In addition, students will actively work on report assignments given in each teaching session, while deepening their understanding of the contents of each unit. It would also be advisable for students to devote twice the amount of time spent in teaching session to review the material and prepare for the next session.

（Other information (office hours, etc.)）

Students are divided into two classes and each class is assigned a professor who will conduct teaching sessions in the same time slot.
* For details on office hours, please check KULASIS.

Note: If a student who has already completed "Organic Chemistry I (Basic Industrial Chemistry)" takes "Organic Chemistry I (Advanced Chemistry)" and earns credit, these will be treated as additional credits.

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	化学数学I（先端化学） Mathematical Method in Chemistry I (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,ITOU AKIHIRO Center for the Promotion of Interdisciplinary Education and Research Program-Specific Associate Professor,FUKUDA RYOICHI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Thu.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

化学を学修する上で必要な数学の基礎としての線型代数・複素解析の基本的事項について講義するとともに演習を行う。

[Course objectives]

化学のツールとして必要な数学の基礎を固め、物理化学II、物理化学III、化学数学IIなどの専門科目の学習の際に必要となる数学的記述を容易に理解できるようになる。

[Course schedule and contents]

[行列と線形代数の技法 (担当:伊藤)]
物理化学に現れる諸問題はしばしば行列の形に表現され、その固有値問題に還元される場合がある。線形写像(演算子)の具体的な表現としての行列について、以下の各項目について演習を含めた形で講述する。

行列式と行列 [2回]

線形空間と行列 [2回]

行列の固有値問題1 [1回]

行列の固有値問題2 (ヒュッケル行列の対角化) [1回]

学習到達度の確認 [1回]
学習内容の理解度を確認する。

[複素解析の技法 (担当:福田)]
変数と関数値を複素数とする 1 変数複素関数論の基礎について以下のようなサブテーマに沿って演習を含めた形で講述する。留数定理を用いた各種定積分の計算ができるようになることを目標とする。

三角関数と指数関数 [1回]
複素数と複素関数についての基礎となる事項を解説する。三角関数と指数関数を複素数の範疇で統一的に扱えるようにする。

正則関数[1回]
複素解析において重要な概念である正則関数について理解する。

Continue to 化学数学I（先端化学）(2)↓↓↓

化学数学I（先端化学）(2)

積分定理と積分公式 [1回]
複素関数の積分定理や積分公式を理解し導出できるようにする。

複素関数列 [1回]
複素関数列の性質と収束の概念を理解する。関数列の収束について議論できるようにする。

複素関数の整級数展開 [1回]
正則な複素関数が整級数展開できることを理解し、整級数展開を利用できるようにする。

留数定理 [1回]
特異点の性質を理解し、留数定理を用いた計算ができるようにする。

学習到達度の確認 [1回]
学習内容の理解度を確認する。

定期試験 [1回]

フィードバック [1回]

[Course requirements]
自然現象と数学、全学共通科目 微分積分A・B、線形代数学A・B を履修していることが望ましい。

[Evaluation methods and policy]
前半部分終了時に実施する確認テスト(50%)と定期試験(50%)の合計点をもって評価する.

[Textbooks]
Not used
授業中にプリント等を配布する。

[References, etc.]
（**Reference books**）
大岩正芳 『化学者のための数学十講』（化学同人）ISBN:9784759800081
藤森裕基,松澤秀則,筑紫格訳 『マッカーリ化学数学』（丸善）ISBN:9784621088104
松田哲 『理工系の基礎数学５ 複素関数』（岩波書店）ISBN:4000079751

[Study outside of class (preparation and review)]
本シラバス記載の参考書等で、基本的な事項について予習しておくこと。さらに、授業中に配布されるプリントや参考書中の演習問題を解き、内容について復習しておくこと。

（Other information (office hours, etc.)）
オフィスアワーの詳細については、KULASISで確認してください。

Continue to 化学数学I（先端化学）(3)↓↓↓

化学数学I（先端化学）(3)

注意：「化学数学Ⅰ（工業基礎化学）」を、すでに単位修得した学生が「化学数学Ⅰ(先端化学）」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	物理化学II（先端化学）［工化1・工化3］ Physical Chemistry II (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,SATO HIROFUMI Graduate School of Engineering Associate Professor,ITOU AKIHIRO Graduate School of Engineering Associate Professor,HIGASHI MASAHIRO Institute for Chemical Research Professor,MIZUOCHI NORIKAZU

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Wed.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]
量子力学の原理と応用、原子軌道に基づく原子構造及び分子軌道に基づく化学結合論について講述し、必要に応じて関連事項の演習を実施する。

[Course objectives]
量子力学の基礎、簡単なSchroedinger方程式の例、原子軌道と分子軌道及びこれらに基づいた原子・分子の性質を理解できるようになること。

[Course schedule and contents]
波の性質と古典物理の破綻【１回】
粒子性と波動性、二重スリット実験

分子の解析力学【２回】
分子の並進・回転・振動および電子の運動、Lagrange形式の解析力学、Hamilton形式の解析力学

量子力学の基礎【３回】
状態、演算子、オブザーバブル、確率解釈、正準交換関係、不確定性関係、自由粒子と井戸型ポテンシャルのSchroedinger方程式

二原子分子の量子力学【１回】
調和振動子、剛体回転子

中間試験【１回】

水素原子【１回】
水素原子と原子軌道

多電子系と化学結合【２回】
パウリの原理 、多電子原子の構造、分子軌道の考え方、等核二原子分子

ヒュッケル法【２回】
π共役系分子の分子軌道、ヒュッケル法

より一般的化学結合【１回】
異核二原子分子の化学結合、多原子分子の構造と定性的分子軌道

Continue to 物理化学II（先端化学）［工化1・工化3］(2)↓↓↓

物理化学II（先端化学）［工化1・工化3］(2)

学習到達度の確認【１回】
学習内容の理解度を確認する。

フィードバック【１回】

[Course requirements]
基礎物理化学A／基礎物理化学（量子論）および化学数学Ⅰで取り上げた関連事項を修得していること。

[Evaluation methods and policy]
平常点（５０％）、期末試験（５０％）
平常点には中間試験の評価を含む。
１００点満点中６０点以上を合格、５９点以下を不合格とする。

[Textbooks]
Not used

[References, etc.]
（**Reference books**）
アトキンス物理化学（上）第８版　千原ら訳（東京化学同人）(ISBN 9784807906956)
マッカーリ・サイモン物理化学　分子論的アプローチ（上）千原ら訳（東京化学同人）(ISBN 9784807905089)

[Study outside of class (preparation and review)]
講義内容の十分な理解には初歩的な数学が必要であり、講義内容と併せて適宜復習すること。また同時期に開講される化学数学IIを並行して履修することが望ましい。

（Other information (office hours, etc.)）
量子力学の化学への応用体系を量子化学と呼ぶ。これは有機合成化学、高分子化学、無機化学あるいは触媒化学や有機金属化学、分子分光学を問わず、全ての化学の基盤となる。量子化学的素養は現代の化学研究において必須であり、しっかり身につけて欲しい。

注意：「物理化学Ⅱ（工業基礎化学）」を、すでに単位修得した学生が「物理化学Ⅱ(先端化学）」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	物理化学II（先端化学）［工化2・工化4］ Physical Chemistry II (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,SATO HIROFUMI Graduate School of Engineering Associate Professor,ITOU AKIHIRO Graduate School of Engineering Associate Professor,HIGASHI MASAHIRO Institute for Chemical Research Professor,MIZUOCHI NORIKAZU

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Wed.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

量子力学の原理と応用、原子軌道に基づく原子構造及び分子軌道に基づく化学結合論について講述し、必要に応じて関連事項の演習を実施する。

[Course objectives]

量子力学の基礎、簡単なSchroedinger方程式の例、原子軌道と分子軌道及びこれらに基づいた原子・分子の性質を理解できるようになること。

[Course schedule and contents]

波の性質と古典物理の破綻【１回】
粒子性と波動性、二重スリット実験

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分子の並進・回転・振動および電子の運動、Lagrange形式の解析力学、Hamilton形式の解析力学

量子力学の基礎【３回】
状態、演算子、オブザーバブル、確率解釈、正準交換関係、不確定性関係、自由粒子と井戸型ポテンシャルのSchroedinger方程式

二原子分子の量子力学【１回】
調和振動子、剛体回転子

中間試験【１回】

水素原子【１回】
水素原子と原子軌道

多電子系と化学結合【２回】
パウリの原理 、多電子原子の構造、分子軌道の考え方、等核二原子分子

ヒュッケル法【２回】
π共役系分子の分子軌道、ヒュッケル法

より一般的化学結合【１回】
異核二原子分子の化学結合、多原子分子の構造と定性的分子軌道

Continue to 物理化学II（先端化学）［工化2・工化4］(2)↓↓↓

物理化学II（先端化学）［工化2・工化4］(2)

学習到達度の確認【１回】
学習内容の理解度を確認する。

フィードバック【１回】

[Course requirements]

基礎物理化学A／基礎物理化学（量子論）および化学数学Ⅰで取り上げた関連事項を修得していること。

[Evaluation methods and policy]

平常点（５０％）、期末試験（５０％）
平常点には中間試験の評価を含む。
１００点満点中６０点以上を合格、５９点以下を不合格とする。

[Textbooks]

Not used

[References, etc.]

（Reference books）
その他
アトキンス物理化学（上）第８版　千原ら訳（東京化学同人）(ISBN 9784807906956)
マッカーリ・サイモン物理化学　分子論的アプローチ（上）千原ら訳（東京化学同人）(ISBN 9784807905089)

[Study outside of class (preparation and review)]

講義内容の十分な理解には初歩的な数学が必要であり、講義内容と併せて適宜復習すること。また同時期に開講される化学数学IIを並行して履修することが望ましい。

（Other information (office hours, etc.)）

量子力学の化学への応用体系を量子化学と呼ぶ。これは有機合成化学、高分子化学、無機化学あるいは触媒化学や有機金属化学、分子分光学を問わず、全ての化学の基盤となる。量子化学的素養は現代の化学研究において必須であり、しっかり身につけて欲しい。

注意：「物理化学Ⅱ（工業基礎化学）」を、すでに単位修得した学生が「物理化学Ⅱ(先端化学）」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	有機化学II（先端化学）［工化1・工化3］ Organic Chemistry II (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,SUGINOME MICHINORI Graduate School of Engineering Associate Professor,FUJIHARA TETSUAKI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Wed.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

化学が関係するあらゆる分野（学・産・官）で、自立した研究者および技術者として第一線で活躍するために必要不可欠な有機化学の基礎を系統的に学ぶために、有機化学I,II,IIIが２年後期から３年後期に開講される。有機化学IIは、大きく３つのパートから構成されている。最初のパートでは有機化合物の立体化学や反応の立体選択性，立体特異性について概説する。第２のパートでは，主として脱離基を有する飽和有機化合物の反応性を取扱い，求核置換反応と脱離反応について詳述する。第３のパートでは，不飽和有機化合物のπ電子が関与する反応を取扱い，特にアルケン，エノール，芳香族化合物に対する求電子的反応について講述する。

[Course objectives]

本講義は有機化学IおよびIIIと密接に連携して行い，基礎有機化学I,IIおよび有機化学基礎及び演習で養った基礎的な知識を，より実践的なレベルへ飛躍的に発展させることを目標としている。反応機構の考察や，合成に際しての反応設計を自ら行える能力を養う。

[Course schedule and contents]

立体化学,2回
鏡像異性体（エナンチオマー）／ジアステレオマー／不斉炭素中心を持たないキラル化合物／分子の対称性／光学分割 （14章）

求核置換反応,2回
求核置換反応の機構／ SN1反応と SN2反応／脱離基／求核剤／脱離と転位（15章）

脱離反応,2回
置換と脱離におよぼす求核剤の効果／E1反応とE2反応／脱離基の役割／脱離の立体選択性と立体特異性／E2反応の位置選択性／E1cB反応（17章）

前半の講義内容に関連する演習，1 回

アルケンに対する求電子付加反応,2回
臭素化／エポキシ化／求電子付加の位置および立体選択性／共役ジエンに対する付加／反応機構／ハロラクトン化による環状構造の構築（19章）

