Academic Year 2024

# Course Catalog

Graduate School of Science |

Tokyo Metropolitan University

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 kibaco when available.

△: The course is not offered in 2024.

# 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

**2024 Graduate School Course Catalog**
**General courses of the Graduate School of Science**

＊M = master's courses, D = doctoral courses
＊NA 2024 = Courses not offered in the academic year 2024

| Course outline No. | M | D | NA 2024 | Semester | Day | Time | Course Number | Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ○ | ○ | | Summer intensive | Other | | M(R0005) D(R0006) | Radiation Science I (lecture) | 2 | (Chemistry)KUBUKI Siro ＊Part-time | For all majors A retake is not allowed for students who took this course in the undergraduate program. |
| 2 | ○ | ○ | | Summer intensive | Other | | M(R0007) D(R0008) | Radiation Science II (experiment) | 1 | (Chemistry)KUBUKI Siro | For all majors A retake is not allowed for students who took this course in the undergraduate program. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Radiation Science I (lecture) | R0005 | Summer intensive | - | - | 2 |
| Doctoral program | Radiation Science I (lecture) | R0006 | | | | |

| Instructor(s) | Note |
|---|---|
| (Chemistry) KUBUKI Shiro, *Part-time lecturer | For all majors, a retake is not allowed for students who took this course in the undergraduate program. |

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|---|---|
| (1) Course policies and topics | This subject fosters the 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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Radiation Science II (experiment) | R0007 | Summer intensive | - | - | 1 |
| Doctoral program | Radiation Science II (experiment) | R0008 | | | | |

| Instructor(s) | Note |
|---|---|
| (Chemistry) KUBUKI Shiro | For all majors, a retake is not allowed for students who took this course in the undergraduate program. |

| | |
|---|---|
| (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. |

**2024 Graduate School Course Catalog**
**Graduate School of Science (Mathematical Sciences)**

＊M = master's courses, D = doctoral courses
＊NA 2024 = Courses not offered in the academic year 2024

| Course outline No. | M | D | NA 2024 | Semester | Day | Time | Course Number | Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ○ | | | 1st Semester | Thu. | 2 | M(R0011) | ＊Special Lectures in Algebra | 2 | UEHARA Hokuto | This course is also offered in the undergraduate program |
| 2 | ○ | | | 1st Semester | Fri. | 4 | M(R0012) | ＊Special Lectures in Algebra | 2 | TOKUNAGA Hiro-o | This course is also offered in the undergraduate program |
| 3 | ○ | | | 2nd Semester | Mon. | 3 | M(R0013) | ＊Special Lectures in Algebra | 2 | KURODA Shigeru | This course is also offered in the undergraduate program |
| 4 | ○ | | | 1st Semester | Tue. | 3 | M(R0014) | ＊Special Lectures in Geometry | 2 | FUKAYA Tomohiro | This course is also offered in the undergraduate program |
| 5 | ○ | | | 2nd Semester | Thu. | 3 | M(R0015) | ＊Special Lectures in Geometry | 2 | KOBAYASHI Masanori | This course is also offered in the undergraduate program |
| 6 | ○ | | | 2nd Semester | Thu. | 2 | M(R0016) | ＊Special Lectures in Geometry | 2 | SAKAI Takashi | This course is also offered in the undergraduate program |
| 7 | ○ | | | 1st Semester | Mon. | 2 | M(R0017) | ＊Special Lectures in Analysis | 2 | YOSHITOMI Kazushi | This course is also offered in the undergraduate program |
| 8 | ○ | | | 1st Semester | Mon. | 3 | M(R0018) | ＊Special Lectures in Analysis | 2 | ISHITANI Kensuke | This course is also offered in the undergraduate program |
| 9 | ○ | | | 2nd Semester | Mon. | 2 | M(R0019) | ＊Special Lectures in Analysis | 2 | SEKI Yukihiro | This course is also offered in the undergraduate program |
| 10 | ○ | | | 1st Semester | Wed. | 4 | M(R0020) | ＊Special Lectures in Applied Mathematics | 2 | SUZUKI Toshio | This course is also offered in the undergraduate program |
| 11 | ○ | | | 2nd Semester | Tue. | 3 | M(R0021) | ＊Special Lectures in Applied Mathematics | 2 | UCHIDA Yukihiro | This course is also offered in the undergraduate program |
| 12 | ○ | | | 2nd Semester | Mon. | 4 | M(R0022) | ＊Special Lectures in Applied Mathematics | 2 | YOKOYAMA Shunichi | This course is also offered in the undergraduate program |
| | ○ | (○) | △ | #N/A | #N/A | | M(R0023) | ＊Advanced Topics in Algebra 1 | 1 | | |
| 13 | ○ | (○) | | 1st Semester | Fri. | 2 | M(R0095) | ＊Advanced Topics in Algebra 2 | 2 | TSUMURA Hirofumi | |
| 14 | ○ | (○) | | 1st Semester | Thu. | 3 | M(R0025) | ＊Advanced Topics in Geometry 1 | 1 | HISAMOTO Tomoyuki | |
| 15 | ○ | (○) | | 2nd Semester | Tue. | 4 | M(R0027) | ＊Advanced Topics in Geometry 2 | 2 | FUKAYA Tomohiro | |
| 16 | ○ | (○) | | 2nd Semester | Fri. | 2 | M(R0029) | ＊Advanced Topics in Analysis 1 | 1 | SEKI Yukihiro | |
| 17 | ○ | (○) | | 1st Semester | Mon. | 4 | M(R0031) | ＊Advanced Topics in Analysis 2 | 2 | SVADLENKA Karel | |
| 18 | ○ | (○) | | 2nd Semester | Fri. | 4 | M(R0049) | ＊Advanced Topics in Applied Mathematics 1 | 1 | SUZUKI Toshio | |
| | ○ | (○) | △ | | | | M(R0051) | ＊Advanced Topics in Applied Mathematics 2 | 2 | | |
| | ○ | (○) | | 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 | ○ | (○) | | 1st Semester | Wed. | 3 | M(R0033) | ◎Exercises in Mathematical Sciences | 1 | SAKAI Takashi | Searching and collecting information on mathematics |
| 20 | ○ | | | Summer intensive | | | M(R0034) | ◎Seminar in Mathematical Sciences 1 | 3 | Multiple instructors | |
| 20 | ○ | | | Winter intensive | | | M(R0035) | ◎Seminar in Mathematical Sciences 2 | 3 | Multiple instructors | |
| 20 | ○ | | | Summer intensive | | | M(R0036) | ◎Seminar in Mathematical Sciences 3 | 3 | Multiple instructors | |
| 20 | ○ | | | Winter intensive | | | M(R0037) | ◎Seminar in Mathematical Sciences 4 | 3 | Multiple instructors | |
| 22 | ○ | | | Intensive course | | | M(R0045) 1 unit M(R0047) 2 units | ＊Internship | 1 or 2 | Multiple instructors | |
| 23 | ○ | | | Intensive course | | | M(R0817) 1 unit M(R0819) 2 units | ＊Internship | 1 or 2 | Multiple instructors | |
| | (○) | ○ | △ | | | | D(R0024) | ＊Advanced Topics in Algebra 1 | 1 | | |
| 13 | (○) | ○ | | 1st Semester | Fri. | 2 | D(R0096) | ＊Advanced Topics in Algebra 2 | 2 | TSUMURA Hirofumi | |
| 14 | (○) | ○ | | 1st Semester | Thu. | 3 | D(R0026) | ＊Advanced Topics in Geometry 1 | 1 | HISAMOTO Tomoyuki | |
| 15 | (○) | ○ | | 2nd Semester | Tue. | 4 | D(R0028) | ＊Advanced Topics in Geometry 2 | 2 | FUKAYA Tomohiro | |
| 16 | (○) | ○ | | 2nd Semester | Fri. | 2 | D(R0030) | ＊Advanced Topics in Analysis 1 | 1 | SEKI Yukihiro | |
| 17 | (○) | ○ | | 1st Semester | Mon. | 4 | D(R0032) | ＊Advanced Topics in Analysis 2 | 2 | SVADLENKA Karel | |
| 18 | (○) | ○ | | 2nd Semester | Fri. | 4 | D(R0050) | ＊Advanced Topics in Applied Mathematics 1 | 1 | SUZUKI Toshio | |

| Course outline No. | M | D | NA 2024 | Semester | Day | Time | Course Number | Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (○) | ○ | △ | | | | D(R0052) | *Advanced Topics in Applied Mathematics 2 | 2 | | |
| | (○) | ○ | | intensive | | | | *Intensive Lectures in Algebra 1 | 1 | | |
| | (○) | ○ | | intensive | | | | *Intensive Lectures in Algebra 2 | 2 | | |
| | (○) | ○ | | intensive | | | | *Intensive Lectures in Geometry 1 | 1 | | |
| | (○) | ○ | | intensive | | | | *Intensive Lectures in Geometry 2 | 2 | | |
| | (○) | ○ | | intensive | | | | *Intensive Lectures in Analysis 1 | 1 | | |
| | (○) | ○ | | intensive | | | | *Intensive Lectures in Analysis 2 | 2 | | |
| | (○) | ○ | | intensive | | | | *Intensive Lectures in Applied Mathematics 1 | 1 | | |
| | (○) | ○ | | intensive | | | | *Intensive Lectures in Applied Mathematics 2 | 2 | | |
| 19 | | ○ | | 1st Semester | Wed. | 3 | D(R0038) | Special Exercises in Mathematical Sciences | 1 | SAKAI Takashi | Searching and collecting information on mathematics |
| 21 | | ○ | | Summer intensive | | | D(R0039) | ◎Advanced Seminar in Mathematical Sciences 1 | 4 | Multiple instructors | |
| 21 | | ○ | | Winter intensive | | | D(R0040) | ◎Advanced Seminar in Mathematical Sciences 2 | 4 | Multiple instructors | |
| 21 | | ○ | | Summer intensive | | | D(R0041) | ◎Advanced Seminar in Mathematical Sciences 3 | 3 | Multiple instructors | |
| 21 | | ○ | | Winter intensive | | | D(R0042) | ◎Advanced Seminar in Mathematical Sciences 4 | 3 | Multiple instructors | |
| 21 | | ○ | | Summer intensive | | | D(R0043) | ◎Advanced Seminar in Mathematical Sciences 5 | 2 | Multiple instructors | |
| 21 | | ○ | | Winter intensive | | | D(R0044) | ◎Advanced Seminar in Mathematical Sciences 6 | 2 | Multiple instructors | |
| 22 | | ○ | | Intensive course (period TBD) | | | D(R0046) 1 unit D(R0048) 2 units | *External Experience in Mathematical Sciences | 1 or 2 | Multiple instructors | |
| 23 | | ○ | | Intensive course (period TBD) | | | D(R0818) 1 unit D(R0820) 2 units | *Internship | 1 or 2 | Multiple instructors | |

