Academic Year 2023

# Graduate Program and Course Outlines

Graduate School of Science

Tokyo Metropolitan University

Graduate School of Science and Engineering

Tokyo Metropolitan University

# 2023 Academic Calendar

| | | |
|---|---|---|
| First Semester | • Graduate School of Science orientation | April 7 (Fri) |
| | • Entrance ceremony | April 9 (Sun) |
| | • First and First I semesters begin | April 10 (Mon) |
| | • First semester registration period (online) | April 17 (Mon) - April 24 (Mon) |
| | • Registration confirmation due (online) | 5:00 p.m., April 26 (Wed) |
| | • Last week of the First I semester courses | May 29 (Mon) - May 30 (Tue), June 7 (Wed) - June 9 (Fri) |
| | • First II semester begins | June 5 (Mon) - June 6 (Tue), June 14 (Wed) - June 16 (Fri) |
| | • Doctoral degree application due (September completion) | June 9 (Fri) (Scheduled) |
| | • Annual competition with Osaka Metropolitan University | July 1 (Sat) - July 2 (Sun) (Schedule being adjusted) |
| | • Master's degree application due (September completion) | July 10 (Mon) (Scheduled) |
| | • Last week of the First semester courses | July 18 (Tue), July 24 (Mon), July 26 (Wed) - July 28 (Fri) |
| | • Final exams of the First semester courses and last week of the First II semester courses | July 25 (Tue), July 31 (Mon), August 2 (Wed) - August 4 (Fri) |
| | • Substitute final-exam day | August 1 (Tue) |
| | • Summer recess | August 7 (Mon) - September 30 (Sat) |
| Second Semester | • Second and Second I semesters begin | October 2 (Mon) |
| | • Second semester registration period (online) | To be announced on CAMPUSSQUARE and the bulletin board on the first floor of Building 8 |
| | • University festival | November 1 (Wed) - November 5 (Sun) (Preparation and cleanup included) |
| | • Last week of the Second I semester | November 21 (Tue), November 27 (Mon), November 29 (Wed), December 1 (Fri), December 7 (Thu) |
| | • Second II semester begins | November 28 (Tue), December 4 (Mon), December 6 (Wed), December 8 (Fri), December 14(Thu) |
| | • Doctoral degree application due | December 8 (Fri) (Scheduled) |
| | • Winter recess | December 29 (Fri) – January 3 (Wed) |
| | • Second and Second II semesters resume | January 4 (Thu) |
| | • Master's degree application due | January 10 (Wed) (Scheduled) |
| | • Common Test for University Admissions | January 12 (Fri) - January 14 (Sun) (Preparation included) |
| | • Last week of the Second semester courses | January 29 (Mon) - February 2 (Fri) |
| | • Final exams of the Second semester courses and last week of the Second II courses | February 5 (Mon) - February 9 (Fri) |
| | • Substitute final-exam day | February 13 (Tue) |
| | • Spring recess | February 14 (Wed) - March 31 (Sun) |
| | • Graduation and degree conferment ceremonies | To be announced on CAMPUSSQUARE and the bulletin board on the first floor of Building 8 |

* For notifications and information on course registration, degree application, intensive courses, etc., please check the CAMPUSSQUARE and the Graduate School's bulletin board on the first floor of Building 8 regularly.

# Table of Contents

# Organization of the graduate school and basic rules of the courses
## (Graduate School of Science & Graduate School of Science and Engineering | Tokyo Metropolitan University)

### 1. Objectives and Program Structure of the Graduate School

The Graduate School of Tokyo Metropolitan University aims to teach and research specialized academic theories and applications in technical fields of study from a broad perspective in order for students to gain deep knowledge and outstanding abilities to engage in professions that require a high level of expertise. It also aims to improve the lives of Tokyo citizens and develop the culture of Tokyo.

The graduate program is divided into two sections: the first two years (hereinafter referred to as the "master's program") and the next three years (hereinafter the "doctoral program"). The first part of the graduate program is considered to be a master's program.

The master's program aims to enable students to gain deep knowledge and advanced skills to engage in professions that require research skills or a high level of expertise in the field of study from a broad perspective.

The doctoral program aims to enable students to acquire advanced research skills and profound academic knowledge that are the foundations for conducting independent research activities as researchers or engaging in other highly specialized work in their field of study.

### 2. Educational and research objectives of the graduate program

Educational and research objectives of the Graduate School of Science

The master's program of Graduate School of Science aims to enable students to gain a wide range of knowledge, concepts, and methods in natural science as well as developing research skills and flexible problem-solving and presentation skills. It also aims to train students to become researchers, educators, and engineers with an international perspective, creativity, and applicable skills.

The doctoral program of the Graduate School of Science aims to enable students to gain advanced knowledge, concepts, and methods in natural science as well as developing independent research skills and the ability to explore and discover mid- to long-term projects and issues. It also aims to train students to become researchers, educators, and engineers with international leadership, outstanding creativity, and applicable skills.

Educational and research objectives of the Graduate School of Science and Engineering

The master's program of Graduate School of Science and Engineering aims to enable students to gain a wide range of knowledge, concepts, and methods in natural science and science and technology as well as developing research skills and flexible problem-solving and presentation skills. It also aims to train students to become researchers, educators, and engineers with an international perspective, creativity, and applicable skills.

The doctoral program of the Graduate School of Science and Engineering aims to enable students to gain advanced knowledge, concepts, and methods in natural science and science and technology as well as developing independent research skills and the ability to explore and discover mid- to long-term projects and issues. It also aims to train students to become researchers, educators, and engineers with international leadership, outstanding creativity, and applicable skills.

### 3. Structure of the Graduate School

The Graduate School of Science consists of the following majors: (Enrolled in school in 2018 or later)

| | | | |
|---|---|---|---|
| Master's program | Mathematical Sciences | Doctoral program | Mathematical Sciences |
| | Physics | | Physics |
| | Chemistry | | Chemistry |
| | Biological Sciences | | Biological Sciences |

The Graduate School of Science and Engineering consists of the following majors: (Enrolled in school in 2017 or earlier)

| | | | |
|---|---|---|---|
| Master's program | Mathematics and Information Sciences | Doctoral program | Mathematics and Information Sciences |
| | Physics | | Physics |
| | Molecular Materials Chemistry | | Molecular Materials Chemistry |
| | Biological Sciences | | Biological Sciences |
| | Electrical and Electronic Engineering | | Electrical and Electronic Engineering |
| | Mechanical Engineering | | Mechanical Engineering |

## 4. Educational and research objectives of the Graduate School of Science

### Mathematical Sciences

The Department of Mathematical Sciences aims to develop competent individuals with advanced knowledge of mathematics and applied mathematics as well as flexible and original mathematical and scientific thinking skills. It also aims to develop those who can solve various issues in natural science and modern information society while being aware of the importance of mathematical science as a foundation of science.

Upon completing the master's program, students will acquire:

(1) Advanced technical knowledge in mathematical sciences and flexible mathematical thinking skills
(2) The ability to initiate projects and conduct research in a systematic manner independently or under the guidance of the graduate advisor
(3) The ability to clearly express the research findings and the ability to discuss with other researchers Upon completing the doctoral program, students will acquire:
(1) Advanced technical knowledge in mathematical sciences and flexible and original mathematical thinking skills
(2) The ability to conduct original research activities as independent researchers with an international perspective
(3) The ability to objectively evaluate the significance of their own research and its position in society

### Physics

The Department of Physics aims to develop individuals with advanced knowledge and research skills in physics covering the natural world extensively, including elementary particles, substances with various structures, and the universe. It also aims to develop competent individuals who can lead the next generation of advanced science and solve various social and environmental issues based on science.

The master's program aims to develop researchers, professional engineers, and educators specializing in physics as a basis for science and technology, who have basic knowledge in physics and a global perspective and interact with other natural science fields. In order to achieve these objectives, students will acquire:

(1) The basic knowledge necessary for conducting research in physics as well as logical thinking and practical research methods.
(2) The ability to initiate research projects in each field of physics, solve problems, and conduct research individually or under the graduate advisor's guidance, as well as the ability to write logically organized papers and present the research findings.
(3) The ability to discuss with other researchers and the ability to present research findings from a broad perspective.

The doctoral program aims to develop individuals to be independent researchers and research supervisors who can conduct leading research activities in the global arena. The students will develop broad insights into fundamental and applied physics while having the social responsibilities associated with research in mind. The students will acquire:

(1) The extensive knowledge, logical thinking, and practical research methods necessary to identify advanced and important research projects in physics.

(2) The ability to initiate unique research projects in each field of physics, plan and conduct research, and develop the ability to deliver adequate research findings, write the original papers, and publish them in international journals.
(3) The ability to conduct research projects as an independent researcher, engage in international research discussions, and widely present the findings and significance of the research, and associate the research projects with society.

Chemistry

Chemistry is the essential study of natural science that we explore to understand nature at the atomic and molecular levels and the properties and changes of matter. In recent years, chemistry has been significantly integrated with other fields of natural science, ranging from the development of materials such as electronic devices to space, life, and environmental issues. The Department of Chemistry aims to develop chemical researchers, engineers, and educators with extensive knowledge and understanding of chemistry, and a high level of expertise and the ability to make judgments in a broad and comprehensive manner beyond their specialties.

The master's program aims to develop a wide range of basic academic skills in chemistry and the ability to independently initiate research projects, organize the findings in papers, and present them at academic conferences, etc. Students will also develop the ability to perceive issues from a broad perspective and acquire the basic skills for research and providing guidance on technological and educational issues in their specialized fields. Through this program, students will acquire:
(1) The basic knowledge necessary for conducting research in chemistry as well as logical thinking and practical research methods.
(2) The ability to initiate research projects in each field of chemistry, solve problems, and conduct research individually or under the graduate advisor's guidance, as well as the ability to write logically organized papers and present the research findings.
(3) The ability to discuss with other researchers and the ability to present research findings from a broad perspective.

The doctoral program aims to develop individuals who can independently identify and develop research projects from a broad perspective and organize the findings in papers at the international level. The program is also designed to develop individuals who can play active roles in international settings, presenting the research findings at international conferences and providing technical and educational guidance from a broad perspective. The students will acquire:
(1) The extensive knowledge, logical thinking, and practical research methods necessary to identify advanced and important research projects in chemistry.
(2) The ability to initiate unique research projects in each field of chemistry, plan and conduct research, and develop the ability to deliver adequate research findings, write the original papers, and publish them in international journals.
(3) The ability to conduct research projects as an independent researcher, engage in international research discussions, and widely present the findings and significance of the research, and associate the research projects with society.

Biological Sciences

The Department of Biological Sciences aims to develop graduate students with creative research skills, actively engaging in new projects through biological sciences.

The master's program aims to develop the basic skills to set objectives and methods and identify problems independently to understand the basic mechanisms of the growth of organisms, higher-order structures, behavior, and ecology. The program also aims to train students to become researchers, educators, and developers with global perspectives and communication skills to play active roles in Japan and in the international arena.

The doctoral program aims to develop the basic and applicable skills to set objectives and methods and identify problems independently to understand the basic mechanisms of the growth of organisms, higher-order structures, behavior, and ecology. The program also aims to train students to become researchers, educators, and developers with global perspectives and communication skills to play active roles as leaders in Japan and in the international arena.

## 5. Educational and research objectives of the Graduate School of Science and Engineering

### Mathematics and Information Sciences

The Department of Mathematical and Information Sciences aims to develop researchers with outstanding creativity that are highly skilled in fundamental mathematics and information sciences, who are keen to challenge other fields and disciplines, and who can respond to the needs of society. The program is designed to develop individuals who can master the core curriculum of advanced topics in algebra, geometry, and information sciences and conduct integrated research on these topics. The program also aims to develop individuals who can take on the immediate needs of modern society, according to the nature of mathematics as the foundation of various disciplines such as natural sciences.

The master's program provides a curriculum that is in line with the vision of the department, and the students will acquire:

(1) A broad understanding and expertise in mathematics and information sciences.
(2) The ability to gain knowledge from a global perspective.
(3) The ability to systematically develop learning strategies and integrate related issues to solve an issue.

The doctoral program provides a curriculum based on the knowledge gained in the master's program to help students achieve goals. The students will acquire:

(1) A deep and broad understanding and expertise in mathematics and information sciences research.
(2) The ability to conduct innovative and advanced research and to carry out international research activities as an independent researcher in mathematical and information science.
(3) The ability to objectively evaluate the significance of their research and its position in society.

### Physics

The Department of Physics aims to develop individuals with advanced knowledge and research skills in physics covering the natural world extensively, including elementary particles, substances with various structures, and the universe. It also aims to develop competent individuals who can lead the next generation of advanced science and solve various social and environmental issues based on science.

The master's program aims to develop researchers, professional engineers, and educators specializing in physics as a basis for science and technology, who have basic knowledge in physics and a global perspective and interact with other natural science fields. In order to achieve these objectives, students will acquire:

(1) The basic knowledge necessary for conducting research in physics as well as logical thinking and practical research methods.
(2) The ability to initiate research projects in each field of physics, solve problems, and conduct research individually or under the graduate advisor's guidance, as well as the ability to write logically organized papers and present the research findings.
(3) The ability to discuss with other researchers and the ability to present research findings from a broad perspective.

The doctoral program aims to develop individuals to be independent researchers and research supervisors who can conduct leading research activities in the global arena. The students will develop broad insights into fundamental and applied physics while having the social responsibilities associated with research in mind. The students will acquire:

(1) The extensive knowledge, logical thinking, and practical research methods necessary to identify advanced and important research projects in physics.
(2) The ability to initiate unique research projects in each field of physics, plan and conduct research, and develop the ability to deliver adequate research findings, write the original papers, and publish them in international journals.
(3) The ability to conduct research projects as an independent researcher, engage in international research discussions, and widely present the findings and significance of the research, and associate the research projects with society.

## Molecular Materials Chemistry

Chemistry is the essential study of natural science that we explore to understand nature at the atomic and molecular levels and the properties and changes of matter. In recent years, chemistry has been significantly integrated with other fields of natural science, ranging from conventional organic, inorganic, and biological materials to materials related to the ocean, atmospheric environment, and space. The Department of Molecular Materials Chemistry aims to train students to become professionals with extensive knowledge and understanding of chemistry as well as enabling them to have deep expertise and become successful in the international community.

The master's program aims to develop a wide range of basic academic skills in chemistry and the ability to independently initiate research projects, organize the findings in papers, and present them at academic conferences, etc. Students will also develop the ability to perceive issues from a broad perspective and acquire the basic skills for research and providing guidance on technological and educational issues in their specialized fields.

The doctoral program aims to develop individuals who can uniquely identify and develop research projects from a broad perspective, organize the findings in papers at the international level, and present them at international conferences. The program is also designed to develop leaders who can conduct research and provide technical and educational guidance on various issues in their specialized fields from a global perspective based on their research experience while continuing to develop their skills.

## Biological Sciences

The Department of Biological Sciences aims to develop creative researchers who can plan and evaluate in various biological sciences and biology fields. The goals are set for students for each course, and the education and research organizations will provide support for students to achieve their goals. The program covers various fields from micro to macro, microorganisms to higher plants and animals.

The master's program is designed to develop researchers, educators, planners and developers, and business managers in the fields of biological science and biology with a global perspective, creativity, and applicable skills. In order to achieve these objectives, students will acquire:

(1) Extensive knowledge, ways of thinking, and practical methods necessary to conduct research in basic biological sciences and biology, as well as more specialized knowledge, ways of thinking, and practical research methods related to their chosen research topics.

(2) Basic research skills in each field of biological science and biology through initiating new research projects or applied or educational research projects independently or under the graduate advisor's guidance as well as writing papers and presenting the research findings.

(3) Writing and communication skills in English necessary to conduct research and work on the international stage, and the ability to present the research findings to a wide range of audiences.

The doctoral program is designed to develop researchers, educators, planners and developers, and business managers in the fields of biological science and biology with global leadership, exceptional creativity, and applicable skills. In order to achieve these objectives, students will acquire:

(1) Extensive knowledge, ways of thinking, and practical research methods necessary to develop the skills to explore and discover advanced and important topics in basic biological science and biological research.

(2) Independent research skills in each field of basic biological science and biology through initiating new research projects or applied or educational research projects independently, as well as delivering satisfactory research findings and publishing them as original papers in English.

(3) Advanced communication skills in English, which are essential for leading research in the international arena, and the presentation skills to convey the results and significance of research to a broad audience.

## Electrical and Electronic Engineering

The Department of Electrical and Electronic Engineering has a unique curriculum and instruction method for students to acquire advanced specialized knowledge in the field and develop the ability to discover and solve problems.

In the master's program, the students will acquire:

(1) A deep understanding of the fundamentals and latest studies, know-how, and techniques in the field of electrical and electronic engineering.
(2) Engineering knowledge, applicable skills, and creativity that can help contribute to the new development of the industry and society.
(3) A sense of value and mission to make engineering contributions considering the impact of technological development on the sustainable society and the environment, rather than focusing solely
y on producing results.
(4) Skills to continuously fulfill their various responsibilities with a high level of scientific and technological ethics.

In the master's program, the students will acquire:

(1) A deep understanding of the fundamentals and latest studies, know-how, and techniques in the field of electrical and electronic engineering and related fields.
(2) Engineering knowledge, applicable skills, creativity, and a comprehensive perspective to explore unknown technologies and engineering fields that can lead to new developments and technological innovations in the industry and society.
(3) A sense of value and mission to make comprehensive engineering contributions considering the impact of technological development on the sustainable society and the environment, rather than focusing solely on producing results.
(4) Leadership skills with a high level of scientific and technological ethics to fulfill various responsibilities.

## Mechanical Engineering

The field of mechanical engineering has a demand for high-level engineers and creative researchers with flexible thinking who can provide foreknowledge in various manufacturing and advanced technology fields, considering all artificial objects are mechanical. With the social demands, the Department of Mechanical Engineering aims to develop mechanical engineers and researchers specializing in research and development who can materialize their ideas and have skills in manufacturing gained through practical academic training.

The master's program provides a curriculum that helps students achieve academic goals. The students will acquire:

(1) The ability to gain a wide range of interdisciplinary knowledge and information and think and develop independently and organically to solve given problems based on the solid fundamental understanding of mechanical engineering.
(2) Basic research skills by initiating research projects independently or under the graduate advisor's guidance, writing papers, and presenting the research findings regarding "basic research to form the basis of mechanical engineering" or "applied research to contribute to advancing the mechanical industry."
(3) A broad range of communication skills with a global perspective by taking part in joint and collaborative research and development with various private companies and public research institutions and through research activities at overseas universities and international conferences.

The doctoral program provides a curriculum to help students achieve academic goals. The students will acquire:

(1) The ability to gain a wide range of interdisciplinary knowledge and information and think and develop independently and organically to identify and solve the latest problems based on the solid fundamental understanding of mechanical engineering.
(2) Research skills by initiating research projects independently on "basic research to form the basis of mechanical engineering" or "applied research to contribute to advancing the mechanical industry." Students are also expected to deliver satisfactory research results and publish them as original papers in English.
(3) International leadership and a broad range of communication skills necessary for leaders in research and development organizations. The students acquire the skills by actively initiating joint and collaborative research and development with private companies and public research institutions and through research activities at overseas universities and international conferences and publishing original academic papers in English.

## 6. Certification of the program completion

Master's program

In order to complete the master's program, students must complete the two-year enrollment period by attending regular classes, acquiring 30 or more credits of required courses in the master's program, submitting a thesis, and taking the final examination. In this case, if the graduate advisor considers it academically beneficial, up to 10 credits out of the 30 credits may be used as required credits by taking the following courses as prescribed by the graduate school:

- Non-major courses in the graduate program,
- Major courses in other graduate programs, or
- Undergraduate courses

(Collectively referred to as "non-major courses that can fulfill the major's requirements.")

As for the enrollment period for those who are recognized as delivering excellent research results, enrollment in the master's program for one year or more satisfies the requirement. (referred to as "completion with a shortened period of enrollment").

Doctoral program

In order to complete the doctoral program, the students must complete the three-year enrollment period by attending regular classes, acquiring 20 or more credits in the required courses in the doctoral program, submitting a dissertation, and taking the final examination.

As for the enrollment period for those who are recognized as delivering exceptional research results, enrollment in the doctoral program for one year or more shall satisfy the requirement. However, for those who have completed the master's program with one-year enrollment, two-year enrollment satisfies the completion requirement of the doctoral program. (referred to as "completion with a shortened period of enrollment").

## 7. Years of the enrollment period

The regular enrollment period for the master's program shall be two years, and the regular enrollment period for the doctoral program shall be three years.

The enrollment period in the master's program shall not exceed four years, and the enrollment period in the doctoral program shall not exceed six years. However, when exceptionally approved by the Graduate Faculty Committee under particular circumstances, the student may stay enrolled beyond the regular enrollment period.

## 8. The long-term enrollment system

Students who need to plan the enrollment for a certain period beyond the regular enrollment period stated in section 7 above under certain circumstances (employment, childbirth, childcare, nursing care, etc.) may apply for long-term enrollment to be reviewed by the Graduate Faculty Committee. The period for long-term enrollment is either 3 or 4 years for the master's program and 4, 5, or 6 years for the doctoral program from the first day of the enrollment. In this case, tuition fees will be calculated by dividing the total tuition fees for the regular enrollment period by the number of admitted years for the long-term enrollment, which will be due from the following term. The application for current students will be accepted during the first year of the master's program and during the first and second year of the doctoral program. The details of the application period, qualifications, and application form will be announced separately.

## 9. Degrees

In order to complete the master's programs or doctoral program and obtain respective degrees, students must earn the required credits for accredited courses as described in section 6 above and pass the thesis examination and the final examination.

## 10. Courses and credits in the Graduate School of Science and Graduate School of Science and Engineering

Refer to the list of general courses and courses for each department

## 11. Credit acceptance and grades on academic achievement

Credit for courses shall be granted at the end of each semester or academic year based on absolute evaluation of written or oral examinations or research reports, which are scored in accordance with the standards for each course as stated in the “Course Outline”. As a general rule, grading of academic achievement is based on a five-point grade scale, with the top four grades passing.

| Grade | Transcript | | Credit | Assessment standard of academic achievement | 100-point grading scale (approx.) |
|---|---|---|---|---|---|
| 5 | Outstanding | S | ○ | Goal attainment has been satisfactorily achieved and is outstanding. | 90 points or above |
| 4 | Excellent | A | ○ | Goal attainment has been satisfactorily achieved. | 80 – 89 points |
| 3 | Good | B | ○ | Goal attainment has been achieved. | 70 – 79 points |
| 2 | Satisfactory | C | ○ | Minimal goal attainment has been achieved. | 60 – 69 points |
| 1 | (Hidden) | | × | Goas attainment has not been achieved. | 59 points or less |
| 0 | (Hidden) | | × | Not subject to assessment | |

## 12. Course enrollment

(1) After admission to the graduate school, each student shall be assigned a professor (hereinafter referred to as a "graduate/doctoral advisor") who will provide guidance to the student.
(2) At the beginning of each academic year, students shall apply to attend courses for the academic year according to the instruction and need to be admitted for the course enrollment.
(3) Students shall receive guidance from their respective graduate/doctoral advisors on selecting courses, writing theses, and conducting research.
(4) When the graduate/doctoral advisor deems it necessary, the student may take specified courses. (However, non-major courses within the graduate program, major courses of other graduate programs, or undergraduate courses (collectively referred to as "non-major courses that can fulfill the major's requirements
(will not be counted toward the credits required for course completion. Only "non-major courses that can fulfill the major's requirements" will be counted toward the credits required for course completion)

The approval of the Graduate Faculty Committee or Graduate Academic Affairs Committee is required for one of the following two cases:
(1) When the student takes "non-major courses that can fulfill the major's requirements."
(2) When a student becomes a non-degree student to take undergraduate courses required for teacher certification or curator qualification.

The procedures and schedule for course registration for the 2023 academic year are as follows:

- In general, students apply for courses through the student portal site by logging in. (https://jjh.tmu.ac.jp/)
- Students of **the Graduate School of Science**: Select courses with **5-digit** course numbers starting with "R"
- Students of **the Graduate School of Science and Engineering**: Select courses with **4-digit** course numbers starting with "R"
- For non-major courses that can fulfill the major's requirements, students can apply only the courses approved by the Graduate Faculty Committee or Graduate Academic Affairs Committee.

The course registration schedules are as follows:

- Courses offered throughout the year and regular and intensive courses in the first semester
  Registration period : April 17, 2023 – April 24, 2023
  Course confirmation/change deadline : 5 p.m., April 26, 2023
- The registration schedule for regular and intensive courses offered in the second semester will be posted on the student portal CAMPUSSQUARE and the bulletin board on the first floor of Building 8 when available.

- Intensive courses that start in the middle of the year will be posted on the student portal CAMPUSSQUARE and the bulletin board on the first floor of Building 8. Students must register for courses by the designated date (by one week before the first day of the class in principle).

## 13. Questions about grades

For any questions about the course grades in the Graduate School of Science or the Graduate School of Science and Engineering, students shall notify at the window of the Academic Affairs Section of Science within 7 days from the date of grade disclosure (including Saturday, Sunday, and public holidays), fill out the prescribed form, and submit it to them.

## 14. Academic leave of absence, return to school, withdrawal, and removal

### Leave of absence

(1) When the student cannot attend courses for six months or more due to illness or other reasons, the student may apply for a leave of absence to the provost.
(2) A medical leave of absence application must be accompanied by the medical record from the doctor.
(3) A leave of absence cannot exceed one year. However, in the case of special circumstances, an extension of leave of absence may be granted up to one year.
(4) The leave of absence cannot exceed the three years in total for each program.
(5) The period of absence is not counted toward the required years of enrollment.
(6) The period of absence is not counted toward the period of enrollment.
(7) The student needs to repeat the grade in principal after the leave of absence. However, the student will move up to the next grade if the following requirements are met.

| Academic year | 1st year | 2nd year* |
|---|---|---|
| Enrollment period | 12 months or more | 24 months or more |

* Applicable to the doctoral program only

### Return to school

When the leave of absence period ends or the student no longer needs to take a leave of absence, the student may apply for permission to return to school to the provost.

### Withdrawal

(1) In order to withdraw from the school, the student must submit the form with a guarantor's signature to the provost to obtain permission.
(2) If a student has exceeded the allowed enrollment period or is unable to return to school after a leave of absence, the provost shall advise the student to withdraw from school based on the Faculty Committee's decision.

### Expulsion

If a student fails to pay tuition even after the reminder, the provost shall expel the student from school based on the Faculty Committee's decision.

### Payment of tuition

(1) Tuition during the leave of absence will be waived. However, if the leave of absence or return of school starts in the middle of the first or second semester, the student is obliged to pay the tuition for the entire semester.
(2) If a student is allowed to leave school or advised to withdraw or be expelled from school, the student is obliged to pay the tuition for the entire semester.

### Others

In general, the request for a leave of absence, return to school, or withdrawal from school must be submitted to the Academic Affairs Section of Science no later than one month before the date of the leave, return, or withdrawal.

## 15. Research guidance at other graduate schools or research institutes, etc.

If the provost finds that it is academically beneficial for the student, the student may be allowed to receive research guidance at another graduate school or research institute, etc., after having the Graduate Faculty Committee's approval and an agreement or discussion with the other graduate school or institution. (For more information, consult with your graduate/doctoral advisor or the Academic Affairs Section of Science.)

## 16. Courses for teacher certification

In principle, each student must complete at least 24 credits of the major-specific courses (excluding general courses for all majors) Each major has different requirements of courses that can be counted for 24 credits. Therefore, each student shall consult with the Academic Affairs Section of Science for confirmation. Note that non-major courses that can fulfill the major's requirements and related courses cannot be counted toward the credits for this purpose.

## 17. General Courses for All Graduate Programs (Graduate School Career Courses)

These courses are offered by the University Education Center for the purpose of career development of graduate students and is available for all graduate students (master's and doctoral programs).

However, credits from these courses cannot be counted as required credits for program completion.

For course descriptions, see this document and the course syllabi.

## 18. Approval of previously earned credits

Students who have completed or dropped out of other graduate schools, or who have earned credits as a non-degree student, and who are newly admitted to the first year after passing the entrance examination for the Graduate School of Science of TMU, may be granted up to 10 credits in total if the credits they have earned are educationally beneficial and their academic ability is deemed adequate.

Students who wish to receive credits from TMU for the credits that they already earned elsewhere must apply to the Academic Affairs Section of Science and submit the necessary documents within one month of enrollment.

# Graduate School of Science & Graduate School of Science and Engineering | Tokyo Metropolitan University Course Catalog

This course catalog is made for all students of Tokyo Metropolitan University. It includes general courses for all majors, notes for each major, the list of graduate courses, and the course outlines.

Abbreviations and special markings used in the course list are as follows:

Year round : The course is offered throughout the year.

1st : The course is offered in the first semester.

1st A : The course is offered in the first half of the first semester.

1st B : The course is offered in the second half of the first semester.

2nd : The course is offered in the second semester.

2nd A : The course is offered in the first half of the second semester.

2nd B : The course is offered in the second half of the second semester.

1st (Summer) I : The course is offered as an intensive course in the first semester.

2nd (Winter) I : The course is offered as an intensive course in the second semester.

*Intensive courses without a schedule will be posted on the student portal CAMPUSSQUARE and the bulletin board on the first floor of Building 8 when available.

△: The course is not offered in 2023.

# General Courses for All Majors
## (Graduate School of Science & Graduate School of Science and Engineering)

Notes on course enrollment

[Graduate School of Science]

Of general courses, "Selected Topics in Physics and Chemistry I" and "Selected Topics in Physics and Chemistry II" are considered to be courses for Physics and Chemistry majors.

All other courses are considered to be general courses for all majors.

Students may retake the same course for the following courses if respective courses provide different subject matter.

- Selected Topics in Physics and Chemistry I
- Selected Topics in Physics and Chemistry II

[Graduate School of Science and Engineering]

Of general courses, "Selected Topics in Physics and Chemistry I" and "Selected Topics in Physics and Chemistry II" are considered to be courses for Physics and Molecular Materials Chemistry majors.

All other courses are considered to be general courses for all majors.

Students may retake the same course for the following courses if the respective courses provide different subject matter.

- Special Lecture on Science and Engineering I
- Special Lecture on Science and Engineering II
- Selected Topics in Physics and Chemistry I
- Selected Topics in Physics and Chemistry II

2023 Graduate School Course Catalog
(General courses of the Graduate School of Science) (General courses of the Graduate School of Science and Engineering)

* M = master's courses, D = doctoral courses
* NA 2023 = Courses not offered in the academic year 2023

| Course outline | M | D | NA 2023 | Semester | Day of the week | Time | Course Number | | Course Name | Units | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Graduate School of Science | Graduate School of Science and Engineering | | | | |
| 1 | ○ | ○ | | Summer intensive course | | | M(R0005)<br>D (R0006) | D (R006) | Radiation Experiment Ⅰ | 2 | (Chemistry) Shiro Kubuki<br>* Part-time | For all majors. Not allowed to retake this course for both as a general course and a major course |
| 2 | ○ | ○ | | Summer intensive course | | | M(R0007)<br>D (R0008) | D (R008) | Radiation Experiment Ⅱ | 1 | (Chemistry) Shiro Kubuki | For all majors. Not allowed to retake this course for both as a general course and a major course |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Radiation Experiment I | R0005 | | | Summer intensive course | | | 2 |
| Doctoral program | Radiation Experiment I | R0006 | Radiation Experiment I | R006 | | | | |

| Instructor(s) | Note |
|---|---|
| (Chemistry) Shiro Kubuki | For all majors. Not allowed to retake this course for both as a general course and a major course |

| | |
|---|---|
| (1) Course policies and topics | This subject fosters scientific literacy for handling radioisotopes (RI) and radiation. The lectures are composed of physics, chemistry, biology and legal affairs regarding RI and radiation, which instructors give in specialized fields. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The goal of this lecture is that the students who take this lecture can handle RI and radiation properly in terms of scientifically and legally. |
| (3) Course schedule, subject matter, and classroom activities | 1. Physics related to RI and Radiation<br>2. Chemistry related to RI and Radiation<br>3. Biology related to RI and Radiation<br>4. Legal affairs related to RI and Radiation<br>5. Control techniques of RI and Radiation |
| (4) Outside-class activities and assignments | Assigned reports are given to attending students at each end of the experiments. They should be submitted by the deadline. |
| (5) Textbooks and course materials | No textbooks are required because each instructor provides the lecture materials. |
| (6) Assessment and grading | The assigned reports for each subject evaluate the assessment of this lecture. |
| (7) Questions to the instructor (Office hours, etc.) | Each instructor answer students' questions at the end of each experiment because this is a subject of a summer intensive course. |
| (8) Special note | The students who took this lecture in the bachelors' course cannot retake this lecture. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Radiation Experiment II | R0007 | | | Summer intensive course | . | | 1 |
| Doctoral program | Radiation Experiment II | R0008 | Radiation Experiment II | R008 | | | | |

| Instructor(s) | Note |
|---|---|
| (Chemistry) Shiro Kubuki | For all majors. Not allowed to retake this course for both as a general course and a major course |

| | |
|---|---|
| (1) Course policies and topics | This subject aims to understand how to handle isotopes and radiations. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | This lecture aims to learn how to handle radioisotopes and radiations properly in terms of scientifically and legally correct. |
| (3) Course schedule, subject matter, and classroom activities | 1. Experiments in physics related to RI and Radiation<br>(Measurement of radiation dose)<br>2. Experiments in chemistry related to RI and Radiation<br>(Measurement of half-life time of α-ray emitting radioisotope)<br>3. Experiments in biology related to RI and Radiation<br>(In-vitro protein synthesis by using $^{35}S$) |
| (4) Outside-class activities and assignments | Assigned reports are given to attending students at each end of the experiments. They should be submitted them by the deadline. |
| (5) Textbooks and course materials | No textbooks are required because each instructor provides the lecture materials. |
| (6) Assessment and grading | The assigned reports for each subject evaluate the assessment of this lecture. |
| (7) Questions to the instructor (Office hours, etc.) | Each instructor answer students' questions at the end of each experiment because this is a subject of a summer intensive course. |
| (8) Special note | The students who took this lecture in the bachelors' course cannot retake this lecture again. |

# Mathematical Sciences / Mathematics and Information Sciences
## (Graduate School of Science & Graduate School of Science and Engineering)



Notes on course enrollment

### [Mathematical Sciences]

(Master's program)

1. Exercises in Mathematical Sciences is a required course for the master's program in the Graduate School of Science.
2. Seminar in Mathematical Sciences is a required course for the master's program in the Graduate School of Science.
   The first-year students should take the course first.
3. As for the courses marked with an asterisk (*) in the graduate school course catalog (for Mathematical Sciences of the Graduate School of Science), students may retake the same course if the respective courses provide different subject matter.

(Doctoral program)

1. Advanced Seminar in Mathematical Sciences is a required course for the doctoral program in the Graduate School of Science.
   The first-year students should take the course first.
2. As for the courses marked with an asterisk (*) in the graduate school course catalog (for Mathematical Sciences of the Graduate School of Science), students may retake the same course if the respective courses provide different subject matter.

### [Mathematics and Information Sciences]

(Doctoral program)

1. Advanced Seminar in Mathematical and Information Sciences is a required course for the doctoral program in the Graduate School of Science and Engineering.
   The first-year students should take the course first.
2. As for the courses marked with an asterisk (*) in the graduate school course catalog (for Mathematical and Information Sciences of the Graduate School of Science and Engineering), students may retake the same course if respective courses provide different subject matter.

* M = master's courses, D = doctoral courses
* NA 2023 = Courses not offered in the academic year 2023

| Course outline | M | D | NA 2023 | Semester | Day | Time | [Graduate School of Science] | | [Graduate School of Science and Engineering] | | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Course Number | Course Name | Course Number | Course Name | | | |
| 1 | ○ | | | First Semester | Thu. | 2 | M(R0011) | * Special Lectures in Algebra (1) | | | 2 | Hokuto Uehara | This course is also offered in the undergraduate program |
| 2 | ○ | | | First Semester | Tue. | 2 | M(R0012) | * Special Lectures in Algebra (2) | | | 2 | Shigeru Kuroda | This course is also offered in the undergraduate program |
| 3 | ○ | | | Second Semester | Fri. | 4 | M(R0013) | * Special Lectures in Algebra (3) | | | 2 | Hirofumi Tsumura | This course is also offered in the undergraduate program |
| 4 | ○ | | | First Semester | Tue. | 3 | M(R0014) | * Special Lectures in Geometry (1) | | | 2 | Tomohiro Fukaya | This course is also offered in the undergraduate program |
| 5 | ○ | | | Second Semester | Wed. | 3 | M(R0015) | * Special Lectures in Geometry (2) | | | 2 | Asuka Takatsu | This course is also offered in the undergraduate program |
| 6 | ○ | | | Second Semester | Tue. | 2 | M(R0016) | * Special Lectures in Geometry (3) | | | 2 | Masanori Kobayashi | This course is also offered in the undergraduate program |
| 7 | ○ | | | First Semester | Mon. | 2 | M(R0017) | * Special Lectures in Analysis (1) | | | 2 | Kazushi Yoshitomi | This course is also offered in the undergraduate program |
| 8 | ○ | | | Second Semester | Thu. | 2 | M(R0018) | * Special Lectures in Analysis (2) | | | 2 | Kensuke Ishitani | This course is also offered in the undergraduate program |
| 9 | ○ | | | Second Semester | Mon. | 2 | M(R0019) | * Special Lectures in Analysis (3) | | | 2 | Yukihiro Seki | This course is also offered in the undergraduate program |
| 10 | ○ | | | First Semester | Wed. | 4 | M(R0020) | * Special Lectures in Applied Mathematics (1) | | | 2 | Toshio Suzuki | This course is also offered in the undergraduate program |
| 11 | ○ | | | Second Semester | Tue. | 3 | M(R0021) | * Special Lectures in Applied Mathematics (2) | | | 2 | Yukihiro Uchida | This course is also offered in the undergraduate program |
| 12 | ○ | | | Second Semester | Mon. | 4 | M(R0022) | * Special Lectures in Applied Mathematics (3) | | | 2 | Shigenori Uchiyama | This course is also offered in the undergraduate program |
| 13 | ○ | (○) | | First Semester | Fri. | 5 | M(R0023) | * Advanced Topics in Algebra 1 | | | 1 | Hiroo Tokunaga | |
| 14 | ○ | (○) | | Second Semester | Fri. | 3 | M(R0095) | * Advanced Topics in Algebra 2 | | | 2 | Hokuto Uehara | |
| 15 | ○ | (○) | | First Semester | Tue. | 4 | M(R0025) | * Advanced Topics in Geometry 1 | | | 1 | Takashi Sakai | |
| 16 | ○ | (○) | | Second Semester | Thu. | 3 | M(R0027) | * Advanced Topics in Geometry 2 | | | 2 | Tomohiro Fukaya | |
| | ○ | (○) | △ | | . | | M(R0029) | * Advanced Topics in Analysis 1 | | | 1 | | |
| 17 | ○ | (○) | | First Semester | Mon. | 4 | M(R0031) | * Advanced Topics in Analysis 2 | | | 2 | Kazushi Yoshitomi | |
| | ○ | (○) | △ | | | | M(R0049) | * Advanced Topics in Applied Mathematics 1 | | | 1 | | |
| 18 | ○ | (○) | | Second Semester | Fri. | 2 | M(R0051) | * Advanced Topics in Applied Mathematics 2 | | | 2 | Shigenori Uchiyama | |
| | ○ | (○) | | Intensive course | | | | * Intensive Lectures in Algebra 1 | | | 1 | | |
| | ○ | (○) | | Intensive course | | | | * Intensive Lectures in Algebra 2 | | | 2 | | |
| | ○ | (○) | | Intensive course | | | | * Intensive Lectures in Geometry 1 | | | 1 | | |
| | ○ | (○) | | Intensive course | | | | * Intensive Lectures in Geometry 2 | | | 2 | | |
| | ○ | (○) | | Intensive course | | | | * Intensive Lectures in Analysis 1 | | | 1 | | |
| | ○ | (○) | | Intensive course | | | | * Intensive Lectures in Analysis 2 | | | 2 | | |
| | ○ | (○) | | Intensive course | | | | * Intensive Lectures in Applied Mathematics 1 | | | 1 | | |
| | ○ | (○) | | Intensive course | | | | * Intensive Lectures in Applied Mathematics 2 | | | 2 | | |
| | ○ | (○) | | Intensive course | | | | * Intensive Lectures in Mathematical Sciences 1 | | | 1 | | |
| | ○ | (○) | | Intensive course | | | | * Intensive Lectures in Mathematical Sciences 2 | | | 2 | | |
| 19 | ○ | (○) | | First Semester | Wed. | 3 | M(R0033) | ◎Exercises in Mathematical Sciences | | | 1 | Takashi Sakai | Searching and collecting information on mathematics |
| 20 | ○ | | | First Semester | Intensive course | | M(R0034) | ◎Seminar in Mathematical Sciences 1 | | | 3 | Multiple instructors | |
| 20 | ○ | | | Second Semester | Intensive course | | M(R0035) | ◎Seminar in Mathematical Sciences 2 | | | 3 | Multiple instructors | |
| 20 | ○ | | | First Semester | Intensive course | | M(R0036) | ◎Seminar in Mathematical Sciences 3 | | | 3 | Multiple instructors | |
| 20 | ○ | | | Second Semester | Intensive course | | M(R0037) | ◎Seminar in Mathematical Sciences 4 | | | 3 | Multiple instructors | |
| 22 | ○ | | | Intensive course | | | M (R0045) 1 unit M (R0047) 2 units | * Internship in Mathematical Sciences | | | 1 or 2 | Multiple instructors | |
| 13 | (○) | ○ | | First Semester | Fri. | 5 | D (R0024) | * Advanced Topics in Algebra 1 | D (R028) | * Advanced Topics in Geometry 1 | 1 | Hiroo Tokunaga | |
| 14 | (○) | ○ | | Second Semester | Fri. | 3 | D (R0096) | * Advanced Topics in Algebra 2 | D (R096) | * Advanced Topics in Geometry 2 | 2 | Hokuto Uehara | |
| 15 | (○) | ○ | | First Semester | Tue. | 4 | D (R0026) | * Advanced Topics in Geometry 1 | D (R056) | * Advanced Topics in Geometry 1 | 1 | Takashi Sakai | |
| 16 | (○) | ○ | | Second Semester | Thu. | 3 | D (R0028) | * Advanced Topics in Geometry 2 | D (R026) | * Advanced Topics in Geometry 2 | 2 | Tomohiro Fukaya | |
| | (○) | ○ | △ | | | | D (R0030) | * Advanced Topics in Analysis 1 | D (R024) | * Advanced Topics in Algebra 1 | 1 | | |
| 17 | (○) | ○ | | First Semester | Mon. | 4 | D (R0032) | * Advanced Topics in Analysis 2 | D (R030) | * Advanced Topics in Algebra 2 | 2 | Kazushi Yoshitomi | |
| | (○) | ○ | △ | | | | D (R0050) | * Advanced Topics in Applied Mathematics 1 | D (R060) | * Advanced Topics in Information Sciences 1 | 1 | | |
| 18 | (○) | ○ | | Second Semester | Fri. | 2 | D (R0052) | * Advanced Topics in Applied Mathematics 2 | D (R032) | * Advanced Topics in Information Sciences 2 | 2 | Shigenori Uchiyama | |
| | (○) | ○ | | Intensive course | | | | * Intensive Lectures in Algebra 1 | | * Advanced Topics in Algebra 1 | 1 | | |
| | (○) | ○ | | Intensive course | | | | * Intensive Lectures in Algebra 2 | | * Advanced Topics in Algebra 2 | 2 | | |
| | (○) | ○ | | Intensive course | | | | * Intensive Lectures in Geometry 1 | | * Advanced Topics in Geometry 1 | 1 | | |
| | (○) | ○ | | Intensive course | | | | * Intensive Lectures in Geometry 2 | | * Advanced Topics in Geometry 2 | 2 | | |
| | (○) | ○ | | Intensive course | | | | * Intensive Lectures in Analysis 1 | | * Advanced Topics in Analysis 1 | 1 | | |
| | (○) | ○ | | Intensive course | | | | * Intensive Lectures in Analysis 2 | | * Advanced Topics in Analysis 2 | 2 | | |
| | (○) | ○ | | Intensive course | | | | * Intensive Lectures in Applied Mathematics 1 | | * Advanced Topics in Information Sciences 1 | 1 | | |

| Course outline | M | D | NA 2023 | Semester | Day | Time | [Graduate School of Science] | | [Graduate School of Science and Engineering] | | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Course Number | Course Name | Course Number | Course Name | | | |
| | (○) | ○ | | Intensive course | | | | * Intensive Lectures in Applied Mathematics 2 | | * Advanced Topics in Information Sciences 2 | 2 | | |
| 19 | | ○ | | First Semester | Wed. | 3 | D (R0038) | Special Exercises in Mathematical Sciences | D (R038) | Special Exercises in Mathematics and Information Sciences | 1 | Takashi Sakai | Searching and collecting information on mathematics |
| 21 | | ○ | | First Semester | Intensive course | | D (R0039) | ◎Advanced Seminar in Mathematical Sciences 1 | D (R039) | ◎Advanced Seminar in Mathematics and Information Sciences 1 | 4 | Multiple instructors | |
| 21 | | ○ | | Second Semester | Intensive course | | D (R0040) | ◎Advanced Seminar in Mathematical Sciences 2 | D (R040) | ◎Advanced Seminar in Mathematics and Information Sciences 2 | 4 | Multiple instructors | |
| 21 | | ○ | | First Semester | Intensive course | | D (R0041) | ◎Advanced Seminar in Mathematical Sciences 3 | D (R041) | ◎Advanced Seminar in Mathematics and Information Sciences 3 | 3 | Multiple instructors | |
| 21 | | ○ | | Second Semester | Intensive course | | D (R0042) | ◎Advanced Seminar in Mathematical Sciences 4 | D (R042) | ◎Advanced Seminar in Mathematics and Information Sciences 4 | 3 | Multiple instructors | |
| 21 | | ○ | | First Semester | Intensive course | | D (R0043) | ◎Advanced Seminar in Mathematical Sciences 5 | D (R043) | ◎Advanced Seminar in Mathematics and Information Sciences 5 | 2 | Multiple instructors | |
| 21 | | ○ | | Second Semester | Intensive course | | D (R0044) | - Advanced Seminar in Mathematical Sciences 6 | D (R044) | ◎Advanced Seminar in Mathematics and Information Sciences 6 | 2 | Multiple instructors | |
| 22 | | ○ | | Intensive course | | | D (R0046) 1 unit<br>D (R0048) 2 units | * Internship in Mathematical Sciences | D (R046) 1 unit<br>D (R048) 2 units | * Internship in Mathematics and Information Sciences | 1 or 2 | Multiple instructors | |

*Students may retake the same course if respective courses provide different subject matter.
◎ Required course for the major

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lectures in Algebra (1) | R0011 | | | First Semester | Thu. | 2 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Hokuto Uehara | |

| | |
|---|---|
| (1) Course policies and topics | Galois theory, solvability of polynomial equations |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | We learn the proof of the fundamental theorem of Galois theory, and its application. |
| (3) Course schedule, subject matter, and classroom activities | 1-5 Review of field theory<br>6-8 Proof of Galois fundamental theorem<br>9-15 Applications |
| (4) Outside-class activities and assignments | Sometimes homework will be given. |
| (5) Textbooks and course materials | None |
| (6) Assessment and grading | Reports (app. 50%), exams (app/ 50%) |
| (7) Questions to the instructor (Office hours, etc.) | Send an e-mail to<br>hokuto[at]tmu.ac.jp |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lectures in Algebra (2) | R0012 | | | First Semester | Tue. | 2 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Shigeru Kuroda | This course is also offered in the undergraduate program |

| | |
|---|---|
| (1) Course policies and topics | The (multivariate) polynomial ring is a fundamental object in algebra and at the same time a very profound commutative ring. This lecture covers several interesting topics related to homomorphisms between polynomial rings, automorphisms of polynomial rings, and subrings of polynomial rings. The necessary concepts in algebra are reviewed when they are used. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Learn about polynomial rings, related objects and concepts, focusing on the following items, and know the profound world of algebra: Notation for multivariate polynomials, ring homomorphism and automorphism group, amalgamated free product of groups, algebraically independence, polynomial ring over a field of positive characteristic, derivation and locally nilpotent derivation, UFD |
| (3) Course schedule, subject matter, and classroom activities | 1. Commutative rings, polynomial rings<br>2. Elementary transformations<br>3. Substitution maps, generation of a subalgebra<br>4-5. Automorphisms of a polynomial ring<br>6. Nilpotents elements of a ring<br>7-8. Amalgamated free product<br>9. Linearization, diagonalization<br>10. Translations<br>11-13. Locally nilpotent derivations and group actions<br>14. Factorially closed subrings<br>15. Summary and supplement<br><br>The explanation will be given based on the lecture materials. Homework is assigned to confirm comprehension. |
| (4) Outside-class activities and assignments | Homework,<br>Review of the previous lecture |
| (5) Textbooks and course materials | Distribute lecture materials |
| (6) Assessment and grading | Homework, the term paper, participation and activity (total 100%) |
| (7) Questions to the instructor (Office hours, etc.) | Details will be explained during class. When visiting, contact by e-mail in advance. |
| (8) Special note | Prior knowledge is not required, but a basic knowledge of ring and module theory is helpful. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lectures in Algebra (3) | R0013 | | | Second Semester | Fri. | 4 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Hirofumi Tsumura | |

| | |
|---|---|
| (1) Course policies and topics | The aim of this course is to introduce the basic theory of p-adic analysis analogous to complex analysis. Students learn Bernoulli and Euler numbers, complex Dirichlet L-series and their p-analogous objects. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Basic knowledge of general topology, algebra and complex analysis is required. The goal is to understand the theory of p-adic analysis, and consider several applications to number theory. |
| (3) Course schedule, subject matter, and classroom activities | Course schedule:<br>1. A review of topological spaces from the view point of algebra<br>2. Definitions of p-adic valuation and p-adic metric<br>3. Properties of the ring of p-adic integers<br>4. The structure of the ring of p-adic integers<br>5. p-adic exponential and logarithm functions<br>6. Quadratic residues and Hilbert symbols<br>7. Bernoulli and Euler numbers<br>8. The definition of Dirichlet L-series<br>9. Properties of Dirichlet L-series<br>10. p-adic properties of Bernoulli and Euler numbers<br>11. p-adic measure<br>12. The definition of p-adic L-functions<br>13. Properties of p-adic L-functions<br>14. p-adic congruences<br>15. Summary and issues |
| (4) Outside-class activities and assignments | Homework will be provided. |
| (5) Textbooks and course materials | No textbooks will be used.<br>Reference books:<br>Local Fields (Graduate Texts in Mathematics, 67), J.-P. Serre, Springer 1980<br>Number Theory 1: Fermat's Dream, K. Kato, N. Kurokawa and T. Saito, AMS 2000 |
| (6) Assessment and grading | Final issues (70%), activity and homework (30%) |
| (7) Questions to the instructor (Office hours, etc.) | The office hour will be announced in the first lecture. |
| (8) Special note | The following topics is required:<br>General topology (topological spaces, metric spaces)<br>Algebra (groups, rings, fields)<br>Complex analysis (holomorphic functions, residue calculus) |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lectures in Geometry (1) | R0014 | | | First Semester | Tue. | 3 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Tomohiro Fukaya | |

| | |
|---|---|
| (1) Course policies and topics | The purpose of this course is to introduce fundamental groups of topological spaces and show applications. The fundamental group is, as the name suggests, a most fundamental invariant together with homology groups. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The goal is to become familiar with important properties of fundamental groups and to know how to compute them. In addition, you can learn about some of closely related concepts such as group actions and covering spaces. |
| (3) Course schedule, subject matter, and classroom activities | The plan of this course is the following:<br>1. A review of topological spaces<br>2. A sketch on surfaces and manifolds<br>3. Groups and group actions (1) definitions and basic concepts<br>4. Groups and group actions (2) examples<br>5. The fundamental group and homotopies (1) equivalences by homotopies<br>6. The fundamental group and homotopies (2) definition of the fundamental group<br>7. The fundamental group and homotopies (3) induced homomorphism between fundamental groups<br>8. The fundamental group and covering spaces (1) definition of covering space and examples<br>9. The fundamental group and covering spaces (2) relation between covering projections and group actions 10.<br>The fundamental group and covering spaces (3) lifting of maps<br>11. The fundamental group and covering spaces (4) construction of covering spaces<br>12. Computations of the fundamental group (1) representation of groups and the Tietze transformations<br>13. Computations of the fundamental group (2) computation by Van-Kampen's theorem<br>14. Computations of the fundamental group (3) basic results on the fundamental group<br>15. Summary and comments |
| (4) Outside-class activities and assignments | The session time is limited and therefore self-directed learning is important. Students are required to prepare and review for each class. |
| (5) Textbooks and course materials | No textbooks will be used.<br>Reference books: A First Course in Algebraic Topology, Czes Kosniowski, Cambridge University Press, 1980.<br>Isokikagaku (topology), Mitsuyoshi Kato, Shokabo, 1988 (in Japanese).<br>Algebraic Topology by William Fulton |
| (6) Assessment and grading | Attendance (40 per cent) Report ( 60 per cent) |
| (7) Questions to the instructor (Office hours, etc.) | Office hours will be given at the beginning of course. |
| (8) Special note | It is preferable to have some basic knowledge of topological spaces and group theory<br>This class is common to the undergraduate courses.<br>Students who already have the unit of Undergraduate Special Lectures on Geometry (1) cannot take this class. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lectures in Geometry (2) | R0015 | | | Second Semester | Wed | 3 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Asuka Takatsu | This course is also offered in the undergraduate program |

| | |
|---|---|
| (1) Course policies and topics | Lecture on Riemannian geometry; we study on how to measure the length and area in a smoothly curved space. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The purpose of this course is to learn Riemannian geometry and to deepen understanding of properties of curvatures. Students also learn about comparison geometry. |
| (3) Course schedule, subject matter, and classroom activities | This is a lecture-centered course. The contents and schedule are as shown below, but subject to change as needed.<br>no.1: Review 1 (manifold)<br>no.2: Review 2 (tensor)<br>no.3: Riemannian metric<br>no.4: Connection<br>no.5: Parallel translation<br>no.6: Geodesic and exponential map<br>no.7: Curvature<br>no.8: Jacobi fields and space Riemannian distance function<br>no.9: Riemannian distance application of Riemannian distance function<br>no.10: Application of Riemannian distance function<br>no.11: Riemannian volume measure<br>no.12: Application of Riemannian volume measure<br>no.13: Comparison geometry<br>no.14: Brunn—Minkowski inequality<br>no.15:Summary |
| (4) Outside-class activities and assignments | Students are required not only to submit class assignments but also to review each class using handouts |
| (5) Textbooks and course materials | References are handed out at every class. No textbooks will be used but the following book is a reference.<br>Takashi Sakai, *Riemannian Geometry* (Translations of Mathematical Monographs), ISBN-13 : 978-0821802847. |
| (6) Assessment and grading | class participation + report = 100% |
| (7) Questions to the instructor (Office hours, etc.) | Office hours will be given at the beginning of course. |
| (8) Special note | Those who are interested in this course are supposed to have some knowledge on Manifold theory (Geometry A) and Differential form (Geometry B). |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lectures in Geometry (3) | R0016 | | | Second Semester | Tue. | 2 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Masanori Kobayashi | |

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|---|---|
| (1) Course policies and topics | Lecture on Morse Theory |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | For a smooth function, the point at which the derivative vanishes is called the "critical point". A manifold can be decomposed into neighborhoods (handles) of critical points of an appropriate function and undersood combinatorially. Morse theory, which you will learn, is a classical theory of differential topology that has been applied to a wide variety of problems up to the present day.<br>As a development of the Morse lemma used in the theory, the following topics are also touched upon: a classification of degenerate critical points, analytic function, the preparation theorem as a generalization of the implicit function theorem. |
| (3) Course schedule, subject matter, and classroom activities | 1 critical points of a function on a manifold<br>2 the Hessian matrix<br>3 the Morse lemma<br>4 Sard's theorem<br>5 Whitney's embedding theorem<br>6 Morse function<br>7 integral curve of a vector field<br>8 handle decomposition<br>9 Morse's inequality<br>10 the preparation theorem<br>11 the Milnor number<br>12 Mather's theorem<br>13 Tom's splitting lemma<br>14 catastrophe theory<br>15 supplement and summary<br>*The order of the items may be subject to change.<br>Classes will be conducted in lecture form. |
| (4) Outside-class activities and assignments | A small assignment for review will be given. |
| (5) Textbooks and course materials | Textbooks are not specified. References are as follows.<br>J. Milnor, Morse Thoery, Princeton Univ. Press.<br>Y. Matsumoto, Introduction to Morse Theory, AMS.<br>S. Izumiya and G. Ishikawa, Ouyou Tokuitenron (Applied Singularity Theory), Kyoritsu Publishing Co. (in Japanese). |
| (6) Assessment and grading | Evaluation will be based on the submitted assignment (40%) and final report (60%).<br>No exams. |
| (7) Questions to the instructor (Office hours, etc.) | Office Hours: Monday 4$^{th}$ period @ 8-670 (tentative) |
| (8) Special note | This lecture is related to Special Lectures in Geometry (1) (homotopy theory). |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lectures in Analysis (1) | R0017 | | | First Semester | Mon. | 2 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Kazushi Yoshitomi | This course is also offered in the undergraduate program |