エノール及びエノラートの生成と反応,2回
ケトエノール互変異性／酸及び塩基触媒によるエノール化／安定なエノール／エノール及びエノラートを中間体とする反応／安定なエノラート等価体／エノールおよびエノラートの酸素原子上での反応／エノールエーテルの反応（20章）

Continue to 有機化学II（先端化学）［工化1・工化3］(2)↓↓↓

有機化学II（先端化学）［工化1・工化3］(2)

求電子芳香族置換反応,2回
ベンゼンの求電子置換反応／フェノールの求電子置換反応／アニリン誘導体の求電子置換反応／オルト・パラ配向性及びメタ配向性／求電子置換反応の選択性（21章）

全体の講義内容に関連する演習，1 回

フィードバック講義,1回
本講義の全体の振返りと試験の講評。

[Course requirements]

基礎有機化学I,II、有機化学基礎及び演習、有機化学Iで学んだ内容が習得されていることを前提に講義を行う。

[Evaluation methods and policy]

【評価方法】毎回の講義で小テストを行うとともに、次回の講義前にレポートとして提出する課題を与える。小テスト、レポートおよび演習に基づく平常点（３０点）、および定期試験（７０点）を総合して評価する。

【評価方針】到達目標について、工学部の成績評価の方針に従って６段階の成績評点で評価する。

[Textbooks]

Jonathan Clayden他『Organic Chemistry (Second Edition）』（Oxford University Press）ISBN: 9780199270293（(１４、１５、１７、１９、２０、２１章を中心に取り扱う)）

[References, etc.]

（Reference books）
柴崎正勝ら『マクマリー有機化学ー生体反応へのアプローチー』（東京化学同人）ISBN: 9784807906918（(基礎有機化学I,IIで用いた教科書)）

[Study outside of class (preparation and review)]

予習：各回の授業を受ける前に、基礎有機化学I,IIおよび有機化学基礎および演習ですでに学んだ関連する内容につき、復習しておくこと。
復習：授業で課された課題の全てを自らの手で解き、自らの理解度を確認すること。もし理解が不足している時には、教科書やノートを確認して、確実に理解すること。

（Other information (office hours, etc.)）

受講生を２クラスに分け、クラス毎に定められた教員により授業を進める。

注意：「有機化学II（工業基礎化学）」を、すでに単位修得した学生が「有機化学II(先端化学）」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	有機化学II（先端化学）［工化2・工化4］ Organic Chemistry II (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Institute for Chemical Research Professor,MURATA YASUJIROU

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Wed.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

化学が関係するあらゆる分野（学・産・官）で、自立した研究者および技術者として第一線で活躍するために必要不可欠な有機化学の基礎を系統的に学ぶために、有機化学I,II,IIIが２年後期から３年後期に開講される。有機化学IIは、大きく３つのパートから構成されている。最初のパートでは有機化合物の立体化学や反応の立体選択性，立体特異性について概説する。第２のパートでは，主として脱離基を有する飽和有機化合物の反応性を取扱い，求核置換反応と脱離反応について詳述する。第３のパートでは，不飽和有機化合物のπ電子が関与する反応を取扱い，特にアルケン，エノール，芳香族化合物に対する求電子的反応について講述する。

[Course objectives]

本講義は有機化学IおよびIIIと密接に連携して行い，基礎有機化学I,IIおよび有機化学基礎及び演習で養った基礎的な知識を，より実践的なレベルへ飛躍的に発展させることを目標としている。反応機構の考察や，合成に際しての反応設計を自ら行える能力を養う。

[Course schedule and contents]

立体化学,2回
鏡像異性体（エナンチオマー）／ジアステレオマー／不斉炭素中心を持たないキラル化合物／分子の対称性／光学分割 （14章）

求核置換反応,2回
求核置換反応の機構／ SN1反応と SN2反応／脱離基／求核剤／脱離と転位（15章）

脱離反応,2回
置換と脱離におよぼす求核剤の効果／E1反応とE2反応／脱離基の役割／脱離の立体選択性と立体特異性／E2反応の位置選択性／E1cB反応（17章）

前半の講義内容に関連する演習，1回

アルケンに対する求電子付加反応,2回
臭素化／エポキシ化／求電子付加の位置および立体選択性／共役ジエンに対する付加／反応機構／ハロラクトン化による環状構造の構築（19章）

エノール及びエノラートの生成と反応,2回
ケトエノール互変異性／酸及び塩基触媒によるエノール化／安定なエノール／エノール及びエノラートを中間体とする反応／安定なエノラート等価体／エノールおよびエノラートの酸素原子上での反応／エノールエーテルの反応（20章）

Continue to 有機化学II（先端化学）［工化2・工化4］(2)↓↓↓

求電子芳香族置換反応,2回
ベンゼンの求電子置換反応／フェノールの求電子置換反応／アニリン誘導体の求電子置換反応／オルト・パラ配向性及びメタ配向性／求電子置換反応の選択性（21章）

全体の講義内容に関連する演習，1 回

フィードバック講義,1回
本講義の全体の振返りと試験の講評。

[Course requirements]

基礎有機化学I,II、有機化学基礎及び演習、有機化学Iで学んだ内容が習得されていることを前提に講義を行う。

[Evaluation methods and policy]

【評価方法】毎回の講義で小テストを行うとともに、次回の講義前にレポートとして提出する課題を与える。小テスト、レポートおよび演習に基づく平常点（３０点）、および定期試験（７０点）を総合して評価する。

【評価方針】到達目標について、工学部の成績評価の方針に従って６段階の成績評点で評価する。

[Textbooks]

Jonathan Clayden他 『Organic Chemistry (Second Edition）』（Oxford University Press）ISBN: 9780199270293（（１４、１５、１７、１９、２０、２１章を中心に取り扱う））

[References, etc.]

（Reference books）
柴崎正勝ら 『マクマリー有機化学ー生体反応へのアプローチー』（東京化学同人）ISBN: 9784807906918（(基礎有機化学I,IIで用いた教科書)）

[Study outside of class (preparation and review)]

予習：各回の授業を受ける前に、基礎有機化学I,IIおよび有機化学基礎および演習ですでに学んだ関連する内容につき、復習しておくこと。
復習：授業で課された課題の全てを自らの手で解き、自らの理解度を確認すること。もし理解が不足している時には、教科書やノートを確認して、確実に理解すること。

（Other information (office hours, etc.)）

受講生を２クラスに分け、クラス毎に定められた教員により授業を進める。

注意：「有機化学II（工業基礎化学）」を、すでに単位修得した学生が「有機化学II(先端化学）」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	無機化学II（先端化学）［工化1・工化3］ Inorganic Chemistry II (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,ABE TAKESHI Institute for Integrated Cell-Material Sciences Professor,FUKAZAWA AIKO Graduate School of Engineering Professor,OHKI YASUHIRO Graduate School of Engineering Associate Professor,MATSUI TOSHIAKI Graduate School of Engineering Associate Professor,MIKI KOUJI Graduate School of Engineering Associate Professor,SAKAMOTO RYOTA Institute for Advanced Study Professor,FURUKAWA SHIYUUHEI Institute for Advanced Study Associate Professor,HORIKE SATOSHI Graduate School of Engineering Senior Lecturer,TAKATSU HIROSHI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Mon.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

基礎無機化学と無機化学 I を修得した後のアドバンスドコースとして、金属錯体及び有機金属化合物の配位化学について、構造、電子スペクトル、反応機構を講述する。

[Course objectives]

金属錯体及び有機金属化合物の立体構造、電子構造、電子スペクトル、反応機構についての基礎を理解する

[Course schedule and contents]

19. d 金属錯体：電子構造とスペクトル,7回
金属錯体（特に d -ブロックの金属の錯体）の電子スペクトルの起源を電子minus電子間反発に基づいて詳細に学び、錯体の結合についての理解を深める。

20. 配位化学：錯体の反応,4回
d -ブロック錯体の反応機構を詳細に検討する。まず反応機構の分類について記述し、反応が起こる各段階と、活性錯体が生成する機構の詳細を区別する。次いで、これらの概念を用いて錯体の置換反応と酸化還元反応の機構を記述する。

21. d 金属の有機金属化合物,3回
d -ブロック有機金属化合物の基盤である金属カルボニル錯体の構造、結合、反応について述べる。次いで、水素および炭化水素配位子の結合様式と反応性について述べる。

学習到達度の確認,1回
本講義の内容に関する到達度を確認（講評）する

Continue to 無機化学II（先端化学）［工化1・工化3］(2)↓↓↓

[Course requirements]

授業の前に該当の章ならびにシュライバー・アトキンス無機化学（上） １～７章を通読しておくこと。

[Evaluation methods and policy]

平常点および期末試験にて評価する。

[Textbooks]

シュライバー・アトキンス無機化学（下）[第6版] M.Weller, T.Overton J.P.Rourke, F.Armstrong 共著 田中勝久、高橋雅英、安部武志、平尾一之、北川進 共訳　東京化学同人（2017） ISBN：9784807908998

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

授業までに教科書をよく読んでおくこと

（Other information (office hours, etc.)）

キーワード：ｄ－ブロック錯体、電子スペクトル、電子間反発、配位化合物の構造、配位化合物の反応機構、有機金属化合物

注意：「無機化学Ⅱ（工業基礎化学）」を、すでに単位修得した学生が「無機化学Ⅱ(先端化学）」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	無機化学II（先端化学）［工化2・工化4］ Inorganic Chemistry II (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,ABE TAKESHI Institute for Integrated Cell-Material Sciences Professor,FUKAZAWA AIKO Graduate School of Engineering Professor,OHKI YASUHIRO Graduate School of Engineering Associate Professor,MATSUI TOSHIAKI Graduate School of Engineering Associate Professor,MIKI KOUJI Graduate School of Engineering Associate Professor,SAKAMOTO RYOTA Institute for Advanced Study Professor,FURUKAWA SHIYUUHEI Institute for Advanced Study Associate Professor,HORIKE SATOSHI Graduate School of Engineering Senior Lecturer,TAKATSU HIROSHI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Mon.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

基礎無機化学と無機化学 I を修得した後のアドバンスドコースとして、金属錯体及び有機金属化合物の配位化学について、構造、電子スペクトル、反応機構を講述する。

[Course objectives]

金属錯体及び有機金属化合物の立体構造、電子構造、電子スペクトル、反応機構についての基礎を理解する

[Course schedule and contents]

19. d 金属錯体：電子構造とスペクトル,7回,金属錯体（特に d minusブロックの金属の錯体）の電子スペクトルの起源を電子minus電子間反発に基づいて詳細に学び、錯体の結合についての理解を深める。
20. 配位化学：錯体の反応,4回, d minusブロック錯体の反応機構を詳細に検討する。まず反応機構の分類について記述し、反応が起こる各段階と、活性錯体が生成する機構の詳細を区別する。次いで、これらの概念を用いて錯体の置換反応と酸化還元反応の機構を記述する。
21. d 金属の有機金属化合物,3回, d minusブロック有機金属化合物の基盤である金属カルボニル錯体の構造、結合、反応について述べる。次いで、水素および炭化水素配位子の結合様式と反応性について述べる。
学習到達度の確認,1回,本講義の内容に関する到達度を確認（講評）する

Continue to 無機化学II（先端化学）［工化2・工化4］(2)↓↓↓

[Course requirements]

授業の前に該当の章ならびにシュライバー・アトキンス無機化学（上）１～７章を通読しておくこと。

[Evaluation methods and policy]

出席および期末試験にて評価する。

[Textbooks]