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

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lectures in Algebra (1) | M(R0011) | 1st Semester | Thu. | 2 | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | | Note |
|---|---|---|
| UEHARA Hokuto | | This course is also offered in the undergraduate program. |

| | | |
|---|---|---|
| (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 | | 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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lectures in Algebra | M(R0012) | 1st Semester | Fri. | 4 | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
|---|---|
| TOKUNAGA, Hiro-o | This course is also offered in the undergraduate program. |

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|---|---|
| (1) Course policies and topics | The theory of Groebner bases have many applications not only in algebra but also in various fields in mathematics. In this course, students first learn some basic results on the theory of Groenber bases. Afterward, various applications are explained. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Students learn basic knowledge on Groebner bases and their applications. The course goal is to acquire ability to make use of such knowledge to solve various problems |
| (3) Course schedule, subject matter, and classroom activities | 1. Overview. Ideals.<br>2. Monomial orderings.<br>3. A division algorithms and monomial orderings<br>4. Dickson's Lemma and Groebner bases.<br>5. Properties of Groebner bases and the Hilbert Basis Theorem.<br>6, 7, 8. Buchberger's criterion and Buchberger's algorithm.<br>9.10. Elimination Theory and Groebner bases.<br>11, 12, 13, 14. Applications.<br>15. Review.<br>For 1 -10, lectures are given based on [CLO] below. For 11-14, suitable references will be given |
| (4) Outside-class activities and assignments | Those who attend at the class are expected to work with some assignments. |
| (5) Textbooks and course materials | [CLO] D. Cox, J. Little and D. O'Shea: Ideals, Varieties and Algorithms, 4th edition. Springer.<br>(The 4th edition is strongly recommended) |
| (6) Assessment and grading | Attendance(oral report) and assignments |
| (7) Questions to the instructor (Office hours, etc.) | Those who have questions are supposed to make appointments via email. The instructor's email address will be given in the 1st lecture. |
| (8) Special note | Those who are interested in this course are supposed to have some knowledge on commutative algebra. As, applications are involved with various field, students are strongly encouraged to learn various fields (including computer sciences and programming). |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lectures in Algebra | M(R0013) | 2nd Semester | Mon. | 3 | 2 |
| Doctoral program | | | | | | |

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

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|---|---|
| (1) Course policies and topics | I will give lectures on some interesting topics in commutative algebra and related fields, with introducing some basic concepts. No much prior knowledge is assumed. The necessary concepts in algebra are reviewed when they are used. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Learn about the following items and know the deep world of commutative algebra and related fields: integral extension of rings, Noetherian ring, Hilbert's basis theorem, finite generation of a ring, polynomial ring and its coefficient ring, invariant ring, convex polyhedral cone, Gordan's lemma, monoid algebra |
| (3) Course schedule, subject matter, and classroom activities | 1. Introduction: symmetric polynomials and elementary symmetric polynomials<br>2. Extensions and generations of commutative rings<br>3. Monic polynomials and integral extensions<br>4. Noetherian rings and Noetherian modules<br>5. A criterion for finite generation of commutative rings<br>6. Application 1: The kernel of a derivation<br>7. Application 2: Invariant theory for finite groups<br>8. Elementary automorphisms of a polynomial ring<br>9. Polynomial rings and their coefficient rings<br>10. Convex polyhedral cones<br>11. Gordan's lemma<br>12. Monoid algebras<br>13. Subfields and Hilbert's 14th Problem<br>14. A criterion for non-finite generation of commutative rings<br>15. Summary and supplement<br>(Contents may change depending on the student's situation) |
| (4) Outside-class activities and assignments | The explanation will be given based on the lecture materials. Homework is assigned to confirm comprehension.<br>Homework,<br>Review of the previous lecture |
| (5) Textbooks and course materials | Distribute lecture materials on Kibaco |
| (6) Assessment and grading | Evaluation will be based on homework, term report, and class participation (100%).<br>In homework and term report, students are evaluated on whether they understand specialized knowledge, use it comprehensively to think about problems from multiple perspectives, determine the essence of the problem to be solved, and logically express their ideas. |
| (7) Questions to the instructor (Office hours, etc.) | Contact by email etc. Office hours will be announced in class. |
| (8) Special note | Prior knowledge is not required, but a basic knowledge of ring and module theory is helpful. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lectures in Geometry (1) | M(R0014) | 1st Semester | Tue. | 3 | 2 |
| Doctoral program | | | | | | |

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

| | |
|---|---|
| (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | *Special Lectures in Geometry (2) | M(R0015) | 2nd Semester | Thu. | 3 | 2 |
| Doctoral program | – | – | | | | |

| Instructor(s) | Note |
|---|---|
| KOBAYASHI Masanori | This course is also offered in the undergraduate program. |

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|---|---|
| (1) Course policies and topics | **Introduction to Lie groups, Lie algebras and their representations**<br>A Lie group is both an algebraic and geometric object; it is a group describing a continuous (analytic) symmetry of a space, and a manifold with symmetry. The main properties of Lie groups can be studied through Lie algebra. Functions on spaces with symmetry are described using representations. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | One can learn the fundamentals of basic Lie groups and Lie algebras and their representations, while becoming familiar with concrete examples using matrices. |
| (3) Course schedule, subject matter, and classroom activities | We first study the basic Lie groups, Lie algebras and their representations in detail. Then the general theory will be outlined, especially for compact Lie groups.<br><br>Schedule:<br>1. Rotation group SO(3)<br>2. Exponential functions of matrices<br>3. Lie algebra so(3)<br>4. SU(2) and spin<br>5. Sp(1) and quaternions<br>6. su(3) and root systems<br>7. Representation of sl(2,C)<br>8--9. Lie groups and exponential maps, linear Lie groups and Lie algebras<br>10--12. Properties of complex semisimple Lie algebras<br>13--15. Root systems<br>the order and contents may be slightly changed.<br><br>Method of teaching:<br>The class will be conducted through a combination of lectures and assignments. |
| (4) Outside-class activities and assignments | Assignments to review the class content should be submitted to kibaco (LMS). |
| (5) Textbooks and course materials | As a reference book for the first half (up to the 7th lecture)<br>“Lie Groups and Lie algebras in exercise form," SGC Library 88, Shin-ichi Shimeno, Science, 2012 (in Japanese).<br>As a comprehensive reference book including the latter half,<br>“Lie groups and representation theory," Toshiyuki Kobayashi and Toshio Oshima, Iwanami Shoten, 2005 (in Japanese).<br>As an English textbook,<br>“Lie Groups, Lie Algebras, and Representations, An Elementary Introduction”, Brian C. Hall, Springer, 2015. |
| (6) Assessment and grading | Class participation and report 100%.<br>Mainly, the evaluation will be based on whether the student has mastered the basic concepts of Lie groups, Lie algebras and their representations, and whether the student is able to compute and prove things using fundamental theorems. |
| (7) Questions to the instructor (Office hours, etc.) | Office hours will be announced at the first class. |
| (8) Special note | The basic content of manifold theory (definition of tangent space) is used. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lectures in Geometry | M(R0016) | 2nd Semester | Thu. | 2 | 2 |
| Doctoral program | — | — | | | | |

| Instructor(s) | Note |
|---|---|
| SAKAI Takashi | This course is also offered in the undergraduate program. |

| | |
|---|---|
| (1) Course policies and topics | A linear connection, which defines the covariant derivation of a vector field, is obtained by considering the parallel translation of tangent vectors on a differentiable manifold. The concept of a linear connection is generalized to the notion of connections on vector bundles. Various geometric structures on a differentiable manifold can be described in terms of connections on vector bundles. In this class, we study the theory of connections on vector bundles, which is the foundation of modern differential geometry. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The goal of this course is to study the theory of connections on vector bundles, and to lean basics of differential geometry, such as connections, curvatures, fiber metrics, and parallel translations. |
| (3) Course schedule, subject matter, and classroom activities | 1. Review of the theory of differentiable manifolds<br>2. Tensor fields on manifolds<br>3. Parallel translation and covariant derivative of tangent vectors<br>4. Linear connections<br>5. Covariant derivative of tensor fields<br>6. Riemannian manifolds<br>7. The Levi-Civita connection<br>8. Vector bundles<br>9. Dual vector bundle, tensor product of vector bundles and pull-back bundle<br>10. Connections on vector bundles<br>11. Connections on the dual vector bundle, tensor product of vector bundles and pull-back bundle<br>12. Exterior covariant derivative and curvature<br>13. Fiber metrics<br>14. Parallel translations and holonomy group<br>15. Summary of the course |
| (4) Outside-class activities and assignments | Preparation and review on the lecture notes and references |
| (5) Textbooks and course materials | H. Konno, Differential Geometry, The University of Tokyo Press<br>S. Kobayashi, Differential Geometry of Connections and Gauge Theory, Shokabo.<br>L.W. Tu, Differential Geometry: Connections, Curvature, and Characteristic Classes, Springer<br>C.H. Taubes, Differential Geometry: Bundles, Connections, Metrics and Curvature, Oxford University Press |
| (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://tsakai.fpark.tmu.ac.jp/ |
| (8) Special note | It is desirable to know differentiable manifolds, vector fields and differential forms. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lectures in Analysis | M(R0017) | 1 st Semester | Mon. | 2 | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
|---|---|
| YOSHITOMI Kazushi | 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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | *Special Lectures in Analysis | M(R0018) | 1 st Semester | Mon. | 3 | 2 |
| Doctoral program | | | | | | |