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|---|---|
| (1) Course policies and topics | Functional Analysis |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | We learn the fundamentals in functional analysis. |
| (3) Course schedule, subject matter, and classroom activities | 1. Normed vector spaces, Banach spaces, examples<br>2. L^p space, bounded linear operators<br>3. Dual Spaces<br>4. Second dual spaces, completion<br>5. The Hahn-Banach theorem<br>6. Direct sums and quotient spaces of Banach spaces<br>7. The Baire category theorem, the Banach-Steinhaus theorem<br>8. Open mapping theorem, inverse mapping theorem<br>9. Closed graph theorem<br>10. Hilbert spaces<br>11. Orthogonal projection, the Riesz theorem<br>12. Compact operators<br>13. The Fredholm alternative<br>14. Spectrum of self-adjoint operators<br>15. Summary |
| (4) Outside-class activities and assignments | Sometimes homework will be given. |
| (5) Textbooks and course materials | ・M. Fabian, P. Habala, P. Hajek, V. Montesinos, V. Zizler, Banach Space Theory, CMS Books in Mathematics, Springer, 2011.<br>・F. Riesz and B. Sz.-Nazy, Functional Analysis, Dover, 1990.<br>・T. Kato, Perturbation Theory for Linear Operators, Springer. |
| (6) Assessment and grading | Reports (100%) |
| (7) Questions to the instructor (Office hours, etc.) | Send an e-mail to yositomi[at]tmu.ac.jp |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lectures in Analysis (2) | R0018 | | | Second Semester | Thu. | 2 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Kensuke Ishitani | |

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|---|---|
| (1) Course policies and topics | The first half of the lecture will cover elementary statistics, while the second half of the lecture will cover modern probability theory. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | 1. In this lecture, students will be able to understand various concepts of probability theory, acquire basic knowledge of probability theory, and understand how to construct the logic of probability theory.<br>2. In this lecture, students will be able to understand the implications of various concepts of probability theory in real-world problems. Furthermore, this lecture will enable students to apply probability theory to solve social problems. |
| (3) Course schedule, subject matter, and classroom activities | 1-3. Elementary Statistics.<br>4-15. Modern Probability Theory |
| (4) Outside-class activities and assignments | In each lecture, homework will be given. One should prepare enough before each lecture. |
| (5) Textbooks and course materials | Some useful references will be suggested in the class. |
| (6) Assessment and grading | Test (50%), report (50%). |
| (7) Questions to the instructor (Office hours, etc.) | If one have questions, make an appointment via email. (k-ishitani@tmu.ac.jp) |
| (8) Special note | Check the information of this class on kibaco. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lectures in Analysis (3) | R0019 | | | Second Semester | Mon. | 2 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Yukihiro Seki | |

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|---|---|
| (1) Course policies and topics | Study basic materials on distribution theory, Sobolev spaces and their applications to differential equations. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The purpose of this lecture is to learn the basic materials on the distribution theory, Sobolev spaces and their applications to partial differential equations.<br>Moreover, this course aims to improve one's knowledge on the subject and the logical mathematical thinking. |
| (3) Course schedule, subject matter, and classroom activities | 1. Lebesgue spaces, mollifier<br>2. The distribution theory, derivatives of the distribution<br>3. The rapidly decreasing functions, the inversion formula of the Fourier transform<br>4. The tempered distributions and their Fourier transform<br>5. Sobolev spaces and their fundamental properties<br>6. Sobolev's embedding theorem, the extension theorem<br>7. Sobolev's inequality, the compactness theorem<br>8. Elliptic boundary value problems<br>9. Elliptic regularity theorems for weak solutions<br>10. Eigenvalue problems<br>11. Fredholm theory<br>12. Introduction to variational methods<br>13. Fixed point theorems<br>14. Sub- and supersolutions method<br>15. Summary<br>This is a lecture-centered course. Solving exercises (report) helps students in understanding the subject. |
| (4) Outside-class activities and assignments | Complementary notes will be provided when the necessary. Consult them as well as the references appropriately. |
| (5) Textbooks and course materials | 1. A course in Sobolev Spaces -with applications to Partial Differential Equations, by S. Miyajima, Kyoritsu Shuppan, Co., Ltd. (in Japanese) 2. Functional Analysis and Partial Differential Equations, by H. Brezis, Springer (e-Book is available at the Mathematical Library) 3. Partial Differential Equations, by L.C. Evans, Amer. Mas. Soc. |
| (6) Assessment and grading | Evaluation is performed by an intermediate report (50%) and a final report (50%). |
| (7) Questions to the instructor (Office hours, etc.) | Office hours and the contact information for the lecturer will be given at the beginning of the course. |
| (8) Special note | Basic materials in the Lebesgue integration theory and the functional analysis are required. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lectures in Applied Mathematics (1) | R0020 | | | First Semester | Wed. | 4 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Toshio Suzuki | |

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|---|---|
| (1) Course policies and topics | This is an introduction to logic in 20th century and its application. Logical formulas defines various interesting structures across mathematics, computer science, and philosophy. Logic is a mathematical science of such structures. This year we learn completeness theorem of predicate logic. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | We learn first-order logic with a focus on Gödel-Henkin completeness theorem (logical thinking). Completeness theorem shows a beautiful relationship between syntax and semantics of first-order logic. Among some known proofs of completeness theorem, we employ analytic tableaux and the fundamental theorem of quantification theory developed by Smullyan (Basic knowledge and understanding of specialized fields). |
| (3) Course schedule, subject matter, and classroom activities | 1. König's lemma<br>2-3. Analytic tableaux for propositional logic<br>4-5. Compactness theorem and completeness theorem of propositional logic<br>6-9. Analytic tableaux for predicate logic<br>10-11. The fundamental theorem of quantification theory<br>12-13. Completeness theorem of predicate logic<br>14-16. Advanced topics (Genzen's LK, equality symbol and function symbols) |
| (4) Outside-class activities and assignments | You are expected to prepare and review each time by reading the textbook. |
| (5) Textbooks and course materials | Kazuyuki Tanaka: Gödel and logic in the 20th century volume 2, University of Tokyo Press, 2006 (written in Japanese). |
| (6) Assessment and grading | It is 50 percent the term paper, and 50 percent the others (including assignments) |
| (7) Questions to the instructor (Office hours, etc.) | My office our is 5th period of Monday. |
| (8) Special note | - A book in English with similar content: Raymond Smullyan: First-order logic, Dover, 1968, 1995.<br>- Check the information of this course on kibaco. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lectures in Applied Mathematics (2) | R0021 | | | Second Semester | Tue. | 3 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Yukihiro Uchida | |

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|---|---|
| (1) Course policies and topics | This course will provide basics on algebraic number theory from the viewpoint of algorithmic number theory. As applications, two factoring methods, the quadratic sieve and the number field sieve will be explained. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Students learn basics on algebraic number theory (prime ideal decomposition, finiteness of the ideal class group, Dirichlet's unit theorem, and so on) with related number theoretic algorithms. They also learn factoring algorithms such as the quadratic sieve and the number field sieve. |
| (3) Course schedule, subject matter, and classroom activities | The schedule of this course is below. The following schedule may be changed according to circumstances.<br>1. Introduction and guidance<br>2. Integral extensions and integrally closed domains<br>3. Algebraic extensions and conjugates<br>4. Norms and traces<br>5. Discriminants<br>6. Noetherian rings<br>7. Dedekind rings<br>8. Prime ideal decomposition<br>9. Prime ideal decomposition of a prime number in a number field<br>10. Minkowski's theorem<br>11. Finiteness of the ideal class group<br>12. Dirichlet's unit theorem<br>13. Quadratic sieve<br>14. Outline of the number field sieve<br>15. Details of the number field sieve |
| (4) Outside-class activities and assignments | The contents of each lecture should be reviewed. Some assignments will be given. |
| (5) Textbooks and course materials | There are no specific texts. As references, three books are suggested below and other references will be suggested if necessary.<br>P. Samuel, Algebraic Theory of Numbers, Hermann, 1970.<br>F. Jarvis, Algebraic Number Theory, Springer, 2014.<br>R. Crandall, C. Pomerance, Prime Numbers: A Computational Perspective, Springer, 2nd ed., 2005. |
| (6) Assessment and grading | Participation and activity (30%), report (70%) |
| (7) Questions to the instructor (Office hours, etc.) | Office hours will be announced in the first lecture and posted on the instructor's web page. Please visit the instructor's room (8-667) during the office hours if you have any questions. |
| (8) Special note | - The prerequisite for this course is a basic knowledge of groups, rings, and fields.<br>- Students are recommended to attend the first lecture in which a detailed guidance about the overview, assessment, and grading will be given.<br>- For information of this course and the instructor's contact details, please see kibaco and the instructor's web page:<br>https://www.comp.tmu.ac.jp/y-uchida/ |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lectures in Applied Mathematics (3) | R0022 | --- | --- | Second Semester | Mon. | 4 | 2 |
| Doctoral program | --- | --- | --- | --- | | | | |

| Instructor(s) | Note |
|---|---|
| Shigenori Uchiyama | This course is also offered in the undergraduate program |

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|---|---|
| (1) Course policies and topics | This lecture will focus on computational number theory with applications to cryptography, code theory. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Modern cryptography and code theory have their mathematical scientific basis in computational theory and computer algebra (in particular, computational number theory). Here, we will study the theory of computational number theory from the standpoint of applied algebra. The first half of the lecture focuses on the fundamentals of p-adic analysis, applications to cryptography and code theory, and the second half of it will cover representative number theory algorithms. |
| (3) Course schedule, subject matter, and classroom activities | The class schedule is as follows. However, it may be changed depending on the situation.<br>1. Introduction and guidance<br>2. Valuation<br>3. Norm fields<br>4. Completeness of norm fields<br>5. p-adic special functions and the Fermat quotient<br>6. Hensel's lemma<br>7. Some cryptographic schemes<br>8. Mid-term summary and report<br>9. Fundamentals of computation theory<br>10. Primality testing algorithm<br>11. Elliptic curves<br>12. Elliptic curve primality test<br>13. Prime factorization algorithm<br>14. Applications to cryptography<br>15. Summary and report |
| (4) Outside-class activities and assignments | Some practical problems will be given in a class, so be sure to solve them before the next class. |
| (5) Textbooks and course materials | The textbook will not be specified, but some useful references will be introduced as necessary. |
| (6) Assessment and grading | Evaluation will be based on class participation (30%) and reports (70%). |
| (7) Questions to the instructor (Office hours, etc.) | If you have any questions, they are always welcome.<br>Email address: uchiyama-shigenori@tmu.ac.jp |
| (8) Special note | Basic knowledge of integers, congruences, polynomials, and finite fields is assumed as prior knowledge.<br>In the first class, detailed guidance will be given on the outline of the course and grading methods.<br>It is recommended to attend.<br>Important information about the class will be provided through the e-learning system, kibaco.<br>Please be sure to check it. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Topics in Algebra1 | R0023 | | | First Semester | Fri. | 5 | 1 |
| Doctoral program | Advanced Topics in Algebra1 | R0024 | Advanced Topics in Geometry1 | R028 | | | | |

| Instructor(s) | Note |
|---|---|
| Hiroo Tokunaga | |

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|---|---|
| (1) Course policies and topics | Among algebraic curves, hyperelliptic and elliptic curves are in special positions. In this lecture, representations for divisors on hyperelliptic (elliptic) curves are explained from the scratch and descriptions via Groebner bases are given. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Student learn basic knowledge to deal with the divisor class group of hyperelliptic curves through two representations: Mumford representation and Leitenberger representation. Our goals are to understand that these two relations are related through Groebner bases and the addition on the Jacobian in terms of operations of ideals. |
| (3) Course schedule, subject matter, and classroom activities | 1. Hyperelliptic curves and elliptic curves.<br>2. Coordinate rings and the field of rational functions.<br>3. Divisors.<br>4., 5, 6. Representations of divisors, Groebner bases and the addition on the divisor class group.<br>7, 8. Applications: 0-dimesional ideal, explicit descriptions of the addition on the Jacobian, etc<br>The above plan can be changed based on attending students. Detail will be found in the kibaco |
| (4) Outside-class activities and assignments | Those who attend at the class are expected to work with some assignments. |
| (5) Textbooks and course materials | 1. A.J. Menezes, Y.-H. Wu and R.J.Zuccherato: An elementary introduction to hyperelliptic curves, in 'N.Koblitz:Algebraic Aspects of Cryptography'<br>2. Some other references will be given. |
| (6) Assessment and grading | Attendance and assignments |
| (7) Questions to the instructor (Office hours, etc.) | Students who have questions are supposed to make appointments via email in advance. The instructor's address will be given In the 1st lecture. |
| (8) Special note | Those who take this course are supposed to have some knowledge on plane algebraic curves and surfaces, in particular, elliptic curves and their group structure. Also some knowledge on the theory of Groebner bases will be assumed. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced topics in Algebra 2 | R0095 | | | Second Semester | Fri. | 3 | 2 |
| Doctoral program | Advanced topics in Algebra 2 | R0096 | Advanced Topics in Geometry 2 | R096 | | | | |

| Instructor(s) | Note |
|---|---|
| Hokuto Uehara | |

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|---|---|
| (1) Course policies and topics | We study special phenomena for algebraic varieties over positive characteristic fields. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The goal of this course to become familiar with several properties for algebraic varieties over positive characteristic fields. |
| (3) Course schedule, subject matter, and classroom activities | 1. differential sheaf and tangent sheaf<br>2. Frobenius morphisms<br>3. 4. 5. Foliation and inseparable morphisms<br>6. 7. Frobenius descent<br>8. 9. Finite group action and G-equivalent sheaves<br>10. 11. 12. Algebraic surfaces in positive characteristics<br>13. 14. 15. Miscellaneous |
| (4) Outside-class activities and assignments | Sometimes homework will be given. |
| (5) Textbooks and course materials | Miyaoka--Peternell "Geometry of Higher Dimensional Algebraic Varieties"<br>Liedtke "Algebraic Surfaces in Positive Characteristic"<br>Katz "Nilpotent connections and the monodromy theorem" |
| (6) Assessment and grading | Reports |
| (7) Questions to the instructor (Office hours, etc.) | Send an e-mail to<br>hokuto[at]tmu.ac.jp |
| (8) Special note | Students are required to have knowledge in the Hartshorne's book "Algebraic Geometry". |

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| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Topics in Geometry 1 | R0025 | — | — | First Semester | Tue. | 4 | 1 |
| Doctoral program | Advanced Topics in Geometry 1 | R0026 | Advanced Topics in Geometry 1 | R056 | | | | |

| Instructor(s) | Note |
|---|---|
| Takashi Sakai | |

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|---|---|
| (1) Course policies and topics | In this class, we start with basics of Riemannian geometry and the theory of Lie groups and Lie algebras. Then we introduce Riemannian symmetric spaces and their generalizations. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The goal is to acquire foundations of the theory of symmetric spaces and their generalizations. |
| (3) Course schedule, subject matter, and classroom activities | 1. Riemannian manifolds<br>2. Lie groups and Lie algebras<br>3. Compact Lie groups and semisimple Lie groups<br>4. Riemannian symmetric spaces<br>5. Riemannian symmetric pairs<br>6. Semisimple Riemannian symmetric spaces<br>7-8. Γ-symmetric spaces |
| (4) Outside-class activities and assignments | Preparation and review on the lecture notes and references |
| (5) Textbooks and course materials | M. Ise and M. Takeuchi, Lie groups I, II, Iwanami. (in Japanese)<br>A. Arvanitoyeorgos, An Introduction to Lie Groups and the Geometry of Homogeneous Spaces, AMS.<br>S. Helgason, Differential Geometry, Lie Groups, and Symmetric Spaces, AMS.<br>O. Loos, Symmetric Spaces I, II, W. A. Benjamin. |
| (6) Assessment and grading | Participation and activity (40%), report (60%) |
| (7) Questions to the instructor (Office hours, etc.) | See the following web page:<br>https://www.comp.tmu.ac.jp/tsakai/ |
| (8) Special note | It is desirable to know differentiable manifolds, vector fields and differential forms. |

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| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Topics in Geometry 2 | R0027 | | | Second Semester | Thu. | 3 | 2 |
| Doctoral program | Advanced Topics in Geometry 2 | R0028 | Advanced Topics in Geometry 2 | R026 | | | | |

| Instructor(s) | Note |
|---|---|
| Tomohiro Fukaya | |

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|---|---|
| (1) Course policies and topics | The persistent homology is one of the most important tools in Topological Data Analysis. This course provides a mathematical foundation of the persistent homology. |

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|---|---|
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Mathematical foundation of the persistent homology and its stability for noise. An algorithm for computations. |
| (3) Course schedule, subject matter, and classroom activities | The plan of this course is the following:<br>1. An overview of Topological Data Analysis<br>2. Simplicial complex<br>3. Simplicial homology<br>4. Singular homology<br>5. Rips complex<br>6. Filtration<br>7. Persistent homology<br>8. Persistent diagram<br>9. Persistent homology as a graded module<br>10. Algorithm for computation<br>11. Proof of the algorithm<br>12. Stability 1: Bottle-Neck distance<br>13. Stability 2: Interleaving distance<br>14. Stability 3: The Stability Theorem<br>15. Summary |
| (4) Outside-class activities and assignments | The session time is limited and therefore self-directed learning is important. Students are required to prepare and review for each class. |
| (5) Textbooks and course materials | No textbooks will be used. |
| (6) Assessment and grading | Attendance (40 per cent) Report ( 60 per cent) |
| (7) Questions to the instructor (Office hours, etc.) | Office hours will be given at the beginning of course. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Topics in Analysis 2 | R0031 | | | First Semester | Mon. | 4 | 2 |
| Doctoral program | Advanced Topics in Analysis 2 | R0032 | Advanced Topics in Algebra 2 | R030 | | | | |

| Instructor(s) | Note |
|---|---|
| Kazushi Yoshitomi | |

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|---|---|
| (1) Course policies and topics | Pseudo-differential operators |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | We learn the fundamentals in the theory of pseudo-differential operators. |
| (3) Course schedule, subject matter, and classroom activities | 1. The Schwartz space, tempered distributions<br>2-4. Symbols classes, sub-linear weights, temperate weights<br>5. Planck function, strong uncertainty principle<br>6. Asymptotic expansion of symbols<br>7-8. The definition of pseudo-differential operators and their basic properties<br>9-13. Parameter change of symbols and associated asymptotic expansions<br>14-15. Adjoint and transpose of pseudo-differential operators |
| (4) Outside-class activities and assignments | Sometimes homework will be given. |
| (5) Textbooks and course materials | ・F. Nicola and L. Rodino, Global Pseudo-Differential Calculus on Euclidean Spaces, Springer Basel AG, 2010. ISBN: 978-3-7643-8511-8. |
| (6) Assessment and grading | Reports (100%) |
| (7) Questions to the instructor (Office hours, etc.) | Send an e-mail to yositomi[at]tmu.ac.jp |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Topics in Applied Mathematics 2 | R0051 | --- | --- | Second Semester | Fri. | 2 | 2 |
| Doctoral program | Advanced Topics in Applied Mathematics 2 | R0052 | Advanced Topics in Information Sciences 2 | R032 | | | | |

| Instructor(s) | Note |
|---|---|
| Shigenori Uchiyama | |

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|---|---|
| (1) Course policies and topics | Lecture on the basic mathematics of quantum computers. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Although a large-scale practical quantum computer has not been realized yet, here we will learn the basic mathematics of a mathematical model called a quantum Turing machine and some quantum algorithms that will be used as examples. The purpose of this lecture is to learn the basic mathematics of a mathematical model called a quantum Turing machine and some quantum algorithms that can be used as concrete examples. |
| (3) Course schedule, subject matter, and classroom activities | The class schedule is as follows. However, it may be changed depending on the situation.<br>1 Introduction and guidance<br>2.New computer models<br>3 Realization of quantum computers<br>4 Introduction to computational theory<br>5 Tensor product vector space (Part 1)<br>6.Tensor product vector space (Part 2)<br>7 Mathematical models of quantum computers<br>8. Mid-term summary and report<br>9. Simple quantum computers<br>10. Discrete integral transformation<br>11. Deutsch-Jozsa's decision algorithm<br>12. Grover's search algorithm<br>13. Shor's prime factorization algorithm<br>14. Applications to cryptography<br>15. Summary and report |
| (4) Outside-class activities and assignments | Some practical problems will be given in a class, so be sure to solve them before the next class. |
| (5) Textbooks and course materials | The textbook will not be specified, but some useful references will be introduced as necessary. |
| (6) Assessment and grading | Evaluation will be based on class participation (30%) and reports (70%). |
| (7) Questions to the instructor (Office hours, etc.) | If you have any questions, they are always welcome.<br>Email address: uchiyama-shigenori@tmu.ac.jp |
| (8) Special note | In the first class, detailed guidance will be given on the outline of the course and grading methods.<br>It is recommended to attend.<br>Important information about the class will be provided through the e-learning system, kibaco.<br>Please be sure to check it. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Exercises in Mathematical Sciences | R0033 | — | — | First Semester | Wed. | 3 | 1 |
| Doctoral program | Special Exercises in Mathematical Sciences | R0038 | Special Exercises in Mathematics and Information Sciences | R038 | | | | |

| Instructor(s) | Note |
|---|---|
| Takashi Sakai | |

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|---|---|
| (1) Course policies and topics | In the study of mathematics, one needs various skills such as collecting research information and giving research presentations. This course is an exercise class for beginners of mathematical research to train these abilities. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The purpose of this course is to acquire and improve basic skills of collecting research information and learning/studying mathematics by practical training. Moreover, this course is aimed to improve the abilities to write mathematical articles and to give presentations. |
| (3) Course schedule, subject matter, and classroom activities | 1. Searching and collecting information of mathematical research:<br>- How to use library services and electronic journals<br>2. Searching and collecting information of mathematical research:<br>- How to utilize the database of mathematical literature and preprint servers<br>3-4. Introduction to LaTeX: Basics<br>5. Introduction to LaTeX: Practical use<br>6-7. Presentation: Making slides and posters, giving research presentations<br>8. Writing mathematical articles by using LaTeX |
| (4) Outside-class activities and assignments | In each lecture, homework will be given. Students should prepare enough before each lecture.<br>As a final task, an assignment writing a mathematical article by using LaTeX will be given. |
| (5) Textbooks and course materials | Some useful references will be suggested in the class. |
| (6) Assessment and grading | LaTeX report (40%), presentation (30%), participation and activity (30%) |
| (7) Questions to the instructor (Office hours, etc.) | See the following web page:<br>https://www.comp.tmu.ac.jp/tsakai/ |
| (8) Special note | - This course is a required subject in the master's program.<br>- Check the information of this course on kibaco. |



| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Seminar in Mathematical Sciences 1,2,3,4 | | | | First Semester / Second Semester | Intensive course. | | 3 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | |

| | |
|---|---|
| (1) Course policies and topics | In the seminars, students carry out their study on mathematical sciences under the guidance of the instructors. |

| | |
|---|---|
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The purpose of the seminar is to acquire highly specialized knowledge in mathematical sciences, mathematical thinking abilities, problem-solving skills, problem-finding skills, and logical communication skills.<br>The goal is to acquire the abilities to make a research project and to carry out the research premeditatedly under the guidance of the instructors. |
| (3) Course schedule, subject matter, and classroom activities | This course is a seminar-style class. Students belong to the laboratories and carry out their studies on mathematical sciences under the guidance of the instructors. Since the procedure of the seminar differs depending on the laboratory, follow the instructions by the instructor in charge. |
| (4) Outside-class activities and assignments | Make sufficient preparation before the seminar. Also, review the content of the discussions after the seminar. |
| (5) Textbooks and course materials | Textbooks and references will be suggested according to the research theme. Please make contact with the instructor for details. |
| (6) Assessment and grading | It will be evaluated comprehensively based on the progress of the research, presentations at the seminar, and the participation and activity in the seminar. |
| (7) Questions to the instructor (Office hours, etc.) | Please make contact with the instructor in charge. |
| (8) Special note | These courses are required subjects for the master's program in the Department of Mathematical Sciences, and the Department of Mathematics and Information Sciences.<br>Take Seminar in Mathematical Sciences 1,2,3,4 according to the academic year. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | | | | | First Semester / Second Semester | . Intensive course | | See Graduate School Course Catalog |
| Doctoral program | Advanced Seminar in Mathematical Sciences 1,2,3,4,5,6 | | Advanced Seminar in Mathematics and Information Sciences 1,2,3,4,5,6 | | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | |

| | |
|---|---|
| (1) Course policies and topics | In the seminars, students carry out their study on mathematical sciences under the guidance of the instructors. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The purpose of the seminar is to acquire highly specialized knowledge in mathematical sciences, mathematical thinking abilities, problem-solving skills, problem-finding skills, and logical communication skills.<br>The goal is to acquire the abilities to make a research project, to draw up a plan of the research, and to carry out the research premeditatedly by themselves. |
| (3) Course schedule, subject matter, and classroom activities | This course is a seminar-style class. Students belong to the laboratories and carry out their study on mathematical sciences under the guidance of the instructors. Since the procedure of the seminar differs depending on the laboratory, follow the instructions by the instructor in charge. |
| (4) Outside-class activities and assignments | Make sufficient preparation before the seminar. Also, review the content of the discussions after the seminar. |
| (5) Textbooks and course materials | Textbooks and references will be suggested according to the research theme. Please make contact with the instructor for details. |
| (6) Assessment and grading | It will be evaluated comprehensively based on the progress of the research, presentations at the seminar, and the participation and activity in the seminar. |
| (7) Questions to the instructor (Office hours, etc.) | Please make contact with the instructor in charge. |
| (8) Special note | These courses are required subjects for the doctoral program in the Department of Mathematical Sciences, and the Department of Mathematics and Information Sciences.<br>Take Advanced Seminar in Mathematical Sciences 1,2,3,4,5,6 according to the academic year. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Internship in Mathematical Sciences | | | | Intensive course | . | | 1 or 2 |
| Doctoral program | Internship in Mathematical Sciences | | Internship in Mathematics and Information Sciences | | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | |

| | |
|---|---|
| (1) Course policies and topics | The purpose of this course is to acquire a wide range of practical academic abilities by accrediting credits for the off-campus learning (work experience, research / learning experience, volunteer activities) related to mathematical sciences and information sciences, which meets the requirements. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | It depends on the organization of the internship. |
| (3) Course schedule, subject matter, and classroom activities | (1) As a general rule, it must be carried out for several days during the off-term of the classes. It must be no compensation (however, food expenses, transportation expenses, accommodation expenses can be paid by the organization of the internship).<br>(2) The content should relate to mathematical sciences and information sciences. It must be appropriate for the curriculum of the graduate school of Tokyo Metropolitan University. It should not be a requirement for accreditation for another credit or qualification.<br>(3) If the university or research institute is calling for participants publicly, a copy of the information is required. In the case of a company / training school, etc., the application guidelines and the acceptance agreement with the name, affiliation, and contact information of the person in charge of the internship are required. Students must have appropriate insurance.<br>(4) A certificate of completion signed by the organizer is required.<br>(5) Before the internship, make a preliminary application to your academic instructor and obtain permission by attaching the document (4), the contact information of the organizer of the internship, your contact information during the internship, and materials describing the content and purpose of the internship. |
| (4) Outside-class activities and assignments | Make sufficient preparation before the internship. |
| (5) Textbooks and course materials | It depends on the organization of the internship. |
| (6) Assessment and grading | After the internship, students should write a report of several pages compiling a summary of the internship, their impressions, and a practical training diary. Then they should submit it with the document (5) to the academic instructor of Tokyo Metropolitan University.<br>A Credit will be accredited based on the suitability with the above purpose of the course (totally 30 hours or more of learning including a report writing work), the organizer's evaluation, and the report. |
| (7) Questions to the instructor (Office hours, etc.) | Office hours is not fixed. When you have a question, please make contact with your academic instructor directly by e-mail. |
| (8) Special note | Students can take multiple credits of this course (up to 2 credits in each semester).<br>The credits of this course are valid for graduation credits. |

# Physics
## (General courses for Graduate School of Science and Graduate School of Science and Engineering)

Notes on course enrollment

[School of Science]
(Master's program)

1. The following courses are required for the master's degree.
For theoretical physics:
- Advanced Seminar in Physics I–IV and
- Advanced Practice in Physics I–IV
For experimental physics:
- Advanced Seminar in Physics I–IV and
- Advanced Experiment in Physics I–IV Courses I to IV should be taken in order. These courses cannot be taken at the same time.
2. For the following courses, students may retake the same course if respective courses provide different subject matter.
- Special Lecture in Physics I
- Special Lecture in Physics II
- Selected Topics in Physics I
- Selected Topics in Physics II
3. For courses offered both in the undergraduate and graduate program, students are not allowed to take the same course already taken in our undergraduate program if the course provides the same subject matter.
4. For students who are admitted for early completion due to their outstanding research achievements, some of the requirements in Section 1 above may be waived.

(Doctoral program)

1. The following courses are required for the doctorate.
For theoretical physics:
- Advanced Practice in Physics V–VIII
For experimental physics:
- Advanced Experiment in Physics V–VIII
Courses V to VIII should be taken in order. These courses cannot be taken at the same time. Students for theoretical physics can take Advanced Practice in Physics IX after taking the Adcanced Practice in Physics VIII, and students for experimental physics can take Adcanced Experiment in Physics IX after taking the Advanced Experiment in Physics VIII.
2. For the following courses, students may retake the same course if respective courses provide different subject matter.
- Special Lecture in Physics I
- Special Lecture in Physics II
- Selected Topics in Physics I
- Selected Topics in Physics II
3. For courses offered both in the master's and doctoral programs, students are not allowed to take the same courses already taken in our master's program if the course provides the same subject matter.
4. For students who are admitted for early completion due to their outstanding research achievements, some of the requirements in Section 1 above may be waived.

[School of Science and Engineering]
(Doctoral program)

1. The following courses are required for the doctorate.
   For theoretical physics:
   - Advanced Practice in Physics V–VIII
   For experimental physics:
   - Advanced Experiment in Physics V–VIII
   Courses V to VIII should be taken in order. These courses cannot be taken at the same time.
2. For the following courses, students may retake the same course if respective courses provide different subject matter.
   - Special Lecture in Physics I
   - Special Lecture in Physics II
   - Selected Topics in Physics I
   - Selected Topics in Physics II
3. For courses offered both in the master's and doctoral programs, students are not allowed to take the same courses already taken in our master's program if the course provides the same subject matter.
4. For students who are admitted for early completion due to their outstanding research achievements, some of the requirements in Section 1 above may be waived.

* M = master's courses, D = doctoral courses
* NA 2023: Courses not offered in the academic year 2023

| Course outline | M | D | NA 2023 | Semester | Day | Time | [Graduate School of Science] | | [Graduate School of Science and Engineering] | | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Course Number | Course Name | Course Number | Course Name | | | |
| 1 | ○ | | | 1st | Thu. | 2 | M(R0101) | General Relativity | | | 2 | S. Ketov | This course is also offered in the undergraduate program |
| 2 | ○ | | | 1st | Fri. | 4 | M(R0102) | Statistical Physics | | | 2 | Kazumasa Hattori | |
| 3 | ○ | | | 1st | Fri. | 2 | M(R0103) | Field Theory | | | 2 | S. Ketov | |
| 4 | ○ | | | 1st | Thu. | 3 | M(R0105) | Nuclear Physics | | | 2 | Tetsuo Hyodo | This course is also offered in the undergraduate program |
| 5 | ○ | | | 1st | Mon. | 2 | M(R0106) | Particle Physics | | | 2 | Osamu Yasuda | This course is also offered in the undergraduate program |
| 6 | ○ | | | 2nd | Fri. | 2 | M(R0107) | Astrophysics | | | 2 | Yoshitaka Ishisaki | This course is also offered in the undergraduate program |
| 7 | ○ | | | 1st | Tue. | 2 | M(R0108) | Selected Topics in Physics and Chemistry Ⅱ (Atomic physics) | | | 2 | Hajime Tanuma | This course is offered for Physics and Chemistry majors and also in the undergraduate program |
| 8 | ○ | | | 1st | Wed. | 2 | M(R0109) | Selected Topics in Physics and Chemistry Ⅱ (Solid State Physics I) | | | 2 | Emiko Arahata | This course is offered for Physics and Chemistry majors and also in the undergraduate program |
| 9 | ○ | | | 2nd | Mon. | 2 | M(R0111) | Solid State Physics II | | | 2 | Tatsuma Matsuda | This course is also offered in the undergraduate program |
| 10 | ○ | | | 2nd | Wed. | 5 | M(R0114) | Computational Physics | | | 2 | Akira Shudo | This course is also offered in the undergraduate program |
| 11 | ○ | ○ | | 2nd B | Tue. | 3 | M(R0171) D (R0172) | Advanced Experimental Technique in Physics A | D (R0172) | Advanced Experimental Technique in Physics A | 1 | Yuji Aoki | |
| 12 | ○ | ○ | | 2nd A | Tue. | 3 | M(R0937) D (R0938) | Advanced Experimental Technique in Physics B | D (R938) | Advanced Experimental Technique in Physics B | 1 | Kazuhiro Yanagi * Satoshi Tsutsui | |
| 13 | ○ | ○ | | 2nd A | Wed. | 3 | M(R0161) D (R0162) | Selected Topics in Physics and Chemistry I (Advanced Experimental Technique in Physics C) | D (R162) | Selected Topics in Physics and Chemistry I (Advanced Experimental Technique in Physics C) | 1 | Hajime Tanuma | This course is offered for Physics and Chemistry majors |
| 14 | ○ | ○ | | 2nd B | Mon. | 3 | MCR0159) D (R0160) | Selected Topics in Physics and Chemistry I (Advanced Experimental Technique in Physics D) | D (R160) | Selected Topics in Physics and Chemistry I (Advanced Experimental Technique in Physics D) | 1 | * Toshiyuki Azuma | This course is offered for Physics and Chemistry majors |
| 15 | ○ | ○ | | 1st Intensive | | | M(R0097) D (R0098) | Advanced Particle Physics | D (R098) | Advanced particle physics | 1 | Osamu Yasuda | Register during the first semester registration period |
| 16 | ○ | ○ | | 2nd A | Tue. | 2 | M(R0099) D (R0100) | Advanced High Energy Theoretical Physics | D (R100) | Advanced high energy theoretical physics | 1 | S. Ketov | |
| 17 | ○ | ○ | | 2nd A | Thu. | 3 | M(R0125) D (R0126) | Advanced Subatomic Physics | D (R126) | Advanced subatomic physics | 1 | Tetsuo Hyodo | |
| | ○ | ○ | △ | 2nd A | Fri. | 3 | M(R0131) D (R0132) | Advanced High Energy Astrophysics I | D (R132) | Advanced High Energy Astrophysics I | 1 | Yutaka Fujita | |
| 18 | ○ | ○ | | 2nd A | Fri. | 3 | M(R0133) D (R0134) | Advanced High Energy Astrophysics II | D (R134) | Advanced High Energy Astrophysics II | 1 | Yutaka Fujita | |
| 19 | ○ | ○ | | 1st Intensive | | | M(R0141) D (R0142) | Advanced Nonlinear Physics | D (R142) | Advanced nonlinear physics | 1 | Akira Shudo | Register during the first semester registration period |
| 20 | ○ | ○ | | 1st B | Tue. | 3 | M(R0117) D (R0118) | Advanced Statistical Mechanics | D (R118) | Advanced statistical mechanics | 1 | Emiko Arahata | |
| 21 | ○ | ○ | | 1st Intensive | | | M(R0115) D (R0116) | Advanced Quantum Many Body System | D (R116) | Advanced Quantum Many Body System | 1 | Kazumasa Hattori | Register during the first semester registration period |
| 22 | ○ | ○ | | 2nd A | Mon. | 3 | M(R0145) D (R0146) | Advanced Physics of Superconductivity | D (R146) | Advanced physics of superconductivity | 1 | Takashi Hotta | |
| | ○ | ○ | △ | 2nd A | Mon. | 3 | M(R0123) D (R0124) | Advanced Physics of Magnetism | D (R124) | Advanced Physics of Magnetism | 1 | Takashi Hotta | |
| | ○ | ○ | △ | 1st B | Fri. | 3 | M(R0119) D (R0120) | Advanced High Energy Physics I | D (R120) | Advanced High Energy Physics I | 1 | Hidekazu Kakuno | |
| 23 | ○ | ○ | | 1st B | Fri. | 3 | M(R0121) D (R0122) | Advanced High Energy Physics II | D (R122) | Advanced High Energy Physics II | 1 | Hidekazu Kakuno | |
| | ○ | ○ | △ | 2nd B | Mon. | 4 | M(R0153) D (R0154) | Advanced Atomic Physics I | D (R154) | Advanced Atomic Physics I | 1 | * Toshiyuki Azuma | |
| 24 | ○ | ○ | | 2nd A | Wed. | 4 | M(R0155) D (R0156) | Advanced Atomic Physics II | D (R156) | Advanced Atomic Physics II | 1 | Hajime Tanuma | |
| | ○ | ○ | △ | 1st A | Wed. | 3 | M(R0127) D (R0128) | Advanced Astrophysics I | D (R128) | Advanced Astrophysics I | 1 | Yuichiro Ezoe | |
| | ○ | ○ | △ | 1st A | Fri. | 3 | M(R0129) D (R0130) | Advanced Astrophysics II | D (R130) | Advanced Astrophysics II | 1 | Yoshitaka Ishisaki | |
| | ○ | ○ | △ | 2nd A | Thu. | 3 | M(R0149) D (R0150) | Advanced Correlated Electron Physics I | D (R150) | Advanced Correlated Electron Physics I | 1 | Tatsuma Matsuda | |
| 25 | ○ | ○ | | 2nd A | Wed. | 4 | M(R0135) D (R0136) | Advanced Correlated Electron Physics II | D (R136) | Advanced Correlated Electron Physics II | 1 | Yoshikazu Mizuguchi | |
| | ○ | ○ | △ | 2nd A | Tue. | 2 | M(R0147) D (R0148) | Selected Topics in Physics and Chemistry I (Advanced Nanoscience, Surface, and Interface Physics I) | D (R148) | Selected Topics in Physics and Chemistry I (Advanced Nanoscience, Surface, and Interface physics I) | 1 | Yasumitsu Miyata | This course is offered for Physics and Chemistry majors |
| 26 | ○ | ○ | | 1st B | Tue. | 1 | M(R0137) D (R0138) | Selected Topics in Physics and Chemistry I (Advanced Nanoscience, Surface, and Interface Physics II) | D (R138) | Selected Topics in Physics and Chemistry I (Advanced Nanoscience, Surface, and Interface Physics II) | 1 | Kazuhiro Yanagi | |
| | ○ | ○ | △ | 1st B | Thu. | 3 | M(R0151) D (R0152) | Selected Topics in Physics and Chemistry I (Advanced Soft Matter Physics I) | D (R152) | Selected Topics in Physics and Chemistry I (Advanced Soft Matter Physics I) | 1 | Rei Kurita | This course is offered for Physics and Chemistry majors |
| 27 | ○ | ○ | | 1st B | Thu. | 3 | M(R0143) D (R0144) | Selected Topics in Physics and Chemistry I (Advanced Soft Matter Physics II) | D (R144) | Selected Topics in Physics and Chemistry I (Advanced Soft Matter Physics II) | 1 | Rei Kurita | This course is offered for Physics and Chemistry majors |
| | ○ | ○ | △ | 2nd A | Fri. | 2 | M(R0110) D (R0113) | Selected Topics in Physics and Chemistry I (Advanced Minimum Material Science) | D (R113) | Selected Topics in Physics and Chemistry I (Advanced Minimum Material Science) | 1 | Yuji Aoki | This course is offered for Physics and Chemistry majors |
| 28 | ○ | ○ | | 2nd A | Thu. | 2 | M(R0139) D (R0140) | Advanced English for Science | D (R140) | Advanced English for science | 1 | Hiroyuki Mori | |
| 29 | ○ | ○ | | 2nd | Wed. | 1 | M(R0163) D (R0164) | Selected Topics in Physics and Chemistry Ⅱ (Advanced Molecular Spectroscopy) | D (R164) | Selected Topics in Physics and Chemistry Ⅱ (Advanced Molecular Spectroscopy) | 2 | Reika Kanya | This course is offered for Physics and Chemistry majors |
| 30 | ○ | ○ | | 1st | Mon. | 2 | M(R0165) D (R0166) | Selected Topics in Physics and Chemistry Ⅱ (Advanced Physical Chemistry of Condensed Matter) | D (R166) | Selected Topics in Physics and Chemistry Ⅱ (Advanced Physical Chemistry of Condensed Matter) | 2 | Yasushi Hirose | This course is offered for Physics and Chemistry majors |
| 31 | ○ | ○ | | 1st | Tue. | 2 | M(R0167) D (R0168) | Selected Topics in Physics and Chemistry Ⅱ (Advanced Theoretical Chemistry) | D (R168) | Selected Topics in Physics and Chemistry Ⅱ (Advanced Theoretical Chemistry) | 2 | Naoki Nakatani | This course is offered for Physics and Chemistry majors |
| 33 | ○ | | | 1st/2nd | * | * | M (R0173) 1st M (R0330) 2nd | Advanced Seminar Physics I | | | 2 | All instructors | For first-year master's students |
| 33 | ○ | | | 1st/2nd | * | * | M (R0174) 2nd M (R0331) 1st | Advanced Seminar in Physics II | | | 2 | All instructors | For first-year master's students |
| 33 | ○ | | | 1st/2nd | * | * | M (R0175) 1st M (R0332) 2nd | Advanced Seminar in Physics III | | | 2 | All instructors | For second-year master's students |
| 33 | ○ | | | 1st/2nd | * | * | M (R0176) 2nd M (R0333) 1st | Advanced Seminar in Physics IV | | | 2 | All instructors | For second-year master's students |
| 34 | ○ | | | 1st/2nd | * | * | M (R0177) 1st M (R0334) 2nd | Advanced Experiment in Physics I | | | 2 | All instructors of experimental physics | For first-year master's students of experimental physics |

| Course outline | M | D | NA 2022 | Semester | Day | Time | [Graduate School of Science] | | [Graduate School of Science and Engineering] | | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Course Number | Course Name | Course Number | Course Name | | | |
| 34 | ○ | | | 1st/2nd | * | * | M (R0178) 2nd<br>M (R0335) 1st | Advanced Experiment in Physics II | | | 2 | All instructors of experimental physics | For first-year master's students of experimental physics |
| 34 | ○ | | | 1st/2nd | * | * | M (R0179) 1st<br>M (R0336) 2nd | Advanced Experiment in Physics III | | | 2 | All instructors of experimental physics | For second-year master's students of experimental physics |
| 34 | ○ | | | 1st/2nd | * | * | M (R0180) 2nd<br>M (R0337) 1st | Advanced Experiment in Physics IV | | | 2 | All instructors of experimental physics | For second-year master's students of experimental physics |
| 35 | ○ | | | 1st/2nd | * | * | M (R0181) 1st<br>M (R0338) 2nd | Advanced Practice in Physics I | | | 2 | All instructors of theoretical physics | For first-year master's students of theoretical physics |
| 35 | ○ | | | 1st/2nd | * | * | M (R0182) 2nd<br>M (R0339) 1st | Advanced Practice in Physics II | | | 2 | All instructors of theoretical physics | For first-year master's students of theoretical physics |
| 35 | ○ | | | 1st/2nd | * | * | M (R0183) 1st<br>M (R0340) 2nd | Advanced Practice in Physics III | | | 2 | All instructors of theoretical physics | For second-year master's students of theoretical physics |
| 35 | ○ | | | 1st/2nd | * | * | M (R0184) 2nd<br>M (R0341) 1st | Advanced Practice in Physics IV | | | 2 | All instructors of theoretical physics | For second-year master's students of theoretical physics |
| | ○ | ○ | | Intensive course | TBA | TBA | M(R0197)<br>D (R0198) | Advanced Physics I | D (R198) | Advanced Physics I | 1 | TBA | The credit hours will be added if the course provides a different subject matter. |
| | ○ | ○ | | Intensive course | TBA | TBA | M(R0199)<br>D (R0200) | Advanced Physics II | D (R200) | Advanced Physics II | 2 | TBA | The credit hours will be added if the course provides a different subject matter. |
| | ○ | ○ | | Intensive course | TBA | TBA | | Selected Topics in Physics I | | Selected Topics in Physics I | 1 | TBA | The credit hours will be added if the course provides a different subject matter. |
| | ○ | ○ | | Intensive course | TBA | TBA | | Selected Topics in Physics Ⅱ | | Selected Topics in Physics Ⅱ | 2 | TBA | The credit hours will be added if the course provides a different subject matter. |
| | ○ | ○ | | Intensive course | TBA | TBA | | Selected Topics in Physics and Chemistry I | | Selected Topics in Physics and Chemistry I | 1 | TBA | The credit hours will be added if the course provides a different subject matter.<br>This course is offered for Physics and Chemistry majors |
| 32 | ○ | ○ | | Intensive course | TBA | TBA | M (R0193) 2 units<br>M (R0195) 1 unit<br>D (R0194) 1 unit<br>D (R0196) 2 units | External Experience in Physics | D (R194) 1 unit<br>D (R196) 2 units | External experience in physics | 1 or 2 | All instructors | The credit hours will be added if the course provides a different subject matter. |
| 36 | | ○ | | 1st/2nd | * | * | D (R0185) 1st<br>D (R0342) 2nd | Advanced Experiment in Physics V | D (R185) 1st<br>D (R342) 2nd | Advanced Experiment in Physics V | 4 | All instructors of experimental physics | For first-year doctoral students of experimental physics |
| 36 | | ○ | | 1st/2nd | * | * | D (R0186) 2nd<br>D (R0343) 1st | Advanced Experiment in Physics VI | D (R186) 2nd<br>D (R343) 1st | Advanced Experiment in Physics VI | 4 | All instructors of experimental physics | For first-year doctoral students of experimental physics |
| 36 | | ○ | | 1st/2nd | * | * | D (R0187) 1st<br>D (R0344) 2nd | Advanced Experiment in Physics VII | D (R187) 1st<br>D (R344) 2nd | Advanced Experiment in Physics VII | 4 | All instructors of experimental physics | For second-year doctoral students of experimental physics |
| 36 | | ○ | | 1st/2nd | * | * | D (R0188) 2nd<br>D (R0345) 1st | Advanced Experiment in Physics VIII | D (R188) 2nd<br>D (R345) 1st | Advanced Experiment in Physics VIII | 4 | All instructors of experimental physics | For second-year doctoral students of experimental physics |
| 37 | | | | 1st/2nd | | | D (R0225) 1st<br>D (R0998) 2nd | Advanced Experiment in Physics IX | | Advanced Experiment in Physics IX | 2 | All instructors of experimental physics | For third-year doctoral students of experimental physics |
| 38 | | ○ | | 1st/2nd | * | * | D (R0189) 1st<br>D (R0346) 2nd | Advanced Practice in Physics V | D (R189) 1st<br>D (R346) 2nd | Advanced Practice in Physics V | 4 | All instructors of theoretical physics | For first-year doctoral students of theoretical physics |
| 38 | | ○ | | 1st/2nd | * | * | D (R0190) 2nd<br>D (R0347) 1st | Advanced Practice in Physics VI | D (R190) 2nd<br>D (R347) 1st | Advanced Practice in Physics VI | 4 | All instructors of theoretical physics | For first-year doctoral students of theoretical physics |
| 38 | | ○ | | 1st/2nd | * | * | D (R0191) 1st<br>D (R0348) 2nd | Advanced Practice in Physics VII | D (R191) 1st<br>D (R348) 2nd | Advanced Practice in Physics VII | 4 | All instructors of theoretical physics | For second-year doctoral students of theoretical physics |
| 38 | | ○ | | 1st/2nd | * | * | D (R0192) 2nd<br>D (R0349) 1st | Advanced Practice in Physics VIII | D (R192) 2nd<br>D (R349) 1st | Advanced Practice in Physics VIII | 4 | All instructors of theoretical physics | For second-year doctoral students of theoretical physics |
| 39 | | | | 1st/2nd | | | D (R0226) 1st<br>D (R0999) 2nd | Advanced Practice in Physics IX | | Advanced Practice in Physics IX | 2 | All instructors of theoretical physics | For third-year doctoral students of theoretical physics |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | general relativity | R0101 | | | 1 | Thursday | 2 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
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| Serguei Ketov | |

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| (1) Course policies and topics | Einstein's theory of general relativity is systematically introduced, starting from the first principles. Knowledge of classical mechanics is a prerequisite. The lectures include a brief introduction to Riemannian geometry. Topics include motion of particles in curved space-time, Einstein's equations, black holes, standard cosmology of the Universe, and gravitational waves. The lectures are original and self-contained. Students should make notes during the lectures. Homework will be provided. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The key objectives and skills to be acquired by students include basic knowledge of general relativity theory and ability to do related calculations by using theoretical tools. |
| (3) Course schedule, subject matter, and classroom activities | Schedule and subjects of lectures:<br>[1-2] review of special relativity theory,<br>[3] basic principles of general covariance and equivalence,<br>[4] topology and geometry of Riemann manifolds,<br>[5] parallel transport and covariant derivatives,<br>[6] Riemann curvature tensors,<br>[7] distances and geodesic lines in curved space-time,<br>[8] energy-momentum tensor of matter,<br>[9] Einstein equations,<br>[10] black holes,<br>[11] gravitational waves,<br>[12] gravitational redshift,<br>[13] Solar system in general relativity,<br>[14] standard cosmological model of the Universe,<br>[15] Observational cosmology |
| (4) Outside-class activities and assignments | Homework reports are optional (not mandatory). |
| (5) Textbooks and course materials | The lectures are original (from the teacher) and will be given in English.<br>There is no textbook. |
| (6) Assessment and grading | The conditions for earning credits are attendance of lectures (at least 2/3 or more) and positive results of the written test at the end of the term. During the test, students are allowed to bring any literature with them. |
| (7) Questions to the instructor (Office hours, etc.) | Office hours for questions and consultations with the teacher are on Mondays between 13:00-14:30 (reservations by email are recommended). Email address: ketov@tmu.ac.jp |
| (8) Special note | A Japanese-English vocabulary of special words will be provided to each student.<br>The lectures are related to particle physics theory, general relativity theory and space theory. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Statistical physics | R0102 | | | 1st | Fri. | 4 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
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| Kazumasa Hattori | |

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| (1) Course policies and topics | The lecture will cover a wide range of topics from the basics to specific examples of phase transitions and critical phenomena. The systems covered include, for example, magnetism, superfluidity, and superconductivity. The lecture will also introduce the minimum knowledge of group theory necessary to understand phase transitions, and discuss the fact that critical phenomena have universal properties regardless of the details of the system and their spontaneous symmetry breaking, without requiring knowledge of field theory. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The goal is to understand the basic mechanism of spontaneous symmetry breaking and to understand how free energy can be written down from the symmetry of a given order parameter and system symmetry. |
| (3) Course schedule, subject matter, and classroom activities | Slides pdf files will be uploaded in kibaco before every class<br><br>1. Ferromagnetic and antiferromagnetic Ising models: mean-field approximation<br>2. Bose condensation<br>3. Symmetry in quantum mechanics<br>4. Symmetry and group theory: irreducible representations<br>5. Symmetry and group theory: representation matrices and character<br>6. Order parameters<br>7. Correlation functions<br>8. Scaling hypothesis<br>9. Landau theory of phase transitions<br>10. Liquid-gas transition<br>11. Nematic and tricritical point<br>12. Superconductivity: Cooper's problem<br>13. Ginzburg-Landau theory of superconductivity<br>14. Upper critical field and vortex lattice<br>15. Report and Explanation |
| (4) Outside-class activities and assignments | Students are expected to review and study the related contents on their own since a quiz will be given in each class. In particular, students who do not fully understand the undergraduate contents [quantum mechanics, statistical mechanics, and physical mathematics] may find it difficult to receive credit for the course. If students feel that they do not have sufficient understanding, they will be required to study outside of class for a considerable amount of additional time. For the first session, a quiz will be given on the basic content of statistical mechanics. |
| (5) Textbooks and course materials | References:<br>"The Theory of Critical Phenomena - An Introduction to the Renormalization Group".<br>J. J. Binney, N. J. Dorick, A. J. Fisher, and M. E. J. Newman, Clarendon Press, Oxford.<br>“Statistical Physics of fields" M. Carder, Cambridge University Press, Cambridge.<br>“Fundamentals of Metal Physics 2”, Abrikosov,<br>“Group Theory and Its Applications in Physics” (Springer Series in Solid-State Sciences, 78), Tetsuro Inui, Yukito Tanabe, and Yoshitaka Onodera.<br>Other reference books will be given in class as needed. |
| (6) Assessment and grading | Evaluation will be based on a total of 100 points: 30 points for the quiz and 70 points for the report. |
| (7) Questions to the instructor (Office hours, etc.) | No specific office hours are set, but if you wish to ask questions, please make an appointment in advance by e-mail. |
| (8) Special note | An understanding of quantum mechanics, statistical mechanics, and physical mathematics is assumed. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Field theory | R0103 | | | 1 | Friday | 2 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
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| Serguei Ketov | |

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| (1) Course policies and topics | The lectures offer an introduction to classical and quantum field theories from the first principles to Feynman's graphs. Several applications to particle physics are provided.<br>Knowledge of classical mechanics and electrodynamics is a prerequisite. The lectures are original and self-contained. Students shoud make notes during the lectures and study them at home again. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The key objectives and skills to be acquired by students include basic knowledge of field theory and ability to do related calculations by using field-theoretical tools. |
| (3) Course schedule, subject matter, and classroom activities | Schedule and subjects of lectures:<br>[1] field theory actions and equations of motion,<br>[2] space-time and internal symmetries, Poincare algebra,<br>[3] Maxwell theory of electromagnetism,<br>[4] scalar field and its quantization,<br>[5] Dirac field and its quantization,<br>[6] Fock space of multi-particle states,<br>[7] Green's functions and propagators,<br>[8] group theory and group representations,<br>[9] Lie algebras and Lie groups,<br>[10] local gauge principle,<br>[11] Yang-Mills field theory,<br>[12] S-matrix and particle physics,<br>[13] quantum field theories (QED, QCD, Standard Model),<br>[14] Feynman rules,<br>[15] Grand Unified Theories and quantum gravity |
| (4) Outside-class activities and assignments | No homework reports during the class. |
| (5) Textbooks and course materials | The lectures are original (from the teacher) and will be given in English.<br>Home reading of a textbook is recommended, for example,<br>1. V. Rubakov, "Classical Theory of Gauge Fields",<br>2. L.H. Ryder, "Quantum Field Theory",<br>3. S.V. Ketov, "Conformal Field Theory". |
| (6) Assessment and grading | The conditions for earning credits are attendance of lectures (at least 2/3 or more) and positive results of the written test at the end of the term. During the test, students are allowed to bring any literature with them. |
| (7) Questions to the instructor (Office hours, etc.) | Office hours for questions and consulations with the teacher are on Mondays between 13:00-14:30 (reservations by email are recommended)<br>Email address: ketov@tmu.ac.jp |
| (8) Special note | A Japanese-English vocabulary of special words will be provided to each student.<br>The lectures are related to particle physics theory and experiment, general relativity theory and space theory. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Nuclear physics | M(R0105) | | | 1st | Thu. | 3 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
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| Tetsuo Hyodo | This course is also offered in the undergraduate program |

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| (1) Course policies and topics | We explain the properties of atomic nuclei and their constituent hadrons from both the basic theoretical framework and experimental facts, and learn the physics of "strong force", one of the basic forces of the nature. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | We study the basic contents of atomic nuclei and hadrons, and gain knowledge of their theoretical and experimental methods. We learn that the atomic nucleus, which is a microscopic substance that defines an element at the center of an atom, exhibits various properties by itself, and that the strong force has different properties than the gravitational and electromagnetic forces that dominate the macroscopic system. We learn the nucleons (protons and neutrons) that are the constituents of atomic nuclei, the general structure and basic properties of the strongly interacting particle, hadrons, and the basics of quantum chromodynamics which governs the quarks and gluons (Comprehensive problem thinking ability, logical thinking ability). |
| (3) Course schedule, subject matter, and classroom activities | The atomic nucleus, a microscopic material in the atom, shows various phenomena involving strong and electroweak interactions as a many-body system of hadrons (mesons and baryons). Hadrons are a composite system of elementary particles, quarks and gluons. Nuclear hadron physics that spans these two layers should be understood in principle by quantum chromodynamics, which is the first principle of the strong interaction, but it is not so simple by the dual structure of strong force. In this lecture, we explain the physics of the strong interaction, from the basic properties of atomic nuclei to the structure and properties of hadrons, which are many-body systems of quarks, as well as quark confinement and spontaneous breaking of chiral symmetry.<br>Part 1: Nuclear physics<br>Lecture 1: Overview of nuclear physics<br>Lecture 2: Basic properties of nuclei, form factor, saturation of density Lecture 3: Basic properties of nuclei, mass formulae<br>Lecture 4: Nuclear force, isospin, deuteron<br>Lecture 5: Structure of nuclei, magic number<br>Lecture 6: Structure of nuclei, shell model, independent particule picture Lecture 7: Decay of nuclei, Gamow theory<br>Part 2: Hadron physics<br>Lecture 8: Overview of hadron physics, classification, internal degrees of freedom<br>Lecture 9: Group theory, representations, SU(2), SU(3)<br>Lecture 10: Symmetries of quarks<br>Lecture 11: Exotic hadrons<br>Lecture 12: Hypernuclei<br>Lecture 13: Asymptotic freedom in QCD<br>Lecture 14: Spontaneous breaking of chiral symmetry<br>Lecture 15: Summary and solutions to exercises |
| (4) Outside-class activities and assignments | Solve the exercises specified during the lecture and submit them as a report. |
| (5) Textbooks and course materials | The course follows the lecture nots uploaded on the web. References will be introduced during the course. |
| (6) Assessment and grading | Based on the report and attendance. |
| (7) Questions to the instructor (Office hours, etc.) | Office hours are not specified. Questions are welcome before and after the class. Send e-mail for appointment, or send questions via e-mail. |
| (8) Special note | Knowledge of quantum mechanics is a prerequisite. It is desirable to have basic knowledge of “Particle and nuclei”. Closely related with “Particle physics”. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Particle physics | R0106 | | | 1st | Mon | 2 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
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| Osamu Yasuda | This course is also offered in the undergraduate program |