シュライバー・アトキンス無機化学（下）[第6版] M.Weller, T.Overton J.P.Rourke, F.Armstrong 共著 田中勝久、高橋雅英、安部武志、平尾一之、北川進 共訳　東京化学同人（2017） ISBN：9784807908998

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

授業までに教科書をよく読んでおくこと

（Other information (office hours, etc.)）

キーワード：ｄ－ブロック錯体、電子スペクトル、電子間反発、配位化合物の構造、配位化合物の反応機構、有機金属化合物

注意：「無機化学Ⅱ（工業基礎化学）」を、すでに単位修得した学生が「無機化学Ⅱ(先端化学）」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	生化学I（先端化学） Basic Biochemistry I (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,ATOMI HARUYUKI Graduate School of Engineering Professor,MORI YASUO Graduate School of Engineering Professor,HAMACHI ITARU

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Tue.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

生命を構成する分子を研究する生化学は、様々な学問分野との境界において重要な役割を果たす。また、医薬・物質生産や材料科学などの分野へも広く応用され、生化学は発展している。このような生化学の基礎について、遺伝情報の流れであるセントラルドグマを中心に生命情報の制御を講義するとともに、生化学研究の予備的な知識を与える。

[Course objectives]

生物学における「化学」の基礎知識の習得。

[Course schedule and contents]

生化学の基礎,1回
生化学とはどのような学問・研究分野であるのかなど、生化学の基礎的立場を説明する。

タンパク質の成り立ち,2回
生命反応の制御を直接担うタンパク質の組成、構造の基礎について説明する。

セントラルドグマと遺伝情報の流れ,2回
遺伝子DNAからRNA、タンパク質への遺伝情報の流れであるセントラルドグマの基礎について説明する。

DNAの複製、組換え、修復,1回
遺伝子の分子実体であるDNAがどのように複製され、また、どのようにDNA組換え・変異が生じ修復されるかについて解説する。

RNAの合成と遺伝子発現,2回
遺伝情報の伝令役であるRNAが転写により合成され、その後のプロセッシングを経て成熟する過程を解説する。また、転写を中心に、遺伝子発現の調節機構について解説する。

タンパク質の合成,2回
RNAの担う遺伝情報が翻訳されタンパク質が合成される過程を解説する。

糖質,1回
細胞を構成する重要な生体高分子の一つである糖質の構造と機能について解説する。

脂質と生体膜,1回
細胞と外界との境界や細胞内の区画を形作る生体膜とその構成分子である脂質について解説する。

Continue to 生化学I（先端化学）(2)↓↓↓

細胞シグナル,2回
細胞とその外界をつなぐ情報の流れを解説する。

学習到達度の確認,1回
本講義の内容に関する理解度を確認する。

[Course requirements]

None

[Evaluation methods and policy]

課題とレポートにより評価する。

[Textbooks]

Jeremy M. Berg, John L. Tymoczko, Lubert Stryer 『ストライヤー生化学』（東京化学同人）ISBN: 9784807908035（第7版）

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

教科書等を読み、講義で学ぶことを事前に把握するとともに、講義中に十分理解できなかった箇所の理解に努める。

（Other information (office hours, etc.)）

教科書の全範囲を授業で取り上げることはできないので、生命情報の制御を中心に講義をするが、授業で触れなかった項目についても、教員の指示に応じて学習しておくこと。

注意：「生化学Ⅰ（工業基礎化学）」を、すでに単位修得した学生が「生化学Ⅰ(先端化学）」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number					
Course title (and course title in English)	高分子化学概論I（先端化学） Introduction to Polymer Chemistry I (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,OGOSHI TOMOKI		
Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Thu.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

高分子化合物の概念の確立と発展の歴史を振り返ったあと，高分子合成法に関する入門的解説を行う．前半では代表的な高分子合成法の一つである逐次重合（重縮合，重付加，付加縮合）について概説する．後半では連鎖重合の中で重要な位置を占めるラジカル重合，イオン重合，配位重合，開環重合について解説する．最近の高分子化学に関するトピックも紹介する．

[Course objectives]

高分子の定義を概念を理解する．
高分子合成の基礎知識を習得する．

[Course schedule and contents]

第1回-3回　高分子の基本概念と高分子合成の原理
高分子の定義，特性，多様な分子構造について概説し，高分子の概念がどのように生まれ，現在の高分子化学・工業に育ってきたかを述べる．また，高分子の平均分子量についての概念について解説する．高分子重合法である逐次重合，連鎖重合について解説する．

第4回-第6回　逐次重合（重縮合・重付加・付加縮合）
重縮合による高分子合成反応をポリアミドとポリエステルについて解説し，生成ポリマーの分子量と分子量分布の制御についても解説する．重付加による高分子合成をエポキシ樹脂とポリウレタンを例にして説明する．また，フェノール樹脂，エポキシ樹脂を例として付加縮合についても触れる．

第7回　前半の内容に関する中間試験
前半の内容に関する中間試験を行い，学習到達度の確認を行う．

第8回-第10回　ラジカル重合・共重合
ラジカル重合の定義を述べたのち，モノマーと開始剤の種類，ラジカル重合の特徴，開始・生長・停止などの素反応，重合方法，共重合，モノマー反応性比などについて講述する．

第11回、第12回イオン重合
イオン重合（アニオン重合・カチオン重合）の概略と種類について述べる．とくに，すでに学んだラジカル重合との一般的な違いや特徴を概説する．

第13回　配位重合
配位重合の代表例であるオレフィン類のZiegler-Natta重合並びに立体特異性重合について概説する．

Continue to 高分子化学概論I（先端化学）(2)↓↓↓

第14回　開環重合
開館重合について概説し，環状エーテル，ラクトン，ラクチドなどの環状モノマーから得られるポリマーについて説明する．

<<期末試験>>

第15回　フィードバック

[Course requirements]

有機化学の知識を習得しておくこと

[Evaluation methods and policy]

[評価方法]
小テストに基づく平常点（10%），中間試験（40%），期末試験（50%）の成績を主に判定する．
[評価方針]
１００点満点中、６０点以上となること
６０点以上：合格
５９点以下：不合格

[Textbooks]

Not used

[References, etc.]

（Reference books）
中條　善樹　他『高分子化学 合成編』（丸善出版）ISBN:978-4-621-08259-1

[Study outside of class (preparation and review)]

予習：高分子化学の基となる有機化学について復習しておくこと．
復習：授業で課された小テストなど全てを自らの手で解き，自らの理解度を確認すること．もし理解が不足している時には，授業で配布されたハンドアウト，参考書やノートを確認して，確実に理解すること．

（Other information (office hours, etc.)）

メールによる対応

注意：「高分子化学概論Ⅰ（工業基礎化学）」を、すでに単位修得した学生が「高分子化学概論Ⅰ(先端化学）」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

未更新

Course number					
Course title (and course title in English)	有機化学III（先端化学）［工化1・工化3］ Organic Chemistry III (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,KONDOU TERUYUKI Graduate School of Engineering Associate Professor,OOMURA TOSHIMICHI Graduate School of Engineering Associate Professor,KIMURA YUU		
Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Tue.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

In this subject, a systematic approach is taken to teach students about organic chemistry, which is needed in order for them to work as researchers and engineers. Since Organic Chemistry III is a continuation of Organic Chemistry I, which is offered in the second half of sophomore year, and Organic Chemistry II, which is offered in the first half of junior year, the subject uses the same textbook as Organic Chemistry I and II and conducts lectures based on the contents described in Chapters 22 to 26 of the textbook. During lectures, students are given a detailed explanation of reactions that are characteristic of electron-deficient alkenes and aromatic compounds, and are taught about the protection and deprotection of functional groups essential for the synthesis of complex organic molecules. In addition, in order to help students understand the chemistry of carbonyl compounds, which are one of the most important types of compounds in organic chemistry, lectures are given with a focus on the varied reactivity of enolates.

[Course objectives]

Goals include deepening one’s understanding of the reactions of aromatic compounds, systematically understanding the reactivity of functional groups, as well as completely mastering the chemistry of carbonyl compounds, which are one of the most important types of compounds in organic chemistry (alkylation reactions of enolates, aldol condensation reactions, and other condensation reactions, etc.). In the process of reaching these goals, students will also consolidate the contents they have learned so far from Organic Chemistry I and II, and will strive to master a high level of organic chemistry, which they absolutely need in order to work as researchers and engineers at the forefront of society.

[Course schedule and contents]

Conjugate addition reactions and aromatic nucleophilic substitution reactions, 3 sessions
Lectures are given on conjugate addition reactions, conjugate substitution reactions, nucleophilic epoxidation, aromatic nucleophilic substitution reactions, addition-desorption mechanisms, and reactions that use diazonium compounds and benzyne as intermediates, etc. (Chapter 22).

Chemoselectivity and protecting groups, 3 sessions
Lectures are given on reducing agents, reduction of carbonyl compounds, catalytic hydrogenation reactions, reduction via molten metal, selectivity in oxidation reactions, reactivity of functional groups, and protection/deprotection of functional groups, etc. (Chapter 23).

Regioselectivity, 2 sessions
Lectures are given on regioselectivity in electrophilic aromatic substitution reactions, electrophilic attacks on alkenes, regioselectivity of radical reactions, nucleophilic attacks on allyl compounds, electrophilic attacks on

Continue to 有機化学III（先端化学）［工化1・工化3］(2)↓↓↓

conjugated dienes, and selectivity of direct additions and conjugate additions, etc. (Chapter 24).

Alkylation reactions of enolates, 3 sessions
Lectures are given on the alkylation of nitriles and nitroalkanes, electrophiles used for alkylation, alkylation of lithium enolates, alkylation using enolate equivalents, alkylation of & beta; -dicarbonyl compounds, and regioselectivity in the alkylation of ketones, etc. (Chapter 25).

Reactions of enolates and carbonyl compounds: aldol reactions and Claisen condensation, 3 sessions
Lectures are given on aldol reactions, cross-aldol condensation, aldol reactions using enolates and enolate equivalents, intramolecular aldol reactions, acylation reactions of enolates, Claisen condensation, crossed Claisen condensation, and intramolecular crossed Claisen condensation, etc. (Chapter 26).

Confirmation of learning achieved, 1 session
Students’ understanding of chapters 22 to 26, which are covered in lectures, is confirmed.
Explanation of examinations and lectures, 1 session
Students’ understanding of organic chemistry as a whole is enhanced.

[Course requirements]

Lecture contents from Basic Organic Chemistry I, Basic Organic Chemistry II, Organic Chemistry I (Advanced Chemistry), and Organic Chemistry II (Advanced Chemistry)

[Evaluation methods and policy]

Regular examinations (85%), performance in teaching sessions (15%)

[Textbooks]

Clayden, J., Greeves, N., Warren S., Organic Chemistry, 2nd Ed., (Oxford University Press, 2012) ISBN: 9780199270293

[References, etc.]

（Reference books）
Others; McMurry, J. (translated by Shibasaki, M., Iwasawa, S., Owada, T., Mashino, T.), Makumarii yuuki kagaku - seitai hannou he no apuroochi, (Tokyo Kagaku Dojin, 2009) ISBN: 9784807609918

[Study outside of class (preparation and review)]

A report assignment is given in each teaching session.

（Other information (office hours, etc.)）

Students are divided into two classes and each class is assigned a professor who will conduct teaching sessions in the same time slot.