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

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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 has questions, make an appointment via email. (k-ishitani@tmu.ac.jp) |
| (8) Special note | Check the information of this class on kibaco. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lectures in Analysis (3) | M(R0019) | 2nd Semester | Mon. | 2 | 2 |
| Doctoral program | | | | | | |

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

| | |
|---|---|
| (1) Course policies and topics | We 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.Distribution, derivatives of distribution<br>3.The rapidly decreasing functions, the inversion formula of the Fourier transform<br>4.Tempered distributions and their Fourier transform<br>5.Sobolev spaces and their fundamental properties<br>6.Sobolev's embedding theorem<br>7.Sobolev's inequality, the compactness theorem<br>8.Elliptic boundary value problems (Part 1)<br>9. Elliptic boundary value problems (Part 2)<br>10.Extension theorem<br>11.Elliptic regularity theory for weak solutions (Part 1)<br>12.Elliptic regularity theory for weak solutions (Part 2)<br>13.Eigenvalue problems<br>14.Fredholm theory<br>15.Summary |
| (4) Outside-class activities and assignments | This is a lecture-centered course. Solving exercises (report) helps students in understanding the subject. Complementary notes will be provided in kibaco when necessary, for which each student should register by the first lecture. Making original notes by yourself will help you to understand the subject. Deep consideration of definitions and examples are recommended. |
| (5) Textbooks and course materials | 1.A course in Sobolev Spaces -with applications to Partial Differential Equations, by S. Miyajima, KyoritsuShuppan, Co., Ltd. (in Japanese)<br>2. Functional Analysis and Partial Differential Equations, by H. Brezis, Springer<br>(e-Book is available at the Mathematical Library)<br>3. Partial Differential Equations, by L.C. Evans, Amer. Mas. Soc. |

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| (6) Assessment and grading | Evaluation is performed by two intermediate reports and a final report. The problems will be uploaded to kibaco. |
| (7) Questions to the instructor (Office hours, etc.) | Office hour is Time 5 on Monday. |
| (8) Special note | Basic knowledges in the Lebesgue integration theory and the functional analysis are required. Confirm basic knowledge on the theory of Hilbert spaces. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lectures in Applied Mathematics | R0020 | 1st Semester | Wed. | 4 | 2 |
| Doctoral program | --- | --- | | | | |

| Instructor(s) | Note |
|---|---|
| SUZUKI Toshio | This course is also offered in the undergraduate program. |

| | |
|---|---|
| (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 the first incompleteness theorem of Gödel. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | We learn Gödel's incompleteness theorem in a modern framework rather than in a manner faithful to the original paper (logical thinking skills). Historically, computability theory was born after the incompleteness theorem, but the students will learn the rudiments of computability theory first to improve their outlook. The main goal of this class is to understand exactly what the first incompleteness theorem asserts and to understand the outline of the proof (basic knowledge and understanding of the specialized field) for the system PA of Peano arithmetic. |
| (3) Course schedule, subject matter, and classroom activities | 1-3. Rudiments of computability theory<br>4-5. Formalized Peano arithmetic<br>6-8. Sigma-1-completeness and representability<br>9-11. Provability predicate and diagonalization<br>12-13. The first incompleteness theorem<br>14-15. Advanced topics |
| (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 3, University of Tokyo Press, 2007 (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: Wolfgang Rautenberg: A concise introduction to mathematical logic, Third edition, Springer, 2010.<br>- Check the information of this course on kibaco. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lectures in Applied Mathematics (2) | M(R0021) | 2nd Semester | Tue. | 3 | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
|---|---|
| UCHIDA Yukihiro | This course is also offered in the undergraduate program. |

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|---|---|
| (1) Course policies and topics | Elliptic curves defined as plane cubic curves are one of important research subjects in modern number theory. Elliptic curves are also used in various number theoretic algorithms and have broad applications. Moreover, there are various studies on hyperelliptic curves which are generalizations of elliptic curves since we can apply to them techniques similar to ones for elliptic curves. In this course, the instructor will give lectures on elliptic curves and hyperelliptic curves as generalizations of elliptic curves with applications of these curves. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The purpose of this course is to acquire the theory of elliptic and hyperelliptic curves and to understand their applications. |
| (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. The definition of elliptic curves<br>3. Points of finite order and endomorphisms<br>4. Division polynomials<br>5. Pairings and Hasse's theorem<br>6. Point counting on elliptic curves<br>7. Applications of elliptic curves<br>8. The definition of hyperelliptic curves and rational functions<br>9. Divisors on hyperelliptic curves<br>10. Semi-reduced and reduced divisors<br>11. The Jacobians of hyperelliptic curves<br>12. Addition algorithm of divisors<br>13. Jacobians over finite fields<br>14. Applications of hyperelliptic curves<br>15. Summary and supplement |
| (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>S. Tsujii and M. Kasahara eds., Cryptography and Elliptic Curves, Morikita Publishing, 2008. (Japanese).<br>N. Koblitz, Algebraic Aspects of Cryptography, Springer, 1998.<br>L. C. Washington, Elliptic Curves: Number Theory and Cryptography, Chapman & Hall/CRC, 2nd ed., 2008. |
| (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://y-uchida.fpark.tmu.ac.jp/ |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lectures in Applied Mathematics | M(R0022) | 2nd Semester | Mon. | 4 | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
|---|---|
| YOKOYAMA Shunichi | This course is also offered in the undergraduate program. |

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|---|---|
| (1) Course policies and topics | Course theme: Modularity from the viewpoint of computational number theory<br><br>Modularity is a phenomenon that there is some 1:1 correspondence between algebraic, analytic, and geometric objects. More precisely, elliptic curves, modular forms, and Galois representations are main tools to understand modularity properties. In this course, we will prepare basic theory of these objects and how to handle them as "computable" objects. In particular, fundamental knowledge to use computer algebra system will be given. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Understanding modularity and related topics from the viewpoint of computational number theory.<br>How to use computer algebra system to compute elliptic curves, modular forms, and Galois representations. |
| (3) Course schedule, subject matter, and classroom activities | 1. Overview of the modularity<br>2. Elliptic curves (1)<br>3. Elliptic curves (2)<br>4. Elliptic curves (3)<br>5. Modular forms (1)<br>6. Modular forms (2)<br>7. Modular forms (3)<br>8. Computer algebra system: a guide tour<br>9. Modularity conjecture<br>10. L-function<br>11. Birch and Swinnerton-Dyer conjecture<br>12. Galois representations<br>13. Serre's conjecture (Khare-Wintenberger's thoerem)<br>14. Advanced topics: generalizations<br>15. Summary and ongoing projects |
| (4) Outside-class activities and assignments | Access papers and proceedings actively to understand topics. |
| (5) Textbooks and course materials | No textbooks / References will be given. |
| (6) Assessment and grading | Final report 100% |
| (7) Questions to the instructor (Office hours, etc.) | Please contact before/after the class or by email: s-yokoyama@tmu.ac.jp |
| (8) Special note | Basic knowledge of algebra (groups, rings, and fields) is required.<br>Skills of computer algebra system are NOT required. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced Topics in Algebra 2 | M(R0095) | 1st Semester | Fri. | 2 | 2 |
| Doctoral program | Advanced Topics in Algebra 2 | D(R0096) | | | | |

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

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|---|---|
| (1) Course policies and topics | The main topic of this course is the theory of zeta functions of root systems. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Assume a foundation in complex analysis, basic Lie algebra theory, and the fundamentals of the Riemann zeta function. The purpose of this course is to develop the ability to apply complex analysis through the study of zeta functions of root systems. |
| (3) Course schedule, subject matter, and classroom activities | The schedule of this course is as follows. The following schedule may be subject to change.<br>1-3: Multiple zeta functions and Bernoulli polynomials<br>4-6: Tornheim's multiple zeta functions<br>7-8: Root systems and Weyl groups<br>9-10: Zeta functions of root systems<br>11-12: Examples of type A and B<br>13-14: Functional equations and remarks<br>15: Summary and Exercises |
| (4) Outside-class activities and assignments | Solve the practice problems given during class. |
| (5) Textbooks and course materials | E. M. Stein and R. Shakarchi: Complex Analysis, (Princeton Univ Press), 2003<br>H. Samelson: Notes on Lie Algebras (Springer), 1990<br>Y. Komori, et al: The Theory of Zeta-Functions of Root Systems (Springer), 2023 |
| (6) Assessment and grading | Exercises 80%, class participation and activity 20% |
| (7) Questions to the instructor (Office hours, etc.) | Inquire via the email address provided during class for consultations. |
| (8) Special note | This course is related to complex analysis and the theory of Lie algebras. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced Topics in Geometry I | M(R0025) | 1st Semester | Thu. | 3 | 1 |
| Doctoral program | Advanced Topics in Geometry I | D(R0026) | | | | |

| Instructor(s) | Note |
|---|---|
| HISAMOTO Tomoyuki | |

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|---|---|
| (1) Course policies and topics | We will explain about geometry of theta functions. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Compact Riemann surfaces, or equivalently, algebraic curves, are the most fundamental objects in view of complex analysis, algebraic geometry, and number theory. Theta function gives a homogeneous coordinates of Jacobian varieties which is the abelianization of these objects. |
| (3) Course schedule, subject matter, and classroom activities | 1. Periods of elliptic curves<br>2. About Riemann surfaces Riemann<br>3. Theorem of Abel-Jacobi<br>4. Principally polarized Abelian varieties<br>5. Theta functions<br>6. Riemann's decomposition theorem<br>7. Torelli's theorem<br>8. Jacobian of hyperelliptic curves, if we have time. |
| (4) Outside-class activities and assignments | Review each lectures. |
| (5) Textbooks and course materials | ・Carlson, Mueller-Stach, and Peters: Period Mappings and Period Domains<br>・Mumford: Curves and their Jacobians<br>・Mumford: Tata Lectures on Theta I, II<br>・Beauville: Theta functions Old and New<br>・Birkenhake: Complex Abelian Varieties<br>・McKean and Moll: Elliptic Curves<br>・Harris: Moduli of Curves |
| (6) Assessment and grading | 40% class participation, 60% reports. |
| (7) Questions to the instructor (Office hours, etc.) | Let me explain about this in the first lecture. |
| (8) Special note | It will be nice if you know about complex analysis, manifolds, and cohomology theory. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | *Advanced Topics in Geometry 2 | M(R0027) | 2nd Semester | Tue. | 4 | 2 |
| Doctoral program | *Advanced Topics in Geometry 2 | M(R0027) | | | | |