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|---|---|
| (1) Course policies and topics | The vast majority of particle phenomena observed to date can be successfully described by a theory called the Standard Model of Particle Physics. This course provides an introductory description of the Standard Model, including the basics of spontaneous symmetry breaking, field theories with gauge symmetry, and the unification of electromagnetism and the weak force. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | By taking this course, students will gain a solid foundation in the above concepts. |
| (3) Course schedule, subject matter, and classroom activities | 01. Introduction: Natural unit, special relativity, Dirac equation<br>02. Field quantization, Lagrangian density<br>03. Gauge symmetry (Abelian case)<br>04. Gauge symmetry (Non-Abelian case)<br>05. Spontaneous symmetry breaking (Abelian case)<br>06. Spontaneous symmetry breaking (Non-Abelian case)<br>07. Nambu-Goldstone mode<br>08. Brout-Englert-Higgs mechanism<br>09. Foundation of the electroweak theory<br>10. Interactions of the electroweak theory<br>11. Foundation of quantum chromodynamics<br>12. Interactions of quantum chromodynamics<br>13. Basis of flavor mixing<br>14. Predictions from flavor mixing<br>15. Summary |
| (4) Outside-class activities and assignments | Lecture notes will be available on the course website (the URL will be provided through the KIBACO system). Students are expected to study the course materials in advance and understand the technical terms. |
| (5) Textbooks and course materials | The following are recommended references for this course:<br>(i) "Quarks and Leptons: An Introductory Course in Modern Particle Physics" by F. Halzen and A. D. Martin, published by Wiley in 1984.<br>(ii) "Gauge Theories" by E. S. Abers and B. W. Lee, published in Physical Reports 9 (1973) 1. |
| (6) Assessment and grading | The final grade will be based on a written assignment given at the end of the lectures. |
| (7) Questions to the instructor (Office hours, etc.) | Office hours are not specified, so students should contact the instructor by email (the email address will be provided through the KIBACO system) if they have any questions. |
| (8) Special note | Announcements will be sent to students' TMU email addresses ending with '@ed.tmu.ac.jp', and students should configure their TMU mail accounts to forward all emails addressed to '@ed.tmu.ac.jp' to their private email addresses. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Astrophysics | R107 | | | 2nd | Fri. | 2 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
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| Yoshitaka Ishisaki | This course is also offered in the undergraduate program |

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| (1) Course policies and topics | This course gives explanation of modern view of the Universe based on the Big Bang theory and describes evolution of stars and galaxies as well as large scale structures in the Universe. Compact objects having strong magnetic fields or strong gravity such as netron stars and black holes will be also introduced. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The student will understand basic phenomena observed in the Universe based on physical processes and will learn how basic physics (e.g., particle physics, atomic physics, quantum mechanics, etc) can be applied to astronomical phenomena. |
| (3) Course schedule, subject matter, and classroom activities | 01. Introduction<br>02-04. Expanding Universe<br>05-07. Stellar evolution<br>08-10. Compact stars (white dwarfs, neutron stars) and black holes<br>11 Supernova and supernova remnant<br>12 Galaxy and interstellar materials<br>13-14 Clusters of galaxies, super clusters<br>15. Reports and comments |
| (4) Outside-class activities and assignments | Students are expected to study the contents of the course with materials given in the class and also references. |
| (5) Textbooks and course materials | Not in particular. |
| (6) Assessment and grading | The final grade will be based on reports. |
| (7) Questions to the instructor (Office hours, etc.) | Office hour is 1st period on Friday. Questions via e-mail is welcome. |
| (8) Special note | The student should learn special relativity and general relativity to understand the standard model of the Universe and Einstein equation. High energy emission from compact objects and supernova remanants will be touched in another lecture “high energy astrophysics” so the student is recommended to take that lecture in addition to this one. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Selected Topics in Physics and Chemistry II (Atomic Physics) | R0108 | | | 1st | Tue | 2 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Hajime Tanuma | |

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| (1) Course policies and topics | Fundamental theory on atoms and molecules, which are quantal few-body systems, will be explained based on elementary quantum mechanics. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The most practical and fundamental application of quantum mechanics to one- and many-electron atoms and small molecules. |
| (3) Course schedule, subject matter, and classroom activities | 1. What is the atomic physics?<br>2. Hydrogenic atoms: non-relativistic theory<br>3. Hydrogenic atoms: relativistic theory<br>4. Hydrogenic atoms in electromagnetic fields<br>5. Semi-classical theory for optical transitions of atoms<br>6. Many-electron atoms<br>7. Spin-orbital interaction in atoms<br>8. Electron correlation and configuration interaction<br>9. Dynamics of excited atoms I<br>10. Dynamics of excited atoms II<br>11. Diatomic molecules I: Born-Oppenheimer approximation<br>12. Diatomic molecules II: LCAO-MO method<br>13. Diatomic molecules III: vibration and rotation<br>14. Diatomic molecules IV: electronic transitions<br>15. Recent topics on atomic physics |
| (4) Outside-class activities and assignments | Before the class, check and confirm the understanding of previous lectures. |
| (5) Textbooks and course materials | Presentation slides will be provided through the “kibako” system.<br>Reference books will be introduced in the lectures. |
| (6) Assessment and grading | Questions and reports after whole lectures |
| (7) Questions to the instructor (Office hours, etc.) | Contact via e-mail to tanuma-hajime@tmu.ac.jp |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Selected Topics in Physics and Chemistry II (Solid State Physics I) | M(R0109) | | | 1st | Wed | 2 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
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| Emiko Arahata | |

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| (1) Course policies and topics | In this lecture, we will learn about the motion and energy state of electrons in a solid, which is the periodic potential of crystals, that is, the band theory. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | This lecture will give you a deep knowledge of band theory. You can also learn how to calculate specific values in a simple model |
| (3) Course schedule, subject matter, and classroom activities | 1:Review of quantum mechanics<br>2:Drude theory of metals<br>3:Sommerfeld's theory of metals<br>4:Crystal structures<br>5:Electron states in a periodic potential<br>6:Electrons in a weak periodic potential<br>7:The nearly-free-electron approximation<br>8: Electrons in a periodic potential where the potential is very strong<br>9: The tight-banding approximation<br>10: Transport phenomena<br>11: Boltzmann equation and relaxation time<br>12: Phonon spectroscopy<br>13: Thermoelectric effect<br>14: Semiconductors<br>15: Summery |
| (4) Outside-class activities and assignments | Giving some assignments in every class |
| (5) Textbooks and course materials | Posting materials on kibaco |
| (6) Assessment and grading | Reports(70%) and assignments(30%) |
| (7) Questions to the instructor (Office hours, etc.) | Questions will be accepted at any time. Make an appointment or directly send questions by email. |

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| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Solid State Physics II | R0111 | | | 2nd | Mon. | 2 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
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| Tatsuma Matsuda | This course is also offered in the undergraduate program |

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| (1) Course policies and topics | The aim of this lecture is understanding the magnetism, transport properties, and quantum phenomena in crystal based on the theories for condensed electrons system. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | microscopic theory of solids, group theory, phase transition and spontaneous symmetry breaking, macroscopic response of crystal and its applications |
| (3) Course schedule, subject matter, and classroom activities | The lectures will cover topics which are necessary for those who will be engaging to the fundamental or development research on solid materials.<br><br>1st, 2nd : the origin of magnetic dipole (electron configuration of an atom)<br>3rd : symmetry of crystal structure (point group, space group)<br>4th, 5th : magnetism of crystal, crystalline electric field<br>6th, 7th : magnetic order, mean field theory<br>8th, 9th : magnetic materials, semiconductors, dielectric materials<br>10th : dielectric response of crystal<br>11th, 12th : low temperature, superconductivity, superfluid<br>13th, 14th : theoretical development<br>15th : practices<br><br>Basically, these lectures will be given by the face to face classes. |
| (4) Outside-class activities and assignments | Outside-class activities will be uploaded to kibaco system appropriately. |
| (5) Textbooks and course materials | Textbooks and references will be introduced in the lectures. The contents of this lecture will be uploaded to kibaco system. |
| (6) Assessment and grading | practice problems in the lectures and 5 reports assignments |
| (7) Questions to the instructor (Office hours, etc.) | Send an appointment e-mail to instructor. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Computational physics | M(R0114) | | | 2nd | Wed | 5 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
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| (1) Course policies and topics | In this lecture, the fundamentals of computer-aided research methods in physics and practical numerical methods will be presented, and students will deepen their understanding of these methods using workstations. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | ・To learn basic computational algorithms for analyzing physical phenomena, and to be able to code them using an appropriate programming language.<br>・To learn a series of steps to run a program created on a workstation using Linux.<br>・To be able to create programs using deterministic methods (ordinary differential equations, partial differential equations) and stochastic methods (Monte Carlo methods, etc.) using the C language.<br>・To be able to use graphic routines to display calculation results and create simple movies.<br>・ |
| (3) Course schedule, subject matter, and classroom activities | The class will be conducted in the form of practical lessons at the workstation classroom on the first floor of the Information Processing Facility. Specifically, the class will proceed in the following order.<br>Part 1: Fundamentals for learning computational physics (1) Operating systems<br>Part 2: Fundamentals for learning computational physics (2) Programming languages, etc.<br>Part 3: A brief explanation of using Linux<br>Part 4: How to use graphic libraries<br>Part 5: Numerical solution of ordinary differential equations (1) Euler method<br>Part 6: Numerical methods for solving ordinary differential equations (2) Runge-Kutta method<br>Part 7: Applications of numerical methods for solving ordinary differential equations<br>Part 8: Report practice<br>Part 9: Probabilistic numerical methods (1) Generation of random numbers<br>Part 10: Probabilistic numerical methods (2) Monte Carlo method<br>Part 11: Applications of stochastic numerical methods<br>Part 12: Report practice<br>Part 13: Numerical solution of partial differential equations (1) |
| (4) Outside-class activities and assignments | Each assignment not completed during class time will be worked on during the available time in the workstation classroom. |
| (5) Textbooks and course materials | Handouts will be distributed as needed during class time. Reference books and materials will be introduced at the beginning of the class. |
| (6) Assessment and grading | Students will be required to submit reports three times, and their grades will be based on the reports. |
| (7) Questions to the instructor (Office hours, etc.) | If you have any questions, please feel free to ask me. However, please make an appointment in advance by e-mail.<br>Contact information: shudo@tmu.ac.jp |
| (8) Special note | In this course, students are expected to have computer knowledge equivalent to that of "Physical Information Processing" (knowledge of how to use a workstation classroom and blogging language). |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Experimental Technique in Physics A | R0171 | | | 2nd B | Tue | 3 | 1 |
| Doctoral program | Advanced Experimental Technique in Physics A | R0172 | Advanced Experimental Technique in Physics A | R172 | | | | |

| Instructor(s) | Note |
|---|---|
| Yuji Aoki | |

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|---|---|
| (1) Course policies and topics | "Low temperature" is one of the important fundamental concepts required for various types of experiments in physics. In this course, we will discuss the basics of low temperature experiments and will introduce recent experimental researches on the subject. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | To understand the basic techniques (temperature measurements and constructions of experimental systems) and physical phenomena required for low temperature generation and experiments at low temperatures. |
| (3) Course schedule, subject matter, and classroom activities | Based on the knowledge of thermodynamics, statistical mechanics, quantum mechanics and condensed matter physics, the following major topics will be reviewed. In order to deepen the students' understanding, reports on basic topics will be assigned several times. In addition, latest researches on related topics will be introduced.<br><br>1. Introduction to Low Temperature<br>2. Properties of cryogens (liquid helium, liquid nitrogen) and their handling techniques<br>3. Temperature measurement techniques<br>4. Various types of thermometers<br>5 Properties of materials at low temperatures (specific heat, thermal conductivity, electrical conductivity, etc.)<br>6. Cryostat: Techniques required for low temperature experiments<br>7) Superconducting magnets, adiabatic demagnetization, high-vacuum techniques related to low temperature experiments<br>8. Reports and explanations<br><br>The class will be conducted mainly by lectures. |
| (4) Outside-class activities and assignments | The scope of preparations and reviews will be indicated in the lecture. Students are expected to prepare for the class by reviewing the course materials in advance, sorting out questions, and understanding the meaning of technical terms before attending the class. |
| (5) Textbooks and course materials | Lecture materials will be posted on kibaco.<br>Reference book: Shunichi Kobayashi and Yoichi Otsuka, "Low Temperature Techniques" (University of Tokyo Press: in Japanese) |
| (6) Assessment and grading | Evaluation will be made on the basis of assignment reports (70%) and class activities (30%). |
| (7) Questions to the instructor (Office hours, etc.) | How to ask questions (office hours, etc.)<br>The office hours will be held during the second period on Fridays. Questions will also be accepted on other days. Please contact me in advance by e-mail, etc. and visit my room 8-531. For e-mail addresses and other information, please refer to "Faculty Profiles" on the university website. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Selected Topics in Physics and Chemistry I (Advanced Experimental Technique in Physics C) | R0161 | | | 2nd A | Wed | 3 | 1 |
| Doctoral program | Selected Topics in Physics and Chemistry I (Advanced Experimental | R0162 | Selected Topics in Physics and Chemistry I (Advanced Experimental | R162 | | | | |

| Instructor(s) | Note |
|---|---|
| Hajime Tanuma | |

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|---|---|
| (1) Course policies and topics | Particle detection techniques, which are used in various physical measurements, will be explained for not only high energy radiation, but also low energy photons, electrons, ions, and neutral particles. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Fundamental understanding of physical phenomena used for particle detection, and practical technical methods for measurements of various particles in physics. |
| (3) Course schedule, subject matter, and classroom activities | 1. Fundamental collision processes of electrons and ions in gases<br>2. Gase-based particle detectors<br>3. Particle detectors using processes on solid-surfaces<br>4. Position sensitive detectors<br>5. Particle detectors using processes in solids<br>6. Mass and kinetic energy analyzers for slow charged particles in vacuum<br>7. Energy loss of fast particles in solid<br>8. Question and answers |
| (4) Outside-class activities and assignments | Before the class, check and confirm the understanding of previous lectures. |
| (5) Textbooks and course materials | Presentation slides will be provided through the “kibako” system. |
| (6) Assessment and grading | Questions and reports after whole lectures |
| (7) Questions to the instructor (Office hours, etc.) | Contact via e-mail to tanuma-hajime@tmu.ac.jp |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Selected Topics in Physics and Chemistry I (Advanced Experimental Technique in Physics D) | R0159 | | | 2nd B | Mon. | 3 | 1 |
| Doctoral program | Selected Topics in Physics and Chemistry I (Advanced Experimental Technique in Physics D) | R0160 | Selected Topics in Physics and Chemistry I (Advanced Experimental Technique in Physics D) | R0160 | | | | |

| Instructor(s) | Note |
|---|---|
| Toshiyuki Azuma | |

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| (1) Course policies and topics | This course deals with the fundamentals of vacuum, which is a common feature in various physics experiments. Vacuum technology is indispensable not only for particle beam experiments but also for physical properties, sample fabrication and low-temperature experiments. How to prepare and measure vacuum in the laboratory? The fundamentals of vacuum will be explained also with the viewpoints of atomic physics and surface physics. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | We gain a level of knowledge that will enable to understand the characteristics of vacuum equipment and to design their own equipment. |
| (3) Course schedule, subject matter, and classroom activities | Based on the knowledge of thermo-statistical mechanics, fluid mechanics, quantum mechanics, and condensed matter physics, the following major topics will be reviewed. Students will be required to write reports on fundamental topics in order to deepen their understanding of the subject matter.<br><br>Course schedule<br><br>Lecture 1: Physics of dilute gases<br>Lecture 2: Vacuum measurement<br>Lecture 3: Principles of vacuum pumps<br>Lecture 4: Vacuum system design<br>Lecture 5: Vacuum materials and components<br>Lecture 6: Practical application of vacuum systems (high-energy accelerator)<br>Lecture 7: Practical application of vacuum systems (mass-analysis system)<br>Lecture 8: Practical application of vacuum systems (surface physics) |
| (4) Outside-class activities and assignments | After each class, an assignment related to the content of the class will be given, which will be reviewed in the next class. |
| (5) Textbooks and course materials | Slides to be used in class will be printed and distributed.<br>Others will be given in class |
| (6) Assessment and grading | Based on reports (40%) and attendance (60%). |
| (7) Questions to the instructor (Office hours, etc.) | E-mail questions at any time. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced particle physics | R0097 | | | 1st Intensive | | | 1 |
| Doctoral program | Advanced particle physics | R0098 | Advanced particle physics | R098 | | | | |

| Instructor(s) | Note |
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| Osamu Yasuda | Register during the first semester registration period. |

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| (1) Course policies and topics | This course provides an introduction to neutrino masses, mixings and related experimental results. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | While the Standard Model of Particle Physics successfully describes most particle phenomena at center-of-mass energies less than a TeV, experimental results from the past twenty years have revealed phenomena that cannot be explained by the Standard Model, including neutrino masses and lepton flavor mixing. Through this course, students will gain a basic understanding of these experimental results. |
| (3) Course schedule, subject matter, and classroom activities | 01. Theoretical description of neutrino mass<br>02. Propagation of neutrinos in vacuum and matter<br>03. Information of various neutrino experiments: reactor neutrinos<br>04. Information of various neutrino experiments: atmospheric neutrinos<br>05. Information of various neutrino experiments: solar neutrinos<br>06. Information of various neutrino experiments: accelerator neutrinos<br>07. Nonstandard framework of neutrino mixing: sterile neutrino, nonstandard Interaction<br>08. Nonstandard framework of neutrino mixing: unitarity violation |
| (4) Outside-class activities and assignments | Lecture slides will be available on the website (the URL will be given on the kibaco system). Students are expected to study the contents of the course in advance. |
| (5) Textbooks and course materials | The following is a recommended reference for this course:<br>“Phenomenology of neutrino oscillations", S. M. Bilenky, C. Giunti, W. Grimus, Prog.Part.Nucl.Phys. 43 (1999) 1-86 [e-Print: hep-ph/9812360].” |
| (6) Assessment and grading | The final grade will be based on a written assignment given at the end of the lectures. |
| (7) Questions to the instructor (Office hours, etc.) | Office hours are not specified, so students should contact the instructor by email (the email address will be provided through the KIBACO system) if they have any questions. |
| (8) Special note | Announcements will be sent to students' TMU email addresses ending with '@ed.tmu.ac.jp', and students should configure their TMU mail accounts to forward all emails addressed to '@ed.tmu.ac.jp' to their private email addresses. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | advanced high-energy theoretical physics | R0099 | | | 2 | Tues day | 2 | 1 |
| Doctoral program | advanced high-energy theoretical physics | R0100 | advanced high-energy theoretical physics | R100 | | | | |

| Instructor(s) | Note |
|---|---|
| Serguei Ketov | |

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|---|---|
| (1) Course policies and topics | The lectures offer an introduction to theoretical cosmology of the Universe. Knowledge of field theory and general relativity is a prerequisite. The lectures are original from the teacher. Students should make notes during the lectures and study them at home again. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The key objectives and skills to be acquired by students include basic knowledge of modern cosmology, including related physics and mathematics. |
| (3) Course schedule, subject matter, and classroom activities | Schedule and subjects of lectures:<br>[1] large scale structure of the Universe,<br>[2] general relativity and Friedman universe,<br>[3] dark energy and dark matter,<br>[4] cosmological inflation,<br>[5] reheating after inflation and Big Bang,<br>[6] models of supersymmetric early universe,<br>[7] CP violation, baryon asymmetry, and baryo-genesis,<br>[8] superstring cosmology |
| (4) Outside-class activities and assignments | No homework reports. |
| (5) Textbooks and course materials | The lectures are advanced, and will be given in English. There is no textbook. |
| (6) Assessment and grading | The conditions for earning credits are attendance of lectures (at least 2/3 or more) and positive results of an oral test at the end of the term. |
| (7) Questions to the instructor (Office hours, etc.) | Office hours for questions and consulations with the teacher are on Mondays between 13:00-14:30 (reservations by email are recommended)<br>Email address: ketov@tmu.ac.jp |
| (8) Special note | The lectures are related to particle physics theory, general relativity theory and astrophysics theory. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced subatomic physics | R0125 | | | 2nd A | Thu. | 3 | 1 |
| Doctoral program | Advanced subatomic physics | R0126 | Advanced subatomic physics | R126 | | | | |

| Instructor(s) | Note |
|---|---|
| Tetsuo Hyodo | |

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| (1) Course policies and topics | Theme: Scattering theory and structure of hadron resonances. This lecture introduces a theoretical framework to describe scattering and resonance phenomena which appear in various fields of physics. We then discuss the applications with the examples in hadron physics. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | We gain knowledge of the basics of resonance physics and its importance in hadron physics. As a theoretical framework for understanding the structure of resonances, we learn the scattering theory, Feshbach resonance theory, and nonrelativistic effective field theory. |
| (3) Course schedule, subject matter, and classroom activities | The strong interaction, which is one of the fundamental forces of nature, governs the diverse physics of particles called hadrons. In particular, various excitations induce resonances in the low energy region, and it is necessary to understand their structures. In this lecture, we aim to understand the structure of hadron resonances, and introduce theoretical methods for describing scattering and resonance phenomena from general viewpoints. First, we introduce the basics of dealing with resonance phenomena based on quantum mechanics, and explain the scattering theory and theory of Feshbach resonance. We then introduce non-relativistic effective field theories which are useful for describing actual systems such as hadrons, and the method to discuss the structure of resonance states through the quantity called compositeness.<br>Course schedule<br>Lecture 1: Introduction: resonances in hadron physics<br>Lecture 2: Resonances in quantum mechanics<br>Lecture 3: Basics of scattering theory<br>Lecture 4: Resonances in scattering theory<br>Lecture 5: Theory of Feshbach resonance<br>Lecture 6: Nonrelativistic effective field theories<br>Lecture 7: Compositeness and weak-binding relation<br>Lecture 8: Summary and solutions to exercises |
| (4) Outside-class activities and assignments | Solve the exercises specified during the lecture and submit them as a report. |
| (5) Textbooks and course materials | The course follows the lecture nots uploaded on the web. References will be introduced during the course. |
| (6) Assessment and grading | Based on the report. |
| (7) Questions to the instructor (Office hours, etc.) | Office hours are not specified. Questions are welcome before and after the class. Send e-mail for appointment, or send questions via e-mail. |
| (8) Special note | It is desirable to have basic knowledge of nuclear hadron physics and quantum field theory, but the necessary contents will be explained during the course. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced High Energy Astrophysics II | M(R133) | | | 2nd A | Fri. | 3 | 1 |
| Doctoral program | Advanced High Energy Astrophysics II | D(R134) | Advanced High Energy Astrophysics II | D (R134) | | | | |

| Instructor(s) | Note |
|---|---|
| Yutaka Fujita | |

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| (1) Course policies and topics | This course introduces theories of high energy astrophysics. The aim of this course is to help students understand physical processes relevant to the structure and evolution of high-energy objects. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | At the end of the course, participants are expected to explain spherically symmetric accretion and accretion disks, which are gravitational energy release mechanisms, based on fluid mechanics, and Fermi first- and second-order particle acceleration based on special relativity. |
| (3) Course schedule, subject matter, and classroom activities | 1. Overview of high-energy astrophysics<br>2. Review of fluid dynamics<br>3. Spherically symmetric accretion<br>4. Accretion disk I<br>5. Accretion disk II<br>6. Accretion disk III<br>7. Cosmic ray acceleration I<br>8. Cosmic ray acceleration II |
| (4) Outside-class activities and assignments | Participants are highly recommended to prepare each lecture by reading the textbook and review the things that they have learned in the lecture. |
| (5) Textbooks and course materials | Textbook is provided in the lecture. |
| (6) Assessment and grading | Your final grade will be calculated according to the following process: Usual performance score, Reports. |
| (7) Questions to the instructor (Office hours, etc.) | Make an appointment in advance. |
| (8) Special note | This course is complementary to “Advanced High Energy Astrophysics I”, in which specific phenomena such as radiation processes are dealt with. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Nonlinear Physics | M(R0141) | | | 1st | Mon | 3 | 1 |
| Doctoral program | Advanced Nonlinear Physics | D(R0141) | Advanced Nonlinear Physics | D(R0142) | | | | |

| Instructor(s) | Note |
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| (1) Course policies and topics | Even if we follow determinism such as differential equations, their behavior can be random and unpredictable. Chaos in dynamical systems is a common phenomenon that is universally observed in natural phenomena, and it is also a basic language in natural science. Here, I will introduce the basic idea of chaos in dynamical systems, and introduce some methods to understand nonintegrable dynamical systems. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | ・This course provides an overview of the evolution of undergraduate mechanics and its progress to the present day.<br>・Students will learn the basic concepts and some methods to understand nonlinear dynamics, especially non-integrable Hamiltonian dynamical systems. |
| (3) Course schedule, subject matter, and classroom activities | Part 1: The development of classical mechanics<br>Part 2: Dynamical systems theory and statistical mechanics<br>Part 3: Hamiltonian dynamical systems and integrability<br>Part 4: Nonintegrable dynamical systems<br>Part 5: Initial sensitivities and chaos<br>Part 6: Horseshoe dynamics and entropy of dynamical systems<br>The class will be conducted mainly in lecture format. During the class time, there will be time for questions and to check the level of understanding. |
| (4) Outside-class activities and assignments | Students will be asked to submit reports as needed to ensure understanding of each lesson. |
| (5) Textbooks and course materials | If necessary, reference books and literature will be introduced in the lecture and handouts will be distributed. |
| (6) Assessment and grading | Grades will be based on reports given during the class and at the end of the class. |
| (7) Questions to the instructor (Office hours, etc.) | If you have any questions, please feel free to ask me. However, if you want to ask a question directly, please make an appointment in advance by e-mail. |
| (8) Special note | There is no strong relationship with other graduate courses. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced statistical mechanics | M(R0117) | | | 1st B | Tue. | 3 | 1 |
| Doctoral program | Advanced statistical mechanics | D(R0118) | Advanced statistical mechanics | D(R118) | | | | |

| Instructor(s) | Note |
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| Emiko Arahata | |

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| (1) Course policies and topics | Explains from the beginning of classical statistical mechanics to the basics of quantum statistical mechanics. Learn about perturbation expansion and linear response theory of interaction systems at finite temperatures. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | This lecture will give you a deep knowledge of perturbation expansion of interaction systems and linear response theory at finite temperatures |
| (3) Course schedule, subject matter, and classroom activities | 1: Review of classical statistical mechanics<br>2: Canonical ensemble of quantum statistical mechanics 3: Green's function<br>4: Perturbation theory of interacting systems<br>5: Feynman diagram<br>6: Path integral<br>7: Dyson's equation<br>8: Application of linear response theory |
| (4) Outside-class activities and assignments | Giving some assignments in every class |
| (5) Textbooks and course materials | Posting materials on kibaco |
| (6) Assessment and grading | Reports(100%) |
| (7) Questions to the instructor (Office hours, etc.) | Questions will be accepted at any time. Make an appointment or directly send questions by email. |
| (8) Special note | Statistical mechanics and quantum mechanics have been learned. It is desirable to take Advanced Quantum Many Body System |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Quantum Many Body System | R0115 | | | 1st Intensive | | | 1 |
| Doctoral program | Advanced Quantum Many Body System | R0116 | Advanced Quantum Many Body System | R116 | | | | |

| Instructor(s) | Note |
|---|---|
| Kazumasa Hattori | |

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| (1) Course policies and topics | Quantum field theories play crucial roles on modern condensed-matter physics. In this course, starting from an introduction of second quantization, we learn basic techniques about many-body perturbation theory and its application. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Understanding second quantization and many-body perturbation theory. For example, one of the purposes is to understand mean-field approximations in terms of Feynman diagram techniques. |
| (3) Course schedule, subject matter, and classroom activities | Students should obtain the pdf lecture notes posted on kibaco in advance.<br><br>1. Second quantization<br>2. Exact diagonalization<br>3. Free particles and mean-field approximations<br>4. Green's functions<br>5. Perturbation theory and Feynman diagram techniques<br>6. Dyson's equation<br>7. Mean-field theory in terms of Green function methods<br>8. Random-phase approximation |
| (4) Outside-class activities and assignments | The detail about the schedule will be announced by the middle of April. Students are expected to study at least one of the books in (5) or similar textbooks by yourself. |
| (5) Textbooks and course materials | References:<br>A. Fetter and J. Walecka "Quantum Theory of Many-Particle Systems" (Dover Books on Physics).<br>J. Schrieffer "Theory of Superconductivity" (Advanced Books Classics).<br>E. M. Lifshitz and L. P. Pitaevskii "Statistical Physics" (Butterworth-Heinemann) |
| (6) Assessment and grading | A report (100%) |
| (7) Questions to the instructor (Office hours, etc.) | No specific office hours are set, but if you wish to ask questions, please make an appointment in advance by e-mail. |
| (8) Special note | Knowledge of quantum mechanics, statistical mechanics, and physical mathematics is a prerequisite. It is especially difficult to understand the lecture content without knowledge of quantum statistics.<br><br>Register during the registration period in the first semester. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Physics of Superconductivity | R0145 | | | 2nd A | Mon. | 3 | 1 |
| Doctoral program | Advanced Physics of Superconductivity | R0146 | Advanced Physics of Superconductivity | R146 | | | | |

| Instructor(s) | Note |
|---|---|
| Takashi Hotta | |

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| (1) Course policies and topics | This lecture introduces a theory of superconductivity, which is a typical many-body phenomenon, from a more advanced point of view. Through the understanding of superconductivity, students learn general ideas for elucidating phenomena based on hierarchical structures in physics. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Students gain knowledge of the BCS theory of superconductivity, the Migdal-Eliashberg theory, and electromagnetic response of superconductors. |
| (3) Course schedule, subject matter, and classroom activities | Lecture 1: Experimental facts, hierarchy in the theory of superconductivity, BCS Hamiltonian<br>Lecture 2: BCS theory (1): Cooper instability, Gor'kov approximation, anomalous Green's function<br>Lecture 3: BCS theory (2): Gap equation, thermodynamic potential, specific heat, size of the Cooper pair<br>Lecture 4: Electromagnetic response (1): Meissner effect<br>Lecture 5: Electromagnetic response (2): Vertex corrections, gauge invariance<br>Lecture 6: Electron-phonon Hamiltonian and Migdal approximation<br>Lecture 7: Migdal-Eliashberg theory (1)<br>Lecture 8: Migdal-Eliashberg theory (2)<br>Classroom activities: Classes centered on lectures will be conducted. |
| (4) Outside-class activities and assignments | It is necessary to prepare for the next class and understand the meaning of technical terms. |
| (5) Textbooks and course materials | They will be introduced in the lecture as appropriate. |
| (6) Assessment and grading | Grade evaluation is based on the report assignment. |
| (7) Questions to the instructor (Office hours, etc.) | Office hours are not specified, but questions are welcome. Students should make an appointment by email in advance. |
| (8) Special note | Knowledge of quantum mechanics and statistical mechanics is assumed. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced High Energy Physics II | R0121 | | | 1st B | Fri. | 3 | 1 |
| Doctoral program | Advanced High Energy Physics II | R0122 | Advanced High Energy Physics II | R122 | | | | |

| Instructor(s) | Note |
|---|---|
| Hidekazu Kakuno | |

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| (1) Course policies and topics | This course will focus on collider experiments at the high energy frontier. We will review how we establish the Standard Model using collider experiments, and will discuss current and future collider experiments that will explore new physics beyond the Standard Model. Accelerators and detectors that are used at collider experiments, will also be introduced in this course. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The aim of this lecture is to provide the knowledge of experimental approach to establish the Standard Model and to search for new physics beyond the Standard model. Students will also learn principles and performances of particle detectors and accelerators that are used in energy frontier experiments. |
| (3) Course schedule, subject matter, and classroom activities | 1. Validation of the Quark Model (experiments before TRISTAN)<br>2. The Search for New Generation Quarks (TRISTAN experiment)<br>3. Observation of the W and Z Bosons (SppS experiment)<br>4. The Study of the W and Z Bosons (LEP experiment, SLD experiment)<br>5. Observation of the Top Quark (TEVATRON experiment)<br>6. Observation of the Higgs Boson (LHC experiment)<br>7. The Study of the Higgs Boson and the Search for New Physics (LHC upgrade, ILC project)<br>8. Summary |
| (4) Outside-class activities and assignments | Reference journal articles will be shown in the lecture. Students are asked to summarize contents of articles as necessary. |
| (5) Textbooks and course materials | Reference books and journal articles will be shown in the lecture. |
| (6) Assessment and grading | Assessment will be based on the combination of the final report and in-class short reports. |
| (7) Questions to the instructor (Office hours, etc.) | Office hours are not set. Please contact H.Kakuno by email. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Atomic Physics II | R0155 | | | 2nd A | Wed | 3 | 1 |
| Doctoral program | Advanced Atomic Physics II | R0156 | Advanced Atomic Physics II | R156 | | | | |

| Instructor(s) | Note |
|---|---|
| Hajime Tanuma | |

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|---|---|
| (1) Course policies and topics | Interactions and low energy collisions between atoms and molecules will be explained based on fundamental knowledge for structure and spectroscopy of atoms and molecules. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Understanding of classical, semi-classical, and quantum scattering theory for atoms and molecules |
| (3) Course schedule, subject matter, and classroom activities | 1. Interaction potentials between atoms and molecules<br>2. Classical and quantum theory of scattering<br>3. Semi-classical theory of scattering<br>4. Typical potential scattering experiments<br>5. Non-adiabatic transition theory<br>6. Some simple potential crossing models<br>7. Application for charge transfer collisions of highly charged ions<br>8. Questions and answers |
| (4) Outside-class activities and assignments | Before the class, check and confirm the understanding of previous lectures. |
| (5) Textbooks and course materials | Presentation slides will be provided through the “kibako” system. |
| (6) Assessment and grading | Questions and reports after whole lectures |
| (7) Questions to the instructor (Office hours, etc.) | Contact via e-mail to tanuma-hajime@tmu.ac.jp |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Correlated Electron Physics II | R0135 | - | - | 2nd A | Wed. | 4 | 1 |
| Doctoral program | Advanced Correlated Electron Physics II | R0136 | Advanced Correlated Electron Physics II | R136 | | | | |

| Instructor(s) | Note |
|---|---|
| Yoshikazu Mizuguchi | |

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| (1) Course policies and topics | In this class, we will study the history and methods of research for new superconducting materials. Particularly, strategies for new material design are the focus of this class. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | We will study the background of the research on new superconductors and the probes to investigate superconducting properties, mechanisms, crystal structure, valence states, etc. This class will cover the topics of classical superconductors and recent discoveries of new superconductors. The goal of this class is to learn the method and concept of new material design and prediction of the functionalities. |
| (3) Course schedule, subject matter, and classroom activities | This class will be conducted in English using presentation slides. Since many Japanese and international students are expected to take this class, we will use both English and Japanese when discussion and Q and A.<br>The plan of the lecture contents is summarized below.<br>(1) History of the discoveries of new superconductors and unconventional mechanisms.<br>(2) Experimental methods to study superconducting properties and mechanisms.<br>(3) Crystal structure analysis<br>(4) High pressure studies<br>(5) Material design: layered superconductors<br>(6) Material design: elemental substitution and tuning of superconducting properties<br>(7) Exercise of material design<br>(8) Discussion on the designed materials |
| (4) Outside-class activities and assignments | We will share the presentation slides in advance. Please study with the slides before/after the class. |
| (5) Textbooks and course materials | Announced in the first lecture. |
| (6) Assessment and grading | Two reports will be used for the credit evaluation. |
| (7) Questions to the instructor (Office hours, etc.) | Office hour is 10:30-11:30 on Monday.<br>Before coming, please make an appointment by e-mail. |
| (8) Special note | To take this class, knowledges about physics, condensed matter physics are needed. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Selected Topics in Physics and Chemistry I (Advanced Nanoscience, Surface, and Interface Physics II) | R0137 | - | - | 1st B | Tue. | 1 | 1 |
| Doctoral program | Selected Topics in Physics and Chemistry I (Advanced Nanoscience, Surface, and Interface Physics II) | R0138 | Selected Topics in Physics and Chemistry I (Advanced Nanoscience, Surface, and Interface Physics II) | R138 | | | | |

| Instructor(s) | Note |
|---|---|
| Kazuhiro Yanagi | This course is offered for Physics and Chemistry majors |

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|---|---|
| (1) Course policies and topics | Electrochemistry and semiconductor physics have recently become particularly important fundamental disciplines in the study of physical properties. Carrier injection control using the electric field effect is a fundamental technique for semiconductor devices, and recently it has been applied to the search for new physical properties by integrating electrochemical techniques. For example, it is possible to change an insulator to a metallic state and even induce a superconducting transition. This is based on the precise control of the amount of carriers that accumulate on the surface of materials by utilizing the solid-liquid interface. In order to properly understand the background and apply such field-effects to research on physical properties, this lecture will provide an explanation of the fundamentals of electrochemistry and semiconductor physics and their application to nanoscale material systems. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Students will acquire basic knowledge about electrochemistry and semiconductor physics. To gain knowledge of the relationship between the structure of nanoscale material systems and battery structure. To acquire knowledge that will enable the student to correctly understand the latest research on physical properties using the electric field effect. |
| (3) Course schedule, subject matter, and classroom activities | After an overview in the introduction, the fundamentals of electrochemistry and semiconductor physics will be reviewed according to the following schedule. Finally, the recent researches will be explained.<br>1: Control of physical properties using electric field effect will be explained.<br>2 and 3: Fundamentals of electrochemical techniques.<br>4 and 5: Fundamentals of semiconductor physics.<br>6: Nanostructures and electronic structures - with a focus on nanotube structures<br>7: Conducting properties and applications to optical properties<br>8 Applications to thermoelectric properties |
| (4) Outside-class activities and assignments | Students are required to prepare and submit a report of about one sheet of A4 paper on the assignment shown at the end of each class. |
| (5) Textbooks and course materials | Textbooks and course materials will be introduced during the lecture as appropriate. Handouts and other materials will be distributed as necessary. |
| (6) Assessment and grading | The final grade will be based on the lecture report and the final report. |
| (7) Questions to the instructor (Office hours, etc.) | In principle, office hours will be held on 1st period of Friday. If you have any questions, please come to my room (Room 8-209) after making an appointment by e-mail at least one day in advance. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Selected Topics in Physics and Chemistry I (Advanced Soft Matter Physics II) | R0143 | | | 1st B | Thu. | 3 | 1 |
| Doctoral program | Selected Topics in Physics and Chemistry I (Advanced Soft Matter Physics II) | R0144 | Selected Topics in Physics and Chemistry I (Advanced Soft Matter Physics II) | R144 | | | | |

| Instructor(s) | Note |
|---|---|
| Rei Kurita | This course is offered for Physics and Chemistry majors |

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| (1) Course policies and topics | Soft matter is a subfield of condensed matter comprising a variety of physical systems that can be deformed. They include liquids, colloids, polymers, foams, gels, granular materials, liquid crystals, pillows, flesh, and a number of biological materials. This program aims to understand the basis of the soft matter. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The goals are to learn phase transitions, coarsenings, self similarities, and then the basis of the non-equilibrium dynamics. |
| (3) Course schedule, subject matter, and classroom activities | 1. What is soft matters?<br>2. Thermal equilibrium and phase separations.<br>3. Colloidal dispersion and Brownian motions.<br>4. Ideal chain model for polymers.<br>5. Elastic modulus of polymers.<br>6. Phase transitions in liquid crystals.<br>7. Surfactants.<br>8. Reports and comments. |
| (4) Outside-class activities and assignments | As next content is announced, prepare for next lesson after the class |
| (5) Textbooks and course materials | Not in particular. |
| (6) Assessment and grading | Evaluate marks in a question-and-answer session and in reports |
| (7) Questions to the instructor (Office hours, etc.) | Need to take an appointment by email (kurita@tmu.ac.jp) |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced English for science | R0139 | - | - | 2nd A | Thu. | 2 | 1 |
| Doctoral program | Advanced English for science | R140 | Advanced English for science | R140 | | | | |

| Instructor(s) | Note |
|---|---|
| Hiroyuki Mori | |

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|---|---|
| (1) Course policies and topics | Scientific English is a very important skill for writing scientific papers. In this class, we will focus on writing scientific English and aim to improve skills in this area. Rather than a passive class with lectures, students will practice writing scientific English by composing sentences in English for each assignment. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In addition to learning what to pay attention to when writing scientific English and what to keep in mind on a regular basis, students can write their own English sentences and receive corrections to understand the specific mistakes they are likely to make. |
| (3) Course schedule, subject matter, and classroom activities | [Course schedule, subject matter]<br>1. General explanation of scientific English<br>2. Expressions used in papers in Physics (part 1): Explanation of graphs<br>3. Expressions used in papers in Physics (part 2): Expressions on increase/decrease<br>4. Expressions used in papers in Physics (part 3): Explanation of differences<br>5. Expressions used in papers in Physics (part 4): Explanation of equations<br>6. Expressions used in papers in Physics (part 5): Expressions on “larger than” or “smaller than”<br>7. Expressions used in papers in Physics (part 6): Expressions on research summary 1<br>8. Expressions used in papers in Physics (part 7): Expressions on research summary 2<br>[Classroom activities]<br>The class will be conducted in the form of exercises, and each student will be given an assignment to complete. In class, we will take up some of the submitted answers and correct them during the class time. Those that cannot be corrected during the class time will be corrected and returned by e-mail. |
| (4) Outside-class activities and assignments | Students should write responses in English to the assignments given in each class. It is acceptable to use a dictionary, etc., but it is necessary to develop your English carefully so that there are no grammatical or spelling errors. |
| (5) Textbooks and course materials | Convenient dictionary sites:<br>Weblio (http://ejje.weblio.jp/)<br>ALC (http://www.alc.co.jp/) |
| (6) Assessment and grading | Grades will be based on the submission of assignments. |
| (7) Questions to the instructor (Office hours, etc.) | There are no office hours designated, but if you would like to ask a question in person, I am always available. Please make an appointment by sending an email to mori@phys.se.tmu.ac.jp. |
| (8) Special note | Since the class will be more like an exercise than a lecture, it is desirable to actively ask questions during the class.<br>Note that this class will be provided in Japanese to non-English native students. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Selected Topics in Physics and Chemistry II (Advanced Molecular Spectroscopy) | R0163 | | | 2nd | Wed. | 1 | 2 |
| Doctoral program | Selected Topics in Physics and Chemistry II (Advanced Molecular Spectroscopy) | R0164 | Selected Topics in Physics and Chemistry II (Advanced Molecular Spectroscopy) | R164 | | | | |

| Instructor(s) | Note |
|---|---|
| Reika Kanya | This course is offered for Physics and Chemistry majors |

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| (1) Course policies and topics | Determination of geometrical structures of isolated gas molecules is lectured from the basics to the advanced topics. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Basic theory of electron scattering processes by atoms and molecules as well as the principle of structural determination of molecules. Recent progress of experimental techniques for probing structural dynamics of molecules. |
| (3) Course schedule, subject matter, and classroom activities | 01. Interference of waves and basics of electron diffraction method, 02. Electron scattering by atoms, 03. Green function, 04. Lippmann-Schwinger equation, 05. Differential cross section, 06. Partial wave analysis, 07. Partial wave analysis by numerical calculations, 08. Intermediate summary, 09. Born approximation, 10. Electron scattering by molecules and the independent atom model, 11. Effect of molecular vibration, 12. Molecular scattering curve and radial distribution function, 13. Analyses of electron diffraction images 1, 14. Analyses of electron diffraction images 2, 15. Recent studies in time-resolved electron diffraction method. |
| (4) Outside-class activities and assignments | Lecture slides are uploaded in advance for preparation of the lecture. |
| (5) Textbooks and course materials | “Quantum Mechanics of Molecular Structures”, Kaoru Yamanouchi (Springer, 2012) |
| (6) Assessment and grading | Attendance (20%), Intermediate exam. (40%), Final exam. (40%) |
| (7) Questions to the instructor (Office hours, etc.) | E-mail (kanya@tmu.ac.jp) |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Selected Topics in Physics and Chemistry II (Advanced Physical Chemistry of Condensed Matter) | R0165 | | | 1st | Mon. | 2 | 2 |
| Doctoral program | Selected Topics in Physics and Chemistry II (Advanced Physical Chemistry of Condensed Matter) | R0166 | Selected Topics in Physics and Chemistry II (Advanced Physical Chemistry of Condensed Matter) | R166 | | | | |

| Instructor(s) | Note |
|---|---|
| Yasushi Hirose | This course is offered for Physics and Chemistry majors |

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|---|---|
| (1) Course policies and topics | Semiconductors are widely applied for information technology, communication technology, and materials for energy conversion. In this lecture, fundamental properties and their applications of semiconductors are overviewed. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | To understand the followings:<br>- Fundamental properties of semiconductors and how to control them in Chemistry<br>- Working mechanism of basic semiconductor devices |
| (3) Course schedule, subject matter, and classroom activities | Followings are contents of this course. Detailed schedule will be announced at the first day.<br>- 01 Introduction, Band structure of semiconductor<br>- 02 Intrinsic semiconductor<br>- 03 Carrier doping<br>- 04 Transport of electrons in a semiconductor<br>- 05 Optical properties of a semiconductor<br>- 06 Diffusion of carriers<br>- 07 Short summary<br>- 08-09 - p-n junction<br>- 10-11 Optoelectronics devices and heterojunction<br>- 12 Bipolar transistor<br>-13 Metal-semiconductor junction and field effect transistor<br>-14 MOS transistor<br>-15 Summary |
| (4) Outside-class activities and assignments | Students are assigned for some homework related to the lecture. |
| (5) Textbooks and course materials | Course materials are distributed if necessary. Some textbooks are recommended in the lecture for further learning. |
| (6) Assessment and grading | Grading by class participation and homeworks (or semester exam). |
| (7) Questions to the instructor (Office hours, etc.) | Questions and concerns are accepted by e-mail. |
| (8) Special note | Scientific electrical calculator is used for exercise during the lecture. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Selected Topics in Physics and Chemistry II (Advanced Theoretical Chemistry) | R0167 | | | 1st | Tue. | 2 | 2 |
| Doctoral program | Selected Topics in Physics and Chemistry II (Advanced Theoretical Chemistry) | R0168 | Selected Topics in Physics and Chemistry II (Advanced Theoretical Chemistry) | R168 | | | | |

| Instructor(s) | Note |
|---|---|
| Naoki Nakatani | This course is offered for Physics and Chemistry majors |

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|---|---|
| (1) Course policies and topics | In this course, we provide an advanced lecture about “molecular electronic structure theory”, one of the topics in “quantum chemistry”. Particularly, we focused on the practical methods to compute electronic structures (such that energy, geometry, and properties of molecules). In recent years, it is able to predict the physical properties with the extremely high accuracy. On the other hand, it is also applied for large molecular systems such as proteins and nanomaterials, with an appropriate approximation. We will overview these state-of-the-art methods and their applications, too. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Students will learn advanced and practical knowledge about quantum chemistry and computational chemistry which can be applied for own research topics. Students will learn the recent research results in the lecture to cultivate own skills which help to understand computational results and discussions in academic articles and to apply them for research. |
| (3) Course schedule, subject matter, and classroom activities | Course schedule is provided as follows.<br>[01] Derivation of HF energy<br>[02] Derivation of CI energy<br>[03] Exercise using Excel 1<br>[04] Derivation of MP2 energy<br>[05] Exercise using Excel 2<br>[06] Overview on multi-reference methods<br>[07] Density functional theory – Basic idea<br>[08] Density functional theory – Applications<br>[09] Transition state search – Application 1<br>[10] Transition state search – Application 2<br>[11] Analyses using molecular orbitals (MOs) and natural orbitals (NOs)<br>[12] Excited state calculations – Basic idea<br>[13] Excited state calculations – Applications<br>[14] Electromagnetic properties<br>[15] Relativistic corrections<br><br>NOTE: Course schedule can be changed due to number of registered students, major field of students, and instructor’s circumstances. |
| (4) Outside-class activities and assignments | Students are assigned for a report to summarize the lecture. |
| (5) Textbooks and course materials | Course materials are distributed if necessary. Also, students should have copies of article and web page which are specified preliminary. |
| (6) Assessment and grading | Grading by the report (80%) and some exercises in the lecture (20%). |
| (7) Questions to the instructor (Office hours, etc.) | Though we do not arrange the office-hour, we accept questions directly and by e-mail. In the e-mail, please specify your name in the subject and use an e-mail address which we can reply by internet (we do not accept e-mails including special characters which only available for mobile phone). |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | External Experience in Physics | R0193 2 units<br>R0195 1 unit | - | - | Intensive course | TBA. | TBA | 1 or 2 |
| Doctoral program | External Experience in Physics | R0194 2 units<br>R0196 1 unit | External Experience in Physics | R0194 2 units<br>R0196 1 unit | | | | |

| Instructor(s) | Note |
|---|---|
| All Instructors | The credit hours will be added if the course provides a different subject matter. |

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|---|---|
| (1) Course policies and topics | Off-campus activities such as work experience, off-campus research, and volunteer activities related to the specialized content of physics. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Through off-campus activities such as work experience, off-campus research, and volunteer activities, students will gain knowledge and experience that cannot be acquired through on-campus activities. |
| (3) Course schedule, subject matter, and classroom activities | Changes depending on the content of the off-campus activities. |
| (4) Outside-class activities and assignments | Changes depending on the content of the off-campus activities. |
| (5) Textbooks and course materials | Changes depending on the content of the off-campus activities. |
| (6) Assessment and grading | Students who have completed an off-campus experience are required to submit a report on their learning to their faculty supervisor, who will decide whether or not to grant credit in light of its compatibility with the purpose of the External Experience of Physics. Up to two credits per semester may be granted. Students who wish to obtain credits must apply to their faculty advisor at least two months prior to the scheduled start of the off-campus experience. |
| (7) Questions to the instructor (Office hours, etc.) | Ask your faculty supervisor or staff of the Academic Affairs Committee. |
| (8) Special note | This course is taught by faculty members or others with practical experience.<br>Credit is granted for off-campus activities such as work experience, off-campus research, and volunteer activities related to the specialized content of physics that meet certain requirements. The requirements include the followings:<br>(1) The activity must be conducted for 30 hours or more.<br>(2) The activity must not interfere with the study of other subjects.<br>(3) No remuneration is received.<br>(4) A certificate of completion must be obtained from the organizer after the completion of the experience.<br>(5) The faculty supervisor must certify that the content of the experience is equivalent to the university's curriculum level.<br>The student must find the host institution/organization on his/her own. Since this course is offered as a new course at the request of the student, it is not possible to apply for the course at the beginning of the semester. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Seminar Physics I, II, III, IV | | | | 1st/2nd | ・ | ・ | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| All instructors | |

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|---|---|
| (1) Course policies and topics | This is for students in the master course program. They will belong to individual research labs and conduct literature reviews and oral presentations at seminars and other events. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Through literature reading and oral presentations at seminars, students will acquire the basic knowledge necessary to advance their research in physics, develop logical thinking skills, and gain the ability to engage in discussions with other researchers. |
| (3) Course schedule, subject matter, and classroom activities | Please consult the supervisor regarding the course schedule, content, and methodology. The topics covered in each session are as follows. The course will be conducted flexibly in consultation with the supervisor according to the progress of the research.<br>1 : Introduction to the research conducted in the laboratory and the presentation of future seminar plans.<br>2-7 : Reading and explanation of literature related to the research topic.<br>8-13 : Reading and explanation of related papers.<br>14: Organizing acquired specialized knowledge.<br>15: General discussion. |
| (4) Outside-class activities and assignments | Please consult your supervisor. |
| (5) Textbooks and course materials | The necessary reference materials for the seminar will be provided by the supervisor as appropriate. |
| (6) Assessment and grading | Overall assessment will be based on factors such as literature review, oral presentations, and participation in seminars. |
| (7) Questions to the instructor (Office hours, etc.) | Please consult your supervisor. |
| (8) Special note | Students must take I-IV in order, and cannot take multiple courses simultaneously. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Experiment in Physics I, II, III, IV | | | | 1st/2nd | ・ | ・ | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| All experimental physics instructors | |

| | |
|---|---|
| (1) Course policies and topics | This is for students in the master course program. They will belong to a laboratory and learn how to conduct experimental research in physics by setting and achieving research goals under the guidance of a faculty member in the laboratory. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Through the study of experimental techniques and knowledge of physics, students will acquire the ability to solve problems, write papers, and present research results. |
| (3) Course schedule, subject matter, and classroom activities | The topics covered in each session are as follows. The course will be conducted flexibly in consultation with the supervisor according to the progress of the research.<br>1 : Introduction to the research conducted in the laboratory and the presentation of future seminar plans.<br>2-4 : Task setting and planning.<br>5-7 : Acquisition of experimental and calculation methods necessary for research.<br>8: Interim report and discussion on experimental and computational methods.<br>9-12: Implementation of task experiments.<br>13-14: Arrangement of obtained experimental data.<br>15: Summary report and discussion. |
| (4) Outside-class activities and assignments | Please consult your supervisor about what you will study outside of class. |
| (5) Textbooks and course materials | The necessary reference materials for the seminar will be provided by the supervisor as appropriate. |
| (6) Assessment and grading | Overall assessment will be based on factors such as literature review, oral presentations, and participation in seminars. |
| (7) Questions to the instructor (Office hours, etc.) | Please consult your supervisor. |
| (8) Special note | Students must take I-IV in order, and cannot take multiple courses simultaneously. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Practice in Physics I, II, III, IV | | | | 1st/2nd | ・ | ・ | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| All instructors of theoretical physics | |

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|---|---|
| (1) Course policies and topics | This is for students in the master course program. They will belong to a laboratory and learn how to conduct theoretical research in physics by setting and achieving research goals under the guidance of a faculty member in the laboratory. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Through the study of theoretical physics, students will acquire the ability to solve problems, write papers, and present research results. |
| (3) Course schedule, subject matter, and classroom activities | The topics covered in each session are as follows. The course will be conducted flexibly in consultation with the supervisor according to the progress of the research.<br>1 : Introduction to the research conducted in the laboratory and the presentation of future seminar plans.<br>2-4 : Task setting and planning.<br>5-7 : Acquisition of theoretical and calculation methods necessary for research.<br>8: Interim report and discussion on theoretical and computational methods.<br>9-12: Implementation of task practice.<br>13-14: Arrangement of obtained practice results.<br>15: Summary report and discussion. |
| (4) Outside-class activities and assignments | Please consult your supervisor about what you will study outside of class. |
| (5) Textbooks and course materials | The necessary reference materials for the seminar will be provided by the supervisor as appropriate. |
| (6) Assessment and grading | Overall assessment will be based on factors such as literature review, oral presentations, and participation in seminars. |
| (7) Questions to the instructor (Office hours, etc.) | Please consult your supervisor. |
| (8) Special note | Students must take I-IV in order, and cannot take multiple courses simultaneously. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | | | | | 1st/2nd | ・ | ・ | 4 |
| Doctoral program | Advanced Experiment in Physics V, VI, VII, VIII | | Advanced Experiment in Physics V, VI, VII, VIII | | | | | |

| Instructor(s) | Note |
|---|---|
| All experimental physics instructors | |

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|---|---|
| (1) Course policies and topics | This is for students in the doctor course program. Belonging to each experimental laboratory, and learning how to proceed with research as an autonomous researcher by setting and carrying out original tasks under the guidance or advice of laboratory faculty members. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Acquire knowledge of advanced experimental techniques in physics. Acquire the ability to compile original papers, communicate research results and their significance, and acquire the ability to position them in relation to society. |
| (3) Course schedule, subject matter, and classroom activities | The topics covered in each session are as follows. The course will be conducted flexibly in consultation with the supervisor according to the progress of the research.<br>1 : Introduction to the research conducted in the laboratory and the presentation of future seminar plans.<br>2-4 : Task setting and planning.<br>5-7 : Acquisition of experimental and calculation methods necessary for research.<br>8: Interim report and discussion on experimental and computational methods.<br>9-12: Implementation of task experiments.<br>13-14: Arrangement of obtained experimental data.<br>15: Summary report and discussion. |
| (4) Outside-class activities and assignments | Please consult your supervisor about what you will study outside of class. |
| (5) Textbooks and course materials | The necessary reference materials for the seminar will be provided by the supervisor as appropriate. |
| (6) Assessment and grading | Overall assessment will be based on factors such as literature review, oral presentations, and participation in seminars. |
| (7) Questions to the instructor (Office hours, etc.) | Please consult your supervisor. |
| (8) Special note | Students must take V-VIII in order, and cannot take multiple courses simultaneously. IX can be taken after completing VIII. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | | | | | 1st/2nd | ・ | ・ | 2 |
| Doctoral program | Advanced Experiment in Physics IX | | | | | | | |

| Instructor(s) | Note |
|---|---|
| All experimental physics instructors | |

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|---|---|
| (1) Course policies and topics | This is for students in the doctor course program. Belonging to each experimental laboratory, and learning how to proceed with research as an autonomous researcher by setting and carrying out original tasks under the guidance or advice of laboratory faculty members. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Acquire knowledge of advanced experimental techniques in physics. Acquire the ability to compile original papers, communicate research results and their significance, and acquire the ability to position them in relation to society. |
| (3) Course schedule, subject matter, and classroom activities | The topics covered in each session are as follows. The course will be conducted flexibly in consultation with the supervisor according to the progress of the research.<br>1 : Introduction to the research conducted in the laboratory and the presentation of future seminar plans.<br>2-4 : Task setting and planning.<br>5-7 : Acquisition of experimental and calculation methods necessary for research.<br>8: Interim report and discussion on experimental and computational methods.<br>9-12: Implementation of task experiments.<br>13-14: Arrangement of obtained experimental data.<br>15: Summary report and discussion. |
| (4) Outside-class activities and assignments | Please consult your supervisor about what you will study outside of class. |
| (5) Textbooks and course materials | The necessary reference materials for the seminar will be provided by the supervisor as appropriate. |
| (6) Assessment and grading | Overall assessment will be based on factors such as literature review, oral presentations, and participation in seminars. |
| (7) Questions to the instructor (Office hours, etc.) | Please consult your supervisor. |
| (8) Special note | Students must take V-VIII in order, and cannot take multiple courses simultaneously. IX can be taken after completing VIII. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | | | | | 1st/2nd | ・ | ・ | 4 |
| Doctoral program | Advanced Practice in Physics V, VI, VII, VIII | | Advanced Practice in Physics V, VI, VII, VIII | | | | | |

| Instructor(s) | Note |
|---|---|
| All instructors of theoretical physics | |

| | |
|---|---|
| (1) Course policies and topics | This is for students in the doctor course program. Belonging to each theoretical laboratory, and learning how to proceed with research as an autonomous researcher by setting and carrying out original tasks under the guidance or advice of laboratory faculty members. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Acquire knowledge of advanced theoretical techniques in physics. Acquire the ability to compile original papers, communicate research results and their significance, and acquire the ability to position them in relation to society. |
| (3) Course schedule, subject matter, and classroom activities | The topics covered in each session are as follows. The course will be conducted flexibly in consultation with the supervisor according to the progress of the research.<br>1 : Introduction to the research conducted in the laboratory and the presentation of future seminar plans.<br>2-4 : Task setting and planning.<br>5-7 : Acquisition of theoretical and calculation methods necessary for research.<br>8: Interim report and discussion on theoretical and computational methods.<br>9-12: Implementation of task practice.<br>13-14: Arrangement of obtained practice results.<br>15: Summary report and discussion. |
| (4) Outside-class activities and assignments | Please consult your supervisor about what you will study outside of class. |
| (5) Textbooks and course materials | The necessary reference materials for the seminar will be provided by the supervisor as appropriate. |
| (6) Assessment and grading | Overall assessment will be based on factors such as literature review, oral presentations, and participation in seminars. |
| (7) Questions to the instructor (Office hours, etc.) | Please consult your supervisor. |
| (8) Special note | Students must take V-VIII in order, and cannot take multiple courses simultaneously. IX can be taken after completing VIII. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | | | | | 1st/2nd | ・ | ・ | 2 |
| Doctoral program | Advanced Practice in Physics XI | | | | | | | |

| Instructor(s) | Note |
|---|---|
| All instructors of theoretical physics | |

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|---|---|
| (1) Course policies and topics | This is for students in the doctor course program. Belonging to each theoretical laboratory, and learning how to proceed with research as an autonomous researcher by setting and carrying out original tasks under the guidance or advice of laboratory faculty members. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Acquire knowledge of advanced theoretical techniques in physics. Acquire the ability to compile original papers, communicate research results and their significance, and acquire the ability to position them in relation to society. |
| (3) Course schedule, subject matter, and classroom activities | The topics covered in each session are as follows. The course will be conducted flexibly in consultation with the supervisor according to the progress of the research.<br>1 : Introduction to the research conducted in the laboratory and the presentation of future seminar plans.<br>2-4 : Task setting and planning.<br>5-7 : Acquisition of theoretical and calculation methods necessary for research.<br>8: Interim report and discussion on theoretical and computational methods.<br>9-12: Implementation of task practice.<br>13-14: Arrangement of obtained practice results.<br>15: Summary report and discussion. |
| (4) Outside-class activities and assignments | Please consult your supervisor about what you will study outside of class. |
| (5) Textbooks and course materials | The necessary reference materials for the seminar will be provided by the supervisor as appropriate. |
| (6) Assessment and grading | Overall assessment will be based on factors such as literature review, oral presentations, and participation in seminars. |
| (7) Questions to the instructor (Office hours, etc.) | Please consult your supervisor. |
| (8) Special note | Students must take V-VIII in order, and cannot take multiple courses simultaneously. IX can be taken after completing VIII. |

# Chemistry / Molecular Materials Chemistry
## (General courses for Graduate School of Science and Graduate School of Science and Engineering)

Notes on course enrollment

(Master's program)

1. The following courses are required for the master's degree.
   - Advanced Research of Chemistry IA, IB, IIA, IIB, and
   - Seminar on Advanced Chemistry I, II No credit will be added when taking the same Advanced Research of Chemistry course more than once. In principle, Advanced Research of Chemistry I A and II B should be taken in the first year, and Advanced Research of Chemistry II A and II B should be taken in the second year. Also, students admitted in April should take Seminar on Advanced Chemistry I in the first semester and Seminar on Advanced Chemistry II in the second semester. Likewise, students admitted in October should take Seminar on Advanced Chemistry I in the second semester and Seminar on Advanced Chemistry II in the first semester.
2. The subject matter of Advanced Theoretical Chemistry considers graduate students of other majors. In order to acquire a solid knowledge in non-major subjects, students majoring in chemistry are required to take two or more units from each of the following groups, for a total of eight or more units to meet the master's degree requirement.
   Group 1: Advanced Inorganic Chemistry, Advanced Cosmochemistry
   Group 2: Advanced Organic Chemistry, Advanced Biological Chemistry
   Group 3: Advanced Molecular Spectroscopy, Advanced Physical Chemistry of Condensed Matter, Advanced Theoretical Chemistry
3. Lecture of Advanced Chemistry I is given by guest lecturers to explain basics by sharing their latest research and topics on their expertise. Students are encouraged to take this course to acquire broader knowledge.
4. In general, students are not allowed to take the same course more than once but may retake the same course for the following courses and earn credits if the course provides different subject matter.
   - Lecture of Advanced Chemistry I
   - Lecture of Advanced Chemistry II
   - Internship of Chemistry
   - Seminar on Advanced Chemistry I, II

(Doctoral program)

1. The following courses are required for the doctorate.
   - Advanced Research of Chemistry IIIA, IIIB, IVA, IVB and
   - Seminar on Advanced Chemistry III, IV No credit will be added when taking the same Advanced Research of Chemistry course more than once. In principle, Advanced Research of Chemistry IIIA and IIIB should be taken in the first year, and Advanced Research of Chemistry IVA and IVB should be taken in the second year. Also, students admitted in April should take Seminar on Advanced Chemistry III in the first semester and Seminar on Advanced Chemistry IV in the second semester. Likewise, students admitted in October should take Seminar on Advanced Chemistry III in the second semester and Seminar on Advanced Chemistry IV in the first semester.
2. Lecture of Advanced Chemistry I is given by guest lecturers to explain basics by sharing their latest research and topics on their expertise. Students are encouraged to take this course to acquire broader knowledge.
3. In general, students are not allowed to take the same course more than once but may take the same course more than once for the following courses and earn credits if the course provides different subject matter.