Continue to 有機化学III（先端化学）［工化1・工化3］(3)↓↓↓

有機化学III（先端化学）［工化1・工化3］(3)

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number			
Course title (and course title in English)	有機化学III（先端化学）［工化2・工化4］ Organic Chemistry III (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,KONDOU TERUYUKI Graduate School of Engineering Associate Professor,OOMURA TOSHIMICHI Graduate School of Engineering Associate Professor,KIMURA YUU

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Tue.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

研究者および技術者として活躍するために必要な有機化学を系統的に教授する。有機化学IIIでは、２回生後期開講の有機化学I，３回生前期開講の有機化学IIの後継講義として、これらの講義と同じ教科書を使い、同書の22章から26章に記載の内容を講義する。電子不足アルケンや芳香族化合物に特徴的な反応について詳説するとともに、複雑な有機分子の合成に必須となる官能基の保護・脱保護について述べる。また、有機化学において最も重要な化合物の一つであるカルボニル化合物の化学を理解するために、エノラートの多彩な反応性に注目しつつ講義を進める。

[Course objectives]

芳香族化合物の反応に理解を深め、官能基の反応性について系統的に理解するとともに、有機化学において最も重要な化合物の一つであるカルボニル化合物の化学（エノラートのアルキル化反応，アルドール縮合反応，および他の縮合反応等）を完全に修得する。その過程においてこれまでに学んだ有機化学I，IIの内容を統合し，研究者，技術者として社会の最先端で活躍するために不可欠な高水準の有機化学を修得する。

[Course schedule and contents]

共役付加反応と芳香族求核置換反応,3回
共役付加反応、共役置換反応、求核的エポキシ化、芳香族求核置換反応、付加-脱離機構、およびジアゾニウム化合物、ベンザインを中間体とする反応等について講義する（22章）

化学選択性と保護基,3回
還元剤、カルボニル化合物の還元、触媒的水素化反応、溶融金属による還元、酸化反応における選択性、官能基の反応性、官能基の保護・脱保護等について講義する（23章）

位置選択性,2回
芳香族求電子置換反応における位置選択性、アルケンへの求電子攻撃、ラジカル反応の位置選択性、アリル型化合物への求核攻撃、共役ジエンへの求電子攻撃、直接付加と共役付加の選択性等について講義する（24章）

エノラートのアルキル化反応,3回
ニトリルおよびニトロアルカンのアルキル化、アルキル化に用いる求電子剤、リチウムエノラートのアルキル化、エノラート等価体を用いるアルキル化、beta-ジカルボニル化合物のアルキル化、ケトンのアルキル化における位置選択性等について講義する（25章）

エノラートとカルボニル化合物の反応：アルドール反応およびClaisen縮合,3回

Continue to 有機化学III（先端化学）［工化2・工化4］(2)↓↓↓

有機化学III（先端化学）［工化2・工化4］(2)

アルドール反応、交差アルドール縮合、エノラートおよびエノラート等価体を用いるアルドール反応、分子内アルドール反応、エノラートのアシル化反応、Claisen縮合、
交差Claisen縮合、分子内交差Claisen縮合等について講義する（26章）

学習到達度の確認,1回,講義を行った22章から26章の学習到達度を確認する。
試験・講義についての解説,1回,有機化学全般の理解について到達度を上げる。

[Course requirements]

基礎有機化学Ⅰ，基礎有機化学Ⅱ，有機化学Ⅰ（先端化学），有機化学Ⅱ（先端化学）の講義内容

[Evaluation methods and policy]

定期試験（85%）、平常点評価（15%）

[Textbooks]

Organic Chemistry Second Edition (J. Clayden, N. Greeves, S. Warren, Oxford University Press, 2012) ISBN：9780199270293

[References, etc.]

（**Reference books**）
マクマリー 有機化学 ―生体反応へのアプローチ（マクマリー著；柴崎正勝，岩澤伸治，大和田智彦，増野匡彦　監訳；東京化学同人, 2009） ISBN:9784807906918

[Study outside of class (preparation and review)]

授業毎に課題レポートを課す。

（Other information (office hours, etc.)）

受講生を２クラスに分け、クラス毎に定められた教員により同じ時間帯に授業が行われる。

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course
東レ株式会社　１年

(3) Details of practical classes delivered based on instructors' practical work experience

Course number			
Course title (and course title in English)	物理化学III（先端化学） Physical Chemistry III (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,SUGASE KENJI Graduate School of Engineering Associate Professor,UMEYAMA TOMOKAZU Graduate School of Engineering Senior Lecturer,HIGASHIGUCHI KENJI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Tue.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

In this subject, students are taught the fundamentals of spectroscopy, molecular structure, rotational and vibrational spectra, electronic transitions and photochemistry, magnetic resonance, and statistical thermodynamics.

[Course objectives]

The aim is to learn basic concepts of spectroscopy as a whole and statistical thermodynamics.

[Course schedule and contents]

Basics of spectroscopy, 1 session
What is spectroscopy, optical absorption and quantum mechanics, Einstein coefficients

Rotational and vibrational spectra, 4 sessions
Rotational energy levels and spectra, vibrational energy levels and spectra, lasers, symmetry and normal vibration, Raman spectrum

Electronic transitions and photochemistry, 2 sessions
Electron band spectrum, photochemical principles, fluorescence and phosphorescence, photochemical chain reactions, photolysis, photosynthesis

Magnetic resonance, 2 sessions
Magnetic properties of molecules, nuclear magnetic resonance, chemical shift and spin coupling, spin relaxation, two-dimensional NMR, electron spin resonance

Statistical thermodynamics, 5 sessions
Partition functions and thermodynamics, molecular energy and molecular partition functions, applications of statistical thermodynamics

Confirmation of learning achieved, 1 session
Students' understanding of lecture contents is confirmed.

Continue to 物理化学III（先端化学）(2)↓↓↓

物理化学III（先端化学）(2)

[Course requirements]

It is assumed that students have already taken “Physical Chemistry: Fundamentals and Exercises,” “Physical Chemistry I,” and “Physical Chemistry II.”

[Evaluation methods and policy]

Evaluation is mainly based on results from regular examinations, and, to a lesser degree, attendance in lectures and submission of reports. Attendance, short tests, and assignment reports are all subject to evaluation. Marks are given if these evaluation items are only partially satisfied.

[Textbooks]

Atkins, P., Paula, J. (translated by Nakano, M., Ueda, T., Okumura, M., and Kitagawa, Y.), Atkins butsuri kagaku (ge) dai 10-pan, (Tokyo Kagaku Dojin, 2017) ISBN:978-4-8079-0909-4

[References, etc.]

（**Reference books**）

Moore, W.J. (translated by Fujishiro, R.), Moore butsuri kagaku (jou) oyobi (ge) dai 4-pan, (Tokyo Kagaku Dojin, 1974) ISBN:978-4-8079-0002-2

[Study outside of class (preparation and review)]

Since the subject is taught under the assumption that students have basic knowledge on quantum chemistry, students must thoroughly review the basics of quantum chemistry in advance.

（Other information (office hours, etc.)）

Note: If a student has already completed “Physical Chemistry III (Basic Industrial Chemistry)” and earns credits for “Physical Chemistry III (Advanced Chemistry),” these will be treated as additional credits.

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category

A course with practical content delivered by instructors with practical work experience

(2) Details of instructors’ practical work experience related to the course

(3) Details of practical classes delivered based on instructors’ practical work experience

Course number			
Course title (and course title in English)	高分子化学概論II（先端化学） Introduction to Polymer Chemistry II (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Institute for Chemical Research Professor,WATANABE HIROSHI Institute for Chemical Research Professor,KAJI HIRONORI Institute for Chemical Research Associate Professor,MATSUMIYA YUMI Institute for Chemical Research Assistant Professor,SHIZU KATSUYUKI Institute for Chemical Research Assistant Professor,SUZUKI KATSUAKI
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/Second semester		
Days and periods	Wed.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

高分子が示す特徴的な構造（たとえば結晶と非晶）と特徴的な物性（たとえば粘弾性）は、高分子鎖が長い糸状の構造を持つことに起因する．この視点に基づき、高分子の溶液、融液および固体状態における構造と物性について説明を行う．

[Course objectives]

高分子の構造と動的挙動、物性の関連を分子描像に基づいて理解することを求める．

[Course schedule and contents]

高分子鎖の形と広がり,2回: 線状高分子について、分子特性の基本となる高分子鎖の形の分布と広がりを説明する．

溶液の性質,3回: Flory-Huggins の理論に基づき、混合エントロピー、混合エンタルピーおよび化学ポテンシャルの誘導について述べ、この結果を基に、浸透圧や相平衡などの熱力学的性質を説明する．また、分子量などの基本的な分子特性の決定法についても説明する．

固体の構造,2回: 長い高分子鎖が、結晶化条件により単結晶、球晶、ラメラ晶、伸び切り鎖結晶などを形成することを示し、基本的な結晶化過程について説明する．また、このような結晶化試料の結晶・非晶構造の解析法と解析結果について説明する．

ガラス転移,1回: 高分子が示す熱運動について概説し、主鎖の熱運動の凍結に伴うガラス転移現象について述べる．さらに、ガラス転移に伴う力学的性質と熱的性質の変化、および、その分子機構について説明する．

ゴム弾性,2回: ガラス転移点以上のゴム中で屈曲性高分子鎖が示すコンホーメーション分布について説明し、エントロピー弾性としてのゴム弾性がいかにして発現するかについて鎖の熱運動に主眼を置いて解説する．また、弾性率の分子論的表記についても説明する．

高分子ダイナミクス,4回: 屈曲性高分子鎖の溶融系が示す粘弾性を鎖の運動（ダイナミクス）と対応付けて説明し、鎖同士が互いに横切れないために生じる絡み合い効果について述べる。さらに、鎖の運動と粘弾性についての現在の分子理論についても概説し、主鎖骨格に平行な双極子を持つ高分子（A型高分子）については、長時間域の誘電緩和と粘弾性緩和の対応についても説明する．

学習到達度の確認,1回: 本講義内容全体について要点をまとめて各項目間の関連を概説し、試験などで理解不足が確認される項目に対する学習到達度を高める。

Continue to 高分子化学概論II（先端化学）(2)↓↓↓

高分子化学概論II（先端化学） (2)

[Course requirements]

３年前期配当の「高分子化学概論I」を履修していることが望ましい.

[Evaluation methods and policy]

原則として、講義時間内に行う試験と、レポートで成績評価します。
ただし、コロナの状況によっては、試験を行わず、講義後の課題提出で
成績を付けます。

[Textbooks]

随時、プリントを配布.

[References, etc.]

（**Reference books**）

「新高分子化学序論」（化学同人） isbn{}{4759802584}
「高分子の構造と物性」（講談社）ISBN978-4-06-154380-5 isbn{}{9784061543805}

[Study outside of class (preparation and review)]

高分子の挙動を記述するためには、熱力学と統計力学が必要となる。
このため、熱力学と統計力学（の初歩）について十分な復習を行っていることが必要である。

（Other information (office hours, etc.)）

注意：「高分子化学概論Ⅱ（工業基礎化学）」を、すでに単位修得した学生が「高分子化学概論Ⅱ(先端化学）」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	化学統計力学（先端化学） Statistical Mechanics for Chemistry (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,Shu Seki Graduate School of Engineering Associate Professor,SUDA MASAYUKI
Target year	4th year students or above	Number of credits	2
Year/semesters	2021/First semester		
Days and periods	Mon.2	Class style	Lecture
Language of instruction	Japanese		

[Overview and purpose of the course]

物理化学は「繰り返し」の学問です。固体物理学とともに，おなじ概念を何度も何度も考え直すことで，最終的に理解が進む分野でしょう。さまざまな自然科学の分野で，「概念（コンセプト）」を会得できるまでには長い時間を要します。さまざまなデータや現象に接したときに，「この条件を変えればこのデータは・この現象はこのような変化をするはずだ」，「このデータ・現象を支配している因子は何なのか，それを調べるためにはこの条件を変化させてみよう」，などが自然と思い浮かぶというのが例えば「概念の体得」にあたります。そういう意味では熱統計力学はとても「物理化学」らしい分野でもあります。そして，いったん考えることをやめてしまったら，多分，一生理解が進まずに，物理化学的なもののとらえ方ができなくなってしまうのでしょう。
「化学統計力学」では，化学現象の理解にとって必要な統計力学の基礎について，もすでに学んだ熱力学的な「エントロピー」の発見と発展の歴史とは別に，改めて統計力学によって定義される「エントロピー」の考え方を軸にして，巨視的な物質の物理的性質（一般には物性といいますが，より厳密に定義される物性）の理解のための流れを系統的に講義します。

Repetition of thinking again and again is only the way to master the Physico-Chemical concepts; there is no shortcuts to learn them in principle. This is also the case to learn the concepts in Solid State Physics. Once you master the concepts into yourselves, you will never forget and lose them. It will take a bit longer time to master them, but everybody are able to master them by the “simple repetition of thinking”, however never acquire the concepts if stop the thinking. Mastering the concepts will allow you to judge/make an immediate decision on critical factors controlling data/phenomena in our natural systems, or allow you to interpret the factors changing the systems. This is the “Master of (Physico-Chemical) Concepts”. Statistical mechanics and thermodynamics, the major target of the present class, are representative of Physical Chemistry due to their versatility to reproduce our practical systems.