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

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|---|---|
| (1) Course policies and topics | Geometric group theory is the study of infinite groups from the view point of geometry. We focus on the theory of hyperbolic groups established by Gromov. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Basic notion of coarse geometry, such as coarse maps and coarse equivalences, quasi-isometries. |
| (3) Course schedule, subject matter, and classroom activities | The plan of this course is the following:<br>1. Overview<br>2. Quasi-isometries and quasi-geodesics<br>3. Word metrics and Cayley graphs of finitely generated groups<br>4. Schwarz-Milnor lemma<br>5. Hyperbolic plane and Linear fractional transformation<br>6. Gromov hyperbolic space -- Gromov product<br>7. Hyperbolicity characterized by geodesics -- thin triangles<br>8. Morse lemma<br>9. Toy model: the boundary of the tree<br>10. Boundaries of Gromov hyperbolic spaces: three definitions<br>11. Topology of the boundary<br>12. Busemann functions<br>13. Classification of isometries<br>14. coarsely convex spaces<br>15. injective metric spaces |
| (4) Outside-class activities and assignments | he 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 | Reference books:<br>John Roe Lectures on Coarse Geometry Amer Mathematical Society<br>Ghys, de la Harpe Sur les groupes hyperboliques d'après Mikhael Gromov<br>Clara Löh Geometric group theory Springer<br>John Meier Groups, graphs and trees Cambridge University Press |
| (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 |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced topics in Analysis 1 | M(R0029) | 2nd Semester | Fri. | 2 | 1 |
| Doctoral program | | | | | | |

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

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|---|---|
| (1) Course policies and topics | Some organisms respond to chemical concentration of attractive signals and move to a particular direction. This phenomenon is called chemotaxis, and we call its model chemotaxis equations. In this lecture, we study mathematical analysis for the Keller--Segel system proposed in 1970s, a classical model of chemotaxis equations, which describes aggregation phenomenon of biological organisms in the event of their starvation state. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Get an ability of using basic knowledges of analysis in the course of analyzing a typical mathematical model described by nonlinear partial differential equations. |
| (3) Course schedule, subject matter, and classroom activities | 1. Introduction of chemotaxis equations<br>2. Keller--Segel system: fundamental properties of solutions<br>3. Global solutions (Part 1)<br>4. Global solutions (Part 2)<br>5. Blow-up and aggregation<br>6. Finite-time blow-up<br>7. Partial regularity<br>8. Summary |
| (4) Outside-class activities and assignments | Some elementary computations and proofs will be omitted in lecture. Confirmation of the details are left to students. |
| (5) Textbooks and course materials | Blow-up and aggregation, edited by E. Yanagida, Tokyo university Shuppan (in Japanese), 2006. |
| (6) Assessment and grading | Evaluation is performed by intermediate and final reports. |
| (7) Questions to the instructor (Office hours, etc.) | Office hour is Time 5 on Monday. |
| (8) Special note | It is desirable to have Basic knowledges in the theory of functional analysis (Special lecture of analysis 1). Students are assumed to be familiar with computations using basic vector analysis, ordinary differential equations, and applications of Fourier analysis to differential equations. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced Topics in Analysis 2 | M(R0031) | 1st Semester | Mon. | 4 | 2 |
| Doctoral program | Advanced Topics in Analysis 2 | D(R0032) | | | | |

| Instructor(s) | Note |
|---|---|
| SVADLENKA Karel | |

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|---|---|
| (1) Course policies and topics | In this lecture, we will investigate basic properties of optimization problems that are the main object of study of the mathematical field called calculus of variations.<br>Variational problems are closely connected to the theory of ordinary and partial differential equations, and have wide applications ranging from machine learning to mathematical modeling of natural phenomena. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In the first part, we will study the classical theory of variational analysis due to Euler and Lagrange. The goal is to understand conditions characterizing solutions to optimization problems and apply this knowledge to solving specific optimization problems.<br>In the second part, we will concentrate on the theory of existence of optimal solutions in function spaces and on applying this theoretical knowledge to the analysis of variational problems appearing in various scientific fields such as continuum mechanics. |
| (3) Course schedule, subject matter, and classroom activities | Lecture content (according to the progress of the lecture, some topics may be omitted or added)<br>Week 1: Examples of variational problems, notion of local and global extrema, Euler-Lagrange equation<br>Week 2: Variational problems with constraints<br>Weeks 3-5: Sufficient and necessary conditions for extrema<br>Week 6: Minimization problems over functions of one variable: function spaces<br>Week 7: Minimization problems over functions of one variable: Lipschitz functions<br>Week 8: Minimization problems over functions of one variable: absolutely continuous functions, direct method, Tonelli's existence theorem<br>Weeks 9-10: Minimization problems over functions of one variable: relation between convexity and lower semicontinuity of functionals<br>Week 11: Minimization problems over functions of several variables: Sobolev spaces<br>Week 12: Minimization problems over functions of several variables: Tonelli-Serrin existence theorem<br>Week 13: Minimization problems over functions of several variables: relation between generalized notions of convexity and lower semicontinuity of functionals<br>Week 14: Minimization problems over functions of several variables: Euler-Lagrange equation revisited<br>Week 15: Advanced topics (Young measures, relaxation of functionals, gradient flows, optimal control, numerical methods, etc.)<br><br>Classes will be conducted in lecture form but students are expected to deepen their knowledge through solving exercise problems and assignments. |
| (4) Outside-class activities and assignments | About 3 assignments will be given during the semester.<br>At least 3 hours of review and preparation per week are required to be able to follow the lecture. |
| (5) Textbooks and course materials | No textbooks will be used. Reference books:<br>Mark Kot, A first course in the calculus of variations, AMS, 2014. ISBN: 978-1-4704-1495-5 (e-book available)<br>Francis Clarke, Functional analysis, calculus of variations and optimal control, Springer, 2013. ISBN: 978-1-4471-4819-7 (e-book available)<br>Filip Rindler, Calculus of variations, Springer, 2018. ISBN: 978-3-319-77636-1 (e-book available) |
| (6) Assessment and grading | Evaluation will be based mainly on assignments. |
| (7) Questions to the instructor (Office hours, etc.) | Consultation hours will be announced in the first lecture. Regardless of these hours, the lecturer is available for discussion whenever present in the office. |
| (8) Special note | The lecture will be easier to follow with basic knowledge of functional analysis and differential equations. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lectures in Applied Mathematics | R0020 | 1st Semester | Wed. | 4 | 2 |
| Doctoral program | --- | --- | | | | |

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

| | |
|---|---|
| (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 the first incompleteness theorem of Gödel. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | We learn Gödel's incompleteness theorem in a modern framework rather than in a manner faithful to the original paper (logical thinking skills). Historically, computability theory was born after the incompleteness theorem, but the students will learn the rudiments of computability theory first to improve their outlook. The main goal of this class is to understand exactly what the first incompleteness theorem asserts and to understand the outline of the proof (basic knowledge and understanding of the specialized field) for the system PA of Peano arithmetic. |
| (3) Course schedule, subject matter, and classroom activities | 1-3. Rudiments of computability theory<br>4-5. Formalized Peano arithmetic<br>6-8. Sigma-1-completeness and representability<br>9-11. Provability predicate and diagonalization<br>12-13. The first incompleteness theorem<br>14-15. Advanced topics |
| (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 3, University of Tokyo Press, 2007 (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: Wolfgang Rautenberg: A concise introduction to mathematical logic, Third edition, Springer, 2010.<br>- Check the information of this course on kibaco. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Exercises in Mathematical Sciences | M(R0033) | 1st Semester | Wed. | 3 | 1 |
| Doctoral program | Special Exercises in Mathematical Sciences | D(R0038) | | | | |

| Instructor(s) | Note |
|---|---|
| SAKAI Takashi | Searching and collecting information on mathematics |

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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://tsakai.fpark.tmu.ac.jp/ |
| (8) Special note | - This course is a required subject in the master's program.<br>- Check the information of this course on kibaco. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Seminar in Mathematical Sciences 1,2,3,4 | M(R0034), M(R0035), M(R0036), M(R0037) | 1st Semester / 2nd Semester | Summer intensive/ Winter Intensive | | 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. The course consists of fifteen lectures. |
| (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | | | 1st Semester / 2nd Semester | Summer intensive/ Winter Intensive | | See Graduate School Course Catalog |
| Doctoral program | Advanced Seminar in Mathematical Sciences 1,2,3,4,5,6 | D(R0039), D(R0040), D(R0041), D(R0042), D(R0043), D(R0044) | | | | |

| 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. The course consists of fifteen lectures. |
| (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | External Experience in Mathematical Sciences | M(R0045) 1 unit<br>M(R0047) 2 units | Intensive course (period TBD) | . | | 1 or 2 |
| Doctoral program | External Experience in Mathematical Sciences | D(R0046) 1 unit<br>D(R0048) 2 units | | | | |

| 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, etc.) 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.<br>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 (3), 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 (4) 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, 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 contact 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.<br>The implementation periods are<br>・ 30 hours or more to less than 60 hours: 1 credit<br>・ 60 hours or more: 2 credits. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Internship | M(R0817) 1 unit<br>M(R0819) 2 units | Intensive course (period TBD) | . | | 1 or 2 |
| Doctoral program | Internship | D(R0818) 1 unit<br>D(R0820) 2 units | | | | |

| 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, etc.) 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.<br>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 (3), 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 (4) 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, 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 contact your academic instructor directly by e-mail. |
| (8) Special note | Students can take multiple credits of this course.<br>The credits of this course are valid for graduation credits.<br>The implementation periods are<br>・ 5 days (or 40 hours) or more to less than 8 days (or 60 hours): 1 credit<br>・ 8 days (or 60 hours) or more: 2 credits,<br>and the course should constitute more than half of work experience. |