- Lecture of Advanced Chemistry I
- Lecture of Advanced Chemistry II
- Internship of Chemistry
- Seminar on Advanced Chemistry III, IV

However, courses common to the master's program may not be taken if a student has already earned credits for the course during their master's program and that provides same subject matter as when they earned the course credits.

* M = master's courses, D = doctoral courses
* NA 2023 = Courses not offered in the academic

| Course outline | M | D | NA 2023 | Semester | Day | Time | [Graduate School of Science] | | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Course Number | Course Name | | | |
| 1 | ○ | | | 1st | Fri. | 1 | M(R0221) | Advanced Inorganic Chemistry | 2 | Ken'ichi Sugiura<br>Shiro Kubuki<br>Seiji Yamazoe | |
| 2 | ○ | | | 2nd | Tue. | 2 | M(R0222) | Advanced Geo-and Cosmochemistry | 2 | Nobuyuki Takegawa<br>Yasuji Oura | |
| 3 | ○ | | | 1st | Wed. | 2 | M(R0223) | Advanced Organic Chemistry | 2 | Toshio Shimizu<br>Kotohiro Nomura<br>Abdellatif Mohammed M. | |
| 4 | ○ | | | 2nd | Wed. | 2 | M(R0224) | Advanced Biological Chemistry | 2 | Kouji Hirota<br>Yutaka Ito<br>Masato Taoka<br>Teppei Iketani | |
| 5 | ○ | ○ | | 2nd | Wed. | 1 | M(R0163)<br>D (R0164) | Advanced Molecular Spectroscopy | 2 | Reika Kanya | This course is offered for Physics and Chemistry majors |
| 6 | ○ | ○ | | 1st | Mon. | 2 | M(R0165)<br>D (R0166) | Advanced Physical Chemistry of Condensed Matter | 2 | Yasushi Hirose | This course is offered for Physics and Chemistry majors |
| 7 | ○ | ○ | | 1st | Tue. | 2 | M(R0167)<br>D (R0168) | Selected Topics in Physics and Chemistry (Advanced Theoretical Chemistry) | 2 | Naoki Nakatani | This course is offered for Physics and Chemistry majors |
| 8 | ○ | ○ | | 1st | Tue. | 2 | M(R0108)<br>D (R0205) | Selected Topics in Physics and Chemistry II (Atomic physics) | 2 | Hajime Tanuma | This course is offered for Physics and Chemistry majors<br>This course is also offered in the undergraduate program |
| 9 | ○ | ○ | | 1st | Wed. | 2 | M(R0109)<br>D (R0206) | Selected Topics in Physics and Chemistry II (Solid State Physics I) | 2 | Emiko Arahata | This course is offered for Physics and Chemistry majors<br>This course is also offered in the undergraduate program |
| 10 | ○ | ○ | | 1st | Thu. | 1 | M(R0231)<br>D(R0232) | Advanced Lecture in Chemistry II (Organic Reaction Mechanisms) | 2 | Kotohiro Nomura | |
| 11 | ○ | ○ | | 1st | Wed. | 1 | M(R0233)<br>D(R0237) | Advanced Lecture in Chemistry (Advanced Material Science) | 2 | Daichi Oka | |
| 12 | ○ | ○ | | 2nd | Fri. | 1 | M(R0300)<br>D(R0302) | Advanced Lecture in Chemistry (Functional Material Science) | 2 | Masatoshi Ishida | |
| 13 | ○ | ○ | | 2nd | Fri. | 2 | M(R0299)<br>D(R0301) | Advanced Lecture in Chemistry II (Advanced Materials Chemistry) | 2 | Kotohiro Nomura | |
| 14 | ○ | | | 2nd | Wed. | 5 | M(R0234) | Advanced English in Chemistry | 2 | * Julian Koe | |
| 15 | ○ | ○ | | Intensive course | | | M (R0295) 1 unit<br>M (R0297) 2 units<br>D (R0296) 1 unit<br>D (R0298) 2 units | Internship of Chemistry | 1 or 2 | Multiple instructors | |
| | ○ | ○ | | Intensive course | | | | Lecture of Advanced Chemistry I | 1 | * TBA | This course is also offered in the undergraduate program |
| | ○ | ○ | | Intensive course | | | | Selected Topics in Physics and Chemistry I | 1 | * TBA | This course is offered for Physics and Chemistry majors<br>This course is also offered in the undergraduate program |
| | ○ | ○ | △ | 2nd A | Tue. | 2 | M(R0147)<br>D (R0148) | Selected Topics in Physics and Chemistry I (Advanced Nanoscience, Surface, and Interface Physics I) | 1 | Yasumitsu Miyata | This course is offered for Physics and Chemistry majors |
| 16 | ○ | ○ | | 1st B | Tue. | 1 | M(R0137)<br>D (R0138) | Selected Topics in Physics and Chemistry I (Advanced Nanoscience, Surface, and Interface Physics II) | 1 | Kazuhiro Yanagi | This course is offered for Physics and Chemistry majors |
| | ○ | ○ | △ | 1st B | Thu. | 3 | M(R0151)<br>D (R0152) | Selected Topics in Physics and Chemistry I (Advanced Soft Matter Physics I) | 1 | Rei Kurita | This course is offered for Physics and Chemistry majors |
| 17 | ○ | ○ | | 1st B | Thu. | 3 | M(R0143)<br>D (R0144) | Selected Topics in Physics and Chemistry I (Advanced Soft Matter Physics II) | 1 | Rei Kurita | This course is offered for Physics and Chemistry majors |
| | ○ | ○ | △ | 2nd A | Fri. | 2 | M(R0110)<br>D(R0113) | Selected Topics in Physics and Chemistry I (Advanced Minimum Material Science) | 1 | Yuji Aoki | This course is offered for Physics and Chemistry majors |
| 18 | ○ | ○ | | 2nd A | Wed. | 3 | M(R0161)<br>D (R0162) | Selected Topics in Physics and Chemistry I (Advanced Experimental Technique in Physics C) | 1 | Hajime Tanuma | This course is offered for Physics and Chemistry majors |
| 19 | ○ | ○ | | 2nd B | Mon. | 3 | M(R0159)<br>D (R0160) | Selected Topics in Physics and Chemistry I (Advanced Experimental Technique in Physics D) | 1 | * Toshiyuki Azuma | This course is offered for Physics and Chemistry majors |

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| 20 | ○ | | | 1st | Mon. | 3, 4 | Ⅰ:M(R0235) | Seminar on Advanced Chemistry I (Master's program) | 2 | Hirose Oka | |
| 21 | ○ | | | 2nd | Mon. | 1, 2 | Ⅱ:M(R0236) | Seminar on Advanced Chemistry II (Master's program) | 2 | Hirose Oka | |
| 20 | ○ | | | 1st | Mon. | 1, 2 | Ⅰ:M(R0239) | Seminar on Advanced Chemistry I (Master's program) | 2 | Takegawa | |
| 21 | ○ | | | 2nd | Mon. | 1, 2 | Ⅱ:M(R0240) | Seminar on Advanced Chemistry II (Master's program) | 2 | Takegawa | |
| 20 | ○ | | | 1st | Mon. | 1, 2 | Ⅰ:M(R0241) | Seminar on Advanced Chemistry I (Master's program) | 2 | Hirota, Taoka | |
| 21 | ○ | | | 2nd | Mon. | 1, 2 | Ⅱ:M(R0242) | Seminar on Advanced Chemistry II (Master's program) | 2 | Hirota, Taoka | |
| 20 | ○ | | | 1st | Mon. | 3, 4 | Ⅰ:M(R0243) | Seminar on Advanced Chemistry I (Master's program) | 2 | Kanya | |
| 21 | ○ | | | 2nd | Mon. | 5, 6 | Ⅱ:M(R0244) | Seminar on Advanced Chemistry II (Master's program) | 2 | Kanya | |
| 20 | ○ | | | 1st | Tue. | 4, 5 | Ⅰ:M(R0245) | Seminar on Advanced Chemistry I (Master's program) | 2 | Nakatani | |
| 21 | ○ | | | 2nd | Mon. | 4, 5 | Ⅱ:M(R0246) | Seminar on Advanced Chemistry II (Master's program) | 2 | Nakatani | |
| 20 | ○ | | | 1st | Mon. | 3, 4 | Ⅰ:M(R0247) | Seminar on Advanced Chemistry I (Master's program) | 2 | Shimizu | |
| 21 | ○ | | | 2nd | Mon. | 3, 4 | Ⅱ:M(R0248) | Seminar on Advanced Chemistry II (Master's program) | 2 | Shimizu | |
| 20 | ○ | | | 1st | Fri. | 3, 4 | Ⅰ:M(R0249) | Seminar on Advanced Chemistry I (Master's program) | 2 | Kubuki | |
| 21 | ○ | | | 2nd | Fri. | 1, 2 | Ⅱ:M(R0250) | Seminar on Advanced Chemistry II (Master's program) | 2 | Kubuki | |
| 20 | ○ | | | 1st | Mon. | 1, 2 | Ⅰ:M(R0251) | Seminar on Advanced Chemistry I (Master's program) | 2 | Sugiura, Ishida | |
| 21 | ○ | | | 2nd | Mon. | 1, 2 | Ⅱ:M(R0252) | Seminar on Advanced Chemistry II (Master's program) | 2 | Sugiura, Ishida | |
| 20 | ○ | | | 1st | Mon. | 5, 6 | Ⅰ:M(R0253) | Seminar on Advanced Chemistry I (Master's program) | 2 | Nomura Mohamed | |
| 21 | ○ | | | 2nd | Mon. | 5, 6 | Ⅱ:M(R0254) | Seminar on Advanced Chemistry II (Master's program) | 2 | Nomura Mohamed | |
| 20 | ○ | | | 1st | Fri. | 4, 5 | Ⅰ:M(R0255) | Seminar on Advanced Chemistry I (Master's program) | 2 | Yamazoe, Oura | |
| 21 | ○ | | | 2nd | Fri. | 4, 5 | Ⅱ:M(R0256) | Seminar on Advanced Chemistry II (Master's program) | 2 | Yamazoe, Oura | |
| 20 | ○ | | | 1st | Fri. | 3, 4 | Ⅰ:M(R0257) | Seminar on Advanced Chemistry I (Master's program) | 2 | Ito Iketani | |
| 21 | ○ | | | 2nd | Fri. | 3, 4 | Ⅱ:M(R0258) | Seminar on Advanced Chemistry II (Master's program) | 2 | Ito Iketani | |
| 22 | | ○ | | 1st | Mon. | 3, 4 | III: D (R0259) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Hirose Oka | |
| 23 | | ○ | | 2nd | Mon. | 1, 2 | IV: D (R0260) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Hirose Oka | |
| 22 | | ○ | | 1st | Mon. | 1, 2 | III: D (R0263) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Takegawa | |
| 23 | | ○ | | 2nd | Mon. | 1, 2 | IV: D (R0264) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Takegawa | |
| 22 | | ○ | | 1st | Mon. | 1, 2 | III: D (R0265) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Hirota, Taoka | |
| 23 | | ○ | | 2nd | Mon. | 1, 2 | IV: D (R0266) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Hirota, Taoka | |
| 22 | | ○ | | 1st | Mon. | 3, 4 | III: D (R0267) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Kanya | |
| 23 | | ○ | | 2nd | Mon. | 5, 6 | IV: D (R0268) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Kanya | |
| 22 | | ○ | | 1st | Tue. | 4, 5 | III: D (R0269) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Nakatani | |
| 23 | | ○ | | 2nd | Mon. | 4, 5 | IV: D (R0270) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Nakatani | |
| 22 | | ○ | | 1st | Mon. | 3, 4 | III: D (R0271) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Shimizu | |
| 23 | | ○ | | 2nd | Mon. | 3, 4 | IV: D (R0272) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Shimizu | |
| 22 | | ○ | | 1st | Fri. | 3, 4 | III: D (R0273) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Kubuki | |
| 23 | | ○ | | 2nd | Fri. | 1, 2 | IV: D (R0274) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Kubuki | |
| 22 | | ○ | | 1st | Mon. | 1, 2 | III: D (R0275) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Sugiura, Ishida | |
| 23 | | ○ | | 2nd | Mon. | 1, 2 | IV: D (R0276) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Sugiura, Ishida | |
| 22 | | ○ | | 1st | Mon. | 5, 6 | III: D (R0277) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Nomura Mohamed | |
| 23 | | ○ | | 2nd | Mon. | 5, 6 | IV: D (R0278) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Nomura Mohamed | |
| 22 | | ○ | | 1st | Fri. | 4, 5 | III: D (R0279) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Yamazoe, Oura | |
| 23 | | ○ | | 2nd | Fri. | 4, 5 | IV: D (R0280) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Yamazoe, Oura | |
| 22 | | ○ | | 1st | Fri. | 3, 4 | III: D (R0281) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Ito Iketani | |
| 23 | | ○ | | 2nd | Fri. | 3, 4 | IV: D (R0282) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Ito Iketani | |
| 24 | ○ | | | 1st | | | Ⅰ A:M(R0284) | Advanced Research of Chemistry IA (Master's program) | 2 | Multiple instructors | |
| 25 | ○ | | | 2nd | | | Ⅰ B:M(R0285) | Advanced Research of Chemistry IB (Master's program) | 2 | Multiple instructors | |

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| 26 | ○ | | | 1st | | | ⅡA:M(R0287) | Advanced Research of Chemistry IIA (Master's program) | 2 | Multiple instructors | |
| 27 | ○ | | | 2nd | | | ⅡB:M(R0288) | Advanced Research of Chemistry IIB (Master's program) | 2 | Multiple instructors | |
| 28 | | ○ | | 1st | | | IIIA: D (R0290) | Advanced Research of Chemistry IIIA (Doctoral) | 2 | Multiple instructors | |
| 29 | | ○ | | 2nd | | | ⅢB:M(R0291) | Advanced Research of Chemistry IIIB (Doctoral) | 2 | Multiple instructors | |
| 30 | | ○ | | 1st | | | IVA: D (R0293) | Advanced Research of Chemistry IVA (Doctoral) | 2 | Multiple instructors | |
| 31 | | ○ | | 2nd | | | IVB: D (R0294) | Advanced Research of Chemistry IVB (Doctoral) | 2 | Multiple instructors | |

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| 20 | ○ | | | 2nd | Mon. | 1, 2 | Ⅰ:M(R0951) | Seminar on Advanced Chemistry I (Master's program) | 2 | Hirose Oka | |
| 21 | ○ | | | 1st | Mon. | 3, 4 | Ⅱ:M(R0950) | Seminar on Advanced Chemistry II (Master's program) | 2 | Hirose Oka | |
| 20 | ○ | | | 2nd | Mon. | 1, 2 | Ⅰ:M(R0955) | Seminar on Advanced Chemistry I (Master's program) | 2 | Takegawa | |
| 21 | ○ | | | 1st | Mon. | 1, 2 | Ⅱ:M(R0954) | Seminar on Advanced Chemistry II (Master's program) | 2 | Takegawa | |
| 20 | ○ | | | 2nd | Mon. | 1, 2 | Ⅰ:M(R0957) | Seminar on Advanced Chemistry I (Master's program) | 2 | Hirota, Taoka | |
| 21 | ○ | | | 1st | Mon. | 1, 2 | Ⅱ:M(R0956) | Seminar on Advanced Chemistry II (Master's program) | 2 | Hirota, Taoka | |
| 20 | ○ | | | 2nd | Mon. | 5, 6 | Ⅰ:M(R0959) | Seminar on Advanced Chemistry I (Master's program) | 2 | Kanya | |
| 21 | ○ | | | 1st | Mon. | 3, 4 | Ⅱ:M(R0958) | Seminar on Advanced Chemistry II (Master's program) | 2 | Kanya | |
| 20 | ○ | | | 2nd | Mon. | 4, 5 | Ⅰ:M(R0961) | Seminar on Advanced Chemistry I (Master's program) | 2 | Nakatani | |
| 21 | ○ | | | 1st | Tue. | 4, 5 | Ⅱ:M(R0960) | Seminar on Advanced Chemistry II (Master's program) | 2 | Nakatani | |
| 20 | ○ | | | 2nd | Mon. | 3, 4 | Ⅰ:M(R0963) | Seminar on Advanced Chemistry I (Master's program) | 2 | Shimizu | |
| 21 | ○ | | | 1st | Mon. | 3, 4 | Ⅱ:M(R0962) | Seminar on Advanced Chemistry II (Master's program) | 2 | Shimizu | |
| 20 | ○ | | | 2nd | Fri. | 1, 2 | Ⅰ:M(R0965) | Seminar on Advanced Chemistry I (Master's program) | 2 | Kubuki | |
| 21 | ○ | | | 1st | Fri. | 3, 4 | Ⅱ:M(R0964) | Seminar on Advanced Chemistry II (Master's program) | 2 | Kubuki | |
| 20 | ○ | | | 2nd | Mon. | 1, 2 | Ⅰ:M(R0967) | Seminar on Advanced Chemistry I (Master's program) | 2 | Sugiura Ishida | |
| 21 | ○ | | | 1st | Mon. | 1, 2 | Ⅱ:M(R0966) | Seminar on Advanced Chemistry II (Master's program) | 2 | Sugiura Ishida | |
| 20 | ○ | | | 2nd | Mon. | 5, 6 | Ⅰ:M(R0969) | Seminar on Advanced Chemistry I (Master's program) | 2 | Nomura, Mohamed | |
| 21 | ○ | | | 1st | Mon. | 5, 6 | Ⅱ:M(R0968) | Seminar on Advanced Chemistry II (Master's program) | 2 | Nomura, Mohamed | |
| 20 | ○ | | | 2nd | Fri. | 4, 5 | Ⅰ:M(R0971) | Seminar on Advanced Chemistry I (Master's program) | 2 | Yamazoe Oura | |
| 21 | ○ | | | 1st | Fri. | 4, 5 | Ⅱ:M(R0970) | Seminar on Advanced Chemistry II (Master's program) | 2 | Yamazoe Oura | |
| 20 | ○ | | | 2nd | Fri. | 3, 4 | Ⅰ:M(R0973) | Seminar on Advanced Chemistry I (Master's program) | 2 | Ito Iketani | |
| 21 | ○ | | | 1st | Fri. | 3, 4 | Ⅱ:M(R0972) | Seminar on Advanced Chemistry II (Master's program) | 2 | Ito Iketani | |
| 22 | | ○ | | 2nd | Mon. | 1, 2 | III: D (R0975) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Hirose Oka | |
| 23 | | ○ | | 1st | Mon. | 3, 4 | IV: D (R0974) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Hirose Oka | |
| 22 | | ○ | | 2nd | Mon. | 1, 2 | III: D (R0979) | Seminar on Advanced Chemistry III (Master's) | 2 | Takegawa | |
| 23 | | ○ | | 1st | Mon. | 1, 2 | IV: D (R0978) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Takegawa | |
| 22 | | ○ | | 2nd | Mon. | 1, 2 | III: D (R0981) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Hirota Taoka | |
| 23 | | ○ | | 1st | Mon. | 1, 2 | IV: D (R0980) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Hirota Taoka | |
| 22 | | ○ | | 2nd | Mon. | 5, 6 | III: D (R0983) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Kanya | |
| 23 | | ○ | | 1st | Mon. | 3, 4 | IV: D (R0982) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Kanya | |
| 22 | | ○ | | 2nd | Mon. | 4, 5 | III: D (R0985) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Nakatani | |
| 23 | | ○ | | 1st | Tue. | 4, 5 | IV: D (R0984) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Nakatani | |
| 22 | | ○ | | 2nd | Mon. | 3, 4 | III: D (R0987) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Shimizu | |
| 23 | | ○ | | 1st | Mon. | 3, 4 | IV: D (R0986) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Shimizu | |
| 22 | | ○ | | 2nd | Fri. | 1, 2 | III: D (R0989) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Kubuki | |
| 23 | | ○ | | 1st | Fri. | 3, 4 | IV: D (R0988) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Kubuki | |
| 22 | | ○ | | 2nd | Mon. | 1, 2 | III: D (R0991) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Sugiura Ishida | |
| 23 | | ○ | | 1st | Mon. | 1, 2 | IV: D (R0990) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Sugiura Ishida | |
| 22 | | ○ | | 2nd | Mon. | 5, 6 | III: D (R0993) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Nomura Mohamed | |
| 23 | | ○ | | 1st | Mon. | 5, 6 | IV: D (R0992) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Nomura Mohamed | |
| 22 | | ○ | | 2nd | Fri. | 4, 5 | III: D (R0995) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Yamazoe Oura | |
| 23 | | ○ | | 1st | Fri. | 4, 5 | IV: D (R0994) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Yamazoe Oura | |
| 22 | | ○ | | 2nd | Fri. | 3, 4 | III: D (R0997) | Seminar on Advanced Chemistry III (Doctoral program) | 2 | Ito Iketani | |
| 23 | | ○ | | 1st | Fri. | 3, 4 | IV: D (R0996) | Seminar on Advanced Chemistry IV (Doctoral program) | 2 | Ito Iketani | |
| 24 | ○ | | | 2nd | | | ⅠA:M(R0941) | Advanced Research of Chemistry IA (Master's program) | 2 | Multiple instructors | |
| 25 | ○ | | | 1st | | | ⅠB:M(R0940) | Advanced Research of Chemistry IB (Master's program) | 2 | Multiple instructors | |
| 26 | ○ | | | 2nd | | | ⅡA:M(R0943) | Advanced Research of Chemistry IIA (Master's program) | 2 | Multiple instructors | |
| 27 | ○ | | | 1st | | | ⅡB:M(R0942) | Advanced Research of Chemistry IIB (Master's program) | 2 | Multiple instructors | |
| 28 | | ○ | | 2nd | | | IIIA: D (R0945) | Advanced Research of Chemistry IIIA (Doctoral) | 2 | Multiple instructors | |

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| 29 | | ○ | | 1st | | | IIIB: D (R0944) | Advanced Research of Chemistry IIIB (Doctoral) | 2 | Multiple instructors | |
| 30 | | ○ | | 2nd | | | IVA: D (R0947) | Advanced Research of Chemistry IVA (Doctoral) | 2 | Multiple instructors | |
| 31 | | ○ | | 1st | | | IV IIB: D (R0946) | Advanced Research of Chemistry IVB (Doctoral) | 2 | Multiple instructors | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Inorganic Chemistry | R0221 | | | 1st | Fri. | 1 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Ken'ichi Sugiura, Shiro Kubuki, Seiji Yamazoe | |

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| (1) Course policies and topics | Dr. Kubuki provides the first seven lectures, and the latter seven ones are by prof. Sugiura. The remaining lecture is presented by either instructor concerning a cutting-edge topic in the specialized field. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | <Letctures by Dr. Kubuki><br>The attending students will study the relationship between structures and physical properties of inorganic solid material such as metal, ionic solids and glass-ceramics.<br><Letctures by prof. Sugiura><br>Molecular orbital (MO) theory is one of the most important "tool" for the contemporary inorganic chemistry. This class introduces the basics of MO<br>theory using the simple inorganic molecules as examples. |
| (3) Course schedule, subject matter, and classroom activities | <1st half (Kubuki)><br>1. Crystal structure (1) Notification of crystal structures (ccp, hcp, bcc)<br>2. Crystal structure (2) Lattice and unit cell, lattice energy<br>3. Electrical property: Band model, conductivity of metal and semiconductor<br>4. Optical property: Interaction between light and electron, absorption and emission of light<br>5. Magnetic property: Magnetic susceptibility, ferromagnetism, Antiferromagnetism, Ferrimagnetism<br>6. Superconductivity: Discovery and theory of superconductivity<br>7. Summary<br><2nd half (Sugiura)><br>8. Basics of MO theory and hydrogen molecule (H2)<br>9. Extension of H2 to triangle H3+, linear Hn oligomers, and metallic hydrogen<br>10. MOs of symmetric and/or unsymmetric diatomic molecules<br>11. MOs of AH2, AH3, and AH4 (1)<br>12. MOs of AH2, AH3, and AH4 (2)<br>13. MOs of aromatic molecules<br>14. Chemical reactivities<br>15. A cutting edge topic in the specialized field (by Sugiura or Kubuki) |
| (4) Outside-class activities and assignments | <Kubuki><br>Assigned reports are given to attending students at each end of the lecture. They should be submitted by the beginning of the next lecture.<br><Sugiura><br>None |
| (5) Textbooks and course materials | <Kubuki><br>L. Smart and E. Moore "Solid State Chemistry -an introduction" (Chapman and Hall)<br><Sugiura><br>Albright, Burdett, Whangbo, "Orbital interactions in chemistry" (John Wiley & Sons) |
| (6) Assessment and grading | <Kubuki> The rating is done by the assigned reports (100 points).<br><Sugiura> Written examination will be performed (100 points).<br><br>The total score is the average of each instructor's evaluation. If one of the ratings is less than 60%, the credit may not be provided. |
| (7) Questions to the instructor (Office hours, etc.) | Each instructor will answer students' questions personally after adjusting the available time by e-mail. Therefore, the answer will not be given by sending an e-mail. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Geo-and Cosmochemistry | R0222 | | | 2nd | Tue. | 2 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Nobuyuki Takegawa, Yasuji Oura | |

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|---|---|
| (1) Course policies and topics | This course covers the physical and chemical processes for the formation and circulation of matters in the universe and on the earth. The first half of the course focuses on the Earth's atmosphere and hydrosphere. The second half of the course focuses on the formation of matters in the universe and solar system. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | This course aims to understand important chemical processes in the universe and on Earth, based on basic knowledge of inorganic chemistry, analytical chemistry, radiochemistry, and physical chemistry. |
| (3) Course schedule, subject matter, and classroom activities | 1: Atomic and Molecular Spectra<br>2: Photochemical processes in the atmosphere<br>3: Optical properties of fine particles<br>4: Clouds and precipitation<br>5: Radiative transfer in the atmosphere<br>6: Oxygen and carbon cycles in the atmosphere and oceans<br>7: Global climate change<br>8: Solar system elemental abundance, $B_2FH$ theory<br>9: Radiochemistry (stability of nuclei, radioactive decay)<br>10: Radiochemistry (nuclear reaction)<br>11: Nucleosynthesis - 1 (fundamentals of thermonuclear reactions)<br>12: Nucleosynthesis - 2 (thermonuclear fusion)<br>13: Nucleosynthesis - 3 (s-process)<br>14: Nucleosynthesis - 4 (r-process)<br>15: Exercise and explanation<br>The above schedule is subject to change depending on the progress. |
| (4) Outside-class activities and assignments | Some reports are assigned. |
| (5) Textbooks and course materials | Materials are distributed during the lecture. Other reference books are indicated in class. |
| (6) Assessment and grading | Regular marks (20%), Report (80%) |
| (7) Questions to the instructor (Office hours, etc.) | Office hours are not set, but if you wish to ask questions in person, please make an appointment in advance by e-mail. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Organic Chemistry | R0223 | | | 1st | Wed. | 2 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Toshio Shimizu, Kotohiro Nomura, Abdellatif Mohammed M. | |

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|---|---|
| (1) Course policies and topics | The lecture concerns “Basics for modern organic synthesis and application to bottom up chemistry” for graduate study including introduction of recent topics by each instructor. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Through this lecture series, the students will acquire knowledges concerning historical flow and basics in modern organic chemistry and materials chemistry. For example, supra-molecular chemistry through bottom up chemistry, effect of periodic law toward property in materials, basics in precision synthesis and the methodology including integration of functionality, catalysis mechanism including basic reactions |
| (3) Course schedule, subject matter, and classroom activities | The course consists of lectures by each instructor.<br>Introduction of basic and bottom up chemistry for functional molecules through supramolecular interactions<br>Basics for precision synthesis and/or methodologies directed toward advanced organic and polymeric materials including integration of functionality<br>Heavier main group elements from the viewpoint of fundamental chemistry and material sciences<br>Basic catalysis mechanism for green sustainable synthesis |
| (4) Outside-class activities and assignments | The students should read and understand textbook, handout before/after the lecture. |
| (5) Textbooks and course materials | Will be introduced |
| (6) Assessment and grading | Lecture attendance, report or examination |
| (7) Questions to the instructor (Office hours, etc.) | No specified office hours but contact by e-mail to each instructor |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Biological Chemistry | R0224 | | | 2nd | Wed. | 2 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Kouji Hirota, Yutaka Ito, Masato Taoka, Teppei Ikeya | |

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|---|---|
| (1) Course policies and topics | The life sciences have made remarkable progress, and new interdisciplinary fields that differ from the conventional framework of academic disciplines are emerging. In such advanced fields, it is necessary to objectively perceive and reconstruct chemical concepts and methods having been built up over the years. This lecture will explain recent biochemistry, molecular biology, and structural biology trends in the background of living organisms' genomic information. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The goal is to deepen students' understanding of the relationship between new "chemistry" and "life" based on the network of biological macromolecules. |
| (3) Course schedule, subject matter, and classroom activities | Recent trends in biochemistry, molecular biology, and structural biology in the context of genomic information of organisms will be explained.<br><br>1. Aerobic respiration, fermentation pathway<br>2.Energy metabolism and diabetes mellitus<br>3. Physicochemical properties and biological effects of radiation<br>4. Understanding DNA repair pathways and cancer therapy<br>5. Introduction to omics research<br>6. Genomics<br>7. Proteomics<br>8. Ribonucleomics<br>9. Fundamentals of heterogeneous nuclear multidimensional NMR for structural biology analysis<br>10. Rapid multidimensional NMR measurement methods<br>11. Protein conformational analysis using solution NMR<br>12. Dynamic analysis of intracellular proteins using solution NMR<br>13. Understanding replication, transcription, and translation by molecular structure<br>14. Intracellular signal transduction understood by molecular structure<br>15. Receptor activation mechanism understood by molecular structure |
| (4) Outside-class activities and assignments | Students are required to write reports on the assignments given at the end of the class. |
| (5) Textbooks and course materials | The textbooks will be introduced during the lecture. Handouts will be distributed as necessary. |
| (6) Assessment and grading | A comprehensive evaluation will be made based on reports and quizzes. |
| (7) Questions to the instructor (Office hours, etc.) | No specific office hours will be set, but if you want to ask questions directly, please make an appointment in advance by e-mail. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Molecular Spectroscopy | R0163 | | | 2nd | Wed. | 1 | 2 |
| Doctoral program | Advanced Molecular Spectroscopy | R0164 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Reika Kanya | This course is offered for Physics and Chemistry majors |

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|---|---|
| (1) Course policies and topics | Determination of geometrical structures of isolated gas molecules is lectured from the basics to the advanced topics. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Basic theory of electron scattering processes by atoms and molecules as well as the principle of structural determination of molecules. Recent progress of experimental techniques for probing structural dynamics of molecules. |
| (3) Course schedule, subject matter, and classroom activities | 01. Interference of waves and basics of electron diffraction method, 02. Electron scattering by atoms, 03. Green function, 04. Lippmann-Schwinger equation, 05. Differential cross section, 06. Partial wave analysis, 07. Partial wave analysis by numerical calculations, 08. Intermediate summary, 09. Born approximation, 10. Electron scattering by molecules and the independent atom model, 11. Effect of molecular vibration, 12. Molecular scattering curve and radial distribution function, 13. Analyses of electron diffraction images 1, 14. Analyses of electron diffraction images 2, 15. Recent studies in time-resolved electron diffraction method. |
| (4) Outside-class activities and assignments | Lecture slides are uploaded in advance for preparation of the lecture. |
| (5) Textbooks and course materials | “Quantum Mechanics of Molecular Structures”, Kaoru Yamanouchi (Springer, 2012) |
| (6) Assessment and grading | Attendance (20%), Intermediate exam. (40%), Final exam. (40%) |
| (7) Questions to the instructor (Office hours, etc.) | E-mail (kanya@tmu.ac.jp) |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Physical Chemistry of Condensed Matter | R0165 | | | 1st | Mon. | 2 | 2 |
| Doctoral program | Advanced Physical Chemistry of Condensed Matter | R0166 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Yasushi Hirose | This course is offered for Physics and Chemistry majors |

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|---|---|
| (1) Course policies and topics | Semiconductors are widely applied for information technology, communication technology, and materials for energy conversion. In this lecture, fundamental properties and their applications of semiconductors are overviewed. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | To understand the followings:<br>- Fundamental properties of semiconductors and how to control them in Chemistry<br>- Working mechanism of basic semiconductor devices |
| (3) Course schedule, subject matter, and classroom activities | Followings are contents of this course. Detailed schedule will be announced at the first day.<br>- 01 Introduction, Band structure of semiconductor<br>- 02 Intrinsic semiconductor<br>- 03 Carrier doping<br>- 04 Transport of electrons in a semiconductor<br>- 05 Optical properties of a semiconductor<br>- 06 Diffusion of carriers<br>- 07 Short summary<br>- 08-09 - p-n junction<br>- 10-11 Optoelectronics devices and heterojunction<br>- 12 Bipolar transistor<br>-13 Metal-semiconductor junction and field effect transistor<br>-14 MOS transistor<br>-15 Summary |
| (4) Outside-class activities and assignments | Students are assigned for some homework related to the lecture. |
| (5) Textbooks and course materials | Course materials are distributed if necessary. Some textbooks are recommended in the lecture for further learning. |
| (6) Assessment and grading | Grading by class participation and homeworks (or semester exam). |
| (7) Questions to the instructor (Office hours, etc.) | Questions and concerns are accepted by e-mail. |
| (8) Special note | Scientific electrical calculator is used for exercise during the lecture. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Selected Topics in Physics and Chemistry II (Advanced Theoretical Chemistry) | R0167 | | | 1st | Tue. | 2 | 2 |
| Doctoral program | Selected Topics in Physics and Chemistry II (Advanced Theoretical Chemistry) | R0168 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Naoki Nakatani | This course is offered for Physics and Chemistry majors |

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|---|---|
| (1) Course policies and topics | In this course, we provide an advanced lecture about “molecular electronic structure theory”, one of the topics in “quantum chemistry”. Particularly, we focused on the practical methods to compute electronic structures (such that energy, geometry, and properties of molecules). In recent years, it is able to predict the physical properties with the extremely high accuracy. On the other hand, it is also applied for large molecular systems such as proteins and nanomaterials, with an appropriate approximation. We will overview these state-of-the-art methods and their applications, too. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Students will learn advanced and practical knowledge about quantum chemistry and computational chemistry which can be applied for own research topics. Students will learn the recent research results in the lecture to cultivate own skills which help to understand computational results and discussions in academic articles and to apply them for research. |
| (3) Course schedule, subject matter, and classroom activities | Course schedule is provided as follows.<br>[01] Derivation of HF energy<br>[02] Derivation of CI energy<br>[03] Exercise using Excel 1<br>[04] Derivation of MP2 energy<br>[05] Exercise using Excel 2<br>[06] Overview on multi-reference methods<br>[07] Density functional theory – Basic idea<br>[08] Density functional theory – Applications<br>[09] Transition state search – Application 1<br>[10] Transition state search – Application 2<br>[11] Analyses using molecular orbitals (MOs) and natural orbitals (NOs)<br>[12] Excited state calculations – Basic idea<br>[13] Excited state calculations – Applications<br>[14] Electromagnetic properties<br>[15] Relativistic corrections<br><br>NOTE: Course schedule can be changed due to number of registered students, major field of students, and instructor’s circumstances. |
| (4) Outside-class activities and assignments | Students are assigned for a report to summarize the lecture. |
| (5) Textbooks and course materials | Course materials are distributed if necessary. Also, students should have copies of article and web page which are specified preliminary. |
| (6) Assessment and grading | Grading by the report (80%) and some exercises in the lecture (20%). |
| (7) Questions to the instructor (Office hours, etc.) | Though we do not arrange the office-hour, we accept questions directly and by e-mail. In the e-mail, please specify your name in the subject and use an e-mail address which we can reply by internet (we do not accept e-mails including special characters which only available for mobile phone). |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Selected Topics in Physics and Chemistry II (Atomic physics) | R0108 | | | 1st | Tue. | 2 | 2 |
| Doctoral program | Selected Topics in Physics and Chemistry II (Atomic physics) | R0205 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Hajime Tanuma | This course is offered for Physics and Chemistry majors<br>This course is also offered in the undergraduate program |

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|---|---|
| (1) Course policies and topics | Fundamental theory on atoms and molecules, which are quantal few-body systems, will be explained based on elementary quantum mechanics. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The most practical and fundamental application of quantum mechanics to one- and many-electron atoms and small molecules. |
| (3) Course schedule, subject matter, and classroom activities | 1. What is the atomic physics?<br>2. Hydrogenic atoms: non-relativistic theory<br>3. Hydrogenic atoms: relativistic theory<br>4. Hydrogenic atoms in electromagnetic fields<br>5. Semi-classical theory for optical transitions of atoms<br>6. Many-electron atoms<br>7. Spin-orbital interaction in atoms<br>8. Electron correlation and configuration interaction<br>9. Dynamics of excited atoms I<br>10. Dynamics of excited atoms II<br>11. Diatomic molecules I: Born-Oppenheimer approximation<br>12. Diatomic molecules II: LCAO-MO method<br>13. Diatomic molecules III: vibration and rotation<br>14. Diatomic molecules IV: electronic transitions<br>15. Recent topics on atomic physics |
| (4) Outside-class activities and assignments | Before the class, check and confirm the understanding of previous lectures. |
| (5) Textbooks and course materials | Presentation slides will be provided through the “kibaco” system.<br>Reference books will be introduced in the lectures. |
| (6) Assessment and grading | Questions and reports after whole lectures |
| (7) Questions to the instructor (Office hours, etc.) | Contact via e-mail to tanuma-hajime@tmu.ac.jp |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Selected Topics in Physics and Chemistry II (Solid State Physics I) | R0109 | | | 1st | Wed. | 2 | 2 |
| Doctoral program | Selected Topics in Physics and Chemistry II (Solid State Physics I) | R0206 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Emiko Arahata | This course is offered for Physics and Chemistry majors<br>This course is also offered in the undergraduate program |

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|---|---|
| (1) Course policies and topics | In this lecture, we will learn about the motion and energy state of electrons in a solid, which is the periodic potential of crystals, that is, the band theory. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | This lecture will give you a deep knowledge of band theory. You can also learn how to calculate specific values in a simple model. |
| (3) Course schedule, subject matter, and classroom activities | 1: Review of quantum mechanics<br>2: Drude theory of metals<br>3: Sommerfeld's theory of metals<br>4: Crystal structures<br>5: Electron states in a periodic potential<br>6: Electrons in a weak periodic potential<br>7: The nearly-free-electron approximation<br>8: Electrons in a periodic potential where the potential is very strong<br>9: The tight-banding approximation<br>10: Transport phenomena<br>11: Boltzmann equation and relaxation time<br>12: Phonon spectroscopy<br>13: Thermoelectric effect<br>14: Semiconductors<br>15: Summery |
| (4) Outside-class activities and assignments | Giving some assignments in every class |
| (5) Textbooks and course materials | Posting materials on kibaco |
| (6) Assessment and grading | Reports(70%) and assignments(30%) |
| (7) Questions to the instructor (Office hours, etc.) | Questions will be accepted at any time. Make an appointment or directly send questions by email. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Lecture in Chemistry II (Organic Reaction Mechanisms) | R0231 | | | 1st | Thu | 1 | 2 |
| Doctoral program | Advanced Lecture in Chemistry II (Organic Reaction Mechanisms) | R0232 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Kotohiro Nomura | |

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|---|---|
| (1) Course policies and topics | For students who learned organic chemistry, coordination chemistry, the lecture provides contents of "organometallic chemistry for precision organic synthesis" required for the graduate study as well as for modern research in organic chemistry, materials science. The lecture also introduces recent topics with explanation of basic mechanism, methodology, historical flow. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Through this lecture, the student will acquire basics in organometallic chemistry that should be required for graduate study, including basic reaction steps in metal catalyzed organic reactions (often employed as conventional synthesis), methodologies for the green sustainable synthesis and advanced materials. |
| (3) Course schedule, subject matter, and classroom activities | The contents are as follows<br>1) Introductory in organometallic chemistry<br>2-3) Basics in coordination chemistry: 18 electron rules, structure and properties, bonding etc.<br>4-8) Basics in organometallic chemistry:<br>Coordination and dissociation, oxidative addition and reductive elimination, insertion and elimination, reaction with coordinative ligands, typical reactions (coupling, carbonylation etc.)<br>9) Practice for reaction mechanism<br>10-12) Topics (olefin polymerization and oligomerization, olefin metathesis, asymmetric synthesis etc.)<br>13-14) Precision polymer synthesis (living polymerization)<br>15) Final examination |
| (4) Outside-class activities and assignments | The students should read and study the handouts (distributed during the lecture course) and notes explained on the white board for better understanding. Lecture will be in both Japanese and English |
| (5) Textbooks and course materials | Handouts will be distributed.<br>Reference: R. H. Crabtree, The Organometallic Chemistry of the Transition Metals, Wiley |
| (6) Assessment and grading | Written Exam (final) 90 % and mini test 10% |
| (7) Questions to the instructor (Office hours, etc.) | No specified office hours but contact by e-mail (ktnomura@tmu.ac.jp) |
| (8) Special note | The students should have basic knowledge in organic chemistry and inorganic chemistry |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Lecture in Chemistry (Advanced Material Science) | R0233 | | | 1st | Wed. | 1 | 2 |
| Doctoral program | Advanced Lecture in Chemistry (Advanced Material Science) | R0237 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Daichi Oka | |

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|---|---|
| (1) Course policies and topics | This lecture introduces synthesis and analysis methods and electronic properties of oxides, including recent topics. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The students will learn experimental methods in solid-state chemistry and the relationship between structure/composition and physical properties in solids focusing on oxide materials. The goal is to achieve basic knowledge to understand the latest research topics. |
| (3) Course schedule, subject matter, and classroom activities | 1. Crystal structure of oxides<br>2. Synthesis and analysis methods for bulk oxides<br>3. Synthesis and analysis methods for oxide thin films<br>4. Band structure and electronic state<br>5. Electron correlation<br>6. Metal-to-insulator transition<br>7. Phenomenology of superconductivity<br>8. Superconductivity in cuprates<br>9. Oxide superconductors discovered after cuprates<br>10. Magnetism in oxides<br>11. Dielectric properties of oxides<br>12. Multiferroic oxides<br>13. Heavy fermionic oxides<br>14. Mixed anion oxides<br>15. Optical properties and transparent conducting oxides |
| (4) Outside-class activities and assignments | Please study the course materials and references before and after the classes. |
| (5) Textbooks and course materials | The presentation slides will be shared. |
| (6) Assessment and grading | Attendance (20%) and reports (80%) |
| (7) Questions to the instructor (Office hours, etc.) | No specified office hours are arranged. Please contact by e-mail (daichi.oka@tmu.ac.jp). |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Lecture in Chemistry II (Functional material chemistry) | R0300 | | | 2nd | Fri. | 1 | 2 |
| Doctoral program | Advanced Lecture in Chemistry II (Functional material chemistry) | R0302 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Masatoshi Ishida | |

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|---|---|
| (1) Course policies and topics | This course aims to give basics of the structure-property relationship of π-conjugated materials and the recent advancement of functional material chemistry. The first half of the lecture focuses on the materials showing electrical conductivity, magnetism, and thermoelectric conversion. The latter part focuses on the materials applicable for electroluminescence, bioimaging, and artificial photosynthesis. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Development of various π-conjugated molecules and transition metal complexes combined with π-conjugated ligand systems have been paid attention to utilizing as functional materials. The goal is to understand the critical structure and properties of functional molecular materials. |
| (3) Course schedule, subject matter, and classroom activities | 1~2: Fundamentals and Applications of Conductive Molecules<br>3: Molecular Semiconductor<br>4: Photochromism<br>5: Photosensitizer for Solar Cells<br>6: Molecular Wires and Molecular Machines<br>7: Molecular Magnetism<br>8~9: Basics of Dye Chemistry<br>10: Spectroscopy<br>11: Biosensor<br>12: Phototherapy<br>13: Photocatalyst<br>14: Artificial Photosynthesis<br>15: Report and Commentary |
| (4) Outside-class activities and assignments | The assigned reports during the lecture. |
| (5) Textbooks and course materials | Handout materials will be distributed. Additional materials (e.g., copies of research articles) will be used if necessary. |
| (6) Assessment and grading | Grading will be evaluated by attendance and assigned report (presentation). |
| (7) Questions to the instructor (Office hours, etc.) | Please make an appointment by e-mail (ishidam@tmu.ac.jp) if necessary. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Lecture in Chemistry II (Advanced Materials Chemistry) | R0299 | | | 2nd | Fri. | 2 | 2 |
| Doctoral program | Advanced Lecture in Chemistry II (Advanced Materials Chemistry) | R0301 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Kotohiro Nomura | |

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|---|---|
| (1) Course policies and topics | Advanced Materials Chemistry: To gain basic sense in advanced materials chemistry using precise synthetic skills [efficient organic transformations and precise (living) polymerization in the presence of catalysis; end/post modification of polymers including grafting (clicking, grafting to/from/through technique etc.); unique materials such as bottle brush, stars, controlled cross links, adaptable networks etc.; preparation of supported molecular catalysts including their characterization etc.]. Better understanding in basic knowledge and trends in design of recent advanced materials through basic introductory lectures, presentations, and discussions through literature reviews. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Basic sense in advanced materials chemistry, and design of functional advanced materials by adopting precise synthetic skills. Basic understanding in trend and outlooks in advanced materials chemistry including basic synthetic techniques. Improve English presentation skills, confidence in speaking/presentation in English. |
| (3) Course schedule, subject matter, and classroom activities | Lectures consists of basic introductory lectures, presentation of literature reviews concerning advanced materials chemistry (by graduate students) and discussion. The person in the presentation should discuss in advance to gain better understanding in the backgrounds as well as knowledge.<br>Lectures will be provided in English. |
| (4) Outside-class activities and assignments | None |
| (5) Textbooks and course materials | None, will be distributed (handout). |
| (6) Assessment and grading | Mini test, presentation and attitude (asking questions and discussion). |
| (7) Questions to the instructor (Office hours, etc.) | Office Hour: Contact by e-mail: ktnomura@tmu.ac.jp |
| (8) Special note | On line, the student should have enough knowledge as graduate student in synthetic chemistry. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced English in Chemistry | R0234 | | | 2nd | Wed. | 5 | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| * Julian Koe | |

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|---|---|
| (1) Course policies and topics | English is a vital communication medium in modern science. This course aims to give chemistry students practice and greater confidence in using English. The course is taught in English and is highly interactive, so that students will develop greater active ability in the language. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | 1. To gain confidence in using English.<br>2. To become familiar with technical English grammar and vocabulary used in Chemistry<br>3. To improve writing, reading, speaking and listening in English<br>4. To improve communication and presentation skills |
| (3) Course schedule, subject matter, and classroom activities | 1. Introduction. Useful supporting aids; pronunciation<br>2. The Elements. Tom Lehrer song<br>3. Chemistry - concepts. Following instructions; passive voice<br>4. Laboratory Equipment. Extracting information; grammar<br>5. Periodic Table. Grammar: parts of speech<br>6. Halogens. Grammar.<br>7. Inorganic Chemistry I. Chemical crossword<br>8. Inorganic Chemistry II.<br>9. Organic Chemistry I<br>10. Organic Chemistry II, Polymers<br>11. Polymer presentations.<br>12. Analytical Chemistry. IR, NMR<br>13. Environmental chemistry. Presentations; quiz<br>14. Writing papers<br>15. Comment<br>Interactive lecture including short presentation and conversation practice. |
| (4) Outside-class activities and assignments | Weekly work is assigned. |
| (5) Textbooks and course materials | On-line text: http://www.upjs.sk/public/media/3499/English-for-Chemists.pdf |
| (6) Assessment and grading | Continual assessment of weekly assignment course work (~70%) and final examination (~30%) |
| (7) Questions to the instructor (Office hours, etc.) | Office: TEL: 0422-33-3249 E-mail: koe@icu.ac.jp |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Internship of Chemistry | R0295 R0297 | | | Intensive course | . | | 1 or 2 |
| Doctoral program | Internship of Chemistry | R0296 R0298 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | |

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|---|---|
| (1) Course policies and topics | The purpose of this program is to help students acquire a wide range of practical academic skills by granting credits for off-campus learning (work experience, research/study experience, volunteer activities) related to specialized education in chemistry that fulfills certain requirements. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Depends on the internship site. |
| (3) Course schedule, subject matter, and classroom activities | Depends on the internship site. |
| (4) Outside-class activities and assignments | Follow the instructions of your instructor. |
| (5) Textbooks and course materials | Depends on the internship site. |
| (6) Assessment and grading | See Special Notes. |
| (7) Questions to the instructor (Office hours, etc.) | Office hours are not set, but if students wish to ask questions in person, they may do so at any time, so please contact the office in advance by e-mail. |
| (8) Special note | Number of credits, etc.: One or two credits may be earned in designated courses, which may be taken concurrently. The credits may be added to the credits required for graduation.<br>Requirements for enrollment: (1) As a rule, courses must be offered over several days during holidays. (2) The content of the course must be equivalent to the undergraduate curriculum and related to specialized education in chemistry. The portion of the internship that corresponds to this training must not be a requirement for the recognition of other credits or qualifications. (3) If the university or research institution is inviting external participants, a copy of the announcement must be available. In the case of a company or training school, there must be a letter of acceptance signed and stamped with the name, affiliation, and contact information of the person in charge of supervising the host institution. The applicant must have "Accident Insurance for Student Education and Research" and "Liability Insurance for Internships, Care Experience Activities, Educational Training, etc." or equivalent or higher accident insurance and liability insurance. (4) Have a certificate of completion issued by the organizer (lecturer) or agree to have the organizer (lecturer) sign and seal the attached certificate of completion. (5) Students who wish to receive credits must submit a preliminary application to the Academic Affairs Committee with the documents mentioned in (3) above, along with the contact information of the host institution, the student's contact information during the training, and materials describing the content and purpose of the training, and obtain permission before the training takes place. (6) After the completion of the practical training, the student must submit a several-page report summarizing his/her impressions of the content and a journal of the practical training, along with the documents mentioned in (4) above, to the Academic Affairs Committee members. (7) Credit will be granted by the Academic Affairs Committee members based on the conformity with the above objectives, the evaluation by the organizer, and the grade of the report. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Selected Topics in Physics and Chemistry I (Advanced Nanoscience, Surface, and Interface Physics II) | R0137 | | | 1st B | Tue. | 1 | 1 |
| Doctoral program | Selected Topics in Physics and Chemistry I (Advanced Nanoscience, Surface, and Interface Physics II) | R0138 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Kazuhiro Yanagi | This course is offered for Physics and Chemistry majors |