The major aim of the present class is:
Starting from the basic concept of "Entropy" defined by statistical mechanics, unlikely to the discoverly and development of "Entropy" in classical thermodynamics, to understand macroscopic physical properties of matters quantitatively by an use of Physico-Chemical concepts in Statistical Mechanics.

[Course objectives]

到達目標
物理化学基礎及び演習で学んだことをもとにして，
１）エントロピーの統計力学的な定義の理解と概念の会得

Continue to 化学統計力学（先端化学）(2)↓↓↓

化学統計力学（先端化学）(2)

２）アンサンブルの考え方の会得
３）物質の物理的な性質に関する統計力学的な理解
４）古典統計力学から量子統計力学への発展
を具体的な学習目標とします。基礎統計力学をもとにして，化学反応動力学などの分野でこれを使いこなすための能力を養うことが目的です。今後誰もが目にする・耳にする情報を正しく判断するために，とても重要な概念・考え方の一つとして統計力学を捉えます。

Targets:
1) Definition of entropy by statistical mechanics and understanding the concepts of entropy via mathematical derivations
2) Concepts of ensembles
3) Physical properties of matters in view of statistical mechanics
4) From classical statistical mechanics to quantum statistical mechanics

Finally we approach to the limitations of the classical statistical mechanics, leading to the dawn of quantum mechanical treatment for the thermodynamic bodies: unlikely to the case for the requirements of the treatments in atomic structures/blackbody radiations. We finally discuss on the gap between Maxwell-Boltzmann systems and Fermi-Dirac/Bose-Einstein statistical systems.

[Course schedule and contents]

１．統計力学の基礎，1回
２．「確率と統計」の考え方の整理，分布という考え方，1回
３．ランダムウォーク，ブラウン運動，拡散方程式，状態数，1回
４．気体分子運動論，1回
５．統計力学におけるエントロピー,1回
６．確からしい配置，統計力学的エントロピー，分配関数と熱力学量の導出, 3回
７．小正準アンサンブルと小正準分布，正準アンサンブルと正準分布，2回
８．大正準アンサンブルと大正準分布，2回
９．ボルツマン分布，フェルミ・ディラック分布，ボース・アインシュタイン分布
１０．自発的な対称性の破れと物質の性質，2回
１１．統計力学の応用と学習到達度の確認,1回,本講義の内容に関する理解度の確認をする。

1. Fundamentals of Statistical Mechanics
2. Probability and Statistics: Leading distributions
3. Random walk theory and Brownian motion, in relation to diffusion equation
4. Movement of particles, in gas phase
5. Entropy derived from statistical mechanics: Boltzmann entropy
6. Probable configuration, intensive/extensive variables and partition function
7. Ensembles
8. Grand canonical ensembles and distributions
9. Fermi-Dirac and Bose-Einstein distribution
10. Spontaneous symmetry breaking in the systems
11. Discussions

Continue to 化学統計力学（先端化学）(3)↓↓↓

化学統計力学（先端化学）(3)

[Course requirements]

物理化学基礎及び演習，物理化学 I- III〔先端化学〕の履修を前提とする。

[Evaluation methods and policy]

授業回ごとのQuestion Paper/Quizにて評価する。定期試験は実施しない。100点満点

Making your scores based on Question Papers/Quiz in classes. No final exam is scheduled. Maximum scores: 100.

[Textbooks]

特になし

[References, etc.]

（Reference books）
ムーア「物理化学〔上〕」第４版，藤代亮一訳（東京化学同人） isbn{}{4807900021}；
アトキンス「物理化学（下）」第８版，千原秀昭，中村恒男訳（東京化学同人） isbn{}{9784807906963}；
マッカーリ・サイモン「物理化学－分子論的アプローチ（下）」，千原秀昭，江口太郎，斎藤一弥訳（東京化学同人） isbn{}{9784807905096}
久保亮伍　「統計力学」（共立出版） isbn{}{9784320034235}

[Study outside of class (preparation and review)]

授業中に指示する

（Other information (office hours, etc.)）

月曜日　17-18時
Monday, 17:00-18:00

注意：「化学統計力学（工業基礎化学）」を、すでに単位修得した学生が「化学統計力学（先端化学）」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

Course number							
Course title (and course title in English)	先端機器分析科学（先端化学） Frontiers in Instrumental Analytical Science (Advanced Chemistry)		Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,SAKKA TETSUO			
Target year	4th year students or above	Number of credits	2	Year/semesters	2021/First semester		
Days and periods	Wed.2	Class style	Lecture	Language of instruction	Japanese		

[Overview and purpose of the course]

最先端の機器分析化学を講述する。化学およびその関連分野において、機器を用いる分析を欠かすことが出来ないことは言うまでもないが、装置やマン・マシンインターフェースが大きく進歩しているために、その「利用」においては、必ずしも「箱の中身」を理解しなくても可能であることが多くなっている。しかし、得られたデータの解釈や限界を知るためには、その動作原理を把握しておくべきである。今日では、化学の分野で使用される分析機器は非常に多様となり、その分析の原理や装置の仕組みそのものは化学がカバーする範囲をはるかに越えている。この講義ではこのような学問分野を機器分析科学と定義し、その先端、進歩を集中講義の形式で講述する。本年度は、X線分析、液体クロマトグラフィーおよび電気分析化学に関して、先端的な研究成果を含む内容の講義を行う。

[Course objectives]

分析科学の最先端では、何を、どこまで、いかにして測定しているのかについて、その基本原理から理解し、応用につなげる能力を養う。

[Course schedule and contents]

先端機器分析科学入門,1回
先端機器分析科学の講義計画を説明し、本講義の目的、性格、成績評価等に関して説明する。

高機能充填剤とその分離分析への応用,4回
液体クロマトグラフィー (LC)の今日の発展は、高性能充填剤の開発に負うところが大きい。LC用高性能充填剤には、高分離能充填剤および高機能充填剤がある。前者は、高速・高分解能分離に適用されている。しかし、高分離能充填剤が種々の対象物質の分析に万能であるとは言い難い。そこで、生体試料の直接注入のための浸透制限型充填剤、光学活性化合物の分離のためのキラル充填剤、アフィニティーを利用した分子インプリント充填剤などの高機能充填剤が開発されている。これら高機能充填剤の特性とその分離分析への応用について述べる。 １．浸透制限型充填剤 ２．キラル充填剤、３．分子インプリント充填剤、４．高機能充填剤の分離分析への応用

先端Ｘ線吸収分光法の基礎と応用,4回
Ｘ線吸収によって発生する内殻電子の励起は、価電子準位近傍への遷移や光電子放出をもたらし、その結果として、Ｘ線吸収原子の電子状態や局所構造を解析するために有効なＸ線吸収微細構造（XAFS）が現れる。XAFSの測定法は多岐にわたり、一般的な透過法のほか、希薄試料のための蛍光収量法や表面敏感な電子収量法や全反射法などがある。それらの原理や特徴などを概説した上で、時間分解並びに空間分解の先端的XAFS解析の方法論とその応用例を解説する。また、XAFSを測定するために有効な放射光光源とビームラインの光学素子についても、その原理や特徴を紹介する。さらに、XAFSが得意とするその場での状態解析を不均一触媒材料や二次電池電極材料に応用した

Continue to 先端機器分析科学（先端化学）(2)↓↓↓

先端機器分析科学（先端化学）(2)

解析例について、最近の研究成果を交えて解説する。

pH計測の基礎と応用,6回
pH は、いうまでもなく非常に重要な酸性度の指標である。 pHメータで、簡易に測定できるものであるが、実際には信頼できる値を得ることは難しいことも多い。その理由は、技術的問題にとどまらない。水素イオンの活量 a_{H^+} の対数、 pH = - log_{10}a_{H^+} として定義される pH の測定は、単独イオンの活量を熱力学的な確かさで測定することは出来ないという、原理的・本質的な難しさがある。　単独イオン活量の可測性の問題は、電気化学の根本問題でもある。ここでは、pHメータの原理やガラス電極の作用機作などのpH 測定の技術的な側面だけでなく、このもっともありふれた日常的な測定量である pH の本質的な考え方の枠組を述べ、それを踏まえてとらえ直す酸性雨や海洋の酸性化に関する諸問題の解決の方向性を視野に入れた講義を行う。

[Course requirements]

分析化学、物理化学の基礎的事項を習得していることが望ましい

[Evaluation methods and policy]

講義に参加した上で提出されたレポート内容に基づいて評価する。

[Textbooks]

特に指定しない

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

レポート課題に対応すること

（Other information (office hours, etc.)）

注意：「先端機器分析科学（工業基礎化学）」をすでに単位修得した学生が、「先端機器分析科学（先端化学）」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	有機化学IV（先端化学） Organic Chemistry IV (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,MIKI KOUJI Graduate School of Engineering Associate Professor,NAGAKI AIICHIROU

Target year	4th year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Fri.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

In the class, stereoselective and stereospecific reactions of cyclic and non-cyclic compounds as well as nonionic transformations, such as pericyclic reactions, rearrangement, and radical reactions, are explained.

[Course objectives]

-To understand stereoselective and stereospecific reactions of cyclic and non-cyclic compounds.
-To understand non-ionic transformations, such as pericyclic reactions, rearrangement, and radical reactions.

[Course schedule and contents]

-Stereoselectivity in cyclic molecules, 2 times
-Diastereoselectivity, 2 times
-Pericyclic reactions: cycloadditions, 2 times
-Pericyclic reactions: sigmatropic and electrocyclic reactions, 2 times
-Rearrangements, 2 times
-Fragmentation, 1 time
-Radical reactions, 3 times
-Final examination, 1 time

[Course requirements]

It is desirable for students to take classes of Organic Chemistry I, II, & III (Fundamental Chemistry) before this class.

[Evaluation methods and policy]

Evaluation will be based on examinations (80%) and class performance includes attendance and short reports (20%).

[Textbooks]

Nick Greeves, Stuart Warren, Peter Wothers, Jonathan Clayden 『Organic Chemistry 2nd Edition』（Oxford University Press）ISBN:978-0-199-27029-3

Continue to 有機化学IV（先端化学）(2)↓↓↓

[References, etc.]

（Reference books）

[Study outside of class (preparation and review)]

Before the class, read the textbook and check the contents.
When you have a question, ask via e-mail (kojimiki@scl.kyoto-u.ac.jp or anagaki@sbchem.kyoto-u.ac.jp).

（Other information (office hours, etc.)）

Better to bring the textbook.
*Please visit KULASIS to find out about office hours.