**2024 Graduate School Course Catalog**
**Graduate School of Science (Physics)**

＊M = master's courses, D = doctoral courses
＊NA 2024 = Courses not offered in the academic year 2024

| Course outline No. | M | D | NA 2024 | Semester | Day | Time | Course Number | Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ○ | | | 1st Semester | Thu. | 2 | M(R0101) | General relativity | 2 | KETOV Serguei | This course is also offered in the undergraduate program |
| 2 | ○ | | | 1st Semester | Fri. | 4 | M(R0102) | Statistical physics | 2 | HATTORI Kazumasa | |
| 3 | ○ | | | 1st Semester | Fri. | 2 | M(R0103) | Field theory | 2 | KETOV Serguei | |
| 4 | ○ | | | 1st Semester | Thu. | 3 | M(R0105) | Nuclear physics | 2 | HYODO Tetsuo | This course is also offered in the undergraduate program |
| 5 | ○ | | | 1st Semester | Wed. | 2 | M(R0106) | Particle physics | 2 | IN Bun | This course is also offered in the undergraduate program |
| 6 | ○ | | | 2nd Semester | Fri. | 2 | M(R0107) | Astrophysics | 2 | ISHISAKI Yoshitaka | This course is also offered in the undergraduate program |
| 7 | ○ | | | 1st Semester | Tue. | 2 | M(R0108) | Selected topics in Physics and chemistry Ⅱ(Atomic Physics) | 2 | TANUMA Hajime | This course is offered for Physics and Chemistry majors and also in the undergraduate program |
| 8 | ○ | | | 1st Semester | Mon. | 2 | M(R0109) | Selected topics in Physics and chemistry Ⅱ(Solid state Physics Ⅰ) | 2 | ARAHATA Emiko | This course is offered for Physics and Chemistry majors and also in the undergraduate program |
| 9 | ○ | | | 2nd Semester | Mon. | 2 | M(R0111) | Solid state physics Ⅱ | 2 | MATSUDA Tatsuma | This course is also offered in the undergraduate program |
| 10 | ○ | | | 2nd Semester | Wed. | 5 | M(R0114) | Computational physics | 2 | SHUDO Akira | This course is also offered in the undergraduate program |
| 11 | ○ | ○ | | 2nd Semester Ⅱ | Tue. | 3 | M(R0171) D(R0172) | Advanced experimental technique in physics A | 1 | AOKI Yuji | |
| 12 | ○ | ○ | | Winter intensive | | | M(R0937) D(R0938) | Advanced experimental technique in physics B | 1 | YANAGI Kazuhiro *TSUTSUI Satoshi | Register during the 2nd semester registration period |
| 13 | ○ | ○ | | 2nd Semester Ⅰ | Wed. | 3 | M(R0161) D(R0162) | Selected topics in Physics and chemistry Ⅰ(Advanced experimental technique in physics C) | 1 | TANUMA Hajime | This course is offered for Physics and Chemistry majors |
| 14 | ○ | ○ | | 2nd Semester Ⅱ | Mon. | 3 | M(R0159) D(R0160) | Selected topics in Physics and chemistry Ⅰ(Advanced experimental technique in physics D) | 1 | *AZUMA Toshiyuki | This course is offered for Physics and Chemistry majors |
| 15 | ○ | ○ | | Summer intensive | | | M(R0097) D(R0098) | Advanced particle physics | 1 | *YASUDA Osamu | Register during the 1st semester registration period |
| 16 | ○ | ○ | | 2nd Semester Ⅰ | Tue. | 2 | M(R0099) D(R0100) | Advanced high energy theoretical physics | 1 | KETOV Serguei | |
| 17 | ○ | ○ | | 2nd Semester Ⅰ | Thu. | 3 | M(R0125) D(R0126) | Advanced subatomic physics | 1 | HYODO Tetsuo | |
| 18 | ○ | ○ | | 2nd Semester Ⅰ | Fri. | 3 | M(R0131) D(R0132) | Advanced high energy astrophysics Ⅰ | 1 | FUJITA Yutaka | |
| | ○ | ○ | △ | | | | M(R0133) D(R0134) | Advanced high energy astrophysics Ⅱ | 1 | FUJITA Yutaka | |
| 19 | ○ | ○ | | Summer intensive | | | M(R0141) D(R0142) | Advanced nonlinear physics | 1 | SHUDO Akira | Register during the 1st semester registration period |
| 20 | ○ | ○ | | 1st Semester Ⅱ | Tue. | 3 | M(R0117) D(R0118) | Advanced statistical mechanics | 1 | ARAHATA Emiko | |
| 21 | ○ | ○ | | 1st Semester Ⅰ | Wed. | 3 | M(R0115) D(R0116) | Advanced quantum many body system | 1 | NOMOTO Takuya | |
| | ○ | ○ | △ | | | | M(R0145) D(R0146) | Advanced physics of superconductivity | 1 | HOTTA Takashi | |
| 22 | ○ | ○ | | 2nd Semester Ⅰ | Mon. | 3 | M(R0123) D(R0124) | Advanced physics of magnetism | 1 | HOTTA Takashi | |
| 23 | ○ | ○ | | 1st Semester Ⅱ | Fri. | 3 | M(R0119) D(R0120) | Advanced high energy physics Ⅰ | 1 | KAKUNO Hidekazu | |
| | ○ | ○ | △ | | | | M(R0121) D(R0122) | Advanced high energy physics Ⅱ | 1 | KAKUNO Hidekazu | |
| 24 | ○ | ○ | | 2nd Semester Ⅱ | Mon. | 4 | M(R0153) D(R0154) | Advanced atomic physics Ⅰ | 1 | *AZUMA Toshiyuki | |
| | ○ | ○ | △ | | | | M(R0155) D(R0156) | Advanced atomic physics Ⅱ | 1 | TANUMA Hajime | |
| 25 | ○ | ○ | | 1st Semester Ⅰ | Wed. | 3 | M(R0127) D(R0128) | Advanced astrophysics Ⅰ | 1 | EZOE Yuichirou | |
| | ○ | ○ | △ | | | | M(R0129) D(R0130) | Advanced astrophysics Ⅱ | 1 | ISHISAKI Yoshitaka | |
| 26 | ○ | ○ | | 2nd Semester Ⅰ | Thu. | 3 | M(R0149) D(R0150) | Advanced correlated electron physics Ⅰ | 1 | MATSUDA Tatsuma | |
| | ○ | ○ | △ | | | | M(R0135) D(R0136) | Advanced correlated electron physics Ⅱ | 1 | MIZUGUCHI Yoshikazu | |
| 27 | ○ | ○ | | 1st Semester Ⅱ | Fri. | 2 | M(R0147) D(R0148) | Selected topics in Physics and chemistry Ⅰ(Advanced nanoscience, surface, and interface physics Ⅰ) | 1 | MIYATA Yasumitsu | This course is offered for Physics and Chemistry majors |
| | ○ | ○ | △ | | | | M(R0137) D(R0138) | Selected topics in physics and chemistry Ⅰ(Advanced nanoscience, surface, and interface physics Ⅱ) | 1 | YANAGI Kazuhiro | This course is offered for Physics and Chemistry majors |
| 28 | ○ | ○ | | 1st Semester Ⅱ | Thu. | 3 | M(R0151) D(R0152) | Selected topics in physics and chemistry Ⅰ(Advanced soft matter physics Ⅰ) | 1 | KURITA Rei | This course is offered for Physics and Chemistry majors |
| | ○ | ○ | △ | | | | M(R0143) D(R0144) | Selected topics in physics and chemistry Ⅰ(Advanced soft matter physics Ⅱ) | 1 | KURITA Rei | This course is offered for Physics and Chemistry majors |
| 29 | ○ | ○ | | 2nd Semester Ⅰ | Thu. | 2 | M(R0139) D(R0140) | Advanced English for science | 1 | MORI Hiroyuki | |
| 30 | ○ | ○ | | 2nd Semester | Wed. | 1 | M(R0163) D(R0164) | Advanced Molecula Spectroscopy | 2 | KANYA Reika | This course is offered for Physics and Chemistry majors |
| 31 | ○ | ○ | | 1st Semester | Mon. | 2 | M(R0165) D(R0166) | Advanced Physical Chemistry of Condensed Matter | 2 | HIROSE Yasushi | This course is offered for Physics and Chemistry majors |
| 32 | ○ | ○ | | 1st Semester | Tue. | 2 | M(R0167) D(R0168) | Advanced Theoretical Chemistry | 2 | NAKATANI Naoki | This course is offered for Physics and Chemistry majors |
| 35 | ○ | | | 1st/2nd Semester | ＊ | ＊ | M(R0173) 1st M(R0330) 2nd | Advanced seminar in physics Ⅰ | 2 | All instructors | For first-year master's students |