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| (1) Course policies and topics | Electrochemistry and semiconductor physics have recently become particularly important fundamental disciplines in the study of physical properties. Carrier injection control using the electric field effect is a fundamental technique for semiconductor devices, and recently it has been applied to the search for new physical properties by integrating electrochemical techniques. For example, it is possible to change an insulator to a metallic state and even induce a superconducting transition. This is based on the precise control of the amount of carriers that accumulate on the surface of materials by utilizing the solid-liquid interface. In order to properly understand the background and apply such field-effects to research on physical properties, this lecture will provide an explanation of the fundamentals of electrochemistry and semiconductor physics and their application to nanoscale material systems. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Students will acquire basic knowledge about electrochemistry and semiconductor physics. To gain knowledge of the relationship between the structure of nanoscale material systems and battery structure. To acquire knowledge that will enable the student to correctly understand the latest research on physical properties using the electric field effect. |
| (3) Course schedule, subject matter, and classroom activities | After an overview in the introduction, the fundamentals of electrochemistry and semiconductor physics will be reviewed according to the following schedule. Finally, the recent researches will be explained.<br>1: Control of physical properties using electric field effect will be explained.<br>2 and 3: Fundamentals of electrochemical techniques.<br>4 and 5: Fundamentals of semiconductor physics.<br>6: Nanostructures and electronic structures - with a focus on nanotube structures<br>7: Conducting properties and applications to optical properties<br>8 Applications to thermoelectric properties |
| (4) Outside-class activities and assignments | Students are required to prepare and submit a report of about one sheet of A4 paper on the assignment shown at the end of each class. |
| (5) Textbooks and course materials | Textbooks and course materials will be introduced during the lecture as appropriate. Handouts and other materials will be distributed as necessary. |
| (6) Assessment and grading | The final grade will be based on the lecture report and the final report. |
| (7) Questions to the instructor (Office hours, etc.) | In principle, office hours will be held on 1st period of Friday. If you have any questions, please come to my room (Room 8-209) after making an appointment by e-mail at least one day in advance. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Selected Topics in Physics and Chemistry I (Advanced Soft Matter Physics II) | R0143 | | | 1st B | Thu. | 3 | 1 |
| Doctoral program | Selected Topics in Physics and Chemistry I (Advanced Soft Matter Physics II) | R0144 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Rei Kurita | This course is offered for Physics and Chemistry majors |

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| (1) Course policies and topics | Soft matter is a subfield of condensed matter comprising a variety of physical systems that can be deformed. They include liquids, colloids, polymers, foams, gels, granular materials, liquid crystals, pillows, flesh, and a number of biological materials. This program aims to understand the basis of the soft matter. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The goals are to learn phase transitions, coarsenings, self similarities, and then the basis of the non-equilibrium dynamics. |
| (3) Course schedule, subject matter, and classroom activities | 1. What is soft matters?<br>2. Thermal equilibrium and phase separations.<br>3. Colloidal dispersion and Brownian motions.<br>4. Ideal chain model for polymers.<br>5. Elastic modulus of polymers.<br>6. Phase transitions in liquid crystals.<br>7. Surfactants.<br>8. Reports and comments. |
| (4) Outside-class activities and assignments | As next content is announced, prepare for next lesson after the class |
| (5) Textbooks and course materials | Not in particular. |
| (6) Assessment and grading | Evaluate marks in a question-and-answer session and in reports |
| (7) Questions to the instructor (Office hours, etc.) | Need to take an appointment by email (kurita@tmu.ac.jp) |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Selected Topics in Physics and Chemistry I (Advanced Experimental Technique in Physics C) | R0161 | | | 2nd A | Wed. | 3 | 1 |
| Doctoral program | Selected Topics in Physics and Chemistry I (Advanced Experimental Technique in Physics C) | R0162 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Hajime Tanuma | This course is offered for Physics and Chemistry majors |

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| (1) Course policies and topics | Particle detection techniques, which are used in various physical measurements, will be explained for not only high energy radiation, but also low energy photons, electrons, ions, and neutral particles. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Fundamental understanding of physical phenomena used for particle detection, and practical technical methods for measurements of various particles in physics. |
| (3) Course schedule, subject matter, and classroom activities | 1. Fundamental collision processes of electrons and ions in gases<br>2. Gase-based particle detectors<br>3. Particle detectors using processes on solid-surfaces<br>4. Position sensitive detectors<br>5. Particle detectors using processes in solids<br>6. Mass and kinetic energy analyzers for slow charged particles in vacuum<br>7. Energy loss of fast particles in solid<br>8. Question and answers |
| (4) Outside-class activities and assignments | Before the class, check and confirm the understanding of previous lectures. |
| (5) Textbooks and course materials | Presentation slides will be provided through the “kibaco” system. |
| (6) Assessment and grading | Questions and reports after whole lectures |
| (7) Questions to the instructor (Office hours, etc.) | Contact via e-mail to tanuma-hajime@tmu.ac.jp |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Selected Topics in Physics and Chemistry I (Advanced Experimental Technique in Physics D) | R0159 | | | 2nd B | Mon. | 3 | 1 |
| Doctoral program | Selected Topics in Physics and Chemistry I (Advanced Experimental Technique in Physics D) | R0160 | | | | | | |

| Instructor(s) | Note |
|---|---|
| * Toshiyuki Azuma | This course is offered for Physics and Chemistry majors |

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| (1) Course policies and topics | This course deals with the fundamentals of vacuum, which is a common feature in various physics experiments. Vacuum technology is indispensable not only for particle beam experiments but also for physical properties, sample fabrication and low-temperature experiments. How to prepare and measure vacuum in the laboratory? The fundamentals of vacuum will be explained also with the viewpoints of atomic physics and surface physics. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | We gain a level of knowledge that will enable to understand the characteristics of vacuum equipment and to design their own equipment. |
| (3) Course schedule, subject matter, and classroom activities | Based on the knowledge of thermo-statistical mechanics, fluid mechanics, quantum mechanics, and condensed matter physics, the following major topics will be reviewed. Students will be required to write reports on fundamental topics in order to deepen their understanding of the subject matter.<br><br>Course schedule<br><br>Lecture 1: Physics of dilute gases<br>Lecture 2: Vacuum measurement<br>Lecture 3: Principles of vacuum pumps<br>Lecture 4: Vacuum system design<br>Lecture 5: Vacuum materials and components<br>Lecture 6: Practical application of vacuum systems (high-energy accelerator)<br>Lecture 7: Practical application of vacuum systems (mass-analysis system)<br>Lecture 8: Practical application of vacuum systems (surface physics) |
| (4) Outside-class activities and assignments | After each class, an assignment related to the content of the class will be given, which will be reviewed in the next class. |
| (5) Textbooks and course materials | Slides to be used in class will be printed and distributed.<br>Others will be given in class |
| (6) Assessment and grading | Based on reports (40%) and attendance (60%). |
| (7) Questions to the instructor (Office hours, etc.) | E-mail questions at any time. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Seminar on Advanced Chemistry I | Depending on laboratory | | | 1st | . | | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
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| (1) Course policies and topics | This course is for master's degree students. Students will subscribe to foreign language literature and give presentations on cutting-edge topics in chemistry. In particular, Seminar on Advanced Chemistry I provides students with basic academic skills and specialized knowledge that will serve as an introduction to specialized topics. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In the Department of Chemistry, experimental and theoretical research is conducted on a wide range of subjects extending from organic, inorganic, and biological materials to substances related to the ocean, atmospheric environment, and space. In this class, master's students will read foreign literature and give presentations on cutting-edge topics in chemistry. By being exposed to the latest chemistry, students will acquire a wide range of basic and specialized knowledge in chemistry. |
| (3) Course schedule, subject matter, and classroom activities | The specific content of each of the following classes will vary depending on the specialized theme of each laboratory. In addition, introductory foreign language literature 1-3 and related papers 1-3 will be specifically defined by each laboratory that you belong to.<br>Session 1: Review of each laboratory's specialized topics and explanation of future seminar plans<br>Session 2: Detailed reading of introductory foreign-language literature1 related to the theme of the course<br>Session 3: Introductory foreign-language literature 1 on the theme of your specialty<br>Session 4: Detailed reading of introductory foreign-language literature 2 in accordance with the theme of your specialty<br>Session 5: Explanation of introductory foreign-language literature 2 in accordance with the theme of your specialty<br>Session 6: Detailed reading of introductory foreign-language literature 3 in accordance with the theme of your specialty<br>Session 7: Explanation of introductory foreign-language literature 3 in accordance with the theme of the specialty<br>Session 8: Detailed reading of related paper 1<br>Session 9: Explanation of related paper 1<br>Session 10: Detailed reading of related paper 2<br>Session 11: Commentary on related paper 2<br>12th: Detailed reading of related paper 3<br>Session 13: Explanation of related paper 3<br>Session 14: Summary of basic knowledge acquired<br>Session 15: General Discussion |
| (4) Outside-class activities and assignments | Follow the instructions of your instructor. |
| (5) Textbooks and course materials | Introductions will be made as appropriate to the research topic and progress. |
| (6) Assessment and grading | Judgments will be made comprehensively based on the level of understanding and presentation in the seminar. |
| (7) Questions to the instructor (Office hours, etc.) | Introductions will be made as appropriate to the research topic and progress. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Seminar on Advanced Chemistry II | | | | 2nd | . | | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
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| (1) Course policies and topics | This course is for master's degree students. Students will subscribe to foreign language literature and give presentations on cutting-edge topics in chemistry. In particular, in Seminar on Advanced Chemistry II, students will continue to subscribe to and present foreign language literature as in Seminar on Advanced Chemistry I, thereby further deepening the basic academic skills and specialized knowledge acquired in Seminar on Advanced Chemistry I. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In the Department of Chemistry, experimental and theoretical research is conducted on a wide range of subjects extending from organic, inorganic, and biological materials to substances related to the ocean, atmospheric environment, and space. In this class, master's students will read foreign literature and give presentations on cutting-edge topics in chemistry. By being exposed to the latest chemistry, students will acquire a wide range of basic and specialized knowledge in chemistry. |
| (3) Course schedule, subject matter, and classroom activities | The specific content of each of the following classes will vary depending on the specialized theme of each laboratory. In addition, introductory foreign language literature 1-3 and related papers 1-3 will be specifically defined by each laboratory that you belong to.<br>Session 1: Review of each laboratory's specialized topics and explanation of future seminar plans<br>Session 2: Detailed reading of introductory foreign-language literature1 related to the theme of the course<br>Session 3: Introductory foreign-language literature 1 on the theme of your specialty<br>Session 4: Detailed reading of introductory foreign-language literature 2 in accordance with the theme of the specialty<br>Session 5: Explanation of introductory foreign-language literature 2 in accordance with the theme of the specialty<br>Session 6: Detailed reading of introductory foreign-language literature 3 in accordance with the theme of the specialty<br>Session 7: Explanation of introductory foreign-language literature 3 in accordance with the theme of the specialty<br>Session 8: Detailed reading of related paper 1<br>Session 9: Explanation of related paper 1<br>Session 10: Detailed reading of related paper 2<br>Session 11: Commentary on related paper 2<br>12th: Detailed reading of related paper 3<br>Session 13: Explanation of related paper 3<br>Session 14: Summary of basic knowledge acquired<br>Session 15: General Discussion |
| (4) Outside-class activities and assignments | Follow the instructions of your instructor. |
| (5) Textbooks and course materials | Introductions will be made as appropriate to the research topic and progress. |
| (6) Assessment and grading | Judgments will be made comprehensively based on the level of understanding and presentation in the seminar. |
| (7) Questions to the instructor (Office hours, etc.) | Follow the instructions of your instructor. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | | | | | 1st | . | | 2 |
| Doctoral program | Seminar on Advanced Chemistry III | | | | | | | |

| Instructor(s) | Note |
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| (1) Course policies and topics | The program is for the doctoral course.<br>Students will be assigned to each laboratory and introduced to foreign language literature. The purpose of this course is to cultivate the ability to read, understand, summarize, and orally present the content of original literature written in a foreign language. Students will summarize and orally present their own research topics and related topics, and ask questions and engage in discussions about the contents of the original literature. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In this class, doctoral students will read foreign language literature and give presentations on cutting-edge topics in chemistry. By being exposed to the latest chemistry, students will acquire a wide range of basic and specialized knowledge about chemistry. |
| (3) Course schedule, subject matter, and classroom activities | The content of the program will vary depending on the specialized theme of each laboratory that the student belongs to. |
| (4) Outside-class activities and assignments | Follow the instructions of your instructor. |
| (5) Textbooks and course materials | Introductions will be made as appropriate to the research topic and progress. |
| (6) Assessment and grading | Judgments will be made comprehensively based on the level of understanding and presentation in the seminar. |
| (7) Questions to the instructor (Office hours, etc.) | Follow the instructions of your instructor. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | | | | | 2nd | . | | 2 |
| Doctoral program | Seminar on Advanced Chemistry IV | | | | | | | |

| Instructor(s) | Note |
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| (1) Course policies and topics | The program is for the doctoral course.<br>Students will be assigned to each laboratory and introduced to foreign language literature. The purpose of this course is to cultivate the ability to read, understand, summarize, and orally present the content of original literature written in a foreign language. Students will summarize and orally present their own research topics and related topics, and ask questions and engage in discussions about the contents of the original literature. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In this class, doctoral students will read foreign language literature and give presentations on cutting-edge topics in chemistry. By being exposed to the latest chemistry, students will acquire a wide range of basic and specialized knowledge about chemistry. |
| (3) Course schedule, subject matter, and classroom activities | The content of the program will vary depending on the specialized theme of each laboratory that the student belongs to. |
| (4) Outside-class activities and assignments | Follow the instructions of your instructor. |
| (5) Textbooks and course materials | Introductions will be made as appropriate to the research topic and progress. |
| (6) Assessment and grading | Judgments will be made comprehensively based on the level of understanding and presentation in the seminar. |
| (7) Questions to the instructor (Office hours, etc.) | Follow the instructions of your instructor. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Research of Chemistry IA | R0284 (R0941) | | | 1st (2nd) | . | | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
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| Multiple instructors | (For students of fall enrollment in parenthesis) |

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|---|---|
| (1) Course policies and topics | In this course, students will acquire systematic and state-of-the-art specialized knowledge on one theme in a specific field by continuing with the four Advanced Research of Chemistry IA, IB, IIA, and IIB. The main contents of Advanced Research of Chemistry IA are to set a research theme, formulate a research plan, learn experimental and computational methods necessary for the research, and conduct preliminary experiments. When appropriate, progress, results, and problems are summarized and presented in a debriefing session. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In the Department of Chemistry, experimental and theoretical research is being conducted on a wide range of subjects, from organic, inorganic, and bio-related substances to substances related to the ocean, atmospheric environment, and space. In this course, students will deepen their expertise on specific topics at the cutting edge of chemistry. Students will continue to take the four Advanced Research of Chemistry IA, IB, IIA, and IIB to master experimental and computational methods for their individual appropriate topics, analyze and organize the resulting data, deepen their specific knowledge of chemistry, and comprehensively acquire the ability to present the results of their research. |
| (3) Course schedule, subject matter, and classroom activities | The specific content of each of the following classes will vary depending on the specialized theme of each laboratory that the student belongs to.<br>Session 1: Overview of research conducted in each laboratory<br>Session 2: Establishment of a research theme and research plan (Part 1): Literature review and problem search<br>Session 3: Establishment of a research theme and research plan (Part 2): Setting subject<br>Session 4: Establishment of a research theme and research plan (Part 3): Research planning<br>Session 5: Mastering experimental and computational methods necessary for research (Part 1): Investigation of experimental and computational methods<br>Session 6: Mastering experimental and computational methods necessary for research (Part 2): Conducting experiments and calculations<br>Session 7: Mastering experimental and computational methods necessary for research (Part 3): Reconfirming problems<br>Session 8: Interim debriefing on research plan and experimental and computational methods<br>Session 9: Preliminary experiments (Part 1): Investigations for conducting preliminary experiments<br>Session 10: Preliminary experiments (Part 2): Conducting experiments<br>Session 11: Preliminary experiments (Part 3): Discussion of problems<br>Session 12: Preliminary experiments (Part 4): Re-experimentation based on the results of the study<br>Session 13: Data analysis and organization of preliminary experiments (Part 1)<br>Session 14: Data analysis and organization of preliminary experiments (Part 2)<br>Session 15: Summary report of Advanced Research of Chemistry IA |
| (4) Outside-class activities and assignments | Follow the instructions of your instructor. |
| (5) Textbooks and course materials | Textbooks and reference books will be introduced in each laboratory as appropriate to the content of the experiments. |
| (6) Assessment and grading | Evaluation will be based on the midterm and summary report of Advanced Research of Chemistry IA and the experiment report |
| (7) Questions to the instructor (Office hours, etc.) | Follow the instructions of your instructor. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Research of Chemistry IB | R0285 (R0940) | | | 2nd (1st) | . | | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | (For students of fall enrollment in parenthesis) |

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|---|---|
| (1) Course policies and topics | In this course, students will acquire systematic and state-of-the-art specialized knowledge on a single theme in a specific field by continuing with the four Advanced Research of Chemistry IA, IB, IIA, and IIB. The main content of Advanced Research of Chemistry IB is to conduct basic experiments based on the results of preliminary experiments in Advanced Research of Chemistry IA, and to analyze and evaluate the results of the experiments. The progress, results, and problems will be summarized and presented in debriefing sessions as appropriate. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In the Department of Chemistry, experimental and theoretical research is being conducted on a wide range of subjects from organic, inorganic, and biological substances to substances related to the ocean, atmospheric environment, and space. In this course, each student will conduct research on a specific topic at the cutting edge of chemistry. Students continue to take the four Advanced Research of Chemistry IA, IB, IIA, and IIB to master experimental and computational methods on individually set appropriate themes, as well as to analyze and organize the resulting data, deepen their specific knowledge, and comprehensively acquire the ability to present their research results. |
| (3) Course schedule, subject matter, and classroom activities | The specific content of each of the following classes will vary depending on the specialized theme of each laboratory that the student belongs to.<br>Session 1: Overview of research conducted in each laboratory<br>Session 2: Research planning for basic experiments (Part 1): Literature review and problem search<br>Session 3: Research planning for basic experiments (Part 2): Setting subject<br>Session 4: Research planning for basic experiments (Part 3): Research planning<br>Session 5: Conducting Basic Experiments (Part 1): Investigations for conducting basic experiments<br>Session 6: Conducting Basic Experiments (Part 2): Conducting Experiments<br>Session 7: Conducting Basic Experiments (Part 3): Examining Problems<br>Session 8: Conducting basic experiments (Part 4): Re-experimentation based on the results of the study<br>Session 9: Conducting basic experiments (Part 5): Summary of basic experiments<br>Session 10: Interim debriefing of basic experiments<br>Session 11: Data analysis and organization of basic experiments (Part 1)<br>Session 12: Data analysis and organization of basic experiments (Part 2): Organizing Analysis Results<br>Session 13: Discussion of basic experiment results (Part 1): Comparison with literature, etc.<br>Session 14: Discussion of basic experiment results (Part 2): Discussion of results<br>Session 15: Summary report session of Advanced Research of Chemistry IB |
| (4) Outside-class activities and assignments | Follow the instructions of your instructor. |
| (5) Textbooks and course materials | Textbooks and reference books will be introduced in each laboratory as appropriate to the content of the experiments. |
| (6) Assessment and grading | Evaluation will be based on the midterm and summary report of Advanced Research of Chemistry IB and the experiment report |
| (7) Questions to the instructor (Office hours, etc.) | Follow the instructions of your instructor. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Research of Chemistry IIA | R0287 (R0943) | | | 1st (2nd) | . | | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | (For students of fall enrollment in parenthesis) |

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|---|---|
| (1) Course policies and topics | In this course, students will acquire systematic and state-of-the-art specialized knowledge on a single theme in a specific field by continuing with the four Advanced Research of Chemistry IA, IB, IIA, and IIB. The main content of Advanced Research of Chemistry IIA is to conduct applied experiments based on the results of the basic experiments conducted so far, and to analyze and evaluate the results of the experiments. When appropriate, progress, results, and problems will be summarized and presented in a debriefing session. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In the Department of Chemistry, experimental and theoretical research is being conducted on a wide range of subjects from organic, inorganic, and biological substances to substances related to the ocean, atmospheric environment, and space. In this course, each student will conduct research on a specific topic at the cutting edge of chemistry. Students will continue to take the four Advanced Research of Chemistry IA, IB, IIA, and IIB to master experimental and computational methods for their individually set specific topics, analyze and organize the resulting data, deepen their specialized knowledge of chemistry, and comprehensively acquire the ability to present the results of their research |
| (3) Course schedule, subject matter, and classroom activities | Session 1: Confirmation of outline of applied experiments to be conducted in Advanced Research of Chemistry IIA.<br>Session 2: Research planning for applied experiments (Part 1): Literature Review and problem search<br>Session 3: Research planning for applied experiments (Part 2): Setting subject<br>Session 4: Research planning for applied experiments (Part 3): Research planning<br>Session 5: Conducting applied experiments (Part 1): Investigations for conducting applied experiments<br>Session 6: Conducting applied experiments (Part 2): Conducting Experiment<br>Session 7: Conducting applied experiments (Part 3): Examining problems<br>Session 8: Conducting applied experiments (Part 4): Re-experimentation based on the results of the study<br>Session 9: Conducting applied experiments (Part 5): Summary of applied experiments<br>Session 10: Interim debriefing of applied experiments<br>Session 11: Data analysis and organization of applied experiments (Part 1)<br>Session 12: Data Analysis and organization of applied experiments (Part 2): organizing analysis results<br>Session 13: Discussion of applied experimental results (Part 1): Comparison with literature, etc.<br>Session 14: Discussion of applied experimental results (Part 2): Discussion of results<br>Session 15: Summary report session of Advanced Research of Chemistry IIA |
| (4) Outside-class activities and assignments | Follow the instructions of your instructor. |
| (5) Textbooks and course materials | Textbooks and reference books will be introduced in each laboratory as appropriate to the content of the experiments. |
| (6) Assessment and grading | Evaluation will be based on the midterm and summary report of Advanced Research of Chemistry IIA and the experiment report |
| (7) Questions to the instructor (Office hours, etc.) | Follow the instructions of your instructor. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Research of Chemistry IIB | R0288 (R0942) | | | 2nd (1st) | . | | 2 |
| Doctoral program | | | | | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | (For students of fall enrollment in parenthesis) |

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|---|---|
| (1) Course policies and topics | In this course, students will acquire systematic and state-of-the-art specialized knowledge on a single theme in a specific field by continuing with the four Advanced Research of Chemistry IA, IB, IIA, and IIB. The main content of Advanced Research of Chemistry IIA is to conduct applied experiments based on the results of the basic experiments conducted so far, and to analyze and evaluate the results of the experiments. When appropriate, progress, results, and problems will be summarized and presented in a debriefing session. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In the Department of Chemistry, experimental and theoretical research is being conducted on a wide range of subjects from organic, inorganic, and biological substances to substances related to the ocean, atmospheric environment, and space. In this course, each student will conduct research on a specific topic at the cutting edge of chemistry. Students will continue to take the four Advanced Research of Chemistry IA, IB, IIA, and IIB to master experimental and computational methods for their individually set specific topics, analyze and organize the resulting data, deepen their specialized knowledge of chemistry, and comprehensively acquire the ability to present the results of their research |
| (3) Course schedule, subject matter, and classroom activities | Session 1: Confirmation of outline of applied experiments to be conducted in Advanced Research of Chemistry IIB.<br>Session 2: Research planning for advanced experiments (Part 1): Literature Review and problem search<br>Session 3: Research planning for advanced experiments (Part 2): Setting subject<br>Session 4: Research planning for advanced experiments (Part 3): Research planning<br>Session 5: Conducting advanced experiments (Part 1): Investigations for conducting advanced experiments<br>Session 6: Conducting advanced experiments (Part 2): Conducting Experiment<br>Session 7: Conducting advanced experiments (Part 3): Examining problems<br>Session 8: Conducting advanced experiments (Part 4): Re-experimentation based on the results of the study<br>Session 9: Conducting advanced experiments (Part 5): Summary of advanced experiments<br>Session 10: Interim debriefing of advanced experiments<br>Session 11: Data analysis and organization of advanced experiments (Part 1)<br>Session 12: Data Analysis and organization of advanced experiments (Part 2): organizing analysis results<br>Session 13: Discussion of advanced experimental results (Part 1): Comparison with literature, etc.<br>Session 14: Discussion of advanced experimental results (Part 2): Discussion of results<br>Session 15: Summary report session of Advanced Research of Chemistry IIB |
| (4) Outside-class activities and assignments | Follow the instructions of your instructor. |
| (5) Textbooks and course materials | Textbooks and reference books will be introduced in each laboratory as appropriate to the content of the experiments. |
| (6) Assessment and grading | Evaluation will be based on the midterm and summary report of Advanced Research of Chemistry IIB and the experiment report |
| (7) Questions to the instructor (Office hours, etc.) | Follow the instructions of your instructor. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | | | | | 1st (2nd) | . | | 2 |
| Doctoral program | Advanced Research of Chemistry IIIA | R0290 (R0945) | | | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | (For students of fall enrollment in parenthesis) |

| | |
|---|---|
| (1) Course policies and topics | This course is for doctoral students. Each student will belong to a laboratory and conduct research on a specific research topic under the guidance of the laboratory's faculty members. The research results will be summarized as a doctoral thesis. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Upon completion of this course, students will acquire the knowledge and skills necessary to perform research in cutting-edge chemistry. |
| (3) Course schedule, subject matter, and classroom activities | Depends on the research project. Contact the instructor for details. |
| (4) Outside-class activities and assignments | Follow the instructions of your instructor. |
| (5) Textbooks and course materials | Depends on the research project. Contact the instructor for details. |
| (6) Assessment and grading | Depends on the research project. Contact the instructor for details. |
| (7) Questions to the instructor (Office hours, etc.) | Follow the instructions of your instructor. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | | | | | 2nd (1st) | . | | 2 |
| Doctoral program | Advanced Research of Chemistry IIIB | R0291 (R0944) | | | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | (For students of fall enrollment in parenthesis) |

| | |
|---|---|
| (1) Course policies and topics | This course is for doctoral students. Each student will belong to a laboratory and conduct research on a specific research topic under the guidance of the laboratory's faculty members. The research results will be summarized as a doctoral thesis. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Upon completion of this course, students will acquire the knowledge and skills necessary to perform research in cutting-edge chemistry. |
| (3) Course schedule, subject matter, and classroom activities | Depends on the research project. Contact the instructor for details. |
| (4) Outside-class activities and assignments | Follow the instructions of your instructor. |
| (5) Textbooks and course materials | Depends on the research project. Contact the instructor for details. |
| (6) Assessment and grading | Depends on the research project. Contact the instructor for details. |
| (7) Questions to the instructor (Office hours, etc.) | Follow the instructions of your instructor. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | | | | | 1st (2nd) | . | | 2 |
| Doctoral program | Advanced Research of Chemistry IVA | R0293 (R0947) | | | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | (For students of fall enrollment in parenthesis) |

| | |
|---|---|
| (1) Course policies and topics | This course is for doctoral students. Each student will belong to a laboratory and conduct research on a specific research topic under the guidance of the laboratory's faculty members. The research results will be summarized as a doctoral thesis. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Upon completion of this course, students will acquire the knowledge and skills necessary to perform research in cutting-edge chemistry. |
| (3) Course schedule, subject matter, and classroom activities | Depends on the research project. Contact the instructor for details. |
| (4) Outside-class activities and assignments | Follow the instructions of your instructor. |
| (5) Textbooks and course materials | Depends on the research project. Contact the instructor for details. |
| (6) Assessment and grading | Depends on the research project. Contact the instructor for details. |
| (7) Questions to the instructor (Office hours, etc.) | Follow the instructions of your instructor. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | | | | | 2nd (1st) | . | | 2 |
| Doctoral program | Advanced Research of Chemistry IVB | R0294 (R0946) | | | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | (For students of fall enrollment in parenthesis) |

| | |
|---|---|
| (1) Course policies and topics | This course is for doctoral students. Each student will belong to a laboratory and conduct research on a specific research topic under the guidance of the laboratory's faculty members. The research results will be summarized as a doctoral thesis. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Upon completion of this course, students will acquire the knowledge and skills necessary to perform research in cutting-edge chemistry. |
| (3) Course schedule, subject matter, and classroom activities | Depends on the research project. Contact the instructor for details. |
| (4) Outside-class activities and assignments | Follow the instructions of your instructor. |
| (5) Textbooks and course materials | Depends on the research project. Contact the instructor for details. |
| (6) Assessment and grading | Depends on the research project. Contact the instructor for details. |
| (7) Questions to the instructor (Office hours, etc.) | Follow the instructions of your instructor. |
| (8) Special note | |

# Biological Sciences
## (General courses for Graduate School of Science and Graduate School of Science and Engineering)

Notes on course enrollment

1. Biological Sciences offers the following courses:
   - Advanced Experimental Techniques in Biological Sciences (2 units)
   - Seminar in Biological Sciences (2 units)
   - Special Course in Biological Sciences (1 or 2 units)
   - Advanced Lecture on Biological Sciences (2 units)
   - Special Lecture on Biological Sciences (1 unit)
   - Special Seminar in Biological Sciences (1 unit)
   - Special Experiment in Biological Sciences (1 unit)
   - Special Practice in Biological Sciences (2 units)
   - Practice in Biological Sciences (Radioisotope Techniques; 1 unit)
   - Internship in Biological Sciences (1 or 2 units)

2. Advanced Experimental Techniques in Biological Sciences and Seminar in Biological Sciences will be offered at respective research laboratories. For the following courses, the subject matter and lecture format consider graduate students of other majors.
   - Special Course in Biological Sciences
   - Advanced Lecture on Biological Sciences
   - Special Lecture on Biological Sciences
   - Special Seminar in Biological Sciences
   - Special Experiment in Biological Sciences
   - Special Practice in Biological Sciences
   - Practice in Biological Sciences (Radioisotope Techniques) Advanced Lecture courses focus on the basic subject matter at the master's level in each field. Special Lecture courses provide the more specialized and advanced subject matter in each field. Special Practice courses are offered when there is a particular need.

3. In general, classes start on schedule. However, Advanced Experimental Techniques in Biological Sciences courses may be held on an irregular schedule based on the research topic. If a student spends a large amount of time on activities at off-campus research institutions and field research, the student may be allowed to complete the course by submitting home assignments and reports. The same can be applied to graduate students who work full time and have a hard time attending classes. Students who require such arrangements should consult the graduate/doctoral advisor and the course instructor in advance.

4. Graduate students' off-campus learning activities may be approved as completing the Special Experiment in Biological Sciences (Experimental Techniques) or Internship in Biological Sciences course after the review of the Academic Affairs Committee based on the student or graduate/doctoral advisor's request.

5. Registration is required for all courses. Students may retake the same course (lecture, practice, experiment, or seminar that has the same name) more than once if respective courses provide different subject matter. The credit hours of both courses will be added.

6. Some of the special lectures on Biological Sciences require the recommendation of the graduate/doctoral advisor and the approval of the Academic Affairs Committee of the department. It is recommended that students select the course carefully, considering the specialized field of each student. Read the syllabus of each course carefully.

7. Note that some credits may be transferred from Ochanomizu University.

8. It is strongly recommended that students take at least one of the following courses:
   - Biology Course in Planning and Management
   - Biology Course in International Research Experiences
   - Biology Course in Research Evaluation

(Master's program)

1. In order to complete the master's program, a total of 30 or more credits are required. Of these credits, 20 or more credits must be earned in courses other than Seminar in Biological Sciences or Advanced Experimental Techniques in Biological Sciences offered by the research laboratory where the student belongs.
2. Upon approval of the Academic Affairs Committee of the department, up to 10 credits from graduate courses outside of Biological Sciences can be considered as credits earned in courses other than Seminar in Biological Sciences or Advanced Experimental Techniques in Biological Sciences offered by the research laboratory where the student belongs mentioned above. Also, upon approval of the graduate advisor and the Academic Affairs Committee of the department, up to 10 credits from undergraduate courses can be considered as credits earned in courses other than Seminar in Biological Sciences or Advanced Experimental Techniques in Biological Sciences offered by the research laboratory where the student belongs mentioned above. However, a total of up to 10 credits are allowed from non-major courses and courses other than Seminar in Biological Sciences or Advanced Experimental Techniques in Biological Sciences offered by the research laboratory where the student belongs.
3. In principle, for Seminar in Biological Sciences and Advanced Experimental Techniques in Biological Sciences, students shall take only the courses offered in the research laboratory where the student is assigned. We encourage students to take four or more advanced courses as well as the Special Seminar in Biological Sciences.
4. Since students will need to spend time working on the master's thesis in the second year, we encourage students to earn about two-thirds of the required credits in the first year.

(Doctoral program)

1. In order to complete the doctoral program, a total of 20 or more credits from doctoral courses are required. We encourage students to earn eight or more credits from courses other than Seminar in Biological Sciences or Advanced Experimental Techniques in Biological Sciences offered by the research laboratory where the student belongs.
2. Students are not allowed to retake the same course that was taken in the master's program.
3. In principle, for Seminar in Biological Sciences and Advanced Experimental Techniques in Biological Sciences, students shall take only the courses offered in the research laboratory where the student is assigned as well as the Special Seminar in Biological Sciences.


Biological
Sciences

* M = master's courses, D = doctoral courses
* NA 2023 = Courses not offered in the academic year 2023

| Course outline | M | D | NA 2023 | Semester | Day | Time | [Graduate School of Science] Course Number | [Graduate School of Science] Course Name | [Graduate School of Science and Engineering] Course Number | [Graduate School of Science and Engineering] Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ○ | ○ | △ | | | | M(R0359) D(R0360) | Advanced Lecture on Biological Information | D(R360) | Advanced Lecture on Biological Information | 2 | Takaomi Sakai A. Weitemier | Physiological biochemistry of the brain and nervous system, molecular biology |
| | ○ | ○ | △ | | | | M(R0363) D(R0364) | Advanced Lecture on Biochemistry | D(R364) | Advanced Lecture on Biochemistry | 2 | Hiroyuki Kawahara Takashi Okamoto | Biochemistry of protein metabolism |
| | ○ | ○ | △ | | | | M(R0369) D(R0370) | Advanced Lecture on Developmental Biology | D(R370) | Advanced Lecture on Developmental Biology | 2 | Kimiko Fukuda Naohito Takatori | Modern developmental biology |
| | ○ | ○ | △ | | | | M(R0371) D(R0372) | Advanced Lecture on Molecular Biology | D(R372) | Advanced Lecture on Molecular Biology | 2 | Jun-ichi Kato Shigeki Ehira Shin Haruta | Basics and practice of genomic science |
| 1 | ○ | ○ | | Second Semester | Thu. | 1 | M(R0751) D(R0752) | Advanced Lecture on Evolutionary Genetics | D(R0752) | Advanced Lecture on Evolutionary Genetics | 2 | Koichiro Tamura Aya Takahashi Masafumi Nozawa | Evolutionary biology from the perspective of genetics and ecology |
| 2 | ○ | ○ | | First Semester | Tue. | 1 | M(R0753) D(R0754) | Advanced Lecture on Ecology | D(R0754) | Advanced Lecture on Ecology | 2 | Jun-Ichirou Suzuki Yasukazu Okada | Modern ecology with examples of basic research |
| 3 | ○ | ○ | | First Semester | Thu. | 1 | M(R0755) D(R0756) | Advanced Lecture on Cell Biology | D(R0756) | Advanced Lecture on Cell Biology | 2 | Takeshi Kanegae Rei Narikawa | Light sensing and environmental adaptation of plants |
| 4 | ○ | ○ | | Second Semester | Fri. | 1 | M(R0757) D(R0758) | Advanced Lecture on Taxonomy | D(R0758) | Advanced Lecture on Taxonomy | 2 | Noriaki Murakami Katsuyuki Eguchi | Phylogenetic evolution and diversity of plants and insects |
| 5 | ○ | ○ | | First Semester | Intensive course | | M(R0377) D (R0378) | Advanced Lecture on Biological Sciences | D (R378) | Advanced Lecture on Biological Sciences | 2 | * Hiroyuki Yokomizo | Basic statistical analysis using RStudio for biological systems |
| 6 | ○ | ○ | | First Semester | Intensive course | | M(R0365) D (R0366) | Advanced Lecture on Biological Sciences | D (R366) | Advanced Lecture on Biological Sciences | 2 | * Keita Fukasawa | An introduction to R programming language for biological systems |
| | ○ | ○ | △ | | | | M(R0391) D(R0392) | Special Lecture on Genetic Information | D(R392) | Special Lecture on Genetic Information | 1 | Koichiro Tamura Aya Takahashi Masafumi Nozawa | Population genetics and molecular evolution |
| | ○ | ○ | △ | | | | M(R0393) D(R0394) | Special Lecture on Ecological Science | D(R394) | Special Lecture on Ecological Science | 1 | Jun-Ichirou Suzuki Yasukazu Okada | Animal behavior and society, renewal of plant communities |
| | ○ | ○ | △ | | | | M(R0397) D(R0398) | Special Lecture on Responses to Environment | D(R398) | Special Lecture on Responses to Environment | 1 | Takeshi Kanegae Rei Narikawa | Environmental response and speciation of plants |
| | ○ | ○ | △ | | | | M(R0373) D(R0374) | Special Lecture on Systematics and Evolution | D(R374) | Special Lecture on Systematics and Evolution | 1 | Noriaki Murakami Katsuyuki Eguchi | Phylogenetic evolution of plants and animals |
| 7 | ○ | ○ | | 2nd A | Tue. | 1 | M(R0385) D(R0386) | Special Lecture on Cellular communication | D(R0386) | Special Lecture on Cellular communication | 1 | Takaomi Sakai Newly assigned instructor Adam Weitemier | Physiology and biochemistry of the brain |
| 8 | ○ | ○ | | 1st B | Fri. | 2 | M(R0383) D(R0384) | Special Lecture on Biomolecules | D(R0384) | Special Lecture on Biomolecules | 1 | Hiroyuki Kawahara Takashi Okamoto | Cell differentiation and development |
| 9 | ○ | ○ | | 1st A | Fri | 1 | M(R0399) D(R0400) | Special Lecture on Developmental and Regenerative Biology | D(R0400) | Special Lecture on Developmental and Regenerative Biology | 1 | Kimiko Fukuda Naohito Takatori | Modern developmental biology research and presentation methods |
| 10 | ○ | ○ | | 2nd B | Fri. | 2 | M(R0389) D(R0390) | Special Lecture on Cell Biology | D(R0390) | Special Lecture on Cell Biology | 1 | Jun-ichi Kato Shigeki Ehira Shin Haruta | The latest of genetics and molecular biology |
| 11 | ○ | ○ | | First Semester | Intensive course | | M(R0401) D (R0402) | ★ Special Lecture on Biological Sciences | D (R402) | ★ Special Lecture on Biological Sciences | 1 | Multiple instructors | The continuous education of modern biology |
| 12 | ○ | ○ | | Second Semeste | Intensive course | | M(R0375) D(R0376) | Special Lecture on Cellular Cmmunication | D(R376) | Special Lecture on Cellular Cmmunication | 1 | * Miho Terunuma | |
| 13 | ○ | ○ | | First Semester | Intensive course | | M(R0701) D(R0702) | 生態科学特別講義 | D(R0702) | 生態科学特別講義 | 1 | * Jin Yoshimura | |
| 14 | ○ | ○ | | First Semester | Intensive course | | M(R0703) D(R0704) | 生態科学特別講義 | D(R0704) | 生態科学特別講義 | 1 | * Hitoshi Miyakawa | |
| 15 | ○ | ○ | | First Semester | Intensive course | | M(R0759) D(R0760) | Special Lecture on Responses to Environment | D(R760) | Special Lecture on Responses to Environment | 1 | * Gaku Kumano | |
| 16 | ○ | ○ | | Second Semester | Intensive course | | M(R0395) D(R0396) | Special Lecture on Genetic Information | D(R396) | Special Lecture on Genetic Information | 1 | * Eiriki Sunamura | |
| 17 | ○ | ○ | | First Semester | Intensive course | | M(R0413) D(R0414) | Special Lecture on Biological Sciences | D(R0414) | Special Lecture on Biological Sciences | 1 | * Akihito Ishigami * Takahiko Hara * Yoshihiro Ito | Digest of the latest biomedical research 1 |
| 18 | ○ | ○ | | First Semester | Intensive course | | M(R0415) D (R0416) | Special Lecture on Biological Sciences | D (R416) | Special Lecture on Biological Sciences | 1 | * Azusa Inoue * Yuri Miura * Kohei Ueno * Takashi Nonaka | Digest of the latest biomedical research 2 |
| 19 | ○ | ○ | | First Semester | Intensive course | | M(R0417) D (R0418) | Special Lecture on Biological Sciences | D (R0418) | Special Lecture on Biological Sciences | 1 | * Chiaki Maruyama * Hikari Yoshitane * Kenji Miyado * Takao Iino | |
| 20 | ○ | ○ | | First Semester | Intensive course | | M(R0421) D (R0422) | Special Course in Biological Sciences Ⅱ (English for Biology) | D (R422) | Special Course in Biological Sciences Ⅱ (English for Biology) | 1 | * Yuka Iijima | English for science: listening and speaking |
| 21 | ○ | ○ | | Second Semester | Intensive course | | M(R0423) D (R0424) | Special Course in Biological Sciences Ⅱ (English for Biology) | D (R424) | Special Course in Biological Sciences Ⅱ (English for Biology) | 1 | * Reina Nakamura | How to write English papers |
| 22 | ○ | ○ | | First Semester | Mon. | 4 | M(R0425) D (R0426) | Special Course in Biological Sciences Ⅱ Special Course in Biology Ⅱ | D (R426) | Special Course in Biological Sciences Ⅱ (English Communication for Biology) | 2 | * Elisabeth Zielinska | Nature talk, science and culture |
| 23 | ○ | ○ | | Second Semester | Mon. | 3 | M(R0427) D (R0428) | Special Course in Biological Sciences Ⅱ (English Communication for Biology) | D (R428) | Special Course in Biological Sciences Ⅱ (English Communication for Biology) | 2 | * Elisabeth Zielinska | How to create a persuasive presentation |
| 24 | ○ | ○ | | Second Semester | Mon. | 4 | M(R0429) D (R0430) | Special Course in Biological Sciences Ⅱ (English Communication for Biology) | D (R430) | Special Course in Biological Sciences Ⅱ (English Communication for Biology) | 2 | * Elisabeth Zielinska | Nature talk II |
| 25 | ○ | ○ | | 2nd A | Fri. | 2 | M(R0433) D (R0434) | Special Course in Biological Sciences Ⅱ (Technique for Research Communication) | D (R434) | Special Course in Biological Sciences Ⅱ (Technique for Research Communication) | 1 | Kanae Ando Adam Cronin Adam Weitemier | Technique for Research Communication |
| 26 | ○ | ○ | | First Semest | Intensive course | | M(R0439) D (R0440) | Special Course in Biological Sciences Ⅰ (Computer Practice: Basics) | D (R440) | Special Course in Biological Sciences Ⅰ (Computer Practice: Basics) | 1 | Koichiro Tamura Masafumi Nozawa | Computer Practice: Basics |
| 27 | ○ | ○ | | 1st B | Fri. | 1 | M(R0441) D (R0442) | Special Course in Biological Sciences Ⅰ (Computer Practice: Application) | D (R0442) | Special Course in Biological Sciences Ⅰ (Computer Practice: Application) | 1 | Naohito Takatori Kimiko Fukuda Akiko Asada | Computer Practice: Application |
| 28 | ○ | ○ | | First Semester | Intensive course | | M(R0431) D (R0432) | ★ Special Lecture on Biological Sciences I | D (R432) | ★ Special Lecture on Biological Sciences I | 1 | Jun-ichi Kato | Modern Biology Recurrent Practice 1 |
| 29 | ○ | ○ | | First Semester | Intensive course | | M(R0361) D (R0362) | ★ Special Lecture on Biological Sciences I | D (R362) | ★ Special Lecture on Biological Sciences I | 1 | Kanae Ando Taro Saito | Modern Biology Recurrent Practice 2 |
| 30 | ○ | ○ | | First Semester | Tue. | 2 | M(R0443) D (R0444) | Biology course in planning and management 1 | D (R444) | Biology course in planning and management 1 | 1 | Shin Haruta and other instructors | Biology Course in Planning and Management |
| 31 | ○ | ○ | | Second Semester | Tue. | 2 | M(R0445) D (R0446) | Biology course in planning and management 2 | D (R446) | Biology course in planning and management 2 | 1 | Shin Haruta and other instructors | Biology Course in Planning and Management |
| 32 | ○ | ○ | | First Semester | Tue. | 3 | M(R0447) D (R0448) | Biology course in international research experiences 1 | D (R448) | Biology course in international research experiences 1 | 1 | Kimiko Fukuda Aya Takahashi and other instructors | Training for developing global leadership skills |
| 33 | ○ | ○ | | Second Semester | Tue. | 3 | M(R0449) D (R0450) | Biology course in international research experiences 2 | D (R450) | Biology course in international research experiences 2 | 1 | Kimiko Fukuda Aya Takahashi and other instructors | Training for developing global leadership skills |
| 34 | ○ | ○ | | First Semester | Wed. | 1 | M(R0451) D (R0452) | Biology course in research evaluation 1 | D (R452) | Biology course in research evaluation 1 | 1 | Jun-Ichirou Suzuki and other instructors | Evaluation of research proposals and applications |
| 35 | ○ | ○ | | Second Semester | Wed. | 1 | M(R0453) D (R0454) | Biology course in research evaluation 2 | D (R0454) | Biology course in research evaluation 2 | 1 | Jun-Ichirou Suzuki and other instructors | Evaluation of research presentation |
| 36 | ○ | ○ | | Second Semester | Intensive course | | M(R0455) D(R0456) | Practice in Biological Sciences (Radioisotope Techniques) | D(R456) | Practice in Biological Sciences (Radioisotope Techniques) | 1 | Takashi Okamoto Taro Saito Tsunaki Asano | Basic techniques for handling radiolabeled compounds |
| 37 | ○ | ○ | | At all times | | | M(R0693) D (R0694) | Internship in Biological Sciences 1 | D (R694) | Internship in Biological Sciences 1 | 1 | Multiple instructors | Internship |
| 37 | ○ | ○ | | At all times | | | M (R0695) 2 units D (R0696) 2 units M (R0411) 1 unit D (R0412) 1 unit | Internship in Biological Sciences 2 | D (R696) 2 units D (R412) 1 unit | Internship in Biological Sciences 2 | 1 or 2 | Multiple instructors | Internship |
| 38 | ○ | ○ | | First Semester | Fri. | 5 | M(R0457) D (R0458) | Special Seminar in Biological Sciences 1 | D (R458) | Special Seminar in Biological Sciences 1 | 1 | Multiple instructors | The latest issues in Biological Sciences (department seminar) |

| Course outline | M | D | NA 2023 | Semester | Day | Time | [Graduate School of Science] | | [Graduate School of Science and Engineering] | | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Course Number | Course Name | Course Number | Course Name | | | |
| 39 | ○ | ○ | | Second Semester | Fri. | 5 | M(R0459) D (R0460) | Special Seminar in Descriptive Science 2 | D (R460) | Special Seminar in Descriptive Science 2 | 1 | Multiple instructors | The latest issues in biological sciences (Department seminar) |
| 40 | ○ | ○ | | 2nd A | Mon. | 2 | M(R0715) D (R0716) | Special Lecture on Biological Sciences | D (R716) | Special Lecture on Biological Sciences | 1 | Adam Cronin | No online registration. A retake is not allowed for students who took this course in the undergraduate program. The approval of the Academic Affairs Committee of the Graduate School is required. Special Lecture in Evolutionary Biology 1: Course in English |
| 41 | ○ | ○ | | 2nd A | Tue. | 1 | M(R0709) D(R0710) | Special Lecture on Biological Sciences | D(R0710) | Special Lecture on Biological Sciences | 1 | Kimiko Takahashi NaohitoTakatori | No online registration. A retake is not allowed for students who took this course in the undergraduate program. The approval of the Academic Affairs Committee of the Graduate School is required. Special Lecture in Developmental Biology: Course in English. |
| 42 | ○ | ○ | | 2nd A | Tue. | 2 | M(R0707) D(R0708) | Special Lecture on Biological Sciences | D(R708) | Special Lecture on Biological Sciences | 1 | Kanae Ando | No online registration. A retake is not allowed for students who took this course in the undergraduate program. The approval of the Academic Affairs Committee of the Graduate School is required. Special Lecture in Molecular Biology 1: Course in English |
| 43 | ○ | ○ | | 2nd A | Wed. | 1 | M(R0721) D(R0722) | Special Lecture on Biological Sciences | D(R0722) | Special Lecture on Biological Sciences | 1 | Kanae Ando | No online registration. A retake is not allowed for students who took this course in the undergraduate program. The approval of the Academic Affairs Committee of the Graduate School is required. Special Lecture in Molecular Biology: Course in English |
| 44 | ○ | ○ | | 2nd A | Wed. | 2 | M(R0717) D(R0718) | Special Lecture on Biological Sciences | D(R718) | Special Lecture on Biological Sciences | 1 | Masafumi Nozawa Noriaki Murakami | No online registration. A retake is not allowed for students who took this course in the undergraduate program. The approval of the Academic Affairs Committee of the Graduate School is required. Special Lecture in Evolutionary Biology: Course in English |
| 45 | ○ | ○ | | 2nd A | Thu. | 1 | M(R0711) D(R0712) | Special Lecture on Biological Sciences | D(R0712) | Special Lecture on Biological Sciences | 1 | Jun-ichiro Suzuki Yasukazu Okada | No online registration. A retake is not allowed for students who took this course in the undergraduate program. The approval of the Academic Affairs Committee of the Graduate School is required. Special Lecture on Ecology: Course in English |
| 46 | ○ | ○ | | 2nd A | Fri. | 1 | M(R0733) D(R0734) | Special Lecture on Biological Sciences | D(R734) | Special Lecture on Biological Sciences | 1 | Adam Weitemier | No online registration. A retake is not allowed for students who took this course in the undergraduate program. The approval of the Academic Affairs Committee of the Graduate School is required. Special Lecture in Physiology: Course in English |
| 47 | ○ | ○ | | 2nd A | Fri. | 2 | M(R0713) D(R0714) | Special Lecture on Biological Sciences | D(R0714) | Special Lecture on Biological Sciences | 1 | Takashi Okamoto Takaomi Sakai | No online registration. A retake is not allowed for students who took this course in the undergraduate program. The approval of the Academic Affairs Committee of the Graduate School is required. Special Lecture in Cell Biology: Course in English |
| 48 | ○ | ○ | | First Semester | Intensive course | | M(R0725) D (R0726) | Special Lecture on Biological Sciences | D (R726) | Special Lecture on Biological Sciences | 1 | * Florian Reyda | Course in English |
| 49 | ○ | ○ | | First Semester | Intensive course | | M(R0727) D (R0728) | Special Lecture on Biological Sciences | D (R728) | Special Lecture on Biological Sciences | 1 | * Florian Reyda | Course in English |
| 50 | ○ | ○ | | First Semester | Intensive course | | M(R0719) D (R0720) | Special Lecture on Biological Sciences | D (R720) | Special Lecture on Biological Sciences | 1 | * Diego Tavares Vasques | Students are not allowed to retake this course if already taken last year. Course in English |
| 51 | ○ | ○ | | First Semester | Intensive course | | M(R0729) D (R0730) | Special Lecture on Biological Sciences | D (R730) | Special Lecture on Biological Sciences | 1 | * Ben Wallen | Students are not allowed to retake this course if already taken last year. Course in English |
| 52 | ○ | ○ | | First Semester | Mon. | 1 | M(R0461) D (R0462) | Seminar in Biological Sciences 1 (Molecular Neurobiology 1) | D (R462) | Seminar in Biological Sciences 1 (Molecular Neurobiology 1) | 2 | Kanae Ando Taro Saito Akiko Asada | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 1 | M(R0463) D (R0464) | Seminar in Biological Sciences 2 (Molecular Neurobiology 1) | D (R464) | Seminar in Biological Sciences 2 (Molecular Neurobiology 1) | 2 | Kanae Ando Taro Saito Akiko Asada | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 2 | M(R0465) D (R0466) | Seminar in Biological Sciences 1 (Molecular Neurobiology 2) | D (R466) | Seminar in Biological Sciences 1 (Molecular Neurobiology 2) | 2 | Kanae Ando Taro Sait, Akiko Asada | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 2 | M(R0467) D (R0468) | Seminar in Biological Sciences 2 (Molecular Neurobiology 2) | D (R468) | Seminar in Biological Sciences 2 (Molecular Neurobiology 2) | 2 | Kanae Ando Taro Saito Akiko Asada | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Fri. | 3 | M(R0469) D (R0470) | Seminar in Biological Sciences 1 (Molecular Neurobiology 3) | D (R470) | Seminar in Biological Sciences 1 (Molecular Neurobiology 3) | 2 | Kanae Ando Taro Saito Akiko Asada | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Fri. | 3 | M(R0471) D (R0472) | Seminar in Biological Sciences 2 (Molecular Neurobiology 3) | D (R472) | Seminar in Biological Sciences 2 (Molecular Neurobiology 3) | 2 | Kanae Ando Taro Saito Akiko Asada | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Fri. | 4 | M(R0473) D (R0474) | Seminar in Biological Sciences 1 (Molecular Neurobiology 4) | D (R474) | Seminar in Biological Sciences 1 (Molecular Neurobiology 4) | 2 | Kanae Ando Taro Saito Akiko Asada | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Fri. | 4 | M(R0475) D (R0476) | Seminar in Biological Sciences 2 (Molecular Neurobiology 4) | D (R476) | Seminar in Biological Sciences 2 (Molecular Neurobiology 4) | 2 | Kanae Ando Taro Saito Akiko Asada | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Wed. | 6 | M(R0477) D (R0478) | Seminar in Biological Sciences 1 (Neurobiology 1) | D (R478) | Seminar in Biological Sciences 1 (Neurobiology 1) | 2 | Adam Weitemier | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Wed. | 6 | M(R0479) D (R0480) | Seminar in Biological Sciences 2 (Neurobiology 1) | D (R480) | Seminar in Biological Sciences 2 (Neurobiology 1) | 2 | Adam Weitemier | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Wed. | 7 | M(R0481) D (R0482) | Seminar in Biological Sciences 1 (Neurobiology 2) | D (R482) | Seminar in Biological Sciences 1 (Neurobiology 2) | 2 | Adam Weitemier | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Wed. | 7 | M(R0483) D (R0484) | Seminar in Biological Sciences 2 (Neurobiology 2) | D (R484) | Seminar in Biological Sciences 2 (Neurobiology 2) | 2 | Adam Weitemier | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Tue. | 4 | M(R0485) D (R0486) | Seminar in Biological Sciences 1 (Plant Development and Physiology 1) | D (R486) | Seminar in Biological Sciences 1 (Plant Development and Physiology 1) | 2 | Takashi Okamoto Toshiko Furukawa Atsuko Kinoshita | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Tue. | 4 | M(R0487) D (R0488) | Seminar in Biological Sciences 2 (Plant Development and Physiology 1) | D (R488) | Seminar in Biological Sciences 2 (Plant Development and Physiology 1) | 2 | Takashi Okamoto Toshiko Furukawa Atsuko Kinoshita | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Tue. | 5 | M(R0489) D (R0490) | Seminar in Biological Sciences 1 (Plant Development and Physiology 2) | D (R490) | Seminar in Biological Sciences 1 (Plant Development and Physiology 2) | 2 | Takashi Okamoto Toshiko Furukawa Atsuko Kinoshita | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Tue. | 5 | M(R0491) D (R0492) | Seminar in Biological Sciences 2 (Plant Development and Physiology 2) | D (R492) | Seminar in Biological Sciences 2 (Plant Development and Physiology 2) | 2 | Takashi Okamoto Toshiko Furukawa Atsuko Kinoshita | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Fri. | 3 | M(R0493) D (R0494) | Seminar in Biological Sciences 1 (Plant Development and Physiology 3) | D (R494) | Seminar in Biological Sciences 1 (Plant Development and Physiology 3) | 2 | Takashi Okamoto Toshiko Furukawa Atsuko Kinoshita | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Fri. | 3 | M(R0495) D (R0496) | Seminar in Biological Sciences 2 (Plant Development and Physiology 3) | D (R496) | Seminar in Biological Sciences 2 (Plant Development and Physiology 3) | 2 | Takashi Okamoto Toshiko Furukawa Atsuko Kinoshita | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Fri. | 4 | M(R0497) D (R0498) | Seminar in Biological Sciences 1 (Plant Development and Physiology 4) | D (R498) | Seminar in Biological Sciences 1 (Plant Development and Physiology 4) | 2 | Takashi Okamoto Toshiko Furukawa Atsuko Kinoshita | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Fri. | 4 | M(R0499) D (R0500) | Seminar in Biological Sciences 2 (Plant Development and Physiology 4) | D (R500) | Seminar in Biological Sciences 2 (Plant Development and Physiology 4) | 2 | Takashi Okamoto, Toshiko Furukawa, Atsuko Kinoshita | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 1 | M(R0501) D (R0502) | Seminar in Biological Sciences 1 (Plant environmental responses 1) | D (R502) | Seminar in Biological Sciences 1 (Plant environmental responses 1) | 2 | Takeshi Kanegae Rei Narikawa | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 1 | M(R0503) D (R0504) | Seminar in Biological Sciences 2 (Plant environmental responses 1) | D (R504) | Seminar in Biological Sciences 2 (Plant environmental responses 1) | 2 | Takeshi Kanegae Rei Narikawa | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 2 | M(R0505) D (R0506) | Seminar in Biological Sciences 1 (Plant environmental responses 2) | D (R506) | Seminar in Biological Sciences 1 (Plant environmental responses 2) | 2 | Takeshi Kanegae Rei Narikawa | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 2 | M(R0507) D (R0508) | Seminar in Biological Sciences 2 (Plant environmental responses 2) | D (R508) | Seminar in Biological Sciences 2 (Plant environmental responses 2) | 2 | Takeshi Kanegae Rei Narikawa | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 1 | M(R0509) D (R0510) | Seminar in Biological Sciences 1 (Cytogenetics 1) | D (R510) | Seminar in Biological Sciences 1 (Cytogenetics 1) | 2 | Takaomi Sakai Tsunaki Asano Satomi Takeo | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 1 | M(R0511) D (R0512) | Seminar in Biological Sciences 2 (Cytogenetics 1) | D (R512) | Seminar in Biological Sciences 2 (Cytogenetics 1) | 2 | Takaomi Sakai Tsunaki Asano Satomi Takeo | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 2 | M(R0513) D (R0514) | Seminar in Biological Sciences 1 (Cytogenetics 2) | D (R514) | Seminar in Biological Sciences 1 (Cytogenetics 2) | 2 | Takaomi Sakai Tsunaki Asano Satomi Takeo | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 2 | M(R0515) D (R0516) | Seminar in Biological Sciences 2 (Cytogenetics 2) | D (R516) | Seminar in Biological Sciences 2 (Cytogenetics 2) | 2 | Takaomi Sakai Tsunaki Asano Satomi Takeo | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 1 | M(R0517) D (R0518) | Seminar in Biological Sciences 1 (Evolutionary Genetics 1) | D (R518) | Seminar in Biological Sciences 1 (Evolutionary Genetics 1) | 2 | Koichiro Tamura Aya Takahashi Masafumi Nozawa | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 1 | M(R0519) D (R0520) | Seminar in Biological Sciences 2 (Evolutionary Genetics 1) | D (R520) | Seminar in Biological Sciences 2 (Evolutionary Genetics 1) | 2 | Koichiro Tamura Aya Takahashi Masafumi Nozawa | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 2 | M(R0521) D (R0522) | Seminar in Biological Sciences 1 (Evolutionary Genetics 2) | D (R522) | Seminar in Biological Sciences 1 (Evolutionary Genetics 2) | 2 | Koichiro Tamura Aya Takahashi Masafumi Nozawa | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 2 | M(R0523) D (R0524) | Seminar in Biological Sciences 2 (Evolutionary Genetics 2) | D (R524) | Seminar in Biological Sciences 2 (Evolutionary Genetics 2) | 2 | Koichiro Tamura Aya Takahashi Masafumi Nozawa | Seminar offered at respective research laboratories |