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	先端化学実験I（先端化学） Advanced Chemistry Laboratory I(Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,OGOSHI TOMOKI Faculty of Engineering Professor,

Target year	3rd year students or above	Number of credits	7	Year/semesters	2021/First semester
Days and periods	Tue.3,4,5,Wed.3,4,5,Thu.3,4,5	Class style	Experiment	Language of instruction	Japanese

[Overview and purpose of the course]

先端化学実験第一（実験基礎）を最初に履修した後、先端化学実験第二（物理化学実験）、第三（有機化学実験）、第四（無機化学実験）、ならびに第五（生物化学実験）のうち指示された実験を履修する。

[Course objectives]

特別研究に必須である，実験技術ならびに報告書作成方法を身につける。

[Course schedule and contents]

先端化学実験第一,18回
主として水溶液系での定量分析実験を行う。内容は、化学平衡論を基礎とする重量分析と容量分析である。本実験の目的は、物質の定量的な取扱い方法と測定の基本的な考え方の理解にあり、ガラス器具、電子はかり、測容器などの取扱い法、ならびに溶解、沈殿生成、濾過、恒量操作、測容、滴定、希釈などの基本的操作を習得する。測定データの統計処理の方法および廃液処理についても学ぶ。

先端化学実験第二,18回
熱力学、反応速度、分光学、理論化学計算、材料化学に関する実験を行う。

先端化学実験第三,18回
蒸留操作について習得し、Beckmann転位、カルボニル基の還元、Grignard反応、Wittig反応、Diels-Alder反応、Friedel-Crafts反応、Aldol反応に関する実験、ならびに高分子合成実験を行う。

先端化学実験第四,11回
無機化学における基本的概念を実験を通して習得することを目的として、次の4項目の実験を行う。
1．金属錯体の合成とソルバトクロミズム　2．イオン交換膜・ポリマー膜の膜電位　3．オキソ酸塩のイオン伝導と結晶構造の相関　4．粉末X線回折による結晶構造解析及び電気化学的エネルギー変換　全体を通じて、無機化学（上・下）（シュライバー・アトキンス　第6版）を参考書として用いる。

先端化学実験第五,7回
細胞の形質転換と遺伝子解析ならびに酵素反応の特性とその利用に関する実験を行う。

Continue to 先端化学実験I（先端化学）(2)↓↓↓

[Course requirements]

工業化学科2年生までの配当専門科目を理解していることを強く望む。

[Evaluation methods and policy]

＜評価方法＞
・実験第一
平常点（５０％）、レポート（５０％）
平常点には、実習への参加状況を含む。
・実験第二
平常点（３８％）、レポート（５７％）、プレゼンテーション（５％）
平常点には，実習への参加状況を含む。
・実験第三
平常点（６０％）、レポート（３０％）、試験（１０％）
平常点には，実習への参加状況・受講状況・実験ノートの記述チェックを含む。また、原則としてレポート評点は全てのレポートを提出した場合にのみ与える。
・実験第四
平常点（４０％）、レポート（６０％）
平常点には，実習・講義・講評への参加状況を含む。
・実験第五
平常点（５８％）、レポート（４２％）
平常点には，実験前の講義・実習への参加状況を含む。

＜評価方針＞
実験第一～第五のの評価点（１００点満点）を平均化総合評価とする。ただし、実験第四および実験第五の評価点の重率はそれぞれ、１１／１８、７／１８とする。ただし一つでも不合格（６０点未満）であれば、全体として不合格とする。

[Textbooks]

先端化学コース実験テキスト（先端化学コース関連教員　著）を配布し、それを使用する。

[References, etc.]

（Reference books）
必要であれば適宜指示する。

[Study outside of class (preparation and review)]

授業中に指示する

（Other information (office hours, etc.)）

特別研究に着手するための前段階であるので，実験第１～５の全ての実験に合格せねばならない。不合格になった実験のみ次年度に再履修できる。指定されたクラスで受講すること。
オフィスアワーの詳細については、KULASISで確認してください。

注意：「工業基礎化学実験Ｉ」を、すでに単位修得した学生が「先端化学実験Ｉ」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	先端化学実験II（先端化学） Advanced Chemistry Laboratory II(Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,OGOSHI TOMOKI Faculty of Engineering Professor,

Target year	3rd year students or above	Number of credits	7	Year/semesters	2021/Second semester
Days and periods	Tue.3,4,5,Wed.3,4,5,Thu.3,4,5	Class style	Experiment	Language of instruction	Japanese

[Overview and purpose of the course]

先端化学実験第二（物理化学実験）、第三（有機化学実験）、第四（無機化学実験）、ならびに第五（生物化学実験）のうち指示された実験を履修する。

[Course objectives]

特別研究に必須である，実験技術ならびに報告書作成方法を身につける。

[Course schedule and contents]

先端化学実験第二,18回
熱力学、反応速度、分光学、理論化学計算、材料化学に関する実験を行う。

先端化学実験第三,18回
蒸留操作について習得し、Diels-Alder反応、Beckmann転位反応、Wittig反応、Friedel-Crafts反応、カルボニル基の還元反応、Grignard反応に関する実験、ならびに高分子合成実験を行う。

先端化学実験第四,11回
無機化学における基本的概念を実験を通して習得することを目的として、次の4項目の実験を行う。
1. 金属錯体の合成とソルバトクロミズム　2. イオン交換膜・ポリマー膜の膜電位　3. オキソ酸塩のイオン伝導と結晶構造の相関　4. 粉末X線回折による結晶構造解析及び電気化学的エネルギー変換　全体を通じて、無機化学（上・下）（シュライバー・アトキンス　第6版）を参考書として用いる。

先端化学実験第五,7回
細胞の形質転換と遺伝子解析ならびに酵素反応の特性とその利用に関する実験を行う。

[Course requirements]

工業化学科2年生までの配当専門科目を理解していることを強く望む。

[Evaluation methods and policy]

＜評価方法＞
・実験第二
平常点（３８％）、レポート（５７％）、プレゼンテーション（５％）
平常点には，実習への参加状況を含む。
・実験第三
平常点（６０％）、レポート（３０％）、試験（１０％）
平常点には，実習への参加状況・受講状況・実験ノートの記述チェックを含む。また、原則として

Continue to 先端化学実験II（先端化学）(2)↓↓↓

先端化学実験II（先端化学）(2)

レポート評点は全てのレポートを提出した場合にのみ与える。
・実験第四
平常点（４０％）、レポート（６０％）
平常点には，実習・講義・講評への参加状況を含む。
・実験第五
平常点（５８％）、レポート（４２％）
平常点には，実験前の講義・実習への参加状況を含む。

＜評価方針＞
実験第二～第五のの評価点（１００点満点）を平均化総合評価とする。ただし、実験第四および実験第五の評価点の重率はそれぞれ、１１／１８、７／１８とする。ただし一つでも不合格（６０点未満）であれば、全体として不合格とする。

[Textbooks]

先端化学コース実験テキスト（先端化学コース関連教員　著）を配布し、それを使用する。

[References, etc.]

（**Reference books**）
必要であれば適宜指示する。

[Study outside of class (preparation and review)]

授業中に指示する

（Other information (office hours, etc.)）

特別研究に着手するための前段階であるので，実験第１～５の全ての実験に合格せねばならない。不合格になった実験のみ次年度に再履修できる。指定されたクラスで受講すること。
オフィスアワーの詳細については、KULASISで確認してください。

注意：「工業基礎化学実験Ⅱ」を、すでに単位修得した学生が「先端化学実験Ⅱ」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	生命化学基礎（先端化学） Chemical Basis of Life(Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,ATOMI HARUYUKI Graduate School of Engineering Professor,MORI YASUO Graduate School of Engineering Professor,HAMACHI ITARU Graduate School of Engineering Senior Lecturer,TAMURA TOMONORI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Tue.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

生きているとはどういうことであろうか。生命活動は、数万種類の化学反応系が集積し、システムとして巧妙に制御されることにより営まれている。この講義では、生きているという状態を化学の立場でとらえるための基礎的な知識を解説する。さらに、生命現象の秘密がどのように解き明かされ、現代社会の中で利用されているのか、生命化学の最先端の状況についても解説する。

[Course objectives]

生命現象を化学の立場で理解するための基本的な概念と原理、物質的基盤を修得できる。

[Course schedule and contents]

生命の化学的基礎,2回,生命とは何か、生物の起源と化学進化、生物の進化、組織、細胞や細胞膜など生物の構成単位について概説する
生命を支える分子,2回,アミノ酸、タンパク質、脂質、糖質、核酸など生命活動を支える分子群の構造の特徴と機能について解説する
遺伝子と遺伝情報,3回,ゲノムとは何か、遺伝子からタンパク質を生合成する過程、タンパク質の一生、遺伝子工学について解説する
酵素の働き,3回,酵素とは、反応機構、反応速度、活性調節、酵素の人工改変について解説する
代謝の化学,3回,生体におけるエネルギーとは、生命活動を支える代謝とその調節機構について解説する
生体分子の働き,1回,血液凝固、免疫応答、神経活動、発生と分化、臓器の機能と疾患について解説する
学習到達度の確認,1回,本講義の内容に関する理解度の確認を行う

[Course requirements]

特に必要としない

[Evaluation methods and policy]

平常点評価（40%） レポート（60%）
平常点評価には、授業への参加状況や小テストの評価を含む。
到達目標について、工学部の成績評価の方針に従って評価する。

Continue to 生命化学基礎（先端化学）(2)↓↓↓

生命化学基礎（先端化学）(2)

[Textbooks]

毎回プリントを配布する。

[References, etc.]

（**Reference books**）
・工学系のための生化学 化学同人（ISBN: 9784759814644）
・カラー図解 アメリカ版 大学生物学の教科書 第1-3巻 ブルーバックス
(ISBN:9784062576727, ISBN:9784062576734, ISBN:9784062576741)

[Study outside of class (preparation and review)]

各授業内容についての課題をレポートにまとめて提出する。

（Other information (office hours, etc.)）

注意：「生命化学基礎（工業基礎化学）」を、すでに単位修得した学生が「生命化学基礎Ⅰ(先端化学）」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
A course with practical content delivered by instructors with practical work experience

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

未更新

Course number			
Course title (and course title in English)	無機化学III（先端化学） Inorganic Chemistry III (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,KAGEYAMA HIROSHI Graduate School of Energy Science Associate Professor,TAKAI SHIGEOMI Institute for Chemical Research Professor,MIZUOCHI NORIKAZU Graduate School of Engineering Senior Lecturer,MUROYAMA HIROKI

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Fri.1	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

In this subject, students are taught about the relationship between synthetic methods, structures, and physical properties of inorganic solids using concrete examples.

[Course objectives]

To achieve an even higher level of learning by developing an understanding of the solid-state synthetic methods important for inorganic solids, solid-state characterization, crystal structures, crystallography and diffraction methods, the interpretation of phase diagrams, solid solutions, defects and non‐stoichiometry, and the chemical bonds of solids.

[Course schedule and contents]

Solid-state synthetic methods, 2 sessions
Students are given an explanation on obtaining inorganic solids through solid-phase, liquid -phase, and gas-phase syntheses, ion exchange, electrochemical reactions, thin film, preparation of monocrystals, the hydrothermal method, and so forth.

Solid-state characterization, 2 sessions
Items pertaining to the principles and applications of solid-state characterization, such as optical microscopes, electron microscopes, infrared spectroscopy, Raman scattering, nuclear magnetic resonance, XAFS, and thermal analyses, are explained.

Crystal structures, 2 sessions
Here, the concept of crystal symmetry and crystal structures are explained in relation to one another. By using specific crystals as examples, students are also able to gain an understanding of their formation.

Crystallography and diffraction, 2 sessions
Students are taught the concept of crystallography, structural analysis using diffraction methods, and various characterizations.

Interpretation of phase diagrams, 2 sessions
The thermodynamic basics of phase equilibriums and phase diagrams are explained for one-component and two-component systems. In addition, students are taught about important systems using concrete examples.

Solid solutions, defects and non-stoichiometry, 2 sessions
Students are given an explanation on the structure of solid solutions and how to analyze it. Further, the types

Continue to 無機化学III（先端化学）(2)↓↓↓

of defects that exist in crystals are explained in relation to the physical properties of solids.

Electrical properties, 2 sessions
Materials such as metallic conductors, superconductors, semiconductors, and ionic conductors, along with their electrical properties, are explained.