| Course outline No. | M | D | NA 2024 | Semester | Day | Time | Course Number | Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | ○ | | | 1st/2nd Semester | ＊ | ＊ | M(R0174) 2nd M(R0331) 1st | Advanced seminar physics Ⅱ | 2 | All instructors | For first-year master's students |
| 35 | ○ | | | 1st/2nd Semester | ＊ | ＊ | M(R0175) 1st M(R0332) 2nd | Advanced seminar in physics Ⅲ | 2 | All instructors | For second-year master's students |
| 35 | ○ | | | 1st/2nd Semester | ＊ | ＊ | M(R0176) 2nd M(R0333) 1st | Advanced seminar in physics Ⅳ | 2 | All instructors | For second-year master's students |
| 36 | ○ | | | 1st/2nd Semester | ＊ | ＊ | M(R0177) 1st M(R0334) 2nd | Advanced experiment in physics Ⅰ | 2 | All experimental physics instructors | For first-year master's students of experimental physics |
| 36 | ○ | | | 1st/2nd Semester | ＊ | ＊ | M(R0178) 2nd M(R0335) 1st | Advanced experiment in physics Ⅱ | 2 | All experimental physics instructors | For first-year master's students of experimental physics |
| 36 | ○ | | | 1st/2nd Semester | ＊ | ＊ | M(R0179) 1st M(R0336) 2nd | Advanced experiment in physics Ⅲ | 2 | All experimental physics instructors | For second-year master's students of experimental physics |
| 36 | ○ | | | 1st/2nd Semester | ＊ | ＊ | M(R0180) 2nd M(R0337) 1st | Advanced experiment in physics Ⅳ | 2 | All experimental physics instructors | For second-year master's students of experimental physics |
| 37 | ○ | | | 1st/2nd Semester | ＊ | ＊ | M(R0181) 1st M(R0338) 2nd | Advanced practice in physics Ⅰ | 2 | All instructors of theoretical physics | For first-year master's students of theoretical physics |
| 37 | ○ | | | 1st/2nd Semester | ＊ | ＊ | M(R0182) 2nd M(R0339) 1st | Advanced practice in physics Ⅱ | 2 | All instructors of theoretical physics | For first-year master's students of theoretical physics |
| 37 | ○ | | | 1st/2nd Semester | ＊ | ＊ | M(R0183) 1st M(R0340) 2nd | Advanced practice in physics Ⅲ | 2 | All instructors of theoretical physics | For second-year master's students of theoretical physics |
| 37 | ○ | | | 1st/2nd Semester | ＊ | ＊ | M(R0184) 2nd 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) D(R0198) | Special lecture in physics Ⅰ | 1 | TBA | The credit hours will be added if the course rovides a different subject matter. |
| | ○ | ○ | | Intensive course | TBA | TBA | M(R0199) D(R0200) | Special lecture in physics Ⅱ | 2 | TBA | The credit hours will be added if the course rovides a different subject matter. |
| | ○ | ○ | | Intensive course | TBA | TBA | | Selected topics in physics Ⅰ | 1 | TBA | The credit hours will be added if the course rovides a different subject matter. |
| | ○ | ○ | | Intensive course | TBA | TBA | | Selected topics in physics Ⅱ | 2 | TBA | The credit hours will be added if the course rovides a different subject matter. |
| | ○ | ○ | | Intensive course | TBA | TBA | | Selected topics in Physics and Chemistry Ⅰ | 1 | TBA | The credit hours will be added if the course provides a different subject matter. This course is offered for Physics and Chemistry majors |
| 33 | ○ | ○ | | Intensive course | TBA | TBA | M(R0193) 2 units M(R0195) 1 unit D(R0196) 2 units D(R0194) 1 unit | External experience in physics | 1又2 | All instructors | The credit hours will be added if the course rovides a different subject matter. |
| 34 | ○ | ○ | | Intensive course | TBA | TBA | M(R0823) 2 units M(R0821) 1 unit D(R0824) 2 units D(R0822) 1 unit | Internship | 1又2 | All instructors | The credit hours will be added if the course rovides a different subject matter. |
| 38 | | ○ | | 1st/2nd Semester | ＊ | ＊ | D(R0185) 1st D(R0342) 2nd | Advanced experiment in physics Ⅴ | 4 | All experimental physics instructors | For first-year doctoral students of experimental physics |
| 38 | | ○ | | 1st/2nd Semester | ＊ | ＊ | D(R0186) 2nd D(R0343) 1st | Advanced experiment in physics Ⅵ | 4 | All experimental physics instructors | For first-year doctoral students of experimental physics |
| 38 | | ○ | | 1st/2nd Semester | ＊ | ＊ | D(R0187) 1st D(R0344) 2nd | Advanced experiment in physics Ⅶ | 4 | All experimental physics instructors | For second-year doctoral students of experimental physics |
| 38 | | ○ | | 1st/2nd Semester | ＊ | ＊ | D(R0188) 2nd D(R0345) 1st | Advanced experiment in physics Ⅷ | 4 | All experimental physics instructors | For second-year doctoral students of experimental physics |
| 39 | | ○ | | 1st/2nd Semester | ＊ | ＊ | D(R0225) 1st D(R0998) 2nd | Advanced experiment in physics Ⅸ | 2 | All experimental physics instructors | For third-year doctoral students of experimental physics |
| 40 | | ○ | | 1st/2nd Semester | ＊ | ＊ | D(R0189) 1st D(R0346) 2nd | Advanced practice in physics Ⅴ | 4 | All instructors of theoretical physics | For first-year doctoral students of theoretical physics |
| 40 | | ○ | | 1st/2nd Semester | ＊ | ＊ | D(R0190) 2nd D(R0347) 1st | Advanced practice in physics Ⅵ | 4 | All instructors of theoretical physics | For first-year doctoral students of theoretical physics |
| 40 | | ○ | | 1st/2nd Semester | ＊ | ＊ | D(R0191) 1st D(R0348) 2nd | Advanced practice in physics Ⅶ | 4 | All instructors of theoretical physics | For second-year doctoral students of theoretical physics |
| 40 | | ○ | | 1st/2nd Semester | ＊ | ＊ | D(R0192) 2nd D(R0349) 1st | Advanced practice in physics Ⅷ | 4 | All instructors of theoretical physics | For second-year doctoral students of theoretical physics |
| 41 | | ○ | | 1st/2nd Semester | ＊ | ＊ | D(R0226) 1st D(R0999) 2nd | Advanced practice in physics Ⅸ | 2 | All instructors of theoretical physics | For third-year doctoral students of theoretical physics |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | General relativity | R0101 | 1st Semester | Thu. | 2 | 2 |
| Doctoral program | | | | | | |

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

| | |
|---|---|
| (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 | Class participation and written test results at the end of the term will be comprehensively judged and evaluated. All materials are allowed for the test. Those who did not attend 2/3 or more of the lectures will not be subject to grade evaluation. |
| (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Statistical physics | R0102 | 1st Semester | Fri. | 4 | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
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| HATTORI Kazumasa | |

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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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Field theory | R0103 | 1st Semester | Fri. | 2 | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
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| KETOV Serguei | |

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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 | Class participation and written test results at the end of the term will be comprehensively judged and evaluated. All materials are allowed for the test. Those who did not attend 2/3 or more of the lectures will not be subject to grade evaluation. |
| (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)<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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Nuclear physics | R0105 | 1st Semester | Thu. | 3 | 2 |
| Doctoral program | | | | | | |

| 2Instructor(s) | Note |
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| HYODO Tetsuo | 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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Particle physics | I0022 | 1st Semester | Wed. | 2 | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
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| YIN Wen | This course is also offered in the undergraduate program |

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|---|---|
| (1) Course policies and topics | The phenomena of elementary particles known to date are almost entirely described without contradiction by a theory called the Standard Model. This model has been verified across a wide range of fields, including cosmology and astronomy, and is considered to be close to the ultimate law that describes the universe. In this lecture, we will logically explain the Standard Model of elementary particles and its theoretical background. Additionally, we will present evidence that the Standard Model of elementary particles is not perfect and discuss the possibilities of the underlying theories. |
| (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: Chapter 1 - Introduction to Elementary Particle Physics<br>02: Chapter 2 - Quantum Field Theory (2.1 Relativistic Quantum Mechanics of Free Particles, 2.2 Scattering Theory)<br>03: Chapter 2 - Quantum Field Theory (2.3 Locality + Special Relativity + Quantum Mechanics = Quantum Field Theory, 2.4 Continuous Global Symmetry and Conservation Laws)<br>04: Chapter 3 - Abelian Gauge Theory (3.1 Massless Vector Bosons and Gauge Symmetry, 3.2 Coupling of Gauge Fields and Matter)<br>05: Chapter 3 - Abelian Gauge Theory (3.3 Quantum Electrodynamics, 3.4 Calculation of Specific Examples)<br>06: Chapter 3 - Abelian Gauge Theory (3.5 Renormalizability and Effective Field Theory)<br>07: Chapter 4 - Non-Abelian Gauge Theory (4.1 SU(2) Gauge Symmetry, 4.2 Strong Force, Quantum Chromodynamics, Asymptotic Freedom)<br>08: Chapter 4 - Non-Abelian Gauge Theory (4.3 Spontaneous Breaking of Global Symmetry, 4.4 Nucleons and Mesons)<br>09: Chapter 5 - What is Mass? (5.1 Weak Interactions and Massive Vector Bosons, 5.2 Spontaneous Breaking of Gauge Symmetry)<br>10: Chapter 5 - What is Mass? (5.3 Origin of Elementary Particle Masses, Electroweak Unification, Higgs Field)<br>11: Chapter 6 - Standard Model of Elementary Particles (6.1 Standard Model Lagrangian, 6.2 Generations and CP)<br>12: Chapter 6 - Standard Model of Elementary Particles (6.3 Why is the Proton Stable?, 6.4 Higgs Field Dependence of Hadron Masses, 6.5 Will All Forces Unify?)<br>13: Chapter 7 - Beyond the Standard Model (7.1 Mystery of the Beginning of the Universe - Inflation, 7.2 Existence of Unknown Matter - Dark Matter, 7.3 Vanished Antimatter - Matter-Antimatter Asymmetry, 7.4 Changing Neutrinos - Neutrino Mass, 7.5 Other Topics (Latest Topics))<br>14: Chapter 7 - Beyond the Standard Model (7.1 Mystery of the Beginning of the Universe - Inflation, 7.2 Existence of Unknown Matter - Dark Matter, 7.3 Vanished Antimatter - Matter-Antimatter Asymmetry, 7.4 Changing Neutrinos - Neutrino Mass, 7.5 Other Topics (Latest Topics))<br>15: Discussion of Exercise Problems |
| (4) Outside-class activities and assignments | Self-study using reference books. Solve exercise problems and quizzes presented during class. Review the material. |
| (5) Textbooks and course materials | The lectures will primarily be based on original lecture notes (posted regularly on kibaco). The following can be mentioned as reference books for extracurricular learning:<br>1. “An Introduction to the Standard Model of Particle Physics" by W. Cottingham and D. Greenwood<br>2. Difficult but important for those aspiring to be particle theory researchers: "The Quantum Theory of Fields, Volume I" by S. Weinberg, "The Quantum Theory of Fields, Volume II" by S. Weinberg |
| (6) Assessment and grading | The final grade will be based on a written assignment. Participation in class, such as asking non-trivial questions and presenting on exercise problems, will be rewarded with additional points, up to a maximum of 10%. |
| (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Astrophysics | R0107 | 2nd Semester | Fri. | 2 | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
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| ISHISAKI Yoshitaka | 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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Selected topics in Physics and chemistry Ⅱ(Atomic Physics) | R0108 | 1st Semester | Tue. | 2 | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
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| TANUMA Hajime | This course is offered for Physics and Chemistry majors and also 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 “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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Selected topics in Physics and chemistry Ⅱ(Solid state Physics Ⅰ) | R0109 | 1st Semester | Mon. | 2 | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
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| ARAHATA Emiko | This course is offered for Physics and Chemistry majors and also 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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Solid state physics II | R0111 | 2nd Semester | Mon. | 2 | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
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| MATSUDA Tatsuma | 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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Computational physics | R0114 | 2nd Semester | Wed. | 5 | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
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| SHUDO Akira | This course is also offered in the undergraduate program |