| Course outline | M | D | NA 2023 | Semester | Day | Time | [Graduate School of Science] | | [Graduate School of Science and Engineering] | | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Course Number | Course Name | Course Number | Course Name | | | |
| 52 | ○ | ○ | | First Semester | Mon. | 1 | M(R0525) D (R0526) | Seminar in Biological Sciences 1 (Molecular Genetics 1) | D (R526) | Seminar in Biological Sciences 1 (Molecular Genetics 1) | 2 | Jun-ichi Kato Shigeki Ehira | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 1 | M(R0527) D (R0528) | Seminar in Biological Sciences 2 (Molecular Genetics 1) | D (R528) | Seminar in Biological Sciences 2 (Molecular Genetics 1) | 2 | Jun-ichi Kato Shigeki Ehira | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 2 | M(R0529) D (R0530) | Seminar in Biological Sciences 1 (Molecular Genetics 2) | D (R530) | Seminar in Biological Sciences 1 (Molecular Genetics 2) | 2 | Jun-ichi Kato Shigeki Ehira | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 2 | M(R0531) D (R0532) | Seminar in Biological Sciences 2 (Molecular Genetics 2) | D (R532) | Seminar in Biological Sciences 2 (Molecular Genetics 2) | 2 | Jun-ichi Kato Shigeki Ehira | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 1 | M(R0533) D (R0534) | Seminar in Biological Sciences 1 (Animal Ecology 1) | D (R534) | Seminar in Biological Sciences 1 (Animal Ecology 1) | 2 | Yasukazu Okada | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Tue. | 4 | M(R0535) D (R0536) | Seminar in Biological Sciences 2 (Animal Ecology 1) | D (R536) | Seminar in Biological Sciences 2 (Animal Ecology 1) | 2 | Yasukazu Okada | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 2 | M(R0537) D (R0538) | Seminar in Biological Sciences 1 (Animal Ecology 2) | D (R538) | Seminar in Biological Sciences 1 (Animal Ecology 2) | 2 | Yasukazu Okada | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Tue. | 5 | M(R0539) D (R0540) | Seminar in Biological Sciences 2 (Animal Ecology 2) | D (R540) | Seminar in Biological Sciences 2 (Animal Ecology 2) | 2 | Yasukazu Okada | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Fri. | 3 | M(R0541) D (R0542) | Seminar in Biological Sciences 1 (Plant Ecology 1) | D (R542) | Seminar in Biological Sciences 1 (Plant Ecology 1) | 2 | Jun-Ichirou Suzuki Yuuya Tachiki | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Fri. | 3 | M(R0543) D (R0544) | Seminar in Biological Sciences 2 (Plant Ecology 1) | D (R544) | Seminar in Biological Sciences 2 (Plant Ecology 1) | 2 | Jun-Ichirou Suzuki Yuuya Tachiki | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Fri. | 4 | M(R0545) D (R0546) | Seminar in Biological Sciences 1 (Plant Ecology 2) | D (R546) | Seminar in Biological Sciences 1 (Plant Ecology 2) | 2 | Jun-Ichirou Suzuki Yuuya Tachiki | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Fri. | 4 | M(R0547) D (R0548) | Seminar in Biological Sciences 2 (Plant Ecology 2) | D (R548) | Seminar in Biological Sciences 2 (Plant Ecology 2) | 2 | Jun-Ichirou Suzuki Yuuya Tachiki | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Fri. | 6 | M(R0549) D (R0550) | Seminar in Biological Sciences 1 (Plant Ecology 3) | D (R550) | Seminar in Biological Sciences 1 (Plant Ecology 3) | 2 | Jun-Ichirou Suzuki Yuuya Tachiki | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Fri. | 6 | M(R0551) D (R0552) | Seminar in Biological Sciences 2 (Plant Ecology 3) | D (R552) | Seminar in Biological Sciences 2 (Plant Ecology 3) | 2 | Jun-Ichirou Suzuki Yuuya Tachiki | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Wed. | 6 | M(R0561) D (R0562) | Seminar in Biological Sciences 1 (Developmental Biology 1) | D (R562) | Seminar in Biological Sciences 1 (Developmental Biology 1) | 2 | Kimiko Fukuda Naohito Takatori | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Wed. | 6 | M(R0563) D (R0564) | Seminar in Biological Sciences 2 (Developmental Biology 1) | D (R564) | Seminar in Biological Sciences 2 (Developmental Biology 1) | 2 | Kimiko Fukuda Naohito Takatori | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Wed. | 7 | M(R0565) D (R0566) | Seminar in Biological Sciences 1 (Developmental Biology 2) | D (R566) | Seminar in Biological Sciences 1 (Developmental Biology 2) | 2 | Kimiko Fukuda Naohito Takatori | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Wed. | 7 | M(R0567) D (R0568) | Seminar in Biological Sciences 2 (Developmental Biology 2) | D (R568) | Seminar in Biological Sciences 2 (Developmental Biology 2) | 2 | Kimiko Fukuda Naohito Takatori | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Tue. | 6 | M(R0569) D (R0570) | Seminar in Biological Sciences 1 (Developmental Biology 3) | D (R570) | Seminar in Biological Sciences 1 (Developmental Biology 3) | 2 | Kimiko Fukuda Naohito Takatori | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Tue. | 6 | M(R0571) D (R0572) | Seminar in Biological Sciences 2 (Developmental Biology 3) | D (R572) | Seminar in Biological Sciences 2 (Developmental Biology 3) | 2 | Kimiko Fukuda Naohito Takatori | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Tue. | 5 | M(R0577) D (R0578) | Seminar in Biological Sciences 1 (Systematic Zoology 1) | D (R578) | Seminar in Biological Sciences 1 (Systematic Zoology 1) | 2 | Katsuyuki Eguchi Adam Cronin Takahiro Yoshida | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Tue. | 4 | M(R0579) D (R0580) | Seminar in Biological Sciences 2 (Systematic Zoology 1) | D (R580) | Seminar in Biological Sciences 2 (Systematic Zoology 1) | 2 | Katsuyuki Eguchi Adam Cronin Takahiro Yoshida | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Tue. | 6 | M(R0581) D (R0582) | Seminar in Biological Sciences 1 (Systematic Zoology 2) | D (R582) | Seminar in Biological Sciences 1 (Systematic Zoology 2) | 2 | Katsuyuki Eguchi Adam Cronin Takahiro Yoshida | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Tue. | 5 | M(R0583) D (R0584) | Seminar in Biological Sciences 2 (Systematic Zoology 2) | D (R584) | Seminar in Biological Sciences 2 (Systematic Zoology 2) | 2 | Katsuyuki Eguchi Adam Cronin Takahiro Yoshida | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Fri. | 3 | M(R0585) D (R0586) | Seminar in Biological Sciences 1 (Systematic Botany 1) | D (R586) | Seminar in Biological Sciences 1 (Systematic Botany 1) | 2 | Noriaki Murakami Hidetoshi Kato | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Fri. | 3 | M(R0587) D (R0588) | Seminar in Biological Sciences 2 (Systematic Botany 1) | D (R588) | Seminar in Biological Sciences 2 (Systematic Botany 1) | 2 | Noriaki Murakami Hidetoshi Kato | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Fri. | 4 | M(R0589) D (R0590) | Seminar in Biological Sciences 1 (Systematic Botany 2) | D (R590) | Seminar in Biological Sciences 1 (Systematic Botany 2) | 2 | Noriaki Murakami Hidetoshi Kato | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Fri. | 4 | M(R0591) D (R0592) | Seminar in Biological Sciences 2 (Systematic Botany 2) | D (R592) | Seminar in Biological Sciences 2 (Systematic Botany 2) | 2 | Noriaki Murakami Hidetoshi Kato | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 5 | M(R0593) D (R0594) | Seminar in Biological Sciences 1 (Environmental Microbiology 1) | D (R594) | Seminar in Biological Sciences 1 (Environmental Microbiology 1) | 2 | Shin Haruta | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 5 | M(R0595) D (R0596) | Seminar in Biological Sciences 2 (Environmental Microbiology 1) | D (R596) | Seminar in Biological Sciences 2 (Environmental Microbiology 1) | 2 | Shin Haruta | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 6 | M(R0597) D (R0598) | Seminar in Biological Sciences 1 (Environmental Microbiology 2) | D (R598) | Seminar in Biological Sciences 1 (Environmental Microbiology 2) | 2 | Shin Haruta | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 6 | M(R0599) D (R0600) | Seminar in Biological Sciences 2 (Environmental Microbiology 2) | D (R600) | Seminar in Biological Sciences 2 (Environmental Microbiology 2) | 2 | Shin Haruta | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Fri. | 3 | M(R0601) D (R0602) | Seminar in Biological Sciences 1 (Cellular Biochemistry 1) | D (R602) | Seminar in Biological Sciences 1 (Cellular Biochemistry 1) | 2 | Hiroyuki Kawahara Naoto Yokota | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Fri. | 3 | M(R0603) D (R0604) | Seminar in Biological Sciences 2 (Cellular Biochemistry 1) | D (R604) | Seminar in Biological Sciences 2 (Cellular Biochemistry 1) | 2 | Hiroyuki Kawahara Naoto Yokota | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Fri. | 4 | M(R0605) D (R0606) | Seminar in Biological Sciences 1 (Cellular Biochemistry 2) | D (R606) | Seminar in Biological Sciences 1 (Cellular Biochemistry 2) | 2 | Hiroyuki Kawahara Naoto Yokota | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Fri. | 4 | M(R0607) D (R0608) | Seminar in Biological Sciences 2 (Cellular Biochemistry 2) | D (R608) | Seminar in Biological Sciences 2 (Cellular Biochemistry 2) | 2 | Hiroyuki Kawahara Naoto Yokota | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 1 | M(R0435) D (R0436) | Seminar in Biological Sciences 1 (Stem Cell Modulation 1) | D (R436) | Seminar in Biological Sciences 1 (Stem Cell Modulation 1) | 2 | Takahiko Hara | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 1 | M(R0437) D (R0438) | Seminar in Biological Sciences 2 (Stem Cell Modulation 1) | D (R438) | Seminar in Biological Sciences 2 (Stem Cell Modulation 1) | 2 | Takahiko Hara | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 2 | M(R0573) D (R0574) | Seminar in Biological Sciences 1 (Stem Cell Modulation 2) | D (R574) | Seminar in Biological Sciences 1 (Stem Cell Modulation 2) | 2 | Takahiko Hara | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 2 | M(R0575) D (R0576) | Seminar in Biological Sciences 2 (Stem Cell Modulation 2) | D (R576) | Seminar in Biological Sciences 2 (Stem Cell Modulation 2) | 2 | Takahiko Hara | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 1 | M(R0921) D(R0922) | Seminar in Biological Sciences 1 (Molecular Regulation of Aging 1) | D(R0922) | Seminar in Biological Sciences 1 (Molecular Regulation of Aging 1) | 2 | Akihito Ishigami | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 1 | M(R0923) D(R0924) | Seminar in Biological Sciences 2 (Molecular Regulation of Aging 1) | D(R0924) | Seminar in Biological Sciences 2 (Molecular Regulation of Aging 1) | 2 | Akihito Ishigami | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 2 | M(R0925) D(R0926) | Seminar in Biological Sciences 1 (Molecular Regulation of Aging 2) | D(R0926) | Seminar in Biological Sciences 1 (Molecular Regulation of Aging 2) | 2 | Akihito Ishigami | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 2 | M(R0927) D(R0928) | Seminar in Biological Sciences 2 (Molecular Regulation of Aging 2) | D(R0928) | Seminar in Biological Sciences 2 (Molecular Regulation of Aging 2) | 2 | Akihito Ishigami | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 1 | M(R0351) D (R0352) | Seminar in Biological Sciences 1 (Chemical Biology 1) | D (R352) | Seminar in Biological Sciences 1 (Chemical Biology 1) | 2 | Yoshihiro Ito | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 1 | M(R0353) D (R0354) | Seminar in Biological Sciences 2 (Chemical Biology 1) | D (R354) | Seminar in Biological Sciences 2 (Chemical Biology 1) | 2 | Yoshihiro Ito | Seminar offered at respective research laboratories |
| 52 | ○ | ○ | | First Semester | Mon. | 2 | M(R0357) D (R0358) | Seminar in Biological Sciences 1 (Chemical Biology 2) | D (R358) | Seminar in Biological Sciences 1 (Chemical Biology 2) | 2 | Yoshihiro Ito | Seminar offered at respective research laboratories |
| 53 | ○ | ○ | | Second Semester | Mon. | 2 | M(R0367) D (R0368) | Seminar in Biological Sciences 2 (Chemical Biology 2) | D (R368) | Seminar in Biological Sciences 2 (Chemical Biology 2) | 2 | Yoshihiro Ito | Seminar offered at respective research laboratories |
| 54 | ○ | ○ | | At all times | | | M(R0609) D (R0610) | Special Experiment in Biological Sciences (Experimental Teches) (Experimental Techniques 1) | D(R610) | Special Experiment in Biological Sciences (Experimental Teches) (Experimental Techniques 1) | 1 | Multiple instructors | Basic experimental methods in each field of biological science This course is open to students of other majors. |
| 54 | ○ | ○ | | At all times | | | M(R0611) D (R0612) | Special Experiment in Biological Sciences (Experimental Teches) (Experimental Techniques 2) | D(R612) | Special Experiment in Biological Sciences (Experimental Teches) (Experimental Techniques 2) | 1 | Multiple instructors | Basic experimental methods in each field of biological science This course is open to students of other majors. |
| 54 | ○ | ○ | | At all times | | | M(R0613) D (R0614) | Special Experiment in Biological Sciences (Experimental Teches) (Experimental Techniques 3) | D(R614) | Special Experiment in Biological Sciences (Experimental Teches) (Experimental Techniques 3) | 1 | Multiple instructors | Basic experimental methods in each field of biological science This course is open to students of other majors. |
| 54 | ○ | ○ | | At all times | | | M(R0615) D (R0616) | Special Experiment in Biological Sciences (Experimental Teches) (Experimental Techniques 4) | D(R616) | Special Experiment in Biological Sciences (Experimental Teches) (Experimental Techniques 4) | 1 | Multiple instructors | Basic experimental methods in each field of biological science This course is open to students of other majors. |

| Course outline | M | D | NA 2023 | Semester | Day | Time | [Graduate School of Science] | | [Graduate School of Science and Engineering] | | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Course Number | Course Name | Course Number | Course Name | | | |
| 54 | ○ | ○ | | At all times | | | M(R0617)<br>D (R0618) | Special Experiment in Biological Sciences (Experimental Teches) (Experimental Techniques 5) | D(R618) | Special Experiment in Biological Sciences (Experimental Teches) (Experimental Techniques 5) | 1 | Multiple instructors | Basic experimental methods in each field of biological science This course is open to students of other majors. |
| 54 | ○ | ○ | | At all times | | | M(R0619)<br>D (R0620) | Special Experiment in Biological Sciences (Experimental Teches) (Experimental Techniques 6) | D(R620) | Special Experiment in Biological Sciences (Experimental Teches) (Experimental Techniques 6) | 1 | Multiple instructors | Basic experimental methods in each field of biological science This course is open to students of other majors. |
| 55 | ○ | ○ | | At all times | | | M(R0621)<br>D (R0622) | Special Practice in Biological Sciences II (Research Techniques 1) | D(R622) | Special Practice in Biological Sciences II (Research Techniques 1) | 2 | Multiple instructors | Various experimental methods in each field of biological science and practical research methods |
| 55 | ○ | ○ | | At all times | | | M(R0623)<br>D (R0624) | Special Practice in Biological Sciences II (Research Techniques 2) | D(R624) | Special Practice in Biological Sciences II (Research Techniques 2) | 2 | Multiple instructors | Various experimental methods in each field of biological science and practical research methods |
| 55 | ○ | ○ | | At all times | | | M(R0625)<br>D (R0626) | Special Practice in Biological Sciences II (Research Techniques 3) | D(R626) | Special Practice in Biological Sciences II (Research Techniques 3) | 2 | Multiple instructors | Various experimental methods in each field of biological science and practical research methods |
| 55 | ○ | ○ | | At all times | | | M(R0627)<br>D (R0628) | Special Practice in Biological Sciences II (Research Techniques 4) | D(R628) | Special Practice in Biological Sciences II (Research Techniques 4) | 2 | Multiple instructors | Various experimental methods in each field of biological science and practical research methods |
| 55 | ○ | ○ | | At all times | | | M(R0629)<br>D (R0630) | Special Practice in Biological Sciences II (Research Techniques 5) | D(R630) | Special Practice in Biological Sciences II (Research Techniques 5) | 2 | Multiple instructors | Various experimental methods in each field of biological science and practical research methods |
| 55 | ○ | ○ | | At all times | | | M(R0631)<br>D (R0632) | Special Practice in Biological Sciences II (Research Techniques 6) | D(R632) | Special Practice in Biological Sciences II (Research Techniques 6) | 2 | Multiple instructors | Various experimental methods in each field of biological science and practical research methods |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0633)<br>D (R0634) | Advanced Experimental Techniques in Biological Sciences 1 (Molecular Neurobiology) | D(R634) | Advanced Experimental Techniques in Biological Sciences 1 (Molecular Neurobiology) | 2 | Kanae Ando<br>Taro Saito<br>Akiko Asada | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0635)<br>D (R0636) | Advanced Experimental Techniques in Biological Sciences 2 (Molecular Neurobiology) | D(R636) | Advanced Experimental Techniques in Biological Sciences 2 (Molecular Neurobiology) | 2 | Kanae Ando<br>Taro Saito<br>Akiko Asada | Advanced research technologies in different branches of biological sciences |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0637)<br>D (R0638) | Advanced Experimental Techniques in Biological Sciences 1 (Neurobiology) | D(R638) | Advanced Experimental Techniques in Biological Sciences 1 (Neurobiology) | 2 | Adam Weitemier | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0639)<br>D (R0640) | Advanced Experimental Techniques in Biological Sciences 2 (Neurobiology) | D(R640) | Advanced Experimental Techniques in Biological Sciences 2 (Neurobiology) | 2 | Adam Weitemier | Advanced research technologies in different branches of biological sciences |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0641)<br>D (R0642) | Advanced Experimental Techniques in Biological Sciences 1 (Plant Development and Physiology) | D(R642) | Advanced Experimental Techniques in Biological Sciences 1 (Plant Development and Physiology) | 2 | Takashi Okamoto<br>Toshiko Furukawa<br>Atsuko Kinoshita | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0643)<br>D (R0644) | Advanced Experimental Techniques in Biological Sciences 2 (Plant Development and Physiology) | D(R644) | Advanced Experimental Techniques in Biological Sciences 2 (Plant Development and Physiology) | 2 | Takashi Okamoto<br>Toshiko Furukawa<br>Atsuko Kinoshita | Advanced research technologies in different branches of biological sciences |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0645)<br>D (R0646) | Advanced Experimental Techniques in Biological Sciences 1 (Plant Environmental Responses) | D(R646) | Advanced Experimental Techniques in Biological Sciences 1 (Plant Environmental Responses) | 2 | Takeshi Kanegae<br>Rei Narikawa | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0647)<br>D (R0648) | Advanced Experimental Techniques in Biological Sciences 2 (Plant Environmental Responses) | D(R648) | Advanced Experimental Techniques in Biological Sciences 2 (Plant Environmental Responses) | 2 | Takeshi Kanegae<br>Rei Narikawa | Advanced research technologies in different branches of biological sciences |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0649)<br>D (R0650) | Advanced Experimental Techniques in Biological Sciences 1 (Cytogenetics) | D(R650) | Advanced Experimental Techniques in Biological Sciences 1 (Cytogenetics) | 2 | Takaomi Sakai<br>Tsunaki Asano<br>Satomi Takeo | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0651)<br>D (R0652) | Advanced Experimental Techniques in Biological Sciences 2 (Cytogenetics) | D(R652) | Advanced Experimental Techniques in Biological Sciences 2 (Cytogenetics) | 2 | Takaomi Sakai<br>Tsunaki Asano<br>Satomi Takeo | Advanced research technologies in different branches of biological sciences |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0653)<br>D (R0654) | Advanced Experimental Techniques in Biological Sciences 1 (Evolutionary Genetics) | D(R654) | Advanced Experimental Techniques in Biological Sciences 1 (Evolutionary Genetics) | 2 | Koichiro Tamura<br>Aya Takahashi<br>Masafumi Nozawa | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0655)<br>D (R0656) | Advanced Experimental Techniques in Biological Sciences 2 (Evolutionary Genetics) | D(R656) | Advanced Experimental Techniques in Biological Sciences 2 (Evolutionary Genetics) | 2 | Koichiro Tamura<br>Aya Takahashi<br>Masafumi Nozawa | Advanced research technologies in different branches of biological sciences |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0657)<br>D (R0658) | Advanced Experimental Techniques in Biological Sciences 1 (Molecular Genetics) | D(R658) | Advanced Experimental Techniques in Biological Sciences 1 (Molecular Genetics) | 2 | Jun-ichi Kato<br>Shigeki Ehira | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0659)<br>D (R0660) | Advanced Experimental Techniques in Biological Sciences 2 (Molecular Genetics) | D(R660) | Advanced Experimental Techniques in Biological Sciences 2 (Molecular Genetics) | 2 | Jun-ichi Kato<br>Shigeki Ehira | Advanced research technologies in different branches of biological sciences |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0661)<br>D (R0662) | Advanced Experimental Techniques in Biological Sciences 1 (Animal Ecology) | D(R662) | Advanced Experimental Techniques in Biological Sciences 1 (Animal Ecology) | 2 | Yasukazu Okada | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0663)<br>D (R0664) | Advanced Experimental Techniques in Biological Sciences 2 (Animal Ecology) | D(R664) | Advanced Experimental Techniques in Biological Sciences 2 (Animal Ecology) | 2 | Yasukazu Okada | Advanced research technologies in different branches of biological sciences |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0665)<br>D (R0666) | Advanced Experimental Techniques in Biological Sciences 1 (Plant Ecology) | D(R666) | Advanced Experimental Techniques in Biological Sciences 1 (Plant Ecology) | 2 | Jun-Ichirou Suzuki<br>Yuuya Tachiki | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0667)<br>D (R0668) | Advanced Experimental Techniques in Biological Sciences 2 (Plant Ecology) | D(R668) | Advanced Experimental Techniques in Biological Sciences 2 (Plant Ecology) | 2 | Jun-Ichirou Suzuki<br>Yuuya Tachiki | Advanced research technologies in different branches of biological sciences |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0673)<br>D (R0674) | Advanced Experimental Techniques in Biological Sciences 1 (Developmental Biology) | D(R674) | Advanced Experimental Techniques in Biological Sciences 1 (Developmental Biology) | 2 | Kimiko Fukuda<br>Naohito Takatori | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0675)<br>D (R0676) | Advanced Experimental Techniques in Biological Sciences 2 (Developmental Biology) | D(R676) | Advanced Experimental Techniques in Biological Sciences 2 (Developmental Biology) | 2 | Kimiko Fukuda<br>Naohito Takatori | Advanced research technologies in different branches of biological sciences |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0677)<br>D (R0678) | Advanced Experimental Techniques in Biological Sciences 1 (Systematic Zoology) | D(R678) | Advanced Experimental Techniques in Biological Sciences 1 (Systematic Zoology) | 2 | Katsuyuki Eguchi<br>Adam Cronin<br>Takahiro Yoshida | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0679)<br>D (R0680) | Advanced Experimental Techniques in Biological Sciences 2 (Systematic Zoology) | D(R680) | Advanced Experimental Techniques in Biological Sciences 2 (Systematic Zoology) | 2 | Katsuyuki Eguchi<br>Adam Cronin<br>Takahiro Yoshida | Advanced research technologies in different branches of biological sciences |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0681)<br>D (R0682) | Advanced Experimental Techniques in Biological Sciences 1 (Systematic Botany) | D(R682) | Advanced Experimental Techniques in Biological Sciences 1 (Systematic Botany) | 2 | Noriaki Murakami<br>Hidetoshi Kato | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0683)<br>D (R0684) | Advanced Experimental Techniques in Biological Sciences 2 (Systematic Botany) | D(R684) | Advanced Experimental Techniques in Biological Sciences 2 (Systematic Botany) | 2 | Noriaki Murakami<br>Hidetoshi Kato | Advanced research technologies in different branches of biological sciences |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0685)<br>D (R0686) | Advanced Experimental Techniques in Biological Sciences 1 (Environmental Microbiology) | D(R686) | Advanced Experimental Techniques in Biological Sciences 1 (Environmental Microbiology) | 2 | Shin Haruta | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0687)<br>D (R0688) | Advanced Experimental Techniques in Biological Sciences 2 (Environmental Microbiology) | D(R688) | Advanced Experimental Techniques in Biological Sciences 2 (Environmental Microbiology) | 2 | Shin Haruta | Advanced research technologies in different branches of biological sciences |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0689)<br>D (R0690) | Advanced Experimental Techniques in Biological Sciences 1 (Cellular Biochemistry) | D(R690) | Advanced Experimental Techniques in Biological Sciences 1 (Cellular Biochemistry) | 2 | Hiroyuki Kawahara<br>Naoto Yokota | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0691)<br>D (R0692) | Advanced Experimental Techniques in Biological Sciences 2 (Cellular Biochemistry) | D(R692) | Advanced Experimental Techniques in Biological Sciences 2 (Cellular Biochemistry) | 2 | Hiroyuki Kawahara<br>Naoto Yokota | Advanced research technologies in different branches of biological sciences |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0407)<br>D (R0408) | Advanced Experimental Techniques in Biological Sciences 1 (Stem Cell Modulation) | D (R408) | Advanced Experimental Techniques in Biological Sciences 1 (Stem Cell Modulation) | 2 | Takahiko Hara | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0409)<br>D (R0410) | Advanced Experimental Techniques in Biological Sciences 2 (Stem Cell Modulation) | D (R410) | Advanced Experimental Techniques in Biological Sciences 2 (Stem Cell Modulation) | 2 | Takahiko Hara | Advanced research technologies in different branches of biological sciences |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0741)<br>D (R0742) | Advanced Experimental Techniques in Biological Sciences 1 (Molecular Regulation of Aging) | D (R742) | Advanced Experimental Techniques in Biological Sciences 1 (Molecular Regulation of Aging) | 2 | Akihito Ishigami | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0743)<br>D (R0744) | Advanced Experimental Techniques in Biological Sciences 2 (Molecular Regulation of Aging) | D (R744) | Advanced Experimental Techniques in Biological Sciences 2 (Molecular Regulation of Aging) | 2 | Akihito Ishigami | Advanced research technologies in different branches of biological sciences |
| 56 | ○ | ○ | | First Semester | Thu. | 6, 7 | M(R0381)<br>D (R0382) | Advanced Experimental Techniques in Biological Sciences 1 (Chemical Biology) | D (R382) | Advanced Experimental Techniques in Biological Sciences 1 (Chemical Biology) | 2 | Yoshihiro Ito | Advanced research technologies in different branches of biological sciences |
| 57 | ○ | ○ | | Second Semester | Thu. | 6, 7 | M(R0387)<br>D (R0388) | Advanced Experimental Techniques in Biological Sciences 2 (Chemical Biology) | D (R388) | Advanced Experimental Techniques in Biological Sciences 2 (Chemical Biology) | 2 | Yoshihiro Ito | Advanced research technologies in different branches of biological sciences |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Lecture on Evolutionary Genetics | R0751 | - | - | 2nd | Thu | 1 | 2 |
| Doctoral program | Advanced Lecture on Evolutionary Genetics | R0752 | Advanced Lecture on Evolutionary Genetics | R752 | | | | |

| Instructor(s) | Note |
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| Tamura, Takahashi, and Nozawa | - |

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| (1) Course policies and topics | [Evolutionary biology from the view point of genetics] |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Concept of population genetics in understanding evolutionary processes. Molecular bases of ecological traits (Takahashi)<br>Concept of genome evolution and bioinformatics (Nozawa)<br>Concept of molecular evolution and molecular phylogeny (Tamura) |
| (3) Course schedule, subject matter, and classroom activities | 1. Molecular ecology and population genetics (Takahashi, 5 classes)<br>Learn about genetic mechanisms underlying ecological traits and stochastic processes of allele frequency changes in a population that are essential for understanding evolutionary processes. In particular, theoretical background in population genetics are discussed by introducing previously conducted studies.<br>2. Genome evolution and bioinformatics (Nozawa, 5 classes)<br>Genome evolution has been able to connect organismal evolution by rapid advancement in sequencing technology. Using this advancement, discuss about factors in genome evolution by using old and recent studies. Students are also expected to utilize the bioinformatics skill learned from this course in their own research topics.<br>3. Molecular evolution and molecular phylogeny (Tamura, 5 classes)<br>Understanding how DNA and genomes evolve is crucial to understand organismal evolution. Students are expected to understand the methods in molecular evolution and molecular phylogenetics to analyze empirical molecular sequence data and learn principle underlying the evolution of genes and genomes. |
| (4) Outside-class activities and assignments | Further reading the related subjects and prepare for presentation. |
| (5) Textbooks and course materials | Handouts will be distributed. |
| (6) Assessment and grading | Evaluation is based on presentations, short assignments, and final assignments. |
| (7) Questions to the instructor (Office hours, etc.) | If you have any questions, send an email to Tamura (ktamura@tmu.ac.jp), Takahashi (ayat@tmu.ac.jp), or Nozawa (manozawa@tmu.ac.jp) in advance to make an appointment. |
| (8) Special note | Students can take this course in English. Those who wish to take the course in English should contact the lecturers in advance. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Lecture on Ecology | R0753 | | | 1st | Tue. | 1 | 2 |
| Doctoral program | Advanced Lecture on Ecology | R0754 | Advanced Lecture on Ecology | R754 | | | | |

| Instructor(s) | Note |
|---|---|
| | Available in English. Please inquire in advance. |

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| (1) Course policies and topics | Learn advanced topics in current ecology and related fields. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | 1st to 8th lectures are focused on interdisciplinary area of population ecology, evolution, genetics and development. In lectures 9th to 15th, graduate students learn about applied ecology. |
| (3) Course schedule, subject matter, and classroom activities | 1-3: Population ecology and evolution<br>4-6: Eco-evolutionary feedbacks<br>7-8: How to read and write scientific papers<br>9-10: Theoretical backgrounds of conservation ecology<br>11-12: Research examples of conservation ecology<br>13-14: Urban ecology: its theory and examples<br>15: Biodiversity in cities |
| (4) Outside-class activities and assignments | The review and preparation for the lecture is required. Report assignment will be given in some topics. |
| (5) Textbooks and course materials | Handouts or PDF. References will be announced in lecture (for the course by YO).<br>Handouts will be provided through kibaco. (for the course by JS). |
| (6) Assessment and grading | Students will be assessed based on the average score of the first half by YO and the second half by JS.<br>Active involvement in lecture and argument, reports(for the course by YO). The course by JS will be assessed based on in-class contribution (15%), homework (35%) and an exam or essay (50%). |
| (7) Questions to the instructor (Office hours, etc.) | How to reach out to the instructors; students can make an appointment by email<br>1st-8th yasu_okada@tmu.ac.jp<br>9th-15th jsuzuki@tmu.ac.jp |
| (8) Special note | Students attending this course must have some knowledge in very basic math, basic ecology, basic genetics and/or evolutionary biology. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Lecture on Cell Biology | R0755 | | | | . | | |
| Doctoral program | Advanced Lecture on Cell Biology | R0756 | | | | | | |

| Instructor(s) | Note |
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| (1) Course policies and topics | The purpose of this course is to provide students with an understanding of the techniques used in cell biology research and the results obtained from such research. Example studies and the techniques used will be discussed and the literature will be reviewed. Students will consider what techniques can be used to study their chosen topic and present their ideas. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | First half: To understand the various regulatory mechanisms of light-responsive responses in plants and knowledge of research methods for such responses.<br>Second half: To understand the properties and functions of cyanobacterial photoreceptors and to acquire knowledge of their biochemical and spectroscopic methods. Students will also gain an understanding of examples of applied research on photoreceptors. |
| (3) Course schedule, subject matter, and classroom activities | First half (8 classes): Kanegae<br>1: Overview of light sensing in plants<br>2: Studies on red light-dependent response<br>3: Studies on blue light-dependent response<br>4: Light-dependent regulatory mechanisms<br>5: Transcriptional and post-transcriptional regulation<br>6: Plant light signaling research and related papers<br>7: General discussion<br>8: Summary of the first half<br>Second half (7 classes): Narikawa<br>9th: Overview of studies on light acclimation processes in cyanobacteria<br>10th: Diversity of photoreceptors in cyanobacteria<br>11th: Light perception mechanism of cyanobacteriochromes<br>12th: Light acclimation processes regulated by cyanobacteriochromes<br>13th: Application of cyanobacteriochromes to optogenetics<br>14th: Application of cyanobacteriochromes to fluorescent bioimaging<br>15th: Summary of the second half |
| (4) Outside-class activities and assignments | First half: Students should understand the lecture materials and papers, and actively contribute questions and comments.<br>Second half: Students should prepare for the next lecture and understand the meaning of technical terms. |
| (5) Textbooks and course materials | First half: Handouts and materials related to the major papers will be distributed.<br>Second half: Handouts and materials related to the major papers will be distributed. |
| (6) Assessment and grading | First half: Evaluation will be based on the report and class discussion.<br>Second half: Evaluation will be based on class participation and presentation content. |
| (7) Questions to the instructor (Office hours, etc.) | No specific office hours will be set, but if you wish to ask questions in person, please make an appointment in advance by e-mail. |
| (8) Special note | In principle, the class will be held in a face-to-face format. However, online lectures may be used in some cases due to Covid-19 infection or other reasons.<br>In such a case, the ID of the ZOOM conference room will be provided via kibaco or e-mail.<br>Available in English. Please inquire in advance. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Lecture on Taxonomy | M(R0757) | | | Second Semester | Fri. | 1 | 2 |
| Doctoral program | Advanced Lecture on Taxonomy | D(R0758) | Advanced Lecture on Taxonomy | D(R0758) | | | | |

| Instructor(s) | Note |
|---|---|
| Noriaki Murakami, Katsuyuki Eguchi | Phylogenetic evolution and diversity of plants and insects |

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| (1) Course policies and topics | Understand current research on plant and animal diversity and phylogenetic evolution through literature readings and presentations. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The goal of this course is to understand the perspectives, thoughts and approaches that researchers use to elucidate the factors, processes and mechanisms of phylogenetic evolution. |
| (3) Course schedule, subject matter, and classroom activities | Day 1 to 7 (Noriaki Murakami, Plant Systematics and Evolution)<br>Species is the most basic unit of systematics and has been considered to be a real unit in nature. However, it is very difficult to define what a species is. On the other hand, the process by which one species divides into two (speciation) is also considered to be a major process that generates biodiversity and is therefore important from an evolutionary perspective. This course is designed to deepen students' understanding of species and speciation by reading English review articles on species and speciation.<br><br>Day 8 to 15 (Katsuyuki Eguchi, Animal Systematics)<br>Students will deepen their understanding of the perspectives, thoughts and approaches that have been used to elucidate diversity and evolutionary processes of animals, by reading and introducing articles and literature on systematics and phylogeography of mainly terrestrial arthropods by themselves. |
| (4) Outside-class activities and assignments | Students are requested to read articles provided by lecturers or found by themselves and prepare presentation(s). In addition, it is necessary to deepen their understanding further by reviewing the presentation materials again after the lecture.<br><br>Students will be also required to submit a report on their presentation. |
| (5) Textbooks and course materials | The lecture will be based on the handouts distributed, and references (articles, books, etc.) will be introduced. |
| (6) Assessment and grading | Evaluation will be based on students' performance in the class and the contents of their presentation(s). |
| (7) Questions to the instructor (Office hours, etc.) | Office hours are not set, but if you wish to ask a question directly, please make an appointment in advance by e-mail (Murakami: nmurak[at]tmu.ac.jp, Eguchi: antist[at]tmu.ac.jp). |
| (8) Special note | Students are not required particularly to take other classes in advance.<br><br>Depending on the prevalence of COVID-19, the method of implementation and contents of this class may change. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special lecture on Cellular Communication | R0385 | - | - | 2nd A | Tue. | 1 | 1 |
| Doctoral program | Special lecture on Cellular Communication | R0386 | Special lecture on Cellular Communication | R0386 | | | | |

| Instructor(s) | Note |
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| Takaomi Sakai, Newly assigned instructor, Adam Weitemier | |

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| (1) Course policies and topics | Acquire up-to-date knowledge on varions cell communication pathway |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Understand the discoveries and methods of cutting-edge research on the mechanisms of information exchange in neurons and various cells. A basic understanding of neuroscience is assumed. |
| (3) Course schedule, subject matter, and classroom activities | 8 classes total<br><br>●Adam Weitemier (Lectures 1 - 4)<br>Delivered in English<br>Cellular communication in neurophysiological systems.<br><br>●Takaomi Sakai (Lectures 5 to 8)<br>Molecular genetics in learning & memory |
| (4) Outside-class activities and assignments | Preparation and review of the class |
| (5) Textbooks and course materials | Handouts and other materials will be distributed as appropriate. |
| (6) Assessment and grading | Grading is based on reports. |
| (7) Questions to the instructor (Office hours, etc.) | Questions may be submitted at any time by e-mail. |
| (8) Special note | - |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Biomolecules | R0383 | | | 1st II | Fri. | 2 | 1 |
| Doctoral program | Special Lecture on Biomolecules | R0384 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Prof. Takashi Okamoto, Prof. Hiroyuki Kawahara | |

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| (1) Course policies and topics | Mechanisms in protein metabolism and reproduction |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The first half focuses on the ubiquitin system, which is at the heart of intracellular protein metabolism, from its historical discovery to its biological functions (Kawahara). The second half focuses on the sexual reproduction (Okamoto). |
| (3) Course schedule, subject matter, and classroom activities | 1st-4th classes: From the historical discovery of the ubiquitin system to its biological functions.<br>5th -8th classes: The mechanism of sexual reproduction in organisms |
| (4) Outside-class activities and assignments | As an out-of-class study, it is recommended to review the content of each lecture and exercise after the lecture and to ask questions at the next lecture. |
| (5) Textbooks and course materials | Handouts and other materials will be distributed as appropriate. |
| (6) Assessment and grading | Evaluation is based on class participation and report or presentation content. |
| (7) Questions to the instructor (Office hours, etc.) | Questions will be addressed as needed by e-mail with scheduling.<br>Room 8-320, okamoto-takashi@tmu.ac.jp (Okamoto); Room 9-481b, hkawa@tmu.ac.jp (Kawahara) |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Developmental and Regenerative Biology | R0399 | | | 1st I | Fri. | 1 | 1 |
| Doctoral program | Special Lecture on Developmental and Regenerative Biology | R0400 | | | | | | |

| Instructor(s) | Note |
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| (1) Course policies and topics | Current Research in Developmental Biology<br>The goal of this course is to acquire basic knowledge of developmental biology, to develop the habit of reading papers critically, and to develop the ability to present papers accurately. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Develop the ability to read papers critically, present them accurately, and ask questions |
| (3) Course schedule, subject matter, and classroom activities | Students will read excellent papers on developmental biology, give a presentation on the paper, and discuss. All participants will be asked to speak during the presentation. |
| (4) Outside-class activities and assignments | Read and summarize papers outside of class. |
| (5) Textbooks and course materials | No specific textbook. Papers will be introduced as appropriate. |
| (6) Assessment and grading | Evaluation will focus on active participation, efforts, and attitude in class. |
| (7) Questions to the instructor (Office hours, etc.) | Please schedule appointment prior to visiting the lab.<br>takatori-naohito1[at]tmu.ac.jp |
| (8) Special note | The class may be offered in English in consultation with the student.<br>This class may be offered online in response to COVID-19. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Developmental and Regenerative Biology | R0399 | | | 1st I | Fri. | 1 | 1 |
| Doctoral program | Special Lecture on Developmental and Regenerative Biology | R0400 | | | | | | |

| Instructor(s) | Note |
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| (1) Course policies and topics | Current Research in Developmental Biology<br>The goal of this course is to acquire basic knowledge of developmental biology, to develop the habit of reading papers critically, and to develop the ability to present papers accurately. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Develop the ability to read papers critically, present them accurately, and ask questions |
| (3) Course schedule, subject matter, and classroom activities | Students will read excellent papers on developmental biology, give a presentation on the paper, and discuss. All participants will be asked to speak during the presentation. |
| (4) Outside-class activities and assignments | Read and summarize papers outside of class. |
| (5) Textbooks and course materials | No specific textbook. Papers will be introduced as appropriate. |
| (6) Assessment and grading | Evaluation will focus on active participation, efforts, and attitude in class. |
| (7) Questions to the instructor (Office hours, etc.) | Please schedule appointment prior to visiting the lab.<br>takatori-naohito1[at]tmu.ac.jp |
| (8) Special note | The class may be offered in English in consultation with the student.<br>This class may be offered online in response to COVID-19. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Cellular communication | R0375 | - | - | 2nd intensive | TBA. | 2,3,4, 5 | 1 |
| Doctoral program | Special Lecture on Cellular communication | R0376 | - | - | | | | |

| Instructor(s) | Note |
|---|---|
| Miho Terunuma | |

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| (1) Course policies and topics | DATE: to be announced<br>COURSE DESCRIPTION<br>This module covers a number of clearly identified disease processes from the clinical presentation of the disease to our understanding of the underlying anatomy, physiology, pathology, and therapies used in human. You will be introduced to the current thinking regarding the underlying cause of the diseases and how we can use scientific tools from genetics, molecular biology, and pharmacology to develop novel treatments. You will be required to think across disciplines in their quest to understand the mechanisms of the disease. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | COURSE OBJECTIVES:<br>At the end of the course, students should have basic theoretical knowledge of the topics covered in this course. |
| (3) Course schedule, subject matter, and classroom activities | TENTATIVE COURSE SCHEDULE:<br>1. Lecture 1: Diabetes 1<br>2. Lecture 2: Diabetes 2<br>3. Lecture 3: Microbiome in health and diseases<br>4. Group discussion 1<br>5. Group discussion 2<br>6. Preparation of News and Views<br>7. Preparation of the presentation<br>8. Presentation<br><br>FORMAT:<br>Selected scientific research paper will be provided before the course, then lectures on selected topics will be given to the students. After lecture, students will form small groups to discuss about the topics provided by the lecturer. Each student will prepare an approximately 1000 words News and Views style article from the scientific paper. Finally, each student will give a 10 minutes platform presentation that outlines their News and Views article with a small number of accompanying slides in the last day of the course.<br>Format of News and Views:<br>The goal of the essay should be to (1) Briefly cover the significant issues raise and settled by the paper; (2) How this fit into the previously existing framework of that field; and (3) How this might inform the next generation of studies in this area. |
| (4) Outside-class activities and assignments | OUT OF CLASS ACTIVITY REQUIREMENT:<br>Each student should read the research paper provided by the lecturer beforehand. |
| (5) Textbooks and course materials | MATERIALS:<br>Handouts may be given at the lectures. |
| (6) Assessment and grading | EVALUATION:<br>Class participation (50%)<br>Oral presentation (25%)<br>Short essay (25%) |
| (7) Questions to the instructor (Office hours, etc.) | HOW TO REACH OUT TO THE INSTRUCTOR:<br>Please email to mterunuma@dent.niigata-u.ac.jp |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Ecological Science | R0701 | | | 1st intensive | . | | |
| Doctoral program | Special Lecture on Ecological Science | R0702 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Jin Yoshimura | |

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| (1) Course policies and topics | "Frontier in Evolutionary Biology"<br>To reconstruct the evolutionary optimality based on the basic principle of caliculus (multiplication) and mathematical optimization. Especially, reconsider the mean fitness (biological common knowledge). |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In organisms, what kind of individuals do survive and leave offspring in future, avoiding extinction? We follow the simple calculus (multiplication) and show what is the best optimal strategy. This reveals that the applicability of the traditionally widely accepted concept "mean fitness" is limited to very narrow conditions, not applicable to the common observations of evolutionary phenomena. |
| (3) Course schedule, subject matter, and classroom activities | 1) Who survives over time: calculus of multiplication<br>2) Geometric mean fitness vs arithmetic mean fitness<br>3) Limited applicability of mean fitness and population genetics<br>4) Serious flaws in textbook of science and common sense: few examples<br>5) Example of evolutionary history: periodical cicadas<br>6) Evolution of life and numerous repetitions of geological extinction: building a new hypothesis<br>7) Epigenetics, new discovery against the evolutionary synthesis<br>8) Dynamic optimization: application to human (animal) behavior |
| (4) Outside-class activities and assignments | You should reconcile about the suggestions in the lectures in your own research projects. A report will be assigned after class. |
| (5) Textbooks and course materials | 参考書（in Japanese）：吉村仁著「強い者は生き残れない」新潮選書。<br>参考書（in Japanese）：吉村仁著「素数ゼミの謎」文藝春秋。<br>参考書（in Japanese）：吉村仁著「なぜ男は女より多く産まれるのかー絶滅回避の進化論」ちくまプリマー新書。 |
| (6) Assessment and grading | Grade is evaluated based on positive responses in lectures and a final report. |
| (7) Questions to the instructor (Office hours, etc.) | Email to Dr. Adam Cronin（adam.cronin@tmu.ac.jp） |
| (8) Special note | Check KIBACO or email for class dates. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Course in Biology Ⅱ (English for Biology) | R0421 | — | — | 1st Intensive | — | — | 2 |
| Doctoral program | Special Course in Biology Ⅱ (English for Biology) | R0422 | Special Course in Biology Ⅱ (English for Biology) | R422 | | | | |

| Instructor(s) | Note |
|---|---|
| Yuka Iijima* | |

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| (1) Course policies and topics | Speaking/Listening |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | This course will be a listening/speaking course in English for science students. Students will practice situations in which they may need to speak English in the future, such as when giving oral presentations at conferences, discussing their research with other scientists, attending lectures, or when visiting or working in laboratories overseas. Students will be shown how they can become more independent and autonomous learners of English. |
| (3) Course schedule, subject matter, and classroom activities | Basic scientific terms and expressions not usually covered in general English classes will be studied and practiced. The class will be conducted in English using an interactive workshop style for active listening and speaking practice. |
| (4) Outside-class activities and assignments | The homework will include preparing slides for oral presentations and preparing transcripts of spoken texts. |
| (5) Textbooks and course materials | Reference:<br>理系英語のライティング （野口ジュディー、アルク）<br>Judy先生の成功する理系英語プレゼンテーション（野口ジュディー・照井雅子・藤田清士著，講談社） |
| (6) Assessment and grading | Discussion: 25%<br>Listening dictation: 20%<br>Presentations: 35%<br>Portfolio: 20% |
| (7) Questions to the instructor (Office hours, etc.) | Through e-mail. |
| (8) Special note | The lecturer of this course is Yuka Iijima.<br>Students are required to bring notebook computers (which can access the Internet via WiFi) and earphones to class. Students should also have a Gmail account. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Course in Biology Ⅱ (English for Biology) | R0423 | — | — | 2nd Intensive | — | — | 2 |
| Doctoral program | Special Course in Biology Ⅱ (English for Biology) | R0424 | Special Course in Biology Ⅱ (English for Biology) | R424 | | | | |

| Instructor(s) | Note |
|---|---|
| Rena Nakamura* | |

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|---|---|
| (1) Course policies and topics | Writing |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In this course, students will learn how to write scientific empirical research articles (RAs) in English. |
| (3) Course schedule, subject matter, and classroom activities | This course is open to students who will be writing empirical RAs for academic journals, abstracts for international conferences or their dissertation, or are in the process of preparing to do so. In the course, students will analyze the structure and other features of empirical RAs in order to help improve their reading and writing skills for these articles. Students will also be writing on their own research. The class will be conducted in English. |
| (4) Outside-class activities and assignments | What to bring to the first class:<br>Bring electronic copies of three empirical RAs in the field of your study. These RAs must be written in English and have been published in well-respected peer-reviewed journals. If a student has done little or no research and cannot write about his/her research, he/she must also bring an electronic copy of a full-length Japanese RA in the field of his/her study. Both the English and Japanese RAs should consist of the following sections: Introduction, Methods/Procedure, Results, Discussion, and Conclusion. (Given that these are typical names of sections, names of the sections in RAs you select can deviate slightly from the above-mentioned section names) |
| (5) Textbooks and course materials | 理系英語のライティングVer. 2 野口ジュディー、深山晶子、村尾純子、浅野元子 著(発行： 株式会社 アルク) |
| (6) Assessment and grading | Active class participation: 30%<br>Short writing and other assignments: 40%<br>Final writing assignment: 30% |
| (7) Questions to the instructor (Office hours, etc.) | By e-mail. |
| (8) Special note | The lecturer for this course is Dr. Reina Nakamura.<br>Students are required to bring laptop computers (which can access the Internet via WiFi) to class.<br>Students are also expected to have their own Gmail accounts for file sharing purposes. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Course in Biology II (Communication in English) | R0425 | — | — | 1st | Mon | 4 | 2 |
| Doctoral program | Special Course in Biology II (Communication in English) | R0426 | Special Course in Biology II (Communication in English) | R426 | | | | |

| Instructor(s) | Note |
|---|---|
| Elizabeth Zielinska* | |

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|---|---|
| (1) Course policies and topics | Nature Talk I |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Outline:<br>This class aims to focus on topics selected by the students and relevant to their research programs. The facilitator will encourage participants to reflect, restate, rephrase, summarize, question, interpret, emphasize, and confront the topics and issues. She will also explain the relevant grammatical issues.<br>The focus of the week, an article from a scientific journal, will be selected by a volunteer student and delivered to the participants (e-mail, Kibaco, printout). The final written (open book) exam will conclude the classes at the end of the semester. The test might be conducted online. |
| (3) Course schedule, subject matter, and classroom activities | **Introduction.** Selection of articles dealing with:<br>**Biology of living organisms** – their structure, activities, distribution, space, and time.<br>**Biochemistry** – the application of chemistry to study biological processes at the cellular and molecular levels.<br>**Biodiversity** – talking about different kinds of life found in one area, e.g., animals, plants, fungi, and microorganisms.<br>**Cell Biology** – the study of cell structure and function.<br>**Developmental Biology** – an exploration of the process by which animals and plants grow and develop.<br>**Ecology** – we will try to understand the vital connections between plants, animals, and the world around them.<br>**Evolutionary Biology** – analysis of the evolutionary processes and patterns, especially concerning the diversity of organisms and how they change over time.<br>**Genetics** – we will seek to understand the patterns of inheritance of specific traits relating to genes and genetic information.<br>**Gene Science** – research dealing with understanding fundamental units of heredity.<br>**Genome Science** - looking into the science of an organism's complete set of genetic information.<br>**Molecular Biology** – the study of the molecular basis of biological activity.<br>**Neuroscience** – focusing on the brain and its impact on behavior and cognitive functions.<br>**Taxonomy** – how can we name, describe and classify organisms that include all the world's plants, animals, and microorganisms?<br>**Q & A**, a summary of the course. |
| (4) Outside-class activities and assignments | Article reading(s) is(are) scheduled as homework every week of the class. |
| (5) Textbooks and course materials | Prints will be given if needed. |
| (6) Assessment and grading | Class participation (10%), written exam (90%). |
| (7) Questions to the instructor (Office hours, etc.) | The lecturer of this course is Ms. Elizabeth Zielinska (eliedutm@tmu.ac.jp). You can contact the lecturer by e-mail. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Course in Biology II (Communication in English) | R0427 | — | — | 2nd | Mon | 3 | 2 |
| Doctoral program | Special Course in Biology II (Communication in English) | R0428 | Special Course in Biology II (Communication in English) | R428 | | | | |

| Instructor(s) | Note |
|---|---|
| Elizabeth Zielinska* | |

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| (1) Course policies and topics | How to Create a Persuasive Presentation |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Outline:<br>Fear of Public Speaking in English can sometimes be quite overpowering. This class aims to help you communicate better with fellow researchers and students by reducing the level of nervousness so that you can be better perceived and understood by other English speakers. At the same time, we will work on pronunciation – to smooth the delivery process and content – to make the presentation meaningful and persuasive. Finally, the participants will create and deliver final dynamic presentations.<br>As a facilitator, I hope you will enjoy the content, have fun, learn a lot, and I look forward to your attendance. In case of an emergency, classes will be conducted online using Zoom. |
| (3) Course schedule, subject matter, and classroom activities | Content:<br>How to start your presentation?<br>Body, posture, and personal space. Telling stories (homework).<br>Effective Presentations – required elements.<br>Language used in presentations/vowels and intonation. A story with a twist (homework).<br>Dealing with questions – emphases, rhythm, and stress in speaking.<br>Body language “Fake it till you make it.” Introducing the topic of your research (homework).<br>Six principles of a good presentation.<br>Online presentations – what to do and not to do. Presenting an experiment (homework/online).<br>Dress for presentations.<br>PechaKucha (20X20) and 3MT – how to time your delivery. Why is your research important? (homework).<br>Pester presentations at TMU and elsewhere Theory.<br>Poster presentation – practice.<br>Preparing a concise presentation on the topic of your research – 20 min delivery (homework).<br>Repeating, recapping, rephrasing, and active listening. Being persuasive.<br>Summary and conclusions. |
| (4) Outside-class activities and assignments | Some homework/short presentations (see above) will be required. |
| (5) Textbooks and course materials | Handouts will be uploaded to Kibaco, if necessary. |
| (6) Assessment and grading | Assessment:<br>Class participation (50%), Final presentation (50%). |
| (7) Questions to the instructor (Office hours, etc.) | The lecturer of this course is Ms. Elizabeth Zielinska (eliedutm@tmu.ac.jp). You can contact the lecturer by e-mail. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Course in Biology II (Communication in English) | R0429 | — | — | 2nd | Mon | 4 | 2 |
| Doctoral program | Special Course in Biology II (Communication in English) | R0430 | Special Course in Biology II (Communication in English) | R430 | | | | |

| Instructor(s) | Note |
|---|---|
| Elizabeth Zielinska* | |

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|---|---|
| (1) Course policies and topics | Nature Talk II |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Outline:<br>This class aims to focus on topics selected by the students and relevant to their research programs. The facilitator will encourage participants to reflect, restate, rephrase, summarize, question, interpret, emphasize, and confront the topics and issues. She will also explain the relevant grammatical issues.<br>The focus of the week, an article from a scientific journal, will be selected by a volunteer student and delivered to the participants (e-mail, Kibaco, printout). The final written (open book) exam will conclude the classes at the end of the semester. The test might be conducted online. |
| (3) Course schedule, subject matter, and classroom activities | **Introduction.** Selection of articles dealing with:<br>**Biology of living organisms** – their structure, activities, distribution, space, and time.<br>**Biochemistry** – the application of chemistry to study biological processes at the cellular and molecular levels.<br>**Biodiversity** – talking about different kinds of life found in one area, e.g., animals, plants, fungi, and microorganisms.<br>**Cell Biology** – the study of cell structure and function.<br>**Developmental Biology** – an exploration of the process by which animals and plants grow and develop.<br>**Ecology** – we will try to understand the vital connections between plants, animals, and the world around them.<br>**Evolutionary Biology** – analysis of the evolutionary processes and patterns, especially concerning the diversity of organisms and how they change over time.<br>**Genetics** – we will seek to understand the patterns of inheritance of specific traits relating to genes and genetic information.<br>**Gene Science** – research dealing with understanding fundamental units of heredity.<br>**Genome Science** - looking into the science of an organism's complete set of genetic information.<br>**Molecular Biology** – the study of the molecular basis of biological activity.<br>**Neuroscience** – focusing on the brain and its impact on behavior and cognitive functions.<br>**Taxonomy** – how can we name, describe and classify organisms that include all the world's plants, animals, and microorganisms?<br>**Q & A**, a summary of the course. |
| (4) Outside-class activities and assignments | Article reading(s) is(are) scheduled as homework every week of the class. |
| (5) Textbooks and course materials | Prints will be given if needed. |
| (6) Assessment and grading | Class participation (10%), written exam (90%). |
| (7) Questions to the instructor (Office hours, etc.) | The lecturer of this course is Ms. Elizabeth Zielinska (eliedutm@tmu.ac.jp). You can contact the lecturer by e-mail. |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Course in Biology I (Computer Practice: Basic) | R0439 | | | 1st intensive | .- | - | 1 |
| Doctoral program | Special Course in Biology I (Computer Practice: Basic) | R0440 | Special Course in Biology I (Computer Practice: Basic) | R440 | | | | |

| Instructor(s) | Note |
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| Tamura and Nozawa | On the first day, new students are encouraged to participate regardless of whether they register for the course or not. |