Confirmation of learning achieved, 1 session
Students' understanding of lecture contents is confirmed.

[Course requirements]

None

[Evaluation methods and policy]

Students are evaluated out of 100 marks based on their result on the end-of-term examination (80%) and their performance in teaching sessions (attendance status and reports, etc.) (20%).

[Textbooks]

Others; West, A.R., Solid State Chemistry and its Applications, 2nd Edition, (Wiley, 2014) ISBN: 9781719942948
Or its translated version
West, A.R., Uesuto kotaikagaku kiso to ouyou (KS kagaku senmonsho) ISBN: 9784061543904

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

Students must read through the applicable chapter before attending each teaching session. Generally, students are required to submit assignments weekly.

（Other information (office hours, etc.)）

Note: If a student has already completed "Inorganic Chemistry III (Basic Industrial Chemistry)" and earns credits for "Inorganic Chemistry III (Advanced Chemistry)," these will be treated as additional credits.

*Please visit KULASIS to find out about office hours.

未更新

Course number			
Course title (and course title in English)	物理化学Ia（先端化学） Physical Chemistry Ia (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Associate Professor,TERAMURA KENTARO Center for the Promotion of Interdisciplinary Education and Research Program-Specific Senior Lecturer,ASAKURA HIROYUKI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Wed.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

Students are taught basic contents related to thermodynamics and chemical kinetics, which are necessary for understanding chemical reactions.

[Course objectives]

Through this subject, which continues from "Physical Chemistry: Fundamentals and Exercises," students will develop the necessary abilities to master applied thermodynamics and reaction kinetics.

[Course schedule and contents]

Lectures cover the following items. For each item, lectures are given at the frequency indicated by [ ], meanwhile confirming the students' understanding. The order in which each item and sub-item is taught in lectures is not fixed; rather it is properly determined by the lecturer based on their policy, as well as on students' background and understanding.

(1) Phases [3 sessions]
The concepts of phases, phase equilibriums, the phase rule, chemical potential
(2) Thermodynamics of solutions [3 sessions]
Partial molar quantity, activity, osmotic pressure, vapor pressure
(3) Chemical equilibriums [3 sessions]
Dynamic equilibriums, standard free enthalpy, equilibriums of non-ideal systems, fugacity
(4) Chemical kinetics [5 sessions]
Chemical reaction rate, rate equation, rate constant and equilibrium constant, collision theory, activated-complex theory, chain reactions, catalytic reactions
(5) Confirmation of learning achieved [1 session]
(6) Feedback [1 session]

[Course requirements]

Students are required to have knowledge from "Physical Chemistry: Fundamentals and Exercises," which is taught during the previous term.

Continue to 物理化学Ia（先端化学）(2)↓↓↓

[Evaluation methods and policy]

Evaluation is based on either regular examinations only (100 marks), or performance in teaching sessions (50 marks) and regular examinations (50 marks).
However, performance in teaching sessions encompasses the mid-term examination, as well as tasks such as preparing for and reviewing lectures.
Obtaining at least 60 out of 100 marks is considered passing, while 59 or below is considered a fail.

[Textbooks]

Not used

[References, etc.]

（**Reference books**）

Moore, W.J. (translated by Fujishiro, R.), Mooa butsuri kagaku (ue) dai 4-ban, (Tokyo Kagaku Dojin, 1974) ISBN: ISBN4-8079-0002-1 (Chapters 6, 7, 8 and 9); Atkins, P., Paula, J. (translated by Nakano, M., Ueda, T., Okumura, M., and Kitagawa, Y.), Atokinsu butsuri kagaku (ue) dai 10-ban, (Tokyo Kagaku Dojin, 2017) ISBN:ISBN978-4-8079-0908-7 (Chapters 4, 5 and 6); Atkins, P., Paula, J. (translated by Nakano, M., Ueda, T., Okumura, M., and Kitagawa, Y.), Atokinsu butsuri kagaku (shita) dai 10-ban, (Tokyo Kagaku Dojin, 2017) ISBN:ISBN978-4-8079-0909-4 (Chapters 20 and 21)

[Study outside of class (preparation and review)]

Students must review contents covered in lectures before taking the end-of-term examination.

（Other information (office hours, etc.)）

Note: If a student has already completed and earned credits from "Physical Chemistry I (Basic Industrial Chemistry)" or "Physical Chemistry Ia (Basic Industrial Chemistry)" and earns credits for "Physical Chemistry Ia (Advanced Chemistry)," these will be treated as additional credits.
* For details on office hours, please check KULASIS.

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	物理化学Ib（先端化学） Physical Chemistry Ib (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,Shu Seki Institute for Chemical Research Professor,WATANABE HIROSHI Institute for Chemical Research Assistant Professor,SATO TAKESHI

Target year	2nd year students or above	Number of credits	2	Year/semesters	2021/Second semester
Days and periods	Thu.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

物理化学は「繰り返し」の学問です。固体物理学とともに，おなじ概念を何度も何度も考え直すことで，最終的に理解が進む分野でしょう。さまざまな自然科学の分野で，「概念（コンセプト）」を会得できるまでには長い時間を要します。さまざまなデータや現象に接したときに，「この条件を変えればこのデータは・この現象はこのような変化をするはずだ」，「このデータ・現象を支配している因子は何なのか，それを調べるためにはこの条件を変化させてみよう」，などが自然と思い浮かぶというのが例えば「概念の体得」にあたります。そういう意味では熱統計力学はとても「物理化学」らしい分野でもあります。そして，いったん考えることをやめてしまったら，多分，一生理解が進まずに，物理化学的なもののとらえ方ができなくなってしまうのでしょう。

この講義では，単なる知識ではない「物理化学的な考え方」を通じ，社会全般・自然界で引き起こされる「現象」を定量的に理解するためのツールの一つとして活用できるようになることを目指しています。

物理化学分野の概念や理論構成のなかでも，私自身が最も「美しいもの」と思う統計力学・統計熱力学の体系を端緒に，授業の前半では主に「エントロピー」に着目した考え方を展開します。特に古典的・歴史的な熱力学による間接的なエントロピーの発見と応用の展開からは一旦離れ，統計理論に基づいた理論的なエントロピーの定義をもとに，現実的な系を表現していきます。後半では特に「エントロピー」をもとにした物質の性質や化学反応への応用を試みます。

ややレトリックな表現かもしれませんが，分子の結晶のような，エントロピーの小さな極限の状態は，だれが見ても美しいと考えると思いますが，さまざまな分子の個性を排除して，エントロピーの極大状態にある熱統計力学系において，それを支配する方程式群は，前者よりももっと美しいとも見えることの体現を目指します。

Repetition of thinking again and again is only the way to master the Physico-Chemical concepts; there is no shortcuts to learn them in principle. This is also the case to learn the concepts in Solid State Physics. Once you master the concepts into yourselves, you will never forget and lose them. It will take a bit longer time to master them, but everybody are able to master them by the “simple repetition of thinking”, however never acquire the concepts if stop the thinking. Mastering the concepts will allow you to judge/make an immediate decision on critical factors controlling data/phenomena in our natural systems, or allow you to interpret the factors changing the systems. This is the “Master of (Physico-Chemical) Concepts”. Statistical mechanics and thermodynamics, the major target of the present class, are representative of Physical Chemistry due to their versatility to reproduce our practical systems.

The major aim of the present class is:
To understand macroscopic phenomena in our practical/natural system quantitatively by an use of Physico-Chemical concepts, particularly on statistical physics.

Continue to 物理化学Ib（先端化学）(2)↓↓↓

In the first half of this class, we start to discuss on quantitative definition of “entropy” based on the simple statistical mechanics, away from the hysterical/conventional definition of entropy in line of classical thermodynamics. The discussions on “statistical entropy” will be extended to represent a variety of intensive variables of some practical system via the concept of “Ensemble”, followed by the discussions on the feasibility of statistical mechanics for understanding the physical properties of matters/chemical reactions.

[Course objectives]

物理化学基礎及び演習で学んだことをもとにして，
１）エントロピーの統計力学的な定義の理解と概念の会得
２）統計力学的に表現できる系の把握
３）現実的な系への拡張を目指したアンサンブルの考え方の会得
４）系を表現するさまざまな巨視的変数への展開
５）分光技術・材料や化学反応への応用
を具体的な学習目標とします。基礎統計力学をもとにして，応用熱力学・化学反応理論などの分野でこれを使いこなすための能力を養うことが目的です。今後誰もが目にする・耳にする情報を正しく判断するために，とても重要な概念・考え方の一つとして統計力学を捉えます。

最終的には、Maxwell-Boltzmannによる古典統計力学の体系で系を表現することの限界と，「なぜ量子論的な取扱いが必要になるのか？」を理解し、一般的な輻射の理論をもとにした量子力学的取り扱いの要請とは異なる，「熱」を中心とした物質の性質を表現するための量子力学的な取扱いの要請に至ることを目指します。

Targets:
1) Definition of entropy by statistical mechanics and understanding the concepts of entropy via mathematical derivations
2) Requisites for statistical mechanical approach to the systems
3) Concepts of ensembles: the extension to the real systems
4) Derivation of a series of intensive variables representative of systems
5) Feasibility of the above concepts to understand the practical systems, spectroscopic techniques, physical properties of matters, and practical chemical reactions.

Finally we approach to the limitations of the classical statistical mechanics, leading to the dawn of quantum mechanical treatment for the thermodynamic bodies: unlikely to the case for the requirements of the treatments in atomic structures/blackbody radiations. We finally discuss on the gap between Maxwell-Boltzmann systems and Fermi-Dirac/Bose-Einstein statistical systems.

[Course schedule and contents]

第1回：統計力学の原理と数学的準備
第2回：エントロピー：熱力学的アプローチと統計力学的定義
第3回： ボルツマンの原理へと至る過程とクラウジウスの理論
第4回：並進運動の速度分布
第5回：相転移における統計力学的取り扱い： 気化と気体の熱容量
第6回：気体分子の速度分布と分配関数
第7回：カノニカルアンサンブルと分配関数

Continue to 物理化学Ib（先端化学）(3)↓↓↓

第8回：分配関数とさまざまな熱力学量の関係
第9回： 統計力学の基礎に関する演習と到達度確認
第10回：弾性とエントロピー
第11回：ブラウン運動と衝突・拡散理論
第12回：アレニウスの式の導出と解釈
第13回：活性錯合体理論と絶対反応速度論
第14回：古典的取り扱いの限界
第15回：統計力学の応用展開と到達度確認

1. Principles of Statistical Mechanics and Entropy; mathematical backgrounds
2. Definition of Entropy: Approaches from statistical mechanics and conventional thermodynamics
3. Boltzmann Principles: Historical reviews starting from the discussions by Clausius
4. Translational Motion of Atoms/Molecules
5. Phase Transitions revisited by Statistical Mechanical Approaches: Heat Capacity of Matters
6. Distribution of Molecular Motions in Gases: Partition Functions
7. Canonical Ensembles: Partition Functions
8. A Varieties of Intensive Variables: in relation to macroscopic thermodynamic systems
9. Fundamental Statistical Mechanics including Exercise
10. Entropy Elasticity
11. Brownian Motions and the Collision Theory of Particles
12. Arrhenius Equation and Law
13. Eyring Equations and the Transition State Theory
14. Limitations of Classical Statistical Mechanics towards Quantum Statistical Mechanics
15. Statistical Mechanics Applications including Exercise

[Course requirements]

None

[Evaluation methods and policy]

以下のA，Bの方式のうち，点数が高い方を採用して評価とします。

A方式：期末テスト（100点）のみ
B方式：出席とQuestion Paper（各回２点）＋ 中間テスト＋期末テスト

試験における各種資料の持ち込みは基本的に認めません。
中間テストの結果については公開KULASISを通じて学籍番号を公表することがあります。

※注意※　中間・期末試験の再試験・追試は行いません。

Scores will be made by the following dual ways (finalized by the better one)

1) Active participation + midterm examination + final examination in total
2) Final examination only

No makeup exam after the final examination.