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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. |
| (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced experimental technique in physics A | R0171 | 2nd Semester II | Tue. | 3 | 1 |
| Doctoral program | Advanced experimental technique in physics A | R0172 | | | | |

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

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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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced experimental technique in physics B | R0937 | Winter intensive | | | 1 |
| Doctoral program | Advanced experimental technique in physics B | R0938 | | | | |

| Instructor(s) | Note |
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| YANAGI Kazuhiro, TSUTSUI Satoshi | Register during the 2nd semester registration period |

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|---|---|
| (1) Course policies and topics | Experimental observation and measurement utilizing the properties of light and particle radiation are employed not only in solid-state physics but also in Earth sciences, astrophysics, and other fields. Various techniques are used to observe the microstructure of materials, electronic states, and to investigate the structures of buildings, the Earth's interior, and the universe. Along with fundamental concepts about these experimental methods, students learn about cutting-edge equipment, experimental sites, and practical examples. This course aims to provide introductory content to enable students to apply these techniques in actual research activities. It is envisioned to be held during the third period on Tuesday mornings. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Based on fundamental knowledge about the basic properties and generation principles of light and particle radiation, as well as observation techniques, students will understand practical examples of experiments, particularly in the field of solid-state physics, and applications. This will enable them to acquire the ability to conduct measurement experiments using both on-campus and off-campus experimental equipment. |
| (3) Course schedule, subject matter, and classroom activities | This course will be divided into two parts: the first four sessions will be taught by Prof. Yanagi, while the remaining four sessions will be led by Prof. Tsutsui. In the first half, fundamental principles and applications of optical experiments and laser spectroscopy, focusing particularly on selection rules for optical transitions and Raman spectroscopy, will be covered. The second half will introduce the basics and applications of solid-state experiments using X-rays, gamma rays, electron beams, neutron beams, and muons, in addition to discussing beam characteristics such as synchrotron radiation and heavy ion beams. Although it is planned as a concentrated lecture format, it is expected to be held on Tuesday mornings after the third period.<br><br>Lecturer: Prof. Kazuhiro Yanagi<br>Session 1: Overview of spectroscopic measurement techniques used for material structure and properties elucidation<br>Session 2: Material symmetry, group theory, and optical transitions I<br>Session 3: Material symmetry, group theory, and optical transitions II<br>Session 4: Fundamentals and applications of Raman spectroscopy<br><br>Lecturer: Prof. Satoshi Tsutsui (Part-time lecturer: High Luminosity Science Research Center)<br>Session 5: Introduction of beam types and their characteristics: synchrotron radiation, neutrons, muons, (heavy ion beams, etc.)<br>Session 6: Static structural analysis reflecting crystal structures and electronic states: neutron scattering, synchrotron radiation diffraction (resonant and non-resonant)<br>Session 7: Measurement of electron and atomic dynamics: neutron inelastic scattering, X-ray inelastic scattering (resonant and non-resonant), nuclear resonance inelastic scattering<br>Session 8: Utilization of electron and nuclear interactions (hyperfine interactions) for solid-state measurements: nuclear resonance scattering, μSR, (PAC, β-NMR, etc.)<br>Note: In the lectures conducted by Prof. Tsutsui in the latter half, there may be a possibility of combining two sessions into one day for Sessions 5 and 6, as well as Sessions 7 and 8, depending on discussions with the enrolled students. Further details will be provided through the first half lecturer and communication channels like KIBACO. |
| (4) Outside-class activities and assignments | Students are expected to prepare and review the materials specified in each lecture for their pre-class and post-class studies. It is advisable to go through the provided course materials in advance, organize any uncertainties or questions, and ensure comprehension of specialized terminology before attending the lecture. |
| (5) Textbooks and course materials | The slides and materials used in the lectures will be uploaded to KIBACO. Additionally, reference books and literature will be introduced as needed during the lectures. |
| (6) Assessment and grading | Students will be evaluated based on two reports corresponding to each of the first four sessions and the last four sessions of the course. |
| (7) Questions to the instructor (Office hours, etc.) | Office hours will not be specifically set, but students can schedule appointments via email if they have any questions.<br>Kazuhiro Yanagi (kyanagi@tmu.ac.jp)<br>Satoshi Tsutsui(satoshi@spring8.or.jp) |
| (8) Special note | |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Selected topics in Physics and chemistry Ⅰ(Advanced experimental technique in physics C) | R0161 | 2nd Semester I | Wed. | 3 | 1 |
| Doctoral program | Selected topics in Physics and chemistry Ⅰ(Advanced experimental technique in physics C) | R0162 | | | | |

| Instructor(s) | Note |
|---|---|
| TANUMA Hajime | 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 “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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Selected topics in Physics and chemistry Ⅰ(Advanced experimental technique in physics D) | R0159 | 2nd Semester II | Mon. | 3 | 1 |
| Doctoral program | Selected topics in Physics and chemistry Ⅰ(Advanced experimental technique in physics D) | R0160 | | | | |

| Instructor(s) | Note |
|---|---|
| AZUMA Toshiyuki | 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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced particle physics | R0097 | Summer intensive | | | 1 |
| Doctoral program | Advanced particle physics | R0098 | | | | |

| Instructor(s) | Note |
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| YASUDA Osamu | Register during the 1st 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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced high energy theoretical physics | R0099 | 2nd Semester I | Tue. | 2 | 2 |
| Doctoral program | Advanced high energy theoretical physics | R0100 | | | | |

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

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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 | Class participation and oral test results at the end of the term will be comprehensively judged and evaluated. Those who did not attend 3 or more lectures will not be subject to grade evaluation. |
| (7) Questions to the instructor (Office hours, etc.) | Office hours for questions and consulations with the teacher are<br>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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced subatomic physics | R0125 | 2nd Semester I | Thu. | 3 | 1 |
| Doctoral program | Advanced subatomic physics | R0126 | | | | |

| Instructor(s) | Note |
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| HYODO Tetsuo | |

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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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced high energy astrophysics I | R0131 | 2nd Semester I | Fri. | 3 | 1 |
| Doctoral program | Advanced high energy astrophysics I | R0132 | | | | |

| Instructor(s) | Note |
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| FUJITA Yutaka | |

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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 radiation processes based on physics such as electromagnetism and special relativity. |
| (3) Course schedule, subject matter, and classroom activities | 1. Overview of high-energy astrophysics<br>2. Radiation from moving particles<br>3. Dipole emission<br>4. Special relativity<br>5. Synchrotron emission I<br>6. Synchrotron emission II<br>7. Inverse Compton scattering<br>8. Summary |
| (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.<br>Reference book: Radiative Processes in Astrophysics (George B. Rybicki, Saul A. Teukolsky; Wiley) |
| (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 II”, in which specific phenomena such as accretion disks and cosmic-ray acceleration are dealt with. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced nonlinear physics | R0141 | Summer intensive | | | 1 |
| Doctoral program | Advanced nonlinear physics | R0142 | | | | |

| Instructor(s) | Note |
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| SHUDO Akira | Register during the 1st semester registration period |

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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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced statistical mechanics | R0117 | 1st Semester II | Tue. | 3 | 1 |
| Doctoral program | Advanced statistical mechanics | R0118 | | | | |

| Instructor(s) | Note |
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| ARAHATA Emiko | |

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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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced quantum many body system | R0115 | 1st Semester I | Wed. | 3 | 1 |
| Doctoral program | Advanced quantum many body system | R0116 | | | | |

| Instructor(s) | Note |
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| NOMOTO Takuya | |

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| (1) Course policies and topics | Field theory is one of the most suitable theories for describing the quantum mechanics of many-body systems and plays a central role in modern condensed matter physics. In this lecture, as the foundation, we will study many-body perturbation theory using Green's functions at zero temperature. |
| (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 | 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. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced physics of magnetism | R0123 | 2nd Semester I | Mon. | 3 | 1 |
| Doctoral program | Advanced physics of magnetism | R0124 | | | | |

| Instructor(s) | Note |
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| HOTTA Takashi | |

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| (1) Course policies and topics | We learn from the basics about the magnetic properties of matter. After reviewing the basics of solid-state electron theory, we show that the Heisenberg model can be understood as an effective Hamiltonian in the Mott insulator of the Hubbard model, and we learn about spin-wave approximation. Next, we seek a magnetic phase diagram by molecular field approximation of itinerant magnetic materials, and we further discuss the importance of spin fluctuations. Finally, as an introduction to the latest topics, we explain the basics of topological materials. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | It is possible to acquire basic theoretical methods and basic concepts such as molecular field approximation and correlation function. We also understand that they are indispensable for understanding actual magnetic materials. |
| (3) Course schedule, subject matter, and classroom activities | Lecture 1. Magnetic ions<br>Lecture 2. One-electron approximation, Bloch's theorem, Band structure<br>Lecture 3. Free electron gas model, Hubbard model<br>Lecture 4. Theory of magnetic insulators I<br>Lecture 5. Theory of magnetic insulators II<br>Lecture 6. Theory of itinerant magnetic materials I<br>Lecture 7. Theory of itinerant magnetic materials II<br>Lecture 8. Basics of topological materials<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.<br>Email: hotta@tmu.ac.jp |
| (8) Special note | Knowledge of quantum mechanics and statistical mechanics is assumed. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced high energy physics I | R0119 | 1st Semester II | Fri. | 3 | 1 |
| Doctoral program | Advanced high energy physics I | R0120 | | | | |

| Instructor(s) | Note |
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| KAKUNO Hidekazu | |