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| (1) Course policies and topics | The students taking this course can learn the network system to get information for study and research in Department of Biological Sciences. They will also learn the basics of large-scale sequencing data analysis, which has been rapidly advanced in recent years. The exercise will take the form of a two-day intensive course.<br>Day 1: Wednesday, April 12 2-5 periods (4 classes): 8-287 or 12-106<br>Day 2: Wednesday, April 19 2-5 periods (4 classes): 8-287 or 12-106<br>In the first session (Day 1), students will practice how to use TMU network system, such as the Biological Sciences Forum, TMUNER, and the Library Information System. Therefore, new students are encouraged to participate in the program even for students who do not register for this course.<br>Confirm the user ID and password for using our university system (TMUNER) by the starting time at Day 1. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | ・How to use computers as tools<br>・Basic knowledge on the handling of copyrights and security for using computers<br>・Basic knowledge on bioinformatics and related applications |
| (3) Course schedule, subject matter, and classroom activities | In this course, basics of bioinformatics and its related applications will be introduced for beginners, and the practice will be carried out with real sequence data. The schedule is as follows.<br>・Utilization of computers and networks (BioForum) for study and research in the Department of Biological Sciences<br>・Utilization of the campus network (TMUNER) and the Library Information Center<br>・Proper use of software, copyright, security management, etc.<br>・Utilization of the literature database<br>・Fundamentals of next-generation sequence data analysis<br>*If this exercise cannot be carried out as scheduled due to an inevitable reason, the date, place, and content of the exercise may be changed. In this case, you will be notified by "Biological Sciences Forum" (https://forum.biol.se.tmu.ac.jp/) or e-mail. Students who do not know how to use the Biological Sciences Forum or university e-mail should contact Tamura (ktamura @ tmu.ac.jp) by e-mail. |
| (4) Outside-class activities and assignments | ・Log on to TMUNER and verify your user ID and password in advance.<br>・Review the content of the exercise and address the issues. |
| (5) Textbooks and course materials | [Reference URLs]<br>Tokyo Metropolitan University Information Processing System (TMUNER)<br>http://www.comp.tmu.ac.jp/tmuner/<br>Biological Sciences Forum (BioForum)<br>https://forum.biol.se.tmu.ac.jp/<br>Tokyo Metropolitan University Library<br>http://www.lib.tmu.ac.jp/ |
| (6) Assessment and grading | Attitude (50%) and report (50%) |
| (7) Questions to the instructor (Office hours, etc.) | If you have any questions, please email Tamura (ktamura [at] tmu.ac.jp) or Nozawa (manozawa [at] tmu.ac.jp). |
| (8) Special note | Students can take this course in English. Those who wish to take the course in English should contact the lecturers in advance. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Course in Biology Ⅰ (Computer practice : advance) | R0441 | | | 1st II | Fri. | 1 | 1 |
| Doctoral program | Special Course in Biology Ⅰ (Computer practice : advance) | R0442 | | | | | | |

| Instructor(s) | Note |
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| (1) Course policies and topics | Computer practice: advance<br><br>This class will be offered in the second half of the first semester.<br>Students are required to have already completed " Computer practice: Basic" (first half of the first semester).<br>Students are expected to be familiar with basic computer operations and software such as Word and Excel, and to have a basic knowledge of statistics at the undergraduate level. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Computer applications in biology research<br>Basic programming and practical examples<br>Understanding of the basic structure of image data and its analysis<br>Understanding the necessity of bioinformatics |
| (3) Course schedule, subject matter, and classroom activities | In this exercise, students will be introduced to software commonly used in biological and life science research, and will practice advanced data analysis and statistical processing.<br>The contents are as follows.<br>Class 1 to 3 (Takatori) Image analysis using ImageJ: microscopy<br>Class 4 to 5 (Asada) Image analysis using ImageJ: electrophoresis gel<br>Class 6 to 8 (Fukuda) Practical techniques for presenting research using PowerPoint |
| (4) Outside-class activities and assignments | For image analysis using ImageJ, review the scope of the previous class and understand the meaning of technical terms, etc.<br>For practical techniques of research presentation using PowerPoint, students are to prepare and submit a PowerPoint presentation of their own research. |
| (5) Textbooks and course materials | Handouts and other materials will be distributed as necessary. |
| (6) Assessment and grading | Evaluation will be based on class participation (50%) and reports and other submissions (50%). |
| (7) Questions to the instructor (Office hours, etc.) | takatori-naohito1@tmu.ac.jp (Takatori)<br>a7203ki@tmu.ac.jp (Asada)<br>kokko@tmu.ac.jp (Fukuda) |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Biology Course in Planning and Management 1 | R0443 | — | — | 1st | Tue | 2 | 1 |
| Doctoral program | Biology Course in Planning and Management 1 | R0444 | Biology Course in Planning and Management 1 | R444 | | | | |

| Instructor(s) | Note |
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| Shin Haruta and All faculty member of Department of Biological Sciences | |

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| (1) Course policies and topics | (Course description)<br>Planning and Management Practicum<br>This course will support the voluntary and spontaneous activities by students.<br>Through the activities related to biological sciences, the course will enhance the development of basic skills in research and business. (Examples: outreach activity, planning of research meetings) |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | (Course objectives)<br>This course aims to help students acquire 'the ability to plan, implement, and evaluate' necessary to conduct research creatively. The course also aims to enable students to be actively involved in various fields as professional researchers, development planners, educators, and managers, and so on in the future. |
| (3) Course schedule, subject matter, and classroom activities | Students take the initiative in planning and implementing the following projects while mutually evaluating each other's work. The results of the project will be self- and mutually assessed for the next new project.<br>(1) Outreach activities, including visiting lectures/experiments and production of web content/brochures.<br>(2) Research introduction and study guidance/consultation for undergraduate and graduate students<br>(3) Organizing research meetings<br>(4) Other projects to enhance life science research<br>Students are expected to work in groups, with assistance from the lecturers as needed. Financial support for project implementation may be available. |
| (4) Outside-class activities and assignments | Out-of-class learning is necessary for preparing proposals/reports. |
| (5) Textbooks and course materials | (Reference)<br>Past reports can be available at https://www.biol.se.tmu.ac.jp/impgrad/outreach.html. |
| (6) Assessment and grading | Evaluation will be based on the proposal and report. The progress of the project may also be subject to evaluation. |
| (7) Questions to the instructor (Office hours, etc.) | Questions and consultations will be accepted at any time, both by e-mail and in person.<br>Contact: Shin Haruta (sharuta@tmu.ac.jp) Bldg. 8, Room 434 |
| (8) Special note | All graduate students in the Department of Biological Sciences are expected to participate. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Biology Course in Planning and Management 2 | R0445 | — | — | 2nd | Tue | 2 | 1 |
| Doctoral program | Biology Course in Planning and Management 2 | R0446 | Biology Course in Planning and Management 2 | R446 | | | | |

| Instructor(s) | Note |
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| Shin Haruta and All faculty member of Department of Biological Sciences | |

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| (1) Course policies and topics | (Course description)<br>Planning and Management Practicum<br>This course will support the voluntary and spontaneous activities by students.<br>Through the activities related to biological sciences, the course will enhance the development of basic skills in research and business. (Examples: outreach activity, planning of research meetings) |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | (Course objectives)<br>This course aims to help students acquire 'the ability to plan, implement, and evaluate' necessary to conduct research creatively. The course also aims to enable students to be actively involved in various fields as professional researchers, development planners, educators, and managers, and so on in the future. |
| (3) Course schedule, subject matter, and classroom activities | Students take the initiative in planning and implementing the following projects while mutually evaluating each other's work. The results of the project will be self- and mutually assessed for the next new project.<br>(1) Outreach activities, including visiting lectures/experiments and production of web content/brochures.<br>(2) Research introduction and study guidance/consultation for undergraduate and graduate students<br>(3) Organizing research meetings<br>(4) Other projects to enhance life science research<br>Students are expected to work in groups, with assistance from the lecturers as needed. Financial support for project implementation may be available. |
| (4) Outside-class activities and assignments | Out-of-class learning is necessary for preparing proposals/reports. |
| (5) Textbooks and course materials | (Reference)<br>Past reports can be available at https://www.biol.se.tmu.ac.jp/impgrad/outreach.html. |
| (6) Assessment and grading | Evaluation will be based on the proposal and report. The progress of the project may also be subject to evaluation. |
| (7) Questions to the instructor (Office hours, etc.) | Questions and consultations will be accepted at any time, both by e-mail and in person.<br>Contact: Shin Haruta (sharuta@tmu.ac.jp) Bldg. 8, Room 434 |
| (8) Special note | All graduate students in the Department of Biological Sciences are expected to participate. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Biology Course in International Research Experiences 1 | R0447 | — | — | 1st | Tue | 3 | 1 |
| Doctoral program | Biology Course in International Research Experiences 1 | R0448 | Biology Course in International Research Experiences 1 | R448 | | | | |

| Instructor(s) | Note |
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| Fukuda and All faculty member of Department of Biological Sciences | |

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|---|---|
| (1) Course policies and topics | Exercise for international leadership |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Exercise for international leadership |
| (3) Course schedule, subject matter, and classroom activities | Students plan events and lectures by themselves in order to acquire international leadership, and take them. It includes long term visits to overseas laboratories, invitation of overseas young researchers, and holding of international symposiums.<br>The integrated study period is over 30 hours regardless of class hours.<br>In the case that it is difficult to go abroad and to invite overseas researchers, the proposal of the event using the Internet is accepted. |
| (4) Outside-class activities and assignments | Many activities are conducted outside class hours. |
| (5) Textbooks and course materials | There are no regular texts, but they are provided on request. |
| (6) Assessment and grading | Evaluate in the activity report. |
| (7) Questions to the instructor (Office hours, etc.) | Student can contact the lecturer by e-mail (kokko@tmu.ac.jp). |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Biology Course in International Research Experiences 2 | R0449 | — | — | 2nd | Tue | 3 | 1 |
| Doctoral program | Biology Course in International Research Experiences 2 | R0450 | Biology Course in International Research Experiences 2 | R450 | | | | |

| Instructor(s) | Note |
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| Fukuda and All faculty member of Department of Biological Sciences | |

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|---|---|
| (1) Course policies and topics | Exercise for international leadership |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Exercise for international leadership |
| (3) Course schedule, subject matter, and classroom activities | Students plan events and lectures by themselves in order to acquire international leadership, and take them. It includes long term visits to overseas laboratories, invitation of overseas young researchers, and holding of international symposiums.<br>The integrated study period is over 30 hours regardless of class hours.<br>In the case that it is difficult to go abroad and to invite overseas researchers, the proposal of the event using the Internet is accepted. |
| (4) Outside-class activities and assignments | Many activities are conducted outside class hours. |
| (5) Textbooks and course materials | There are no regular texts, but they are provided on request. |
| (6) Assessment and grading | Evaluate in the activity report. |
| (7) Questions to the instructor (Office hours, etc.) | Student can contact the lecturer by e-mail (kokko@tmu.ac.jp). |
| (8) Special note | |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Biology Course in Research Evaluation 1 | R0451 | — | — | 1st | Wed | 1 | 1 |
| Doctoral program | Biology Course in Research Evaluation 1 | R0452 | Biology Course in Research Evaluation 1 | R452 | | | | |

| Instructor(s) | Note |
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| Suzuki and All faculty member of Department of Biological Sciences | |

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|---|---|
| (1) Course policies and topics | Research Evaluation Exercise 1 - Evaluating Research Proposals and Applications through critical reading of multiple applications and reports written by others, students learn how to formulate better research plans and applications. Students will also learn from the exercise how to critique logically and how to communicate such critiques. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Through this exercise, students will cultivate their ability to learn spontaneously, think logically, and communicate effectively. |
| (3) Course schedule, subject matter, and classroom activities | Using a research plan report, research report, or application form for a JSPS Postdoctoral Fellowship, students will prepare a research plan for their future tenure, present their plan, and mutually critique it. Afterwards, the students revise their applications, serve as referees for each other, and evaluate the applications of others. Furthermore, they will explain the results of their evaluation to the applicant along with the reasons for the evaluation. The results of the mutual evaluation are tabulated, discussed among the evaluators, and the applications are ranked. In some groups (see below), applications that are evaluated as meeting certain criteria will be granted travel expenses for research presentations after review and examination by the faculty. If you wish to receive a research travel grant, you must participate in all of the group's exercises. If you are going to be absent due to unavoidable circumstances, please contact Mr. Suzuki (associate) in advance.<br>The format of the exercises may be subject to change depending on the status of the covid-19 epidemic. Furthermore, if the conference is held online, travel expenses will not be reimbursed. |
| (4) Outside-class activities and assignments | Each group will be required to prepare and revise a research plan report, a research report, or an application for a JSPS Postdoctoral Fellowship as out-of-class learning. Therefore, at least 1.5 hours of preparation (preparation) and review (revision) are required. |
| (5) Textbooks and course materials | Before participating in this course, students whose first language is Japanese are strongly recommended to read 『理科系の作文技術』木下是雄（1981)中央公論新社（中公新書 (624). |
| (6) Assessment and grading | The evaluation will be based on the evaluation of applications mutually evaluated among the participants, taking attendance and comments into consideration. |
| (7) Questions to the instructor (Office hours, etc.) | If you have any questions, please email Suzuki at jsuzuki@tmu.ac.jp. |
| (8) Special note | Students can take this course in English. Those who wish to take the course in English should contact the class lecturers. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Biology Course in Research Evaluation 2 | R0453 | — | — | 2nd | Wed | 1 | 1 |
| Doctoral program | Biology Course in Research Evaluation 2 | R0454 | Biology Course in Research Evaluation 2 | R454 | | | | |

| Instructor(s) | Note |
|---|---|
| Suzuki and All faculty member of Department of Biological Sciences | |

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| (1) Course policies and topics | Research Evaluation Exercise 2 - Evaluation of Research Presentations<br>To understand what is a more understandable presentation through evaluation of others' research presentations, and to improve one's own presentation skills.. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Through this exercise, students will cultivate their ability to learn spontaneously, think logically, and communicate effectively. |
| (3) Course schedule, subject matter, and classroom activities | Attend conferences and research presentations as an audience, listen to multiple presentations, and evaluate their content. The results will be summarized in a report along with the rationale for the evaluation. Guidance on the key points of the evaluation will be given at KIBACO before the presentations. |
| (4) Outside-class activities and assignments | Evaluation reports must be prepared and submitted outside of class. |
| (5) Textbooks and course materials | Materials required for class will be distributed through KIBACO. |
| (6) Assessment and grading | Grading will be based on evaluation reports from conferences and presentations. |
| (7) Questions to the instructor (Office hours, etc.) | f you have any questions, please email Suzuki at jsuzuki@tmu.ac.jp. |
| (8) Special note | Students can take this course in English. Those who wish to take the course in English should contact the class lecturers. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Practice in Biological Sciences (Radioisotope Techniques) | R0455 | — | — | 1st Intensive | — | — | 1 |
| Doctoral program | Practice in Biological Sciences (Radioisotope Techniques) | R0456 | Practice in Biological Sciences (Radioisotope Techniques) | R456 | | | | |

| Instructor(s) | Note |
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| Okamoto, Saito and Asano | |

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| (1) Course policies and topics | This course is designed for graduate students who intend to use unsealed radioisotopes in their research for the first time, and provides them with basic techniques for the safe handling of radioactively labeled compounds in biological experiments. Please note that only those who have been certified as radiation workers are eligible for this course. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Acquire basic techniques for the safe handling of radiolabeled compounds (unsealed radioisotopes) in biological experiments. |
| (3) Course schedule, subject matter, and classroom activities | The following practical training will be conducted in late May or early June for three days (from 2nd period to 4th period) in an intensive format. The plan is to<br>1. basic techniques for safe handling of unsealed radioisotopes<br>2. basics of tracer experiments using radiolabeled compounds<br>3. analysis of protein biosynthesis using 35S (including analysis using an imaging analyzer)<br>4. analysis of protein phosphorylation reaction using 32P (including measurement by scintillation counter) (including)<br>In the event that this training cannot be conducted as scheduled due to a disaster or other reasons, the date, time, place, and content of the training (materials and equipment used in the training, etc.) may be changed. In such a case, the date, time, place, and contents of the training (e.g., materials and equipment used in the training) may be changed. |
| (4) Outside-class activities and assignments | The following practical training will be conducted in late May or early June for three days (from 2nd period to 4th period) in an intensive format. The plan is to<br>1. basic techniques for safe handling of unsealed radioisotopes<br>2. basics of tracer experiments using radiolabeled compounds<br>3. analysis of protein biosynthesis using 35S (including analysis using an imaging analyzer)<br>4. analysis of protein phosphorylation reaction using 32P (including measurement by scintillation counter) (including)<br>In the event that this training cannot be conducted as scheduled due to a disaster or other reasons, the date, time, place, and content of the training (materials and equipment used in the training, etc.) may be changed. In such a case, the date, time, place, and contents of the training (e.g., materials and equipment used in the training) may be changed. |
| (5) Textbooks and course materials | Textbooks and materials will be distributed. |
| (6) Assessment and grading | Evaluation will be based on class participation, experimental attitude, and reports. |
| (7) Questions to the instructor (Office hours, etc.) | Questions are always welcome via email.<br>tasaito@tmu.ac.jp<br>asano-tsunaki@tmu.ac.jp<br>okamoto-takashi@tmu.ac.jp |
| (8) Special note | Only those who are certified as radiation workers are eligible for this course. The number of students may be limited to ensure safety. In such cases, priority will be given to first-timers who have a clear plan to use radioisotopes. Please follow the instructions posted on the bulletin board.<br>Please apply for the course in advance.<br>Those who wish to take the course in English should contact the lecturers. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Seminar in Biological Sciences 1 | R0457 | — | — | 1st | Fri | 5 | 1 |
| Doctoral program | Special Seminar in Biological Sciences 1 | R0458 | Special Seminar in Biological Sciences 1 | R458 | | | | |

| Instructor(s) | Instructor(s) |
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| All faculty member of Department of Biological Sciences | |

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| (1) Course policies and topics | Latest Topics in Biological Sciences<br>As a seminar in the Department of Biological Sciences, faculty member and guest researchers will introduce their research. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In graduate studies, it is necessary to learn from many examples of cutting-edge research how the research was carried out. In addition, they need to learn about the cutting-edge knowledge, methods, and techniques contained in life science research in a variety of fields that cannot be obtained from textbooks, as well as the questions that need to be answered in the life sciences in the future. The goal is to learn the state-of-the-art in various fields through direct contact with and questioning of studies in order to master the expertise of the life sciences. |
| (3) Course schedule, subject matter, and classroom activities | Omnibus format will be used to teach the latest research in metabolic biology, microbiology, cell biology, plant ecology, plant environmental response, plant embryology, plant phylogenetics, and molecular neurobiology. |
| (4) Outside-class activities and assignments | Read the abstract of the research introduction in advance. |
| (5) Textbooks and course materials | No textbook will be provided. Necessary materials will be handed out in each class. |
| (6) Assessment and grading | Evaluation will be based on class participation and questions. |
| (7) Questions to the instructor (Office hours, etc.) | If you have any questions for the instructor, please contact Fukuda (kokko@tmu.ac.jp). |
| (8) Special note | This course is offered in Japanese.<br>Courses are offered in the first semester.<br>It is expected that graduate students in both the master's and doctoral programs will take this course each year. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Seminar in Biological Sciences 2 | R0459 | — | — | 2nd | Fri | 5 | 1 |
| Doctoral program | Special Seminar in Biological Sciences 2 | R0460 | Special Seminar in Biological Sciences 2 | R460 | | | | |
| Instructor(s) | | | Instructor(s) | | | | | |
| All faculty member of Department of Biological Sciences | | | | | | | | |

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| (1) Course policies and topics | Latest Topics in Biological Sciences<br>As a seminar in the Department of Biological Sciences, faculty member and guest researchers will introduce their research. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In graduate studies, it is necessary to learn from many examples of cutting-edge research how the research was carried out. In addition, they need to learn about the cutting-edge knowledge, methods, and techniques contained in life science research in a variety of fields that cannot be obtained from textbooks, as well as the questions that need to be answered in the life sciences in the future. The goal is to learn the state-of-the-art in various fields through direct contact with and questioning of studies in order to master the expertise of the life sciences. |
| (3) Course schedule, subject matter, and classroom activities | Omnibus format will be used to teach current research in behavioral neurology, microbial ecology, population genetics, animal ecology, environmental response of microorganisms, developmental biology, animal phylogenetics, and neurophysiology. |
| (4) Outside-class activities and assignments | Read the abstract of the research introduction in advance. |
| (5) Textbooks and course materials | No textbook will be provided. Necessary materials will be handed out in each class. |
| (6) Assessment and grading | Evaluation will be based on class participation and questions. |
| (7) Questions to the instructor (Office hours, etc.) | If you have any questions for the instructor, please contact Fukuda (kokko@tmu.ac.jp). |
| (8) Special note | This course is offered in Japanese.<br>Courses are offered in the second semester.<br>It is expected that graduate students in both the master's and doctoral programs will take this course each year. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Biological Sciences | R0715 | | | 2nd A. | Mon | 2 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0716 | Special Lecture on Biological Sciences | R716 | | | | |

| Instructor(s) | Note |
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| Adam Cronin | No online registration. A retake is not allowed for students who took this course in the undergraduate program. The approval of the Academic Affairs Committee of the Graduate School is required. Special Lecture in Evolutionary Biology 1: Course in English |

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| (1) Course policies and topics | Many organisms live together in groups, and group-living conveys a wide range of benefits. Coordination of actions in group-living organisms represents a complex challenge, yet group-living species manage to achieve remarkable tasks, such as building complex structures, coordinated movements over long distances, and advanced decision making. Explaining how this is achieved is the focus of complex systems biology. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In this course we will explore how individuals in groups can coordinate activities to produce outcomes far exceeding that which any individual could do alone. In many cases these tasks are achieved with no distinct leadership or top-down control, but via interactions at the local level, which produce emergent phenomena at the level of the group. Studies of collective behavior are important for understanding diverse phenomena such as movements of human crowds, telecommunication networks, and the development of artificial swarm intelligence. |
| (3) Course schedule, subject matter, and classroom activities | 1. Group living<br>2. Group formation<br>3. Information<br>4. Feedback<br>5. Organisation<br>6. Decision making<br>7. Composition<br>8. Presentations/discussion |
| (4) Outside-class activities and assignments | Students will be given occasional tasks to perform outside of class during the semester and are expected to do research related to their selected project theme throughout the course. |
| (5) Textbooks and course materials | Collective Animal Behaviour (2010) by David J. T. Sumpter (ISBN: 9780691148434). Other relevant literature will be presented and discussed in class. |
| (6) Assessment and grading | Assessment will be based on a written assignment based on one or more components of the course and in-class presentations. Presentations will employ TMU's COIL (Collaborative Online International Learning) platform where possible. |
| (7) Questions to the instructor (Office hours, etc.) | There are not set office hours: please visit my office if you have any questions or send queries by email. |
| (8) Special note | This course will be conducted in English. Students should prepare all materials in English and will have the opportunity to discuss among themselves and with the general class in English. This class is for graduates of other universities. The permission of curriculum coordinator is required for the registration. Discuss with your supervisor and class teachers in advance. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Biological Sciences | R0709 | | | 2nd I | Tue. | 1 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0710 | | | | | | |

| Instructor(s) | Note |
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| (1) Course policies and topics | Course description: We will discuss cellular mechanisms of germ layer fate separation during early embryogenesis. Recent discoveries related to asymmetric cell division and cell polarization will be discussed. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Course objectives:<br>Students will learn how to read, understand and interpret resent research results related to embryogenesis. Students will also learn how to formulate research ideas and crystalize original questions through dialectical methods (General ability of problem thinking, Active learning attitude). Students will be encouraged to logically discuss those questions in class (Logical thinking ability). By the end of the course, students will also acquire basic knowledge on germ layer fate separation, asymmetric cell division and polarization of cells. |
| (3) Course schedule, subject matter, and classroom activities | 1. A brief history of Developmental Biology and its essential goals<br>2. Fate specification during embryonic development<br>3. Cell differentiation and asymmetric cell division<br>4. Cell differentiation and gene expression<br>5. Microscopy in developmental biology<br>6. Cell polarization in embryogenesis<br>7. Cell deformation and fate separation<br>8. Summary and final review |
| (4) Outside-class activities and assignments | Reading materials will be assigned every week. |
| (5) Textbooks and course materials | Text: Will be provided by the instructor. |
| (6) Assessment and grading | Assessment: Students will be assessed by their contribution to discussions during class and final test. |
| (7) Questions to the instructor (Office hours, etc.) | Questions can be posted via KIBACO. Office hours; by appointment through e-mail |
| (8) Special note | A basic understanding of cell biology is required. Students will be required to participate in discussions during class. Students who do not yet possess sufficient command of the English language may need to improve their English language skills. For questions regarding class and English proficiency, contact the instructor before registration.<br><br>This course may be delivered online due to COVID-19. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Biological Sciences | R0707 | | | 2nd I | Tue | 1 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0708 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Kanae Ando | |

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|---|---|
| (1) Course policies and topics | COURSE TITLE: Age-related neurodegenerative diseases<br>COURSE DESCRIPTION:<br>Our society is aging, and the number of patients with age-associated diseases is growing. Recent studies revealed that accumulation of misfolded proteins may underlie the pathogenesis of many age-related neurological diseases such as Alzheimer's disease. We will discuss current understanding of molecular mechanisms underlying these diseases and therapeutic strategies.<br>COURSE DESCRIPTION<br>This module covers a number of clearly identified disease processes from the clinical presentation of the disease to our understanding of the underlying anatomy, physiology, pathology, and therapies used in human. You will be introduced to the current thinking regarding the underlying cause of the diseases and how we can use scientific tools from genetics, molecular biology, and pharmacology to develop novel treatments. You will be required to think across disciplines in their quest to understand the mechanisms of the disease. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | COURSE OBJECTIVES:<br>This course aims to introduce current knowledge underlying the pathogenesis of age-related neurodegenerative diseases. The format of this course is a combination of didactic lectures and student presentation. Lectures will introduce concepts, and student presentation followed by discussion will promote an understanding of analytical approaches to questions in neuroscience as well as critical scientific thinking. |
| (3) Course schedule, subject matter, and classroom activities | TENTATIVE COURSE SCHEDULE:<br>Special lecture in biology: Age-related neurodegenerative diseases<br>1. Introduction<br>2. Alzheimer's disease (lecture)<br>3. Alzheimer's disease (student presentation)<br>4. Parkinson's disease (lecture)<br>5. Parkinson's disease (student presentation)<br>6. Amyotrophic lateral sclerosis (lecture)<br>7. Amyotrophic lateral sclerosis (student presentation)<br>8. Review & discussion |
| (4) Outside-class activities and assignments | OUT OF CLASS ACTIVITY REQUIREMENT:<br>Students will be asked to read recent articles from scientific journals and prepare for presentation. |
| (5) Textbooks and course materials | TEXTBOOKS: Reading materials including primary literature will be distributed in the class.<br>In terms of learning the facts about each specific topic, the textbook,<br>'Bear, Mark F., Barry W. Connors, and Michael A. Paradiso. Neuroscience: Exploring the Brain, 3rd ed. Lippincott Williams & Wilkins, 2006. ISBN: 9780781760034' should be your basic study guide. |
| (6) Assessment and grading | EVALUATION:<br>In-class activities 30%, Presentation 30%, Final report 40% |
| (7) Questions to the instructor (Office hours, etc.) | HOW TO REACH OUT TO THE INSTRUCTOR:<br>Please email to k_ando@tmu.ac.jp |
| (8) Special note | This course is open to the students who completed an undergraduate program in the universities other than TMU and are not fluent in Japanese.<br>Talk to your supervisors if this course is appropriate for you.<br>To register, submit a course registration request form to the program organizer. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Biological Sciences | R0721 | | | 2nd I | Wed | 1 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0722 | | | | | | |

| Instructor(s) | Note |
|---|---|
| Kanae Ando | |

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|---|---|
| (1) Course policies and topics | THEME: Brain development and neurodevelopmental disorders<br>INSTRUCTOR: Kanae Ando<br><br>COURSE DESCRIPTION:<br>The human brain is made of the billions of cells and trillions of connections and said to be the most complex object in our known universe. This course aims to introduce molecular and cellular mechanisms underlying the development of the nervous system and neurodevelopmental disorders. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | COURSE OBJECTIVES:<br>This course aims to encourage students to distill and synthesize the information you learn in cell biology, molecular biology and neuroscience, through discussion of current knowledge underlying the development of the brain and neurodevelopmental disorders such as spectrum disorder. The format of this course is a combination of didactic lectures and student presentation. Lectures will introduce concepts, and student presentation followed by discussion will promote an understanding of analytical approaches to questions in neuroscience as well as critical scientific thinking. |
| (3) Course schedule, subject matter, and classroom activities | TENTATIVE COURSE OUTLINE:<br>Development of Nervous System and Related Disorders<br>1. Introduction: The genesis of neurons and connection<br>2. Polarity and segmentation (lecture)<br>3. Polarity and segmentation (student presentation)<br>4. Genesis and migration (lecture)<br>5. Genesis and migration (student presentation)<br>6. Determination and differentiation<br>7. Determination and differentiation (student presentation)<br>8. Review and discussion |
| (4) Outside-class activities and assignments | OUT OF CLASS ACTIVITY REQUIREMENT:<br>Students will be asked to read journal articles and prepare for presentation. |
| (5) Textbooks and course materials | TEXTBOOKS:<br>Reading materials including primary literature will be distributed in the class.<br>In terms of learning the facts about each specific topic, the textbook,<br>'Bear, Mark F., Barry W. Connors, and Michael A. Paradiso. Neuroscience: Exploring the Brain,<br>3rd ed. Lippincott Williams & Wilkins, 2006. ISBN: 9780781760034' should be your basic study guide. |
| (6) Assessment and grading | EVALUATION:<br>In-class activities 30%, Presentation 30%, Final exam 40% |
| (7) Questions to the instructor (Office hours, etc.) | HOW TO REACH OUT TO THE INSTRUCTOR<br>Office hour: Wednesday afternoon, 1-2:30pm. Or, e-mail to k_ando@tmu.ac.jp for an appointment. |
| (8) Special note | This course is open to the students who completed an undergraduate program in the universities other than TMU and are not fluent in Japanese.<br>Talk to your supervisors if this course is appropriate for you.<br>To register, submit a course registration request form to the program organizer. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Biological Sciences | R0717 | - | - | 2nd A | Wed. | 2 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0718 | Special Lecture on Biological Sciences | R718 | | | | |

| Instructor(s) | Note |
|---|---|
| Nozawa and Murakami | Common lecture for undergrads |

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|---|---|
| (1) Course policies and topics | Various topics on evolutionary biology (species diversification, evolution of sex, etc.) |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | First half (Masafumi Nozawa): Mutation is an ultimate source of organismal evolution. Therefore, understanding of molecular and genetic bases of evolution is crucial. In this lecture, the topics on evolution of sex and sex chromosomes will be extensively introduced. Students are expected to understand how evolution has occurred at the molecular level in the long run and to feel enthusiasm how researchers have set questions to be solved and how they have overcome the difficulties during their researches.<br>Second half (Noriaki Murakami): Speciation are the processes of species diversification. Based on the recent studies, the various processes of species diversification and the models of speciation are explained. Students are expected to explain their interesting view points of species and speciation in some specific taxonomic groups. |
| (3) Course schedule, subject matter, and classroom activities | First half: Masafumi Nozawa<br>1. Degeneration of Y chromosome and dosage compensation<br>2. Histone modifications on sex chromosomes and loss of Y chromosome<br>3. Toxicity of Y chromosome and B chromosome<br>4. Sex-chromosome turnover and sex-ratio distortion<br><br>Second half: Noriaki Murakami<br>5. Species and speciation<br>6. Reproductive isolation and speciation<br>7. Ecological speciation<br>8. Reticulate speciation |
| (4) Outside-class activities and assignments | Homework assignments will be given several times. |
| (5) Textbooks and course materials | Handouts will be distributed. |
| (6) Assessment and grading | First half: Response to questions and discussions 20%, Report quality 30%<br>Second half: Response to questions and discussions 10%, Report quality 40% |
| (7) Questions to the instructor (Office hours, etc.) | There is no particular office hour. If you have any questions, send an email to Masafumi Nozawa (manozawa[at]tmu.ac.jp) or Noriaki Murakami (nmurak[at]tmu.ac.jp）. |
| (8) Special note | [Note for graduate students] This course is for the graduate students who graduated from other universities. Permission from the committee on general affairs (Prof. Kimiko Fukuda) is required for course registration. Consult with your supervisor and the lecturers of this course (Prof. Nozawa or Prof. Murakami) in advance. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Biological Sciences | R0711 | — | — | 2nd I | Thr | 1 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0712 | Special Lecture on Biological Sciences | R712 | | | | |

| Instructor(s) | Note |
|---|---|
| Suzuki and Okada | This course is a common course with the undergraduate program. |

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|---|---|
| (1) Course policies and topics | Title<br>Special lecture in Ecology<br>Course Description<br>This course is an advanced and specific introduction to ecology. Students will be introduced to the concepts and theories that lead good research questions, and the methods that are used to answer ecological questions. This course explores topics such as population ecology, evolutionary ecology, experimental ecology, behaviour ecology and reproductive ecology . Both animal and plant systems will be considered.<br>Instructor; Dr. Yasukazu Okada (yasu_okada@tmu.ac.jp) and Dr. Jun-Ichirou Suzuki (jsuzuki@tmu.ac.jp) |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Objectives<br>Students completing this course will be able to;<br>approach natural phenomena with ecological methods, and ask effective questions on ecological aspects. |
| (3) Course schedule, subject matter, and classroom activities | Course Schedule<br>1. Evolution and diversity of life history (YO)<br>2. Sexual selection and sexual dimorphism (YO)<br>3. Behavior: innate or learned behavior ? (YO)<br>4. Intra- and inter-specific interactions (YO)<br>5. Physiological integration in clonal plants (by JS)<br>6. Self-thinning in clonal plants (by JS)<br>7. Performance of clonal plants under heterogeneous environments (by JS)<br>8. Sexual reproduction and genetic structure in populations of clonal plants (by JS)<br>9. exam |
| (4) Outside-class activities and assignments | Out-of-class activities<br>Students will be given homework (ca. A4, 1page) after each class by JS. |
| (5) Textbooks and course materials | Textbook and required supplies<br>supplies; handouts will be provided through kibaco. (for the course by JS)<br>Referenced text books (YO): An Introduction to Behavioural Ecology, (Davies NB, Krebs JR & West SA, Wiley)[日本語版：デイビス・クレブス・ウェスト行動生態学 原著第4版（共立出版）], Ecological Developmental Biology (Gilbert S & Epel S, Oxford University Press)[日本語版：生態進化発生学（東海大学出版会）], シリーズ 現代の生態学(日本生態学会編，共立出版） 第5巻「行動生態学」，第7巻「エコゲノミクス」 |
| (6) Assessment and grading | Assessment<br>Students will be assessed based on the average score of the first half by YO and the second half by JS.<br>The course by YO will be assessed by activity and contribution in lectures (40%), exams (30%), and reports (30%).<br>The course by JS will be assessed based on in-class contribution (15%), homework (35%) and an exam or essay (50%). |
| (7) Questions to the instructor (Office hours, etc.) | How to reach out to the instructors;<br>Students can make an appointment by email (jsuzuki@tmu.ac.jp).<br>You can contact YO any time by email (yasu_okada@tmu.ac.jp) |
| (8) Special note | Notes and prerequisites<br>Students attending this course must have some knowledge in very basic math, basic ecology, basic genetics and/or evolutionary biology.<br>The prerequisite for the course is General Biology IB, General Biology IIB, General Ecology and Ecology at TMU.<br>If you are an exchange student staying for this semester, contact the instructor in advance.<br>This course is open to the students who completed an undergraduate<br>program in the universities other than TMU and are not fluent in Japanese.<br>Talk to your supervisors if this course is appropriate for you.<br>To register, submit a course registration request form to the program<br>organizer, Dr. Kimiko Fukuda. This course is offered in Japanese in an even number of academic years. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Biological Sciences | R0733 | | | 2nd A | Fri. | 1 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0734 | Special Lecture on Biological Sciences | R734 | | | | |

| Instructor(s) | Note |
|---|---|
| Adam Weitemier | No online registration. A retake is not allowed for students who took this course in the undergraduate program. The approval of the Academic Affairs Committee of the Graduate School is required.Special Lecture in Physiology: Course in English |

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|---|---|
| (1) Course policies and topics | Special lecture in Neurobiology<br>Category: Specialized Subjects Credit: 1<br>Instructor: Adam Weitemier<br>Subtitle: Neurobiology of the locus coeruleus norepinephrine system<br>［Course Description］<br>The locus coeruleus (the “blue spot”) is a small nucleus on either side of the vertebrate hindbrain. Its primary neurotransmitter is norepinephrine (NE). Through extensive neuronal projections, NE output from the locus coeruleus influences fundamental bodily functions, emotional responses, and cognition. Although the locus coeruleus NE system is the longest and most well-studied neuronal system, current research continues to make new discoveries about its role in brain function and behavior.<br>This course will take a student-interactive approach to explore fundamental and current knowledge about the locus coeruleus NE system. We will consider current topics and future questions through the lens of recent studies that are conducted from different biological perspectives. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | ［Objectives ］<br>Students taking this course will gain an understanding and perspective on the importance of NE (and related systems) in physiology and behavior. They will be able to use the knowledge that they gain in this course to guide future learning about the diversity of brain function. |
| (3) Course schedule, subject matter, and classroom activities | ［Tentative Course Schedule］<br>1. Introduction – Neuroanatomy basics<br>2. NE System Physiology and Measurement<br>3. Pharmacology – In-class Activity; Reading Homework<br>4. Behavioral Modulation<br>5. NE in Memory and Cognition; quiz<br>6. Human applications; Theories on NE Function<br>7. Student Presentation preparation<br>8. Student presentation |
| (4) Outside-class activities and assignments | ［Our of Class Activity Requirement］<br>Students will be asked to read or search for articles from scientific journals and prepare for presentations. |
| (5) Textbooks and course materials | ［Textbooks/Materials］<br>Research articles and supplementary readings will be distributed throughout the course. General background on these topics may be found in the textbook.<br>‘Bear, Mark F., Barry W. Connors, and Michael A. Paradiso. Neuroscience: Exploring the Brain, 3rd ed. Lippincott Williams & Wilkins, 2006. ISBN: 9780781760034’ - This book may be checked out from the English Mini Library, room 8-246. |
| (6) Assessment and grading | ［Assessment］<br>Class participation 50%, Assigned Work 20%, Presentation 30% |
| (7) Questions to the instructor (Office hours, etc.) | ［Contact］<br>Available for questions/comments via KIBACO online system.<br>E-mail to aweitem@tmu.ac.jp for questions or an appointment. |
| (8) Special note | ［Other Information］<br>This class is for graduates of universities other than TMU. The permission of curriculum coordinator is required for the registration. Discuss with your supervisor and class teachers in advance.<br>Previous knowledge in basic neuroscience or physiology will be helpful.<br>This course invites participation from all students and honors student diversity and different points of view. Active participation in the class is essential. This course is offered in English. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special lecture on Biological Sciences | R0713 | - | - | 2nd I | Fri | 2 | 1 |
| Doctoral program | Special lecture on Biological Sciences | R0714 | Special lecture on Biological Sciences | R0714 | | | | |

| Instructor(s) | Note |
|---|---|
| T. Sakai, T. Okamoto | |

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|---|---|
| (1) Course policies and topics | Molecular and cellular mechanisms of biological processes. This lecture will be taught by Prof. Takaomi Sakai (Part1), Prof. Takashi Okamoto (Part 2) |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | 【Part 1】<br>This lecture will provide opportunities to learn how to use genetics to understand mechanisms of complex biological processes, such as development, aging, cancer, learning and memory.<br>【Part 2】<br>In the later half, students will understand the reproductive and developmental aspects in plants. In addition to these basic aspects in plant sciences, applied usage the plant reproductive/developmental mechanisms will be also learned. |
| (3) Course schedule, subject matter, and classroom activities | 【Part 1】<br>1. Associative learning and behavioral plasticity<br>2. Learning and memory in Drosophila<br>3. Molecullar and cellular mechanisms of Long-term memory 1<br>4. Molecullar and cellular mechanisms of Long-term memory 2<br><br>【Part 2】<br>5. Fertilization in plants I (Self-incompatibility and pollen tube elongation)<br>6. Fertilization in plants II (Pollen tube guidance and gamete fusion)<br>7. Embryogenesis in plants (Zygotic activation and development)<br>8. Plant reproduction and breeding |
| (4) Outside-class activities and assignments | You should review the last lecture every week. |
| (5) Textbooks and course materials | Handouts will be distributed to students through KIBACO. |
| (6) Assessment and grading | Presentation and discussion 30%, Quiz or Report submission 30%, Midterm and final examinations 40%. |
| (7) Questions to the instructor (Office hours, etc.) | Particular office hour is not allocated, but students can make appointments by e-mail. |
| (8) Special note | This course is provided for students who have not graduated from Tokyo Metropolitan University. Permission of the curriculum coordinator (Dr. Fukuda) is necessary for the registration. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Biological Sciences | R0725 | — | — | 1st Intensive | Aug 14, 15, 17, 18 | — | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0726 | — | — | | | | |

| Instructor(s) | Note |
|---|---|
| Florian Reyda * | This course is open for both graduate and undergraduate programs. |

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|---|---|
| (1) Course policies and topics | Course title: Parasitology<br>Lecturer: Florian Reyda<br>Class Location: TBA<br>Aug 14, 15, 17, & 18 (14&15: R0725/R0726, 17&18: R0727/R0728. Please register both.)<br>Times: 8:50-10:20; 10:30-noon; 13:00-14:30; 14:40-16:10, F-M-T-W<br>[Course description]<br>This course will focus on the biology, life cycles, and identification of protozoan and animal parasites of humans and other animals. Emphasis will be placed on groups of particular medical and/or economic importance and/or local significance. This course will consist both of lectures and laboratory exercises involving examination of parasite specimens using compound light microscopy. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The overall goal of this course is for students to gain an introductory knowledge of parasitology:<br>Upon completion of this course students should be able to:<br>1. To discuss the biology of parasitic animals, with emphasis on the major protozoan and metazoan parasite groups.<br>2. To articulate several problems and aspects of the parasitic relationship.<br>3. To describe the diversity and ubiquitous distribution of animal parasites.<br>4. To describe the impact of parasitism on human welfare.<br>5. To employ observational skills in the laboratory, in particular with the microscope.<br>6. To be able to obtain parasites by performing dissections on fish hosts. |
| (3) Course schedule, subject matter, and classroom activities | Tentative schedule R0725/R0726<br><br>Monday Aug 14, 2023<br>08:50-10:20 (Lecture) Introduction of professor and students, Lecture 1A on terminology, significance of parasitism, amoebas, Giardia<br>10:30-12:00 (Lab) Lab1A on amoebas and Giardia<br>13:00-14:30 (Lecture) Lecture 1 on trypanosomes (Trypanosoma), and Leishmania<br>14:40-16:10 (Lab) Lab1B Trypanosomes and kins<br><br>Tuesday Aug 15, 2023<br>08:50-10:20 (Lecture) Quiz covering day1 contents; Lecture 2A on Malaria (Plasmodium), Cryptosporidium and Toxoplasma<br>10:30-12:00 (Lab) Lab2A Apicomplexans including Plasmodium and malaria<br>13:00-14:30 (Lecture) Lecture 2B on Platyhelminthes, liver, lung and blood flukes<br>14:40-16:10 (Lab) Lab2B exercise on Platyhelminthes, liver, lung and blood flukes<br><br>Discussion on research paper: 2 Sessions and Ruth 1990 frog deformities<br>Time to be determined |
| (4) Outside-class activities and assignments | [Out of class activity requirement]<br>Students should study content at the end of each day in order to be ready for the exam that that will take place the following morning. |
| (5) Textbooks and course materials | [Textbooks/Materials]<br>There is no required textbook but each of the labs contains reference information and reference images. I will also provide outside reading materials. Students should bring blank sheets of paper and a pencil for laboratory exercises. |
| (6) Assessment and grading | [Assessment]<br>Students will be graded on attendance, daily exams, completion of laboratory exercises (both questions and drawings), 1-paragraph summaries of research articles, and participation in in-class discussions. |
| (7) Questions to the instructor (Office hours, etc.) | [Office hour]<br>I will be available in person during each of the course meetings, and always responsive to e-mail queries. For more information, please contact Dr. Kanae Ando (k_ando@tmu.ac.jp). |

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| (8) Special note | Please note that this course MUST be taken in conjunction with R0727/R0728. R0725/R0726 is the first half (day 1 and 2) and R0727/R0728 is the second half (day 3 and 4).<br><br>This course is open to the students who completed an undergraduate program in the universities other than TMU and are not fluent in Japanese.Talk to your supervisors if this course is appropriate for you.To register, submit a course registration request form to the program organizer.<br>For questions, please email to Dr. Kanae Ando (k_ando@tmu.ac.jp). |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Biological Sciences | R0725 | — | — | 1st Intensive | Aug 14, 15, 17, 18 | — | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0726 | — | — | | | | |

| Instructor(s) | Note |
|---|---|
| Florian Reyda * | This course is open for both graduate and undergraduate programs. |

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|---|---|
| (1) Course policies and topics | Course title: Parasitology<br>Lecturer: Florian Reyda<br>Class Location: TBA<br>Aug 14, 15, 17, & 18 (14&15: R0725/R0726, 17&18: R0727/R0728. Please register both.)<br>Times: 8:50-10:20; 10:30-noon; 13:00-14:30; 14:40-16:10, F-M-T-W<br>[Course description]<br>This course will focus on the biology, life cycles, and identification of protozoan and animal parasites of humans and other animals. Emphasis will be placed on groups of particular medical and/or economic importance and/or local significance. This course will consist both of lectures and laboratory exercises involving examination of parasite specimens using compound light microscopy. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The overall goal of this course is for students to gain an introductory knowledge of parasitology:<br>Upon completion of this course students should be able to:<br>1. To discuss the biology of parasitic animals, with emphasis on the major protozoan and metazoan parasite groups.<br>2. To articulate several problems and aspects of the parasitic relationship.<br>3. To describe the diversity and ubiquitous distribution of animal parasites.<br>4. To describe the impact of parasitism on human welfare.<br>5. To employ observational skills in the laboratory, in particular with the microscope.<br>6. To be able to obtain parasites by performing dissections on fish hosts. |
| (3) Course schedule, subject matter, and classroom activities | Tentative schedule R0725/R0726<br><br>Monday Aug 14, 2023<br>08:50-10:20 (Lecture) Introduction of professor and students, Lecture 1A on terminology, significance of parasitism, amoebas, Giardia<br>10:30-12:00 (Lab) Lab1A on amoebas and Giardia<br>13:00-14:30 (Lecture) Lecture 1 on trypanosomes (Trypanosoma), and Leishmania<br>14:40-16:10 (Lab) Lab1B Trypanosomes and kins<br><br>Tuesday Aug 15, 2023<br>08:50-10:20 (Lecture) Quiz covering day1 contents; Lecture 2A on Malaria (Plasmodium), Cryptosporidium and Toxoplasma<br>10:30-12:00 (Lab) Lab2A Apicomplexans including Plasmodium and malaria<br>13:00-14:30 (Lecture) Lecture 2B on Platyhelminthes, liver, lung and blood flukes<br>14:40-16:10 (Lab) Lab2B exercise on Platyhelminthes, liver, lung and blood flukes<br><br>Discussion on research paper: 2 Sessions and Ruth 1990 frog deformities<br>Time to be determined |
| (4) Outside-class activities and assignments | [Out of class activity requirement]<br>Students should study content at the end of each day in order to be ready for the exam that that will take place the following morning. |
| (5) Textbooks and course materials | [Textbooks/Materials]<br>There is no required textbook but each of the labs contains reference information and reference images. I will also provide outside reading materials. Students should bring blank sheets of paper and a pencil for laboratory exercises. |
| (6) Assessment and grading | [Assessment]<br>Students will be graded on attendance, daily exams, completion of laboratory exercises (both questions and drawings), 1-paragraph summaries of research articles, and participation in in-class discussions. |

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| (7) Questions to the instructor (Office hours, etc.) | [Office hour]<br>I will be available in person during each of the course meetings, and always responsive to e-mail queries. For more information, please contact Dr. Kanae Ando (k_ando@tmu.ac.jp). |
| (8) Special note | Please note that this course MUST be taken in conjunction with R0727/R0728. R0725/R0726 is the first half (day 1 and 2) and R0727/R0728 is the second half (day 3 and 4).<br><br>This course is open to the students who completed an undergraduate program in the universities other than TMU and are not fluent in Japanese.Talk to your supervisors if this course is appropriate for you.To register, submit a course registration request form to the program organizer.<br>For questions, please email to Dr. Kanae Ando (k_ando@tmu.ac.jp). |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Biological Sciences | R0719 | - | - | 1st Intensive | Aug 7 & 8 | 2,3,4, 5 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0720 | - | - | | | | |

| Instructor(s) | Note |
|---|---|
| *Diego Tavares Vasques | This course is open for both graduate and undergraduate programs. |

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|---|---|
| (1) Course policies and topics | Course Title: Introduction to Plants Systematics and Taxonomy<br>Instructor: Diego Tavares Vasques<br>Evolution is an intriguing phenomenon that rules all biological events. The mechanisms controlling evolution are many in nature and can be studied under different levels of complexity. In this course, theories of evolutionary genetics (such as natural selection, adaptation, speciation, and others) will be explored in the context of the evolutionary history of plants. Together, we will explore how changes in the life cycle have influenced the selective pressure plants have been exposed to, how adaptations on nutrition and body structure have emerged through time and how the reproduction of these eukaryotic organisms has had a deep influence on population genetics. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | By taking this course, you will not only learn basic key-concepts of evolution and plants diversity (important to understanding many other subfields in Biology) but also step-up your baggage knowledge, connecting it to practice experiences in this field.<br>Keywords: Plant diversity, evolution, systematics, Plant taxonomy |
| (3) Course schedule, subject matter, and classroom activities | Day 1<br>Unity 1: Introductory class, The DNA molecule and its importance for evolution<br>1. Concept of evolution in Biology<br>2. Introduction to plants' diversity<br>3. Evidences of Evolution<br>4. History and definition of Taxonomy and Systematics<br>Practice 1: International Biodiversity Databases and morphometrics<br>Groups division and projects decision/ planning<br><br>Day2<br>Extra Practice: Visit to the Makino Herbarium<br>(this practice may not be done, depending on the availability of the herbarium at the day)<br>Unity 2: Plants Taxonomy and Systematics<br>5. Plants Life History – Alternate generations<br>6. Mosses and its allies' diversity<br>7. Ferns and its allies' diversity<br>8. Gymnosperms and Angiosperms diversity<br>Practice 2: Reading and Drawing Phylogenies<br>Groups presentation |
| (4) Outside-class activities and assignments | Students are asked to provide individual reports on this class after the course is finished. |
| (5) Textbooks and course materials | Required Textbook: None - required reading will be provided by the professor.<br>Computer requirements:<br>Students are asked to download and install the following applications before the first class:<br>・ImageJ - https://imagej.nih.gov/ij/<br>・RStudio - https://rstudio.com/<br>・Google Chrome<br>Further instructions will be uploaded to https://dtvasques.wordpress.com/<br>Reference Books:<br>Dawkins, R., & Wong, Y. (2010). The ancestor's tale: A pilgrimage to the dawn of life. Hachette UK.<br>Judd, W. S., Campbell, C. S., Kellog, E. A., Stevens, P. F., & Donoghue, M. J. (2015). Plant Systematics: A Phylogenetic Approach. Sinauer, 1st ed.<br>Ridley, M. (2004). Evolution. Oxford University press.<br>Simpson, M. G. (2010). Plant systematics. Academic press. |
| (6) Assessment and grading | Class participation - 30%, Final project (final presentation and report) - 70% |
| (7) Questions to the instructor (Office hours, etc.) | Dr. Diego Tavares Vasques, The University of Tokyo – Center for Global Communication Strategies (CGCS) dtvasques@g.ecc.u-tokyo.ac.jp<br>Dr. Kanae Ando, k_ando@tmu.ac.jp |
| (8) Special note | To register, submit a course registration request form to the program organizer. |


Biological
Sciences

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Biological Sciences | R0729 | — | — | 1st Intensive | Sep 27& 28 | 2,3,4 ,5 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0730 | — | — | | | | |

| Instructor(s) | Note |
|---|---|
| Ben Wallen * | This course is open for both graduate and undergraduate programs. |