Continue to 物理化学Ib（先端化学）(4)↓↓↓

[Textbooks]

ムーア 『物理化学（上）』（東京化学同人）ISBN:978-4807900022

[References, etc.]

（Reference books）
吉田武 『オイラーの贈物』（東海大学出版会）ISBN:978-4486018636
Richard P. Feynman 『Feynman Lectures on Physics Vol1』ISBN:978-0465024933
田崎晴明 『統計力学I』（培風館）ISBN:978-4563024376

[Study outside of class (preparation and review)]

”Fermi推定”と言えるような，既知の定数・授業で取り扱う定式化された表現を用いて，登校中・帰宅中などの時間を活用してでも、随時身の回りの現象について考え，事象を定量的に見積もってみることをお勧めします。

Think quantitatively and calculate anything.

（Other information (office hours, etc.)）

オフィスアワーは授業日の夕方１７時から２時間
桂キャンパス　Bクラスタ　A4-009号室

基本的に質問はQuestion Paperを活用してください。
場合によってはe-mailによる質問も受け付けます。

Welcome not only the questions during/at the end of classes, but also the question papers.

注意：「物理化学Ⅰ（工業基礎化学）」もしくは「物理化学Ⅰｂ（工業基礎化学）」をすでに単位修得している学生が「物理化学Ⅰｂ（先端化学）」を履修し単位修得した場合、増加単位となる。

※オフィスアワーの詳細については、KULASISで確認してください。

*Please visit KULASIS to find out about office hours.

Course number			
Course title (and course title in English)	科学英語（先端化学） Scientific English	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MORI YASUO Graduate School of Engineering Professor,SHIRAKAWA MASAHIRO Graduate School of Engineering Associate Professor,MIKI KOUJI Part-time Lecturer,Scott,Joseph Walker
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/Second semester		
Days and periods	Mon.3	Class style	Lecture
Language of instruction	English		

[Overview and purpose of the course]

化学を中心とした科学・工学の英語論文・発表から考えを読み取り、英語の文章で自分の考えを表現・伝達ができるようになるための、実践英語の基礎的能力を身につける。

[Course objectives]

国際的に活躍できるために必要な、実践英語力習得の入門編である。今度の研究論文の作成に向けて、英語で物事の背景、疑問、研究調査の目的・手法・結果・考察、今後の展開などを論理的に英語で表現できるようになる。

[Course schedule and contents]

1回
本科目では講義形式の授業のほか、ワークショップ形式の演習も行う。ワークショップでは、受講生が数グループに分かれて実際に論文の独解ならびに作成を行う。Native Speakerの英語にも触れてもらう。

4回
化学分野を中心とした英語で書かれた科学論文・記事の読解と表現方法の解説をする。

4回,
テクニカルライティング。英語論文を書く上で重要な文章・段落構成、論旨の展開、トピックスセンテンスのおき方などの基本的な決まりごとについて解説する。また、英語論文でよく使われるいいまわし、電子ツールなど論文作成の実際についても触れる。

6回,ワークショップと論文発表。受講生を数グループに分け、実際に論文の読解と作成を行ってもらい、それを講師の指導により、より実践的な論文作成の技能の修得とする。また、作成した論文を発表し、それの効果的な発表のためのテクニックを解説する。

[Course requirements]

工業化学科先端化学コース配属であること。

Continue to 科学英語（先端化学）(2)↓↓↓

[Evaluation methods and policy]

定期的な簡単なレポート

[Textbooks]

特に指定しない

[References, etc.]

（**Reference books**）
なし

[Study outside of class (preparation and review)]

教員が配布するプリントで予習復習を行うこと

（Other information (office hours, etc.)）

学生の要望に応じて開講
講義に支障をきたす大人数になった場合、抽選等で適正人数にする場合があります。

注意：「科学英語（工業基礎化学）」を、すでに単位修得した学生が「科学英語（先端化学）」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
An omnibus course delivered by invited lecturers and guest speakers from different companies, etc.

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number			
Course title (and course title in English)	科学英語（先端化学） Scientific English	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,MORI YASUO Graduate School of Engineering Professor,SHIRAKAWA MASAHIRO Graduate School of Engineering Associate Professor,MIKI KOUJI Part-time Lecturer,BOLSTAD, Francesco
Target year	3rd year students or above	Number of credits	2
Year/semesters	2021/Second semester		
Days and periods	Mon.4	Class style	Lecture
Language of instruction	English		

[Overview and purpose of the course]

化学を中心とした科学・工学の英語論文・発表から考えを読み取り、英語の文章で自分の考えを表現・伝達ができるようになるための、実践英語の基礎的能力を身につける。

[Course objectives]

国際的に活躍できるために必要な、実践英語力習得の入門編である。今度の研究論文の作成に向けて、英語で物事の背景、疑問、研究調査の目的・手法・結果・考察、今後の展開などを論理的に英語で表現できるようになる。

[Course schedule and contents]

1回,本科目では講義形式の授業のほか、ワークショップ形式の演習も行う。ワークショップでは、受講生が数グループに分かれて実際に論文の独解ならびに作成を行う。Native Speakerの英語にも触れてもらう。

4回,化学分野を中心とした英語で書かれた科学論文・記事の読解と表現方法の解説をする。

4回, テクニカルライティング。英語論文を書く上で重要な文章・段落構成、論旨の展開、トピックスセンテンスのおき方などの基本的な決まりごとについて解説する。また、英語論文でよく使われるいいまわし、電子ツールなど論文作成の実際についても触れる。

6回,ワークショップと論文発表。受講生を数グループに分け、実際に論文の読解と作成を行ってもらい、それを講師の指導により、より実践的な論文作成の技能の修得とする。また、作成した論文を発表し、それの効果的な発表のためのテクニックを解説する。

[Course requirements]

工業化学科先端化学コース配属であること。

[Evaluation methods and policy]

定期的な簡単なレポート

Continue to 科学英語（先端化学）(2)↓↓↓

[Textbooks]

特に指定しない

[References, etc.]

（**Reference books**）
なし

[Study outside of class (preparation and review)]

授業中に配布するプリントで予習復習を行うこと

（Other information (office hours, etc.)）

学生の要望に応じて開講

注意：「科学英語（工業基礎化学）」を、すでに単位修得した学生が「科学英語(先端化学）」を履修し単位修得した場合、増加単位となる。

*Please visit KULASIS to find out about office hours.

[Courses delivered by instructors with practical work experience]

(1) Category
An omnibus course delivered by invited lecturers and guest speakers from different companies, etc.

(2) Details of instructors' practical work experience related to the course

(3) Details of practical classes delivered based on instructors' practical work experience

Course number			
Course title (and course title in English)	分析化学II（先端化学） Analytical Chemistry II (Advanced Chemistry)	Instructor's name, job title, and department of affiliation	Graduate School of Engineering Professor,ABE TAKESHI Institute for Chemical Research Professor,KAJI HIRONORI Graduate School of Engineering Associate Professor,NISHI NAOYA Institute for Integrated Radiation and Nuclear Science Associate Professor,TAKAMIYA KOUICHI Graduate School of Engineering Senior Lecturer,TAMURA TOMONORI Graduate School of Engineering Assistant Professor,NAKAO AKITO

Target year	3rd year students or above	Number of credits	2	Year/semesters	2021/First semester
Days and periods	Tue.2	Class style	Lecture	Language of instruction	Japanese

[Overview and purpose of the course]

この講義では， 機器分析化学の入門として、クロマトグラフィー、分光分析法、電気化学分析法、質量分析法、核磁気共鳴法について解説する。

[Course objectives]

化学において欠かすことができない分離・分析の手法を、その原理に重点を置いて理解する。

[Course schedule and contents]

クロマトグラフィー,3回
初めに分離の基本である物質の異なる２相への分配過程についてくわしく解説し、それをベースに、ガスクロマトグラフィー、液体クロマトグラフィー、およびその他の関連する分離技術の理論的基礎と実際にについて、くわしく講述する。（担当： 中尾）

スペクトロスコピー,4回
分光学は物質の同定や定量においてひじょうに重要な分析手法である。最初に、分光学の基礎と分光機器の構造を含む測定原理について解説し、つづいて原子スペクトル分光法をくわしく講述する。さらに、その他の分光学のエッセンスを紹介する。（担当： 西・高宮）

電気分析化学,3回
分析化学Iで習得した電気分析化学測定に必要な基礎事項を復習したあと、電位測定法(ポテンショメトリー)、電量測定法（クーロメトリー）、電流電圧測定法（ボルタンメトリー）の原理、考え方、測定法を解説する。ガラス電極によるpH測定や化学センサーなど、応用についても紹介する。（担当： 安部）

質量分析法,2回
イオン化法，質量分析計器の原理，有機低分子やタンパク質のマススペクトルの例を紹介する。（担当： 田村）

核磁気共鳴法,2回
核磁気共鳴現象の基本原理を概説し、主にスピンと磁場との相互作用、スピン間の相互作用、緩和現象について述べる。また、動的核偏極に関しても少し述べる。（担当： 梶）

Continue to 分析化学II（先端化学）(2)↓↓↓

分析化学II（先端化学）(2)

学習到達度の確認,1回
レポート問題に対する解答および解説を行い、学習到達度を確認する。

[Course requirements]

分析化学I（工業基礎化学）, 基礎物理化学A,B

[Evaluation methods and policy]

期末試験の成績を基本とするが、平常点およびレポートを考慮することがある。

[Textbooks]

Daniel C. Harris 『Quantitative Chemical Analysis』（W. H. Freeman）ISBN:9781464135385（9th-ed.）

[References, etc.]

（**Reference books**）
クリスチャン 『分析化学I 〔原書第６版〕』（丸善）ISBN:9784621075555
Gary D. Christian 『分析化学II 〔原書第６版〕』（丸善）ISBN:9784621075555

[Study outside of class (preparation and review)]

教科書・参考書等を読み、講義で学ぶことを事前に把握するとともに、講義中に十分理解できなかった箇所の理解に努める。

（Other information (office hours, etc.)）

教科書に出てくる重要な単語（分析化学を習得する上で重要な概念）に対応する日本語を表としたプリントを配布する。

注意：「分析化学Ⅱ（工業基礎化学）」を、すでに単位修得した学生が「分析化学Ⅱ(先端化学）」を履修し単位修得した場合、増加単位となる。

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未更新

Course number	U-ENG27 47997 GJ61		
Course title (and course title in English)	特別研究（H18年以降入学者） Graduation Thesis	Instructor's name, job title, and department of affiliation	Graduate School of Engineering ALL STAFF

Target year	4th year students or above	Number of credits	12	Year/semesters	2021/Intensive, year-round
Days and periods	Intensive	Class style	Seminar	Language of instruction	Japanese

[Overview and purpose of the course]

Students are assigned to a laboratory where they will individually pursue research on a topic related to industrial chemistry and write a graduation thesis.

[Course objectives]

Through discussions, debates, and experimental exercises on their research topic, students will acquire research skills such as identifying research issues and solving problems, and will improve their communication abilities by learning to explain academic and technical contents clearly.

[Course schedule and contents]

The structure and contents of teaching sessions are decided between students and academic advisor.
For example, they may consider conducting two seminars a week and assigning an individual task at least once a week, etc.

[Course requirements]

In order to begin graduation research, students must be assigned to a laboratory and meet the number of credits required for their year of admission.

[Evaluation methods and policy]

Students are evaluated comprehensively based on their understanding of the research topic, their completion of exercises, and the oral examination for their graduation thesis.

[Textbooks]

Others; instructions are given in each laboratory.

[References, etc.]

（**Reference books**）

[Study outside of class (preparation and review)]

Students must conduct independent study according to their research topic.

（Other information (office hours, etc.)）

*Please visit KULASIS to find out about office hours.