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|---|---|
| (1) Course policies and topics | Course Title – Hearing<br>Instructor: Dr. Ben Warren, University of Leicester, Leicestershire, UK<br>[Course Description]<br>Our ability to enjoy music, converse with friends and interact with our environment depend on the function on delicate structures within our ears. The ears of humans and wider mammals is, however, based on a singularly-evolved ear design – the cochlea. Insects provide a wealth of starkly different ear designs, which have evolved on many different body parts. This intensive two-day course will understand auditory transduction by using a wide variety of ear types, across animal phyla. This comparative approach to understand hearing is particularly insightful and fascinating and brings a broad but deep appreciation of how animals hear.<br>You will learn how ears operate from the mechanical elements that capture sound energy to the microscopic cells responsible to converting vibrations into electrical signals that we eventually interpret as sound. On Day 1 we will revise physical properties of sound before learning the basic operation of ears both in mammals and insects. On Day 2 we delve into the properties arising from sensitive ears such as: phantom oscillations and echoes (so-called otoacoustic emissions), negative stiffness and the cochlear amplifier. We finish by reviewing the arms race between insects and bats and then how hearing loss effects all biological ears – especially our own. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | This intensive course will use a combination of live lectures, guided journal clubs and guided independent research. In addition to learning how auditory transduction operates you will be trained in other transferable skills such as: how to make engaging presentations, experimental design (power analysis) and how to critically interpret scientific presentations.<br>Upon completion of the course, students are expected to:<br>a. Understand basic biophysical principles of sound waves and their reception in ears and how sound waves are converted into movements of sound receivers and then transduced into electrical signals. |
| (3) Course schedule, subject matter, and classroom activities | Course Topics<br>1. Physical principles of sound waves<br>2. Vertebrate Hearing<br>3. Insect Hearing<br>4. Auditory Receptors in Vertebrates<br>5. Auditory Receptors in Insects<br>6. Active Hearing<br>7. Hunt for the Mechanotransducer channel<br>8. Bat vs insects acoustic detection<br>9. Hearing loss (Part 1)<br>10. Hearing loss (Part 2)<br>11. Spot the mistakes - Presentation skills<br>12. Experimental design – Power analysis<br>13. Summary of Lectures<br>Methods of Instruction:<br>This course will consist of 10 lectures and 2 guided journal clubs. This combination of learning approaches will allow students to test and refine their knowledge. There is purposely plenty of active engagement with live lectures, guided journal clubs and interactive presentations. This type of active learning, using a range of different techniques and resources, will result in a deep and enjoyable learning experience and will allow the students to test their understanding as the course progresses. |
| (4) Outside-class activities and assignments | [Basic Requirement of the Course]<br>Reading of the textbook is absolutely required to familiarize the students with the concepts and ideas. Reading of the journal articles is also required, although this is best nearer the start of the course. Although I am not expecting the students to understand all preliminary reading it will make absorbing and understanding the material in the course easier and will maximize the benefit students will get from the course. |
| (5) Textbooks and course materials | Text book and Required Supplies:<br>Required textbook:<br>1. Textbook: An introduction to the physiology of hearing: Forth edition, James O. Pickles<br>ISBN: 9004243771. Essential reading, chapters: 1,2,3 and 5<br>2. Journals (essential reading before the start of the course, or before each day):<br>Day 1 An auditory feature detection circuit for sound pattern recognition,<br>https://www.science.org/doi/10.1126/sciadv.1500325<br>Day 2 Physiological changes throughout the ear due to age and noise – a longitudinal study,<br>Blockley et al., 2021, Journal of Neuroscience<br>https://www.biorxiv.org/content/10.1101/2021.11.25.470017v1 |
| (6) Assessment and grading | [Assessment]<br>Class discussions/presentation and group activities: 20%, Final multiple choice exam 80% |
| (7) Questions to the instructor (Office hours, etc.) | [Office hour] Email to Dr. Kanae Ando (k_ando@tmu.ac.jp) for more information. |
| (8) Special note | If you took the summer course taught by Dr. Warren in 2022, please do not register for this course. The contents are similar. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Experimental Techniques in Biological Sciences 1 | Number assigned to each laboratory | — | — | 1st | — | — | 2 |
| Doctoral program | Advanced Experimental Techniques in Biological Sciences 1 | Number assigned to each laboratory | Advanced Experimental Techniques in Biological Sciences 1 | Number assigned to each laboratory | | | | |

| Instructor(s) | Note |
|---|---|
| All faculty member of Department of Biological Sciences | |

| | |
|---|---|
| (1) Course policies and topics | Learn how to read scientific papers in the biology and life sciences field. Students will learn how scientific papers are organized and determine what papers are worth reading. In addition, students present the paper they read, and ask questions and criticize the paper. Since the latest results and technology are included in the paper, the required knowledge in the life science field is acquired by repeating this process. Choose a paper suitable for each area of study. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In graduate school, the latest knowledge is obtained from scientific papers. To obtain novel and advanced knowledge, it is necessary to select quality papers. It is essential to judge it since the description of the paper is not always correct. Therefore, the training which reads the paper critically and presents logically is accumulated. It is also imperative to ask questions about other students' presentations. The ability to read the paper is also crucial for advancing the research. |
| (3) Course schedule, subject matter, and classroom activities | Read scientific papers, learn scientific English words, the structure of scientific papers, and what kind of papers to read<br>Learn how to ask questions and criticize scientific papers.<br>Obtain necessary knowledge from the latest articles. |
| (4) Outside-class activities and assignments | Reading papers, summarizing presentations, etc., are carried out outside the class hours. |
| (5) Textbooks and course materials | There is no textbook. Use the science paper of students' choice. |
| (6) Assessment and grading | It is evaluated by the result of the paper presentation and whether it is positively asked and criticized. |
| (7) Questions to the instructor (Office hours, etc.) | Contact each laboratory if students have any questions. |
| (8) Special note | It is conducted in each laboratory.<br>All graduate students are expected to take this course.<br>If more than one seminar is held in the same laboratory in each period, or if students wish to take a course in a related laboratory, they should receive guidance from their supervisor.<br>This course starts in the first semester. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Experimental Techniques in Biological Sciences 2 | Number assigned to each laboratory | — | — | 2nd | — | — | 2 |
| Doctoral program | Advanced Experimental Techniques in Biological Sciences 2 | Number assigned to each laboratory | Advanced Experimental Techniques in Biological Sciences 2 | Number assigned to each laboratory | | | | |

| Instructor(s) | Note |
|---|---|
| All faculty member of Department of Biological Sciences | |

| | |
|---|---|
| (1) Course policies and topics | Learn the significance and ethical considerations of publishing research data. Also, students learn how to present research data. Ask questions about other people's presentations and make suggestions for better research. Enhance professional expertise in life sciences by presenting their research and making appropriate suggestions for other people's research. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The research in graduate school explores cutting-edge knowledge in the life sciences. To further develop the research, it is vital to carry out experiments and obtain valuable advice from other people. In order to do that, it is necessary to present research in a way that others can understand easily. In addition, it is also essential to be able to give professional advice and constructive criticism for the research presentation of other people. It is a course necessary for understanding and mastering the more advanced life science field on the subject of own research. |
| (3) Course schedule, subject matter, and classroom activities | Learn the skills to present research.<br>Learn what research presentations are easy for others to understand |
| (4) Outside-class activities and assignments | Reading papers, summarizing presentations, etc., are carried out outside the class hours. |
| (5) Textbooks and course materials | There is no textbook. Use the science paper of students' choice. |
| (6) Assessment and grading | It is evaluated by the result of the paper presentation and whether it is positively asked and criticized. |
| (7) Questions to the instructor (Office hours, etc.) | Contact each laboratory if students have any questions. |
| (8) Special note | It is conducted in each laboratory.<br>All graduate students are expected to take this course.<br>If more than one seminar is held in the same laboratory in each period, or if students wish to take a course in a related laboratory, they should receive guidance from their supervisor.<br>This course starts in the second semester. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Experiment in Biological Sciences | Number assigned to each Experimental Techniques | — | — | As Needed | — | — | 1 |
| Doctoral program | Special Experiment in Biological Sciences | Number assigned to each Experimental Techniques | Special Experiment in Biological Sciences | Number assigned to each Experimental Techniques | | | | |

| Instructor(s) | Note |
|---|---|
| All faculty member of Department of Biological Sciences | |

| | |
|---|---|
| (1) Course policies and topics | Basic Experimental Techniques |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | To acquire basic experimental methods in the field of biology. Students majoring in fields other than biological sciences are eligible. |
| (3) Course schedule, subject matter, and classroom activities | Basic Experimental Techniques 1: Ecology and Microbiology<br>Basic Experimental Techniques 2: Biochemistry and Cell Biology<br>Basic Experimental Techniques 3: Neurobiology<br>Basic Experimental Techniques 4: Developmental Biology<br>Basic Experimental Techniques 5: Genetics<br>Basic Experimental Techniques 6: Taxonomy |
| (4) Outside-class activities and assignments | Study outside of class as needed. |
| (5) Textbooks and course materials | Prints will be given if needed. |
| (6) Assessment and grading | Reports may be required. |
| (7) Questions to the instructor (Office hours, etc.) | Students can contact Dr. Fukuda (kokko@tmu.ac.jp). |
| (8) Special note | Students must obtain permission from their academic advisors and the Educational Affairs Committee. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Special Practice in Biological Sciences II | Number assigned to each Research Techniques | — | — | As Needed | — | — | 2 |
| Doctoral program | Special Practice in Biological Sciences II | Number assigned to each Research Techniques | Special Practice in Biological Sciences II | Number assigned to each Research Techniques | | | | |

| Instructor(s) | Note |
|---|---|
| All faculty member of Department of Biological Sciences | |

| | |
|---|---|
| (1) Course policies and topics | Research Method |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Students learn various experimental and research practices in the biological science field.<br>It is a practical course for students who need to take it for special reasons, and it is tailored to each student. |
| (3) Course schedule, subject matter, and classroom activities | Research Technique 1: Ecology and Microbiology<br>Research Technique 2: Biochemistry and Cell Biology<br>Research Technique 3: Neurobiology<br>Research Technique 4: Developmental Biology<br>Research Technique 5: Genetics<br>Research Technique 6: Taxonomy |
| (4) Outside-class activities and assignments | Study outside of class as needed. |
| (5) Textbooks and course materials | Prints will be given if needed. |
| (6) Assessment and grading | Reports may be required. |
| (7) Questions to the instructor (Office hours, etc.) | Students can contact Dr. Fukuda (kokko@tmu.ac.jp). |
| (8) Special note | Students must obtain permission from their academic advisors and the Educational Affairs Committee. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Experimental Techniques in Biological Sciences 1 | Number assigned to each laboratory | — | — | 1st | Thr | 6・7 | 2 |
| Doctoral program | Advanced Experimental Techniques in Biological Sciences 1 | Number assigned to each laboratory | Advanced Experimental Techniques in Biological Sciences 1 | Number assigned to each laboratory | | | | |

| Instructor(s) | Note |
|---|---|
| All faculty member of Department of Biological Sciences | |

| | |
|---|---|
| (1) Course policies and topics | In graduate school, various abilities are acquired through research. To carry out the research, it is necessary not only to repeat experiments by receiving guidance from supervisors but also to acquire deep expertise, wide interest, latest experimental technology and the principle, research ethics and various laws to be observed. In this course, students learn essential knowledge and advanced technology in accordance with each research. This class is indispensable to raising the specialty in the life science field. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Students receive practical instruction on the knowledge gained in the past related to each research, the latest experimental techniques, data processing, etc., and guidance on acquiring the specialized knowledge necessary for further research development. The guidance is carried out according to each research field and the progress of the research. |
| (3) Course schedule, subject matter, and classroom activities | Learn what it means to study, the ethics to study, the dangers to avoid in research, the techniques to study. |
| (4) Outside-class activities and assignments | Many activities are out of class. |
| (5) Textbooks and course materials | Text is defined by each class. Materials will be distributed as appropriate. |
| (6) Assessment and grading | Evaluate in approach to research and conduct of research. |
| (7) Questions to the instructor (Office hours, etc.) | Contact each laboratory for questions. |
| (8) Special note | I This course starts in the first semester.<br>The implementation is not always following the timetables, so please contact your supervisor.<br>It is expected that students will take the courses offered by their own laboratories. |

| Program | Graduate School of Science | | Graduate School of Science and Engineering | | Semester | Day | Time | Credit |
|---|---|---|---|---|---|---|---|---|
| | Course Name | Course Number | Course Name | Course Number | | | | |
| Master's program | Advanced Experimental Techniques in Biological Sciences 2 | Number assigned to each laboratory | | | 2nd | Thr | 6・7 | 2 |
| Doctoral program | Advanced Experimental Techniques in Biological Sciences 2 | Number assigned to each laboratory | Advanced Experimental Techniques in Biological Sciences 2 | Number assigned to each laboratory | | | | |

| Instructor(s) | Note |
|---|---|
| All faculty member of Department of Biological Sciences | |

| | |
|---|---|
| (1) Course policies and topics | Learn how to read scientific papers in the biology and life sciences field. Students will learn how scientific papers are organized and determine what papers are worth reading. In addition, students present the paper they read, and ask questions and criticize the paper. Since the latest results and technology are included in the paper, the required knowledge in the life science field is acquired by repeating this process. Choose a paper suitable for each area of study. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In graduate school, the latest knowledge is obtained from scientific papers. To obtain novel and advanced knowledge, it is necessary to select quality papers. It is essential to judge it since the description of the paper is not always correct. Therefore, the training which reads the paper critically and presents logically is accumulated. It is also imperative to ask questions about other students' presentations. The ability to read the paper is also crucial for advancing the research. |
| (3) Course schedule, subject matter, and classroom activities | Read scientific papers, learn scientific English words, the structure of scientific papers, and what kind of papers to read.<br>Learn how to ask questions and criticize scientific papers.<br>Obtain necessary knowledge from the latest articles. |
| (4) Outside-class activities and assignments | Reading papers, summarizing presentations, etc., are carried out outside the class hours. |
| (5) Textbooks and course materials | There is no textbook. Use the science paper of students' choice. |
| (6) Assessment and grading | It is evaluated by the result of the paper presentation and whether it is positively asked and criticized. |
| (7) Questions to the instructor (Office hours, etc.) | Contact each laboratory if students have any questions. |
| (8) Special note | It is conducted in each laboratory.<br>All graduate students are expected to take this course.<br>If more than one seminar is held in the same laboratory in each period, or if students wish to take a course in a related laboratory, they should receive guidance from their supervisor.<br>This course starts in the first semester. |


Biological
Sciences

# Graduate School of Science & Graduate School of Science and Engineering List of Course Instructors

[Mathematical Sciences / Mathematics and Information Sciences]

| Instructor Name | Laboratory | Extension No. |
|---|---|---|
| Manabu Akaho | 8-629 | 3136 |
| Kensuke Ishitani | 8-669 | 3167 |
| Hokuto Uehara | 8-623 | 3128 |
| Yukihiro Uchida | 8-667 | 3165 |
| Shigenori Uchiyama | 8-668 | 3166 |
| Kazuhiro Kurata | 8-632 | 3141 |
| Shigeru Kuroda | 8-672 | 3172 |
| Masanori Kobayashi | 8-670 | 3134 |
| Takashi Sakai | 8-631 | 3138 |
| Masahiko Simojo | 8-622 | 3135 |
| Toshio Suzuki | 8-675 | 3175 |
| Shoichiro Takakuwa | 8-663 | 3161 |
| Asuka Takatsu | 8-628 | 3127 |
| Hirofumi Tsumura | 8-674 | 3174 |
| Hiro-o Tokunaga | 8-673 | 3173 |
| Kumiko Hattori | 8-671 | 3171 |
| Tomoyuki Hisamoto | 8-666 | 3164 |
| Tomohiro Fukaya | 8-630 | 3137 |
| Hiroshi Murakami | 8-522 | 3096 |
| Yoshiyuki Yokota | 8-626 | 3133 |
| Shun'ichi Yokoyama | 8-665 | 3168 |
| Kazushi Yoshitomi | 8-624 | 3131 |
| Takeshi Kawasaki | 8-662 | 3158 |
| Masaki Hirata | 8-662 | 3158 |

[Physics]

| Instructor Name | Laboratory | Extension No. |
|---|---|---|
| Yuji Aoki | 8-531 | 3362 |
| Emiko Arahata | 8-580 | 3368 |
| Yoshitaka Ishisaki | 8-227 | 3244 |
| Yuichiro Ezoe | 8-229 | 3246 |
| Hidekazu Kakuno | 8-532 | 3363 |
| Hiroaki Kadowaki | 8-225 | 3242 |
| Rei Kurita | 8-496 | 3333 |
| Akira Shudo | 8-518 | 3351 |
| Sergei Ketov | 8-581 | 3371 |
| Hajime Tanuma | 8-526 | 3355 |
| Kazumasa Hattori | 8-519 | 3352 |
| Tetsuo Hyodo | 8-583 | 3373 |
| Yutaka Fujita | 8-517 | 3348 |
| Takashi Hotta | 8-578 | 3366 |
| Tatsuma Matsuda | 8-226 | 3243 |
| Yoshikazu Mizuguchi | 8-579 | 3367 |
| Yasumitsu Miyata | 8-528 | 3357 |
| Hiroyuki Mori | 8-577 | 3365 |
| Osamu Yasuda | 8-584 | 3374 |
| Kazuhiro Yanagi | 8-290 | 5667 |
| Shimpei Iida | 8-292 | 3255 |
| Kumi Ishikawa | 8-296 | 3257 |
| Hiromi Otsuka | 8-594 | 3383 |
| Noriaki Kitazawa | 8-588 | 3375 |
| Tetsuro Kumita | 8-488 | 3326 |
| Yousuke Goto | 8-125 | 3222 |
| Shin Sasaki | 8-515 | 3346 |
| Atsushi Tanaka | 8-510 | 3341 |
| Marie Tani | 8-483 | 3325 |
| Yusuke Nakanishi | 8-481 | 3324 |
| Ryuji Higashinaka | 8-122 | 3221 |
| Youhei Yomogida | 8-289a | 3258 |

[Chemistry / Molecular Materials Chemistry]

| Instructor Name | Laboratory | Extension No. |
|---|---|---|
| Masatoshi Ishida | 8-566 | 3565 |
| Teppei Ikeya | 8-451 | 3525 |
| Takashi Ito | 8-469 | 3538 |
| Akiko Inagaki | 8-472 | 3541 |
| Yasuji Oura | 8-567 | 3576 |
| Reika Kanya | 8-367 | 3447 |
| Koichi Kikuchi | 8-372 | 3453 |
| Shiro Kubuki | RI-201 | 3922 |
| Shigeyuki Komura | 8-374 | 3455 |
| Toshio Shimizu | 8-574 | 3585 |
| Kenichi Sugiura | 8-565 | 3574 |
| Masato Taoka | 8-467 | 3536 |
| Nobuyuki Takegawa | 8-366 | 3446 |
| Naoki Nakatani | 8-572 | 3543 |
| Tohru Nishinaga | 8-566 | 3565 |
| Kotohiro Nomura | 8-473 | 3542 |
| Masahiko Hada | 8-474 | 3583 |
| Yasushi Hirose | | |
| Kouji Hirota | 8-466 | 3535 |
| Mohammed Meharwed Abdel-Latif Soliman | 8-472 | 3541 |
| Seiji Yamazoe | 8-568 | 3577 |
| Kazuhiko Akiyama | 8-576 | 3587 |
| Takuya Abe | 8-466 | 3535 |
| Soichi Yoshikawa | 8-546 | 3561 |
| Kohei Shibamoto | 8-365 | 3445 |
| Daisuke Shimoyama | | |
| Kazunori Hirabayashi | 8-563 | 3573 |
| Jun Matsumoto | 8-369 | 3451 |
| Kentaro Misawa | 8-365 | 3445 |

[Biological Sciences]

| Instructor Name | Laboratory | Extension No. |
|---|---|---|
| Adam Cronin | Makino-204 | 2751 |
| Adam Weitemier | | |
| Kanae Ando | 9-478 | 4443 |
| Katsuyuki Eguchi | Makino-214 | 2754 |
| Shigeki Ehira | 8-334 | 3672 |
| Yasukazu Okada | 8-543 | 3766 |
| Takashi Okamoto | 8-320 | 3661 |
| Yoko Kakugawa | Makino-107 | 2723 |
| Jun-ichi Kato | 8-329 | 3668 |
| Takeshi Kanegae | 8-312 | 3654 |
| Hiroyuki Kawahara | 8-492 | 4367 |
| Makoto Kurokawa | 8-429 | 3736 |
| Takaomi Sakai | 8-413 | 3724 |
| Jun-Ichirou Suzuki | 8-540 | 3764 |
| Naohito Takatori | 8-336 | 3673 |
| Aya Takahashi | 8-425 | 3733 |
| Koichiro Tamura | 8-415 | 3725 |
| Masafumi Nozawa | 8-417 | 3726 |
| Rei Narikawa | | |
| Fumio Hayashi | 8-541 | 3765 |
| Shin Haruta | 8-434 | 3741 |
| Kimiko Fukuda | 8-339 | 3675 |
| Noriaki Murakami | Makino-117 | 2727 |
| Akiko Asada | 9-493 | 4372 |
| Tsunaki Asano | 8-422 | 3731 |
| Hidetoshi Kato | Makino-116 | 2726 |
| Atsuko Kinoshita | 8-318 | 3657 |
| Taro Saito | 9-493 | 4371 |
| Satomi Takeo | 8-412 | 3723 |
| Yuuya Tachiki | 8-338 | 3674 |
| Toshiko Furukawa | 8-322 | 3662 |
| Naoto Yokota | 9-481b | 4370 |
| Takahiro Yoshida | Makino-215 | 2755 |

[Mechanical Engineering]

| Instructor Name | Laboratory | Extension No. |
|---|---|---|
| Satoshi Ogata | 9-463 | 4143 |
| Toshiki Koguchi | 9-464 | 4277 |
| Hiromichi Obara | 9-457 | 4136 |
| Naoto Kakuta | 9-458 | 4137 |
| Koji Kakehi | 9-454 | 4145 |
| Satoshi Kobayashi | 9-465 | 4133 |
| Toshio Shudo | 9-455 | 4134 |
| Satoru Takahashi | 9-461 | 4254 |
| Kazunori Hase | 9-459 | 4135 |
| Satoshi Honda | 9-460 | 4141 |
| Takuya Yoshimura | 9-453 | 4131 |
| Shuichi Wakayama | 9-467 | 4147 |
| Gen Tamaoki | 10-227 | 4188 |
| Yuichiro Hayashi | 10-127 | 4183 |
| Kazuhiko Murakami | 9-354 | 4164 |
| Makoto Yoshida | 9-459 | 4135 |

# Tokyo Metropolitan University Degree Rules (Excerpts)

Corporate Rules No. 54, 2005
Enacted on April 1, 2005

## Purpose

### Article 1

The purpose of these rules is to provide information concerning degrees at Tokyo Metropolitan University pursuant to the provisions of Article 13, Paragraph 1 of the Degree Regulations (Ordinance of the Ministry of Education No. 9 of 1953).

## Type of degrees

### Article 2

1. The following degree shall be conferred:
   (1) Bachelor's degree
   (2) Master's degree
   (3) Doctoral degree
   (4) Juris Doctor degree (professional)
2. In conferring a bachelor's, master's, or doctoral degree, disciplines shall be appended according to Appended Table 1.

(Appended table revisions of Rule 202 of 2005 and Rule 79 of 2007; partial revisions and appended table revisions of Rule 78 of 2008; appended table revisions of Rule 49 of 2009, Rule 27 of 2011, Rule 25 of 2013, Rule 38 of 2014, Rule 20 of 2015, and Rule 40 of 2017)

## Requirements for conferring a master's degree

### Article 4

Graduate School Rules of Tokyo Metropolitan University (Corporate Rules No. 49, 2005; hereinafter referred to as the "Graduate School Rules").

A master's degree shall be conferred to those who have completed the master's program pursuant to the provisions of Article 35, Paragraph 1.

(Partial revisions of Rule 31 of 2019)

## Requirements for conferring a doctorate

### Article 5

1. A doctorate shall be conferred on those who have completed the doctoral program pursuant to the provisions of Article 35, Paragraph 1 of the Graduate School Rules.
2. A doctorate shall be conferred on those who have passed the dissertation examination and examinations pursuant to the provisions of Article 35, Paragraph 2 of the Graduate School Rules and whose academic ability is confirmed by a test to be equivalent to or higher than those who have completed the doctoral program set forth in the preceding paragraph.

## Method and timing of the degree application

### Article 7

The method and timing of application for degrees shall be set forth in Appended Table 2.

(Appended table revision of Rule 5 of 2013)

## Qualification for the master's degree application

### Article 8

In order to be qualified to apply for the evaluation of the thesis examination (including research findings of a specific subject; hereinafter the same) to obtain a master's degree pursuant to the provision of Article 4, the student must have enrolled in the master's program and earned required credits or be approved to earn the required credits by the end of the evaluation of the thesis examination.

## Qualification for the doctorate application

### Article 9

In order to be qualified to apply for the evaluation of the dissertation examination to obtain a doctorate pursuant to the provision of Article 5, Paragraph 1, the student must have enrolled in the doctoral program and earned required credits or be approved to earn the required credits by the end of the evaluation of the dissertation examination. Provided, however, that this shall not apply where the student applies for a doctorate pursuant to the provisions of Article 5, Paragraph 2.

Application for a doctoral dissertation, etc.

Article 10

1. In order to apply for a doctorate pursuant to the provision of Article 5, Paragraph 2, the student shall submit the application form and related documents set forth in Article 7 with the discipline set forth in Article 2, Paragraph 2, along with the payment of the dissertation evaluation fee, to the Graduate School for the attention of the provost.

2. The dissertation evaluation fee, waiver, and other matters shall be as specified separately.

Acceptance of the degree application

Article 11.

1. Applications for a master's degree pursuant to the provisions of Article 4 and applications for a doctorate pursuant to the provisions of Article 5, Paragraph 1 shall be accepted by the relevant graduate school.

2. Under the provisions of Article 5, Paragraph 2, a dissertation along with a doctorate application shall be checked and determined by the Faculty Committee of the Graduate School (hereinafter "Graduate Faculty Committee") whether to accept it for evaluation.

3. If accepted according to the provision above, an application acceptance certificate shall be issued to the applicant.

4. After accepting a doctorate application pursuant to the provisions of the preceding two paragraphs, the provost shall request the Graduate Faculty Committee of the appropriate discipline to evaluate the dissertation.

Thesis/Dissertation

Article 12

1. One main thesis or dissertation shall be accepted. However, other papers may be attached as references.

2. The terminology used in the thesis/dissertation shall be determined by the Graduate Faculty Committee.

3. Received thesis/dissertation shall not be returned to the applicant under any circumstances.

Review Committee

Article 13

1. The thesis/dissertation shall be evaluated and determined based on the report prepared by the Review Committee, which is established in the Graduate Faculty Committee.

2. The Review Committee set forth in the preceding paragraph shall consist of as follows:

(1) The Review Committee for a thesis/dissertation set forth in Articles 8 and 9 shall consist of a graduate/doctoral advisor as the main evaluator and two or more faculty members who are members of and nominated by the Graduate Faculty Committee and appointed by the provost.

(2) The Review Committee for a dissertation set forth in Article 10 shall consist of one main evaluator and two or more faculty members who are members of and nominated by the Graduate Faculty Committee and appointed by the provost.

3. Notwithstanding the provision of the preceding paragraph, when the Graduate Faculty Committee deemed it necessary, the committee may nominate professors from other departments or other graduate schools or research institutes for the review committee members.

Review period

Article 14

1. The thesis and dissertation set forth in Articles 8 and 9 shall be accepted and the evaluation is completed while the applicant is enrolled in the graduate program.

2. The evaluation of the dissertation set forth in Article 10 must be completed within one year from the date that the doctorate application is received.

3. Notwithstanding the provisions of the preceding two paragraphs, the review period may be extended with the approval of the Graduate Faculty Committee.

Examinations

Article 15

1. While evaluating the dissertation, the Review Committee shall conduct the final examination or test for the subjects mainly related to the dissertation.
2. The final examination or test set forth in the preceding paragraph shall be conducted in an interview or written format.

Test

Article 16

1. The test set forth in Article 5, Paragraph 2 shall be conducted in an interview or written format.
2. For an individual who applies for a doctorate under Article 5, Paragraph 2, if the individual has withdrawn from the school but had enrolled in our doctoral program for one year or more and earned required credits, the test outlined in the preceding paragraph may be waived according to the rule prescribed by respective graduate programs.

**Public presentation**

Article 17

Under the rule prescribed by the Graduate Faculty Committee, the committee may request the doctorate applicant to give a public presentation of the dissertation (hereinafter "public presentation") as the final examination or test. The details of the public presentation shall be determined by the Review Committee.

Informing the Graduate Faculty Committee

Article 18

1. The Review Committee shall submit the evaluation report to the Graduate Faculty Committee immediately after completing the evaluation.
2. If necessary, the Graduate Faculty Committee may request the applicant to submit additional materials such as a copy, Japanese translation, prototype or sample of the dissertation. In some cases, the committee may request the applicant to elaborate on the dissertation.

Pass or fail decision

Article 19

1. The Graduate Faculty Committee shall decide whether to pass or fail the dissertation and final examinations, etc., by anonymous voting based on the evaluation report from the Review Committee.
2. The Graduate Faculty Committee meeting must consist of at least two-thirds of the committee members to qualify the meeting for the purpose in the preceding paragraph, and at least two-thirds favorable votes from attended members are required to pass. Note that those absent due to public duties shall not be counted in the aforementioned quorum.

Article 20

1. Upon the decision of the passing result, the Graduate Faculty Committee shall submit a report summarizing the dissertation evaluation and final examination or test result to the dean of the graduate program.
2. For the applicant of a doctorate pursuant to the provision of Article 5, Paragraph 2, the committee shall also submit the test result.
3. The same shall apply to the case where the committee determined the application failed. However, the evaluation summary shall not be required.

Granting a degree

Article 21-1

1. The provost shall confer a degree based on the report from the department or Graduate Faculty Committee, according to the attached format.
2. The bachelor's degree shall be granted in March. Provided, however, that the degree may be granted in September for those who have been enrolled for four years or more and for whom the Faculty Committee deems it particularly necessary.
3. The master's degree shall be awarded twice a year, in March and September.
4. The doctorate shall be awarded as needed.

(Partial revisions of Rule 31 of 2019)

Completion of the Collaborative International Research Program

Article 21-2If the master's or doctoral degree grantee has been recognized as passing the dissertation examination by the Collaborative International Research Program prescribed in Article 29, Paragraph 2 of the Graduate School Rules of Tokyo Metropolitan University (Corporate Rules No. 49 of 2005), the statement of the program completion shall be added to the diploma.

(Addition of Rule 49 of 2009; Partial revisions of Rule 31 of 2019)

### Publication of the dissertation abstract

### Article 22

After a doctorate is granted, the University shall publish the abstract of the dissertation and the summary of the dissertation examination result on the Internet within three months from the date of conferral of the doctorate. The method shall be prescribed separately.

(Partial revisions of Rule 5 of 2013)

### Publication of the dissertation

### Article 23

1. The individual who has been awarded a doctorate must publish the full text of his or her dissertation within one year of the date of conferral. Provided, however, that this shall not apply where the dissertation has already been published before the degree is conferred.
2. Notwithstanding the provision of the preceding paragraph, under certain circumstances, the doctorate grantee may publish the abstract of the dissertation instead of the full text upon approval of the Graduate Faculty Committee. In this case, the Graduate School shall make the full text of the dissertation available for viewing upon request.
3. The publication made by the doctorate grantee pursuant to the provisions of the preceding two paragraphs shall be on the Internet with the assistance of the school. The method shall be prescribed separately.
4. When publishing the dissertation after the conferral of the degree pursuant to the provisions of the preceding Paragraph 3, the dissertation must be published with the statement "Doctoral dissertation reviewed by Tokyo Metropolitan University."

(Partial revisions of Rule 5 of 2013 and Rule 31 of 2019)

### Name of the degree

### Article 24

When the individual who has been awarded a doctorate uses the name of the degree, the name of Tokyo Metropolitan University shall be added.

(Partial revisions of Rule 31 of 2019)

### Revocation of a degree

### Article 25

1. If the degree awarded was found to be made by fraudulent means, the provost may revoke the degree based on the deliberation of the Graduate Faculty Committee.
2. The decision of the Graduate Faculty Committee outlined in the preceding paragraph shall require the approval of three-quarters of the meeting participants. The provisions of Article 19 shall apply mutatis mutandis to matters such as the number of participants.

### Supplementary provisions

1. These rules shall come into effect as of April 1, 2005.
2. Notwithstanding the provisions of Article 2, Paragraph 2, the discipline of those who transferred to the Graduate School from the following schools on April 1, 2011, the Degree Rules as of March 31, 2011 of those schools shall apply.

- Tokyo Metropolitan University
- Tokyo Metropolitan Institute of Technology
- Tokyo Metropolitan University of Health Sciences

(hereinafter referred to as the "undergraduate schools before transfer")

Appended Table 1 for Article 2

(Partial revisions of Rule 202 of 2005, Rule 79 of 2007, Rule 49 of 2009, Rule 27 of 2011, Rule of 2013, Rule 40 of 2017)

2. Master's degree

| Graduate Program | Major (Field of Study) | Discipline |
|---|---|---|
| Graduate School of Science | Mathematical Sciences | Science |
| | Physics | Science |
| | Chemistry | Science |
| | Biological Sciences | Science |

3. Doctorate

| Graduate Program | Major (Field of Study) | Discipline |
|---|---|---|
| Graduate School of Science | Mathematical Sciences | Science |
| | Physics | Science |
| | Chemistry | Science |
| | Biological Sciences | Science |

Supplementary provisions The examples under the previous prevision (Corporate Rules 29 No. 40 of February 22, 2018) are as follows:

2. Master's degree

| Graduate Program | Major (Field of Study) | Discipline |
|---|---|---|
| Graduate School of Science and Engineering | Mathematics and Information Sciences | Science |
| | Physics | Science |
| | Molecular Materials Chemistry | Science |
| | Biological Sciences | Science |
| | Electrical and Electronic Engineering | Mechanical Engineering |
| | Mechanical Engineering | Engineering |

3. Doctorate

| Graduate Program | Major (Field of Study) | Discipline |
|---|---|---|
| Graduate School of Science and Engineering | Mathematics and Information Sciences | Science |
| | Physics | Science |
| | Molecular Materials Chemistry | Science |
| | Biological Sciences | Science |
| | Electrical and Electronic Engineering | Engineering |
| | Mechanical Engineering | Engineering |

Appended Table 2 for Article 7 (Partial revisions of Rule 5 of 2013)

| Classification | Application Date | Required Documents | Copies | Note |
|---|---|---|---|---|
| Degrees under the provisions of Article 4 | In principle, January 10 or July 31 (Each Graduate Faculty Committee may set the date separately) | 1. Degree application form<br>2. Thesis<br>3. Thesis abstract<br>4. Unofficial transcript | 1<br><br><br>1 | The required number of copies of the thesis/dissertation and the abstract is determined by each graduate school. |
| Degrees under the provisions of Article 5, Paragraph 1 | In principle, April 10 or October 31 (Each Graduate Faculty Committee may set the date separately) | 1. Degree application form<br>2. Dissertation<br>3. Dissertation abstract<br>4. Unofficial transcript<br>5. List of research achievements<br>6. CV | 1<br><br><br>1<br>2<br>2 | The required number of copies of the thesis/dissertation and the abstract is determined by each graduate school. |
| Degrees under the provisions of Article 5, Paragraph 2 | Unspecified | 1. Degree application form<br>2. Dissertations<br>3. Dissertation abstracts<br>4. List of dissertations<br>5. List of research achievements<br>6. CV<br>7. Certificate of the copy of the partial resident card | 1<br><br><br>1<br>2<br>2<br>1 | Specify the discipline prescribed in Appended Table 1 (Article 10)<br>The required number of copies of the thesis/dissertation and the abstract is determined by each graduate school. |

* The application period for the master's degree is no later than January 10 or July 10, and the application period for the doctorate is no later than December 10 or June 10 pursuant to Article 2 of the "Detailed Rules of the Graduate School of Science concerning the Graduate School Rules and Degree Rules of Tokyo Metropolitan University."

# Graduate School Rules of Tokyo Metropolitan University (Excerpts)

Corporate Rules No. 49, 2005

Enacted on April 1, 2005

## Chapter 1 General Provisions

### Purpose

### Article 1

The Graduate School of Tokyo Metropolitan University (hereinafter referred to as the "Graduate School") aims to teach and research specialized academic theories and applications in technical fields of study from a broad perspective in order for students to gain deep knowledge and outstanding abilities to engage in professions that require a high level of expertise. It also aims to improve the lives of Tokyo citizens and develop the culture of Tokyo.

(Partial revisions of Regulation 11 of 2019)

## Article 2

## Structure of the Graduate School

### Programs

### Article 3

1. The Graduate School consists of graduate programs and the professional degree program set forth in Article 2, Paragraph 1 of the Standards for the Establishment of Professional Graduate Schools (Ordinance of the Ministry of Education, Culture, Sports, Science and Technology No. 16 of 2003; the same hereafter).
2. The graduate program is divided into two sections: the first two years (hereinafter referred to as the "master's program") and the next three years (hereinafter the "doctoral program"). The first part of the graduate program is considered to be a master's program.
3. The master's program aims to enable students to gain deep knowledge and advanced skills to engage in professions that require research skills or a high level of expertise in the fields of study from a broad perspective.
4. The doctoral program aims to enable students to acquire advanced research skills and profound academic knowledge that are the foundations for conducting independent research activities as researchers or engaging in other highly specialized work in the field of study.

### Graduate programs and majors

### Article 4

Graduate programs and majors shall be as shown in Appended Table 1.

### Maximum number of students

### Article 6

The maximum number of students shall be as shown in Appended Table 2.

(Appended table revisions of Rule 192 of 2005, Rule 65 of 2006, Rule 33 of 2010, Rule 16 of 2013, Rule 28 of 2017)

### Administrative unit

### Article 7

Administrative tasks related to the graduate program shall be handled by the relevant administrative departments.

## Chapter 2-2. Educational and Research Objectives of Each Graduate Program

(Addition of Rule 24 of 2006)

### Educational and research objectives of the Graduate School of Science and Engineering

### Article 7-5

1. The master's program of Graduate School of Science aims to enable students to gain a wide range of knowledge, concepts, and methods in natural science as well as developing research skills and flexible problem-solving and presentation skills. It also aims to train students to become researchers, educators, and engineers with an international perspective, creativity, and applicable skills.
2. The doctoral program of the Graduate School of Science aims to enable students to gain advanced knowledge, concepts, and methods in natural science as well as developing independent research skills and the ability to explore and discover mid- to long-term projects and issues. It also aims to train students to become researchers, educators, and engineers with international leadership, outstanding creativity, and applicable skills.

(Addition of Rule 24 of 2006; partial revision of Rule 28 of 2017; moved down from Article 7-4)

### Educational and research objectives of each major

### Article 7-9

The objectives of each major on human resource development and other educational and research purposes shall be prescribed separately.

(Addition of Rule 24 of 2006; Rule 28 of 2017 moved down from Article 7-8)

## Chapter 3. Faculty

### Faculty Committee

### Article 8

1. The Graduate School shall have a Faculty Committee.
2. The Faculty Committee shall consist of the professors of the relevant graduate programs.
3. Associate professors and other faculty members may be added to the Faculty Committee.
4. The Dean of the Graduate School shall convene and chair Faculty Committee meetings.
5. Based on the basic policy determined by the Education and Research Council, the Faculty Committee shall deliberate on the following matters related to:
   (1) Student admission, course completion, and other matters related to student enrollment and degree conferral
   (2) Curriculum organization
   (3) Self-inspection and evaluation of the status of education and research in the graduate school
   (4) Systematic training and research conducted by the graduate school to improve the subject matter and teaching methods of courses and research instructions
   (5) Other important matters related to education and research
6. In addition to the above-mentioned five matters, necessary matters concerning the Faculty Committee shall be prescribed separately.

(Partial revisions of Rule 24 of 2006, Rule 13 of 2009)

### Course instructors

### Article 9

1. Courses and instructions at the graduate school shall be conducted by professors of the University or other qualified individuals (hereinafter referred to as "course instructors").
2. The course instructors outlined above shall be designated by the provost based on the deliberation of the Faculty Committee of the relevant graduate school and the approval of the Faculty Committee to which the professor belongs.

### Board of Delegates

### Article 10

1. The Graduate Faculty Committee may establish a Board of Delegates.
2. The matters determined by the Faculty Committee prescribed in Article 8, Paragraph 5 may be delegated to the Board of Delegates in making decisions.
3. The Dean of the Graduate School shall convene and chair the meeting of the Board of Delegates.
4. Necessary matters such as the composition of the Board of Delegates shall be prescribed separately.

## Chapter 4. Academic Year, Semester, Enrollment Period, etc.

### Academic year

### Article 11

1. The academic year shall be from April 1 to March 31 of the following year for those enrolled in the first semester and from October 1 to September 30 of the following year for those enrolled in the second semester.

2. Semesters and recesses shall be pursuant to the University Rules. However, the semesters and recesses of the law school shall be in accordance with the Rules of Tokyo Metropolitan University Graduate School of Law and Politics (hereinafter referred to as "Law School Rules").

(Partial revisions of Rule 65 of 2008)

### Enrollment period

### Article 12

The regular enrollment period for the master's program shall be two years, and the regular enrollment period for the doctoral program shall be three years.

Maximum enrollment period

### Article 14

1. The enrollment period in the master's program shall not exceed four years, and the enrollment period in the doctoral program shall not exceed six years.
3. Notwithstanding the provisions of the preceding two paragraphs, when exceptionally approved by the Faculty Committee of the Graduate School under special circumstances, the student may stay enrolled beyond the regular enrollment period.

### Long-term enrollment

### Article 15

When a student wants to take courses systematically over a certain period of time beyond the regular period prescribed in Article 12, Paragraph 1, under certain circumstances such as full-time work, the Graduate School may allow the student to complete the program in a planned manner as prescribed separately.

(Partial revisions of Rule 39 of 2009)

## Chapter 5. Admission, etc.

### Admission, etc.

### Article 17

1. Matters concerning student status, such as admission, withdrawal, expulsion, transfer, study abroad, and leave of absence, shall be pursuant to the University Rules, except for provisions prescribed in the Graduate School Rules.
2. After deliberate of the Faculty Committee, the provost shall request to withdraw from school if a student falls under any of the following:
   (1) Exceeded the maximum enrollment period set forth in Article 14
   (2) Unable to return to school after the period of absence set forth in Article 19

### Leave of absence

### Article 19

1. The leave of absence cannot exceed the three years in total for each program.
3. Notwithstanding the provisions of the preceding two paragraphs, when exceptionally approved by the Faculty Committee under special circumstances, the student may remain absent beyond the preceded period of absence.
4. The period of absence shall not be factored in the maximum enrollment period for master's program or doctoral program set forth in Article 14, Paragraph 1.
6. In addition to the provision of the preceding paragraphs, the provisions of the University Rules shall apply mutatis mutandis to leaves of absence.

(Partial revisions of Rule 65 of 2008)

### Study abroad

### Article 20

1. A student may be allowed to study at a graduate school or research institute, etc., in a foreign country, based on an agreement or discussion with the other graduate school, etc., if the provost finds that it is academically beneficial for the student.
2. The permission set forth in the preceding paragraph shall be granted based on the student's application to study abroad and after discussion of the Faculty Committee of the Graduate School to which the student belongs.
3. The period of study abroad may be counted as the enrollment period.

## Chapter 6. Enrollment Requirements and Steps

### Assignment of a graduate/doctoral advisor

Article 21

After admission to the graduate school, each student (except low school students) shall be assigned a professor (hereinafter referred to as a "graduate/doctoral advisor") who will provide guidance to the student.

### Guidance from the graduate/doctoral advisor

Article 22

1. At the beginning of each academic year, students shall apply to attend courses for the academic year according to the instruction and need to be admitted for the course enrollment.
2. Students shall receive guidance from their graduate/doctoral advisors on selecting courses, writing theses, and conducting research.
3. When the graduate/doctoral advisor deems it necessary, the student may take specified courses.

### Credits

Article 23

The standards used for course credits in the graduate school shall be pursuant to the standards for course credits of the department.

### Credit requirements, etc.

Article 24

Credit requirements for courses set forth in the preceding article shall be as follows. The detailed rules shall be prescribed separately.

(1) Master's students must earn 30 or more credits during their enrollment.

(2) Doctoral students must earn 20 or more credits during their enrollment. However, doctoral students majored in Human Health Sciences in the Graduate School of Human Health Sciences must earn 14 or more credits during their enrollment.

(Partial revisions of Rule 192 of 2005, Rule 39 of 2009, Rule 30 of 2014, Rule 38 of 2015)

### Curriculum organization policy

Article 24-2

1. The graduate school shall establish courses necessary to achieve its educational objectives and formulate a plan to provide guidance on thesis and dissertations writing, etc. (hereinafter referred to as "research guidance"). The school shall also systematically organize the curriculum.
2. The graduate school shall give appropriate consideration to the curriculum that helps students acquire highly specialized knowledge and skills in the field of study and develop basic knowledge in the related fields.

(Addition of Rule 65 of 2006)

### Cross-disciplinary program of graduate school

Article 24-3

The TMU Graduate School Cross-Disciplinary Program (hereinafter referred to as the "Cross-Disciplinary Program") is explained with the aim of acquiring broad knowledge, a bird's-eye view, and applied skills that transcend graduate schools and departments, and enhancing cross-disciplinary research capabilities, in addition to the curriculum specified in the preceding Article, and the necessary matters are stipulated in the Program's regulations.

### General courses for all graduate programs

Article 24-4

1. In addition to the courses according to the preceding two articles, general courses for students of multiple graduate programs (hereinafter referred to as "general courses for all graduate programs") shall be offered in the graduate school.
2. If the graduate program deems it suitable for education, the credits earned through the general courses for all graduate programs may be counted toward the required credits for program completion as prescribed in Articles 30, 31, and 34. Provided, however, that these courses shall not be counted as the courses prescribed in the provisions of Article 30-2.

(Addition of Rule 17 of 2018)

### Systematic training to improve the curriculum, etc.

Article 24-5

The graduate school shall offer systematic training and research to improve the quality and process of the

course curriculum and research guidance.

(Addition to Rule 65 of 2006; Rule 28 of 2017 moved down from Article 24-3; Rule 17 of 2018 moved down from Article 24-4)

### Courses and credits awarded

### Article 25

1. The courses for each major in the graduate program and the number of credits to be awarded shall be as shown in Appended Table 3.
2. The courses for each major in Graduate School Interdisciplinary Programs and the number of credits to be awarded are set forth in the Graduate School Interdisciplinary Programs Rules.
3. The list of general courses for all graduate programs and the number of credits to be awarded shall be as shown in Appended Table 3-2.
4. In addition to the courses set forth in the preceding three paragraphs, the school may establish other courses with the approval of the Faculty Committee.

Appended table revisions of Rule 178 of 2005, Rule 192 of 2005, Rule 65 of 2006, Rule 71 of 2007, Rule 65 of 2008, Rule 39 of 2009, Rule 33 of 2010, Rule 17 of 2011, Rule 14 of 2012, Rule 16 of 2013, Rule 30 of 2014, Rule 19 of 2015; partial revisions and appended table revisions of Rule 28 of 2017, Rule 17 of 2018)

### Recognition of credits

### Article 26

Credit for courses shall be granted based on written or oral examinations or research reports and shall be awarded at the end of each semester or academic year.

### Course assessment

### Article 27

The provisions of Article 40 of the University Rules shall apply mutatis mutandis to course assessment of student performance.

### Clear presentation of grading criteria, etc.

### Article 27-2

1. The Graduate School shall present to students in advance the teaching method and details of the course and research as well as the class schedule and research guidance plan for the year.
2. In order to ensure objective and rigorous assessment, the Graduate School shall present to students in advance the grading criteria for evaluating the student's performance and thesis/dissertation and recognizing the program completion. In addition, the Graduate School shall adhere properly to said criteria.

(Addition of Rule 65 of 2006)

### Taking courses at other graduate schools, etc.

### Article 28

The acceptance of credits from courses taken at other graduate schools and previously attended institutions shall be pursuant to the provisions of Article 43, Paragraph 1 (also applies mutatis mutandis to Paragraph 2) and Article 45, Paragraphs 1 and 3 of the University Rules. In this case, the term "60 credits" in Article 43, Paragraph 1 of the University Rules shall be read as "10 credits." As to Article 45, Paragraph 3, the term "the previous two paragraphs" shall be read as "Paragraph 1," and the term "60 credits" shall be read as "10 credits."

(Partial revisions of Rule 192 of 2005, Rule 14 of 2012)

### Research guidance at other graduate schools or research institutes, etc.

### Article 29

If the provost finds that it is academically beneficial for the student, the student may be allowed to receive research guidance at another graduate school or research institute, etc., after having the Graduate Faculty Committee's approval and an agreement or discussion with the other graduate school or institution.

### Joint Research Guidance Program

### Article 29-2

1. If the President deems it educationally beneficial for a student to enroll in a graduate school of a foreign university under an agreement or consultation with the graduate school of the foreign university, and to undergo a program of research guidance and dissertation review jointly conducted by the graduate school of the University and the graduate school concerned (hereinafter referred to as "joint research guidance program") while maintaining his/her status as a student of the University, the President may permit the student to undergo the program after consultation with the faculty council of the graduate school to which the student belongs.
2. If there is a student from a graduate school of a foreign university who intends to take a joint research guidance program with the graduate school of TMU, the student may be admitted as an exchange student as stipulated in Article 67-2 of the TMU Academic Regulations, based on an agreement or consultation with the graduate school concerned.
3. When an exchange student accepted under the provisions of the preceding paragraph is recognized as having passed the thesis examination under the joint research guidance program with the graduate school of TMU, the President may, after discussion by the Faculty Council of the graduate school that accepted the exchange

student, award a certificate indicating that the student has completed the joint research guidance program.

## Chapter 7. Completion Requirements

### Completion requirements for the master's program

#### Article 30

1. In order to complete the master's program, students must complete the two-year enrollment period by attending regular classes, acquiring 30 or more credits of required courses in the master's program, submitting a thesis, and taking the final examination.
2. In the case of the preceding paragraph, if the graduate advisor considers it academically beneficial, up to 10 credits out of the 30 credits may be earned by taking the following courses as prescribed by each graduate school:
   - Non-major courses in the graduate program
   - Major courses in other graduate programs
   - Undergraduate courses
3. Of completion requirements set forth in Paragraph 1,
   as for the enrollment period for those who are recognized as delivering excellent research results, enrollment in the master's program for one year or more shall satisfy the requirement. In this case, if it is deemed appropriate for the purpose of the master's program, the evaluation of the research result on a certain topic may be substituted for the evaluation of a thesis.

(Partial revisions of Rule 65 of 2006, Rule 65 of 2008, Rule 28 of 2017)

### Completion requirements for the doctoral program

#### Article 31

1. In order to complete the doctoral program, the students must complete the three-year enrollment period by attending regular classes, acquiring 20 or more credits in the required courses in the doctoral program, submitting a dissertation, and taking the final examination. However, as for the enrollment period for those who are recognized as delivering exceptional research results, enrollment in the doctoral program for one year or more satisfies the requirement, except for those who fall under the following paragraph.
2. As for the enrollment period for those who have completed the master's program with a period of one year of enrollment under the provision of Paragraph 3 of the previous article, if the Faculty Committee of the relevant graduate program recognized the student as delivering excellent research results, enrollment in the doctoral program for two years or more shall satisfy the requirement.

(Partial revisions of Rule 192 of 2005)

### Final examination

#### Article 32

1. The thesis/dissertation and the final examination shall be evaluated by the graduate/doctoral advisor as the main evaluator and two or more course instructors as set forth in Article 9 nominated by the Graduate Faculty Committee and appointed by the provost.
2. The final examination shall be conducted for those who have acquired the required credits and submitted a thesis/dissertation.
3. The final examination set forth in the preceding paragraph shall be conducted primarily on the thesis/dissertation and written or oral examination of a course related to the thesis/dissertation.

### Pass/fail of the thesis/dissertation and final examination

#### Article 33

The pass/fail result of the thesis/dissertation and final examination shall be determined based on the evaluation report submitted by the Review Committee established by the Faculty Committee.

### Recognition of course completion and degree conferral

#### Article 35

1. For a student who has acquired the required credits set forth in Article 30 for the master's program and Article 31 for the doctoral program, and has passed the thesis/dissertation examination and the final examination, the provost shall authorize the program completion and confer a degree.

2. For an individual who has submitted a dissertation and doctorate application, the degree shall be conferred if the content of the dissertation is equivalent or higher quality than that is submitted under Article 31, Paragraph 1, and the examination result proves that the individual has broad academic knowledge and ability to guide research in the major field of study.
4. The degrees to be conferred under this article shall be prescribed separately.

### Obtaining teacher certification

### Article 36

1. In order to obtain teacher certification, the student must earn credits set forth in the School Teacher's License Act (Act No. 147 of 1949) and the Order for Enforcement of the School Teacher's License Act (Order of the Ministry of Education No. 26 of 1954).
2. The types and subjects offered in the graduate school to obtain teacher certification are listed in Appended Table 4.

(Appended table revisions of Rule 192 of 2005, Rule 65 of 2006, Rule 28 of 2017)

## Chapter 8. Awards and Punishments

### Awards and punishments

### Article 37

Awards and punishments shall be pursuant to the University Rules.

## Chapter 9. Tuition and Other Fees

### Tuition and other fees

### Article 38

1. Tuition fees, admission fees, entrance exam fees, certificate issuance fees, and thesis/dissertation examination fees, etc., shall be prescribed separately.
2. The provisions of Chapter 3 of the University Rules shall apply mutatis mutandis to the discount and waiver of admission fees and the payment method, installment payment, discount, waiver, etc. of tuition fees.

## Chapter 10. Non-Degree Students

### Non-degree students, etc.

### Article 39

Non-degree students and international students shall be prescribed separately.

### Supplementary provisions (29 Corporate Rules No. 28, February 22, 2018)

1. These rules shall come into effect as of April 1, 2018.
2. The provisions regarding the names of graduate programs, majors, academic domains, and completion requirements for students who were enrolled in the fields of study listed below as of March 31, 2018, and continue to be enrolled in the graduate program, etc. on or after April 1 of the same year, the previous provisions shall remain in effect.

- Graduate School of Social Sciences

- Graduate School of Science and Engineering

- Graduate School of Urban Environmental Sciences, Urban Environmental Sciences, Department of Geography and Environmental Sciences

- Graduate School of Urban Environmental Sciences, Urban Environmental Sciences, Department of Applied Chemistry

- Graduate School of Urban Environmental Sciences, Urban Environmental Sciences, Department of Urban System Science

- Graduate School of System Design, System Design, Department of Intelligent Mechanical Systems

- Graduate School of System Design, System Design, Department of Information and Communication Systems,

- Graduate School of System Design, System Design, Department of Management System Design

6. Notwithstanding the provisions of the revised Appended Table 4, the previous provisions shall remain in effect for
the types and subjects for teacher certifications for students who were enrolled as of March 31, 2018, and continue to be enrolled in the graduate program, etc., on or after April 1 of the same year.

Appended Table 1 for Article 4 (Partial revisions of Rule 192 of 2005, Rule 65 of 2006, Rule 28 of 2017)

1. Graduate programs

| Master's program | | Doctoral program | |
|---|---|---|---|
| Graduate Program | Major | Graduate Program | Major |
| Graduate School of Science | Mathematical Sciences<br>Physics<br>Chemistry<br>Biological Sciences | Graduate School of Science | Mathematical Sciences<br>Physics<br>Chemistry<br>Biological Sciences |

Appended Table 2 for Article 6 (Partial revisions of Rule 192 of 2005, Rule 65 of 2006, Rule 39 of 2009, Rule 33 of 2010, Rule 16 of 2013, Rule 28 of 2017)

1. Graduate programs

| Master's program | | | | Doctoral program | | | |
|---|---|---|---|---|---|---|---|
| Graduate School | Major | Max. Adm. | Max. Enroll | Graduate School | Major | Max. Adm. | Max. Enroll |
| Graduate School of Science | Mathematical Sciences | 25 | 50 | Graduate School of Science | Mathematical Sciences | 8 | 24 |
| | Physics | 35 | 70 | | Physics | 10 | 30 |
| | Chemistry | 35 | 70 | | Chemistry | 9 | 27 |
| | Biological Sciences | 40 | 80 | | Biological Sciences | 16 | 28 |

Appended Table 4 for Article 36 (Partial revisions of Rule 192 of 2005, Rule 65 of 2006, Rule 28 of 2017)

| Graduate School Master's Program | Major | Types and Subjects for Licenses | |
|---|---|---|---|
| | | Junior High School Teacher's License | High School Teacher's License |
| Graduate School of Science | Mathematical Sciences | Mathematics | Mathematics |
| | Physics<br>Chemistry<br>Biological Sciences | Elementary Science | Elementary Science |

Supplementary provisions The examples of Appended Table 1, Appended Table 2, and Appended Table 4 under the previous prevision (Corporate Rules 29 No. 28 of February 22, 2018) are as follows:

Appended Table 1 for Article 4 (Partial revisions of Rule 192 of 2005, Rule 65 of 2006)

1. Graduate programs

| Master's program | | Doctoral program | |
|---|---|---|---|
| Graduate School | Major | Graduate School | Major |
| Graduate School of Science and Engineering | Mathematics and Information Sciences<br>Physics<br>Molecular Materials Chemistry<br>Biological Sciences<br>Electrical and Electronic Engineering<br>Mechanical Engineering | Graduate School of Science and Engineering | Mathematics and Information Sciences<br>Physics<br>Molecular Materials Chemistry<br>Biological Sciences<br>Electrical and Electronic Engineering<br>Mechanical Engineering |

Appended Table 2 for Article 6 (Partial revisions of Rule 192 of 2005, Rule 65 of 2006, Rule 39 of 2009, Rule 33 of 2010, Rule 16 of 2013)

1. Graduate programs

| Master's program | | | | Doctoral program | | | |
|---|---|---|---|---|---|---|---|
| Graduate School | Major | Max. Adm. | Max. Enroll | Graduate School | Major | Max. Adm. | Max. Enroll |
| Graduate School of Science and Engineering | Mathematics and Information Sciences | 25 | 50 | Graduate School of Science and Engineering | Mathematics and Information Sciences | 8 | 24 |
| | Physics | 33 | 66 | | Physics | 9 | 27 |
| | Molecular Materials Chemistry | 33 | 66 | | Molecular Materials Chemistry | 9 | 27 |
| | Biological Sciences | 40 | 80 | | Biological Sciences | 16 | 48 |
| | Electrical and Electronic Engineering | 32 | 64 | | Electrical and Electronic Engineering | 6 | 18 |
| | Mechanical Engineering | 32 | 64 | | Mechanical Engineering | 6 | 18 |

Appended Table 4 for Article 36 (Partial revisions of Rule 192 of 2005, Rule 65 of 2006)

| Graduate School Master's Program | Major | Types and Subjects for Licenses | |
|---|---|---|---|
| | | Junior High School Teacher's License | High School Teacher's License |
| Graduate School of Science and Engineering | Mathematics and Information Sciences | Mathematics | Mathematics |
| | Physics<br>Molecular Materials Chemistry<br>Biological Sciences | Elementary Science | Elementary Science |
| | Electrical and Electronic Engineering<br>Mechanical Engineering | | Engineering |

Academic Year 2023

# Graduate Program and Course Outlines

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