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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 performance 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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced atomic physics I | R0153 | 2nd Semester II | Mon. | 4 | 1 |
| Doctoral program | Advanced atomic physics I | R0154 | | | | |

| Instructor(s) | Note |
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| AZUMA Toshiyuki | |

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| (1) Course policies and topics | Fundamentals of atomic physics and atomic collisions will be introduced on the basis of quantum mechanics. In particular, the course will focus on the collision processes between charged particles and light and atoms. This knowledge is essential for understanding chemical reactions, atomic and molecular collisions, various spectroscopic methods, and the interaction of light and particle beams with materials. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | We understand basic phenomena and reactions involving atoms and molecules from the viewpoint of quantum mechanics, leading to an overview of the diversity of phenomena and common principles. |
| (3) Course schedule, subject matter, and classroom activities | Atoms and molecules are the basic building blocks of matter and are closely related to natural phenomena in the universe and on Earth. In this lecture, based on the knowledge of quantum mechanics, the basic concepts of atomic collision physics, such as the partial wave expansion method, Born approximation, and generalized oscillator strength, and the absorption and emission processes of light by atoms will be reviewed as scattering problems dealing with the interaction between charged particles and atoms.<br><br>Lecture 1: Cross sections and classical theory of scattering<br>Lecture 2: Quantum theory of scattering: Born approximation<br>Lecture 3: Quantum theory of scattering: Bethe's equation and stopping power<br>Lecture 4: Quantum theory of scattering: partial wave expansion<br>Lecture 5: Light absorption and emission: classical and semiclassical theory<br>Lecture 6: Light absorption and emission: quantum theory<br>Lecture 7: Light absorption and emission: Jaynes-Cummings model<br>Lecture 8: Q&A session |
| (4) Outside-class activities and assignments | After each class, homework 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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced Astrophysics I | R0129 | 1st Semester I | Wed. | 3 | 1 |
| Doctoral program | Advanced Astrophysics I | R0130 | | | | |

| Instructor(s) | Note |
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| EZOE Yuichiro | |

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| (1) Course policies and topics | This course gives explanation of radiation detectors focusing on X-ray detectors. Representative detectors and their structures and principles as well as data analysis methods will be introduced. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Students will understand principles of representative radiation detectors and data analysis methods. |
| (3) Course schedule, subject matter, and classroom activities | 01. Principles of radiation detectors<br>02. Gas radiation detectors<br>03. Solid radiation detectors<br>04. Imaging sensors, energy dispersive detectors<br>05. Low temperature detectors<br>06. Surrounding technologies<br>07. X-ray optics<br>08. Summary |
| (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.) | Students can ask questions via e-mail or zoom. Contact address will be given in the class. |
| (8) Special note | |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced correlated electron physics I | R0149 | 2nd Semester I | Thu. | 3 | 1 |
| Doctoral program | Advanced correlated electron physics I | R0150 | | | | |

| Instructor(s) | Note |
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| MATSUDA Tatsuma, AOKI Yuji | |

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| (1) Course policies and topics | Advanced Solid State Physics. The lectures will cover topics which are necessary for those who will be engaging to the fundamental and development research on solid materials. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | understanding of basis of strongly corelated electron systems, heavy-electron states, quantum critical phenomena, anisotropic superconductivity, understanding of principle of experimental techniques (transport, thermal, and quantum beam) |
| (3) Course schedule, subject matter, and classroom activities | 1st : electron configuration of an atom<br>2nd : crystalline electric field, magnetism in crystal<br>3rd : physical properties of localized f-electron state<br>4th : multipole degrees of freedon in the rare-earth systems<br>5th : Kondo-effect, RKKY interaction, strongly correlated electron systems<br>typical phenomena (heavy electron, quantum critical phenomena, emergence of superconducting state)<br>6th : topological material and phenomena<br>7th : recent topics in solid state physics<br>8th : experimental techniques<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 two reports assignments |
| (7) Questions to the instructor (Office hours, etc.) | Send an appointment e-mail to instructor. |
| (8) Special note | |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Selected topics in Physics and chemistry I (Advanced nanoscience, surface, and interface physics I) | M(R0147) | 1st Semester II | Fri. | 2 | 1 |
| Doctoral program | Selected topics in Physics and chemistry I (Advanced nanoscience, surface, and interface physics I) | D(R0148) | | | | |

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

| | |
|---|---|
| (1) Course policies and topics | Although the study of solid state physics has a long history, new materials are still being created and interesting, unexpected behaviors are still being discovered. In general, it is essential to learn the basics of band theory in order to understand and predict the electrical, optical, thermal, and other properties of materials. In this course, students will calculate the band structure of several materials with simple structures and understand how the structure and electronic state of the materials are related. In particular, the course will focus on explanations of the fundamentals of band calculations and exercises. However, the course is primarily intended for experimental students of solid state physics, and is intended to provide an opportunity to properly reorganize the knowledge and ideas common to solid state physics. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The objectives of this course are to learn the basics of electronic band calculations using the tight-binding approximation, to draw the band structures of simple materials such as graphene, and to derive physical properties such as density of states and Fermi velocities. Students will also learn the basics of extracting information from measurement results. |
| (3) Course schedule, subject matter, and classroom activities | [Course schedule and subject matter]<br>1. Hybridization and energy of atomic orbitals<br>2. Tight biding calculation<br>3. Electronic structure of polyacetylene<br>4. Symmetry and electronic structure of polyacetylene<br>5. Electronic structure of graphene<br>6. Dimensionality and density of states<br>7. Relationship between band structure and electrical and optical properties<br><br>[Classroom activities]<br>The class will be conducted mainly through lectures and exercises. |
| (4) Outside-class activities and assignments | Learning outside of class<br>The students are expected to solve the exercises given at the end of each class before the next class. Explanations will be given in the next lecture. |
| (5) Textbooks and course materials | Materials describing the lecture and exercises will be distributed at the beginning of each class. Reference materials will be introduced during the lecture. |
| (6) Assessment and grading | Evaluation will be based on reports (70%) and class participation (attendance, in-class exercises) (30%). |
| (7) Questions to the instructor (Office hours, etc.) | Office hours are not set. Questions can be asked in the office (Room 8-532) or by e-mail (miyata-yasumitsu_at_tmu.ac.jp). (_at_ is converted to @) |
| (8) Special note | It is desirable to have taken Fundamentals of Condensed Matter Physics I, II, or equivalent courses. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Selected topics in physics and chemistry Ⅰ(Advanced soft matter physics I) | R0151 | 1st Semester II | Thu. | 3 | 1 |
| Doctoral program | Selected topics in physics and chemistry Ⅰ(Advanced soft matter physics I) | R0152 | | | | |

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

| | |
|---|---|
| (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 aim is to study Brownian motion, variational principles and diffusion as the dynamics of soft matter (logical thinking skills) and to understand and master the basic methods for dealing with non-equilibrium statistical mechanics in a physical context (integrated problem thinking skills). |
| (3) Course schedule, subject matter, and classroom activities | 1. Importance of kinetics in soft matter<br>2. Brownian motion<br>3. dissipation theorem<br>4. principle for non-equilibrium soft matter<br>5. Critical phenomena<br>6. Conservative and non-conservative phase separation and interfacial energy<br>7. Non-equilibrium dynamics of phase separation<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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced English for science | R0139 | 2nd Semester I | Thu. | 2 | 1 |
| Doctoral program | Advanced English for science | R0140 | | | | |

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

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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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | External experience in physics | | Intensive course | TBA | TBA | 1 or 2 |
| Doctoral program | External experience in physics | | | | | |

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

| | |
|---|---|
| (1) Course policies and topics | Engage in extracurricular activities such as work experience, research outside of the university, and volunteer work related to specialized topics in physics. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Through work experience, research outside of the university, volunteer work, and other extracurricular activities, students acquire knowledge and experience that cannot be gained through activities within the university. |
| (3) Course schedule, subject matter, and classroom activities | Dependent on the content of the practical training. |
| (4) Outside-class activities and assignments | Dependent on the content of the practical training. |
| (5) Textbooks and course materials | Dependent on the content of the practical training. |
| (6) Assessment and grading | Students who participate in experiential learning are required to submit a report on their learning experiences to their supervising instructor upon completion. The supervising instructor will then determine the eligibility for unit accreditation based on the alignment with the objectives of the experiential learning. The maximum limit for units in one semester is set at 2. Those wishing to obtain units must notify the supervising instructor at least 2 months before the scheduled start date of the experiential learning. |
| (7) Questions to the instructor (Office hours, etc.) | Inquire with the supervising instructor or the Academic Affairs Committee. |
| (8) Special note | This class is taught by instructors or faculty members with practical experience.<br>Units will be recognized for extracurricular activities such as work experience, research outside of the university, and volunteer work related to specialized topics in physics, provided they meet certain criteria. These criteria include:<br>(1) The activity must be conducted for a minimum of 30 hours. If it exceeds 30 hours but is less than 60 hours, it counts as 1 unit; if it is 60 hours or more, it counts as 2 units.<br>(2) The activity should not impede the learning of other subjects.<br>(3) Participants should not receive compensation.<br>(4) A completion certificate must be obtained from the organizer upon completion of the experiential learning.<br>(5) The content of the experiential learning must be deemed equivalent to the curriculum level of the university by the supervising instructor.<br>Furthermore, students are responsible for finding their own placement. As these activities are offered as newly established courses upon student request, they cannot be included in the initial course registration at the beginning of the semester. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Internship | | Intensive course | TBA | TBA | 1 or 2 |
| Doctoral program | Internship | | | | | |

| 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 | The aim is for students to acquire a wide range of practical skills by certifying units of study based on completion of at least 5 days (or 40 hours) of work experience related to specialized education in physics, meeting specific criteria. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Through extracurricular learning, students gain knowledge and experience that cannot be acquired through activities within the university. |
| (3) Course schedule, subject matter, and classroom activities | 【Course Plan and Content】Dependent on the location of the internship.<br>【Teaching Method】Undertake work experience at the internship site for a period of 5 days (or 40 hours) or more. Work experience should be conducted for more than half of the scheduled dates. |
| (4) Outside-class activities and assignments | Dependent on the location of the internship. |
| (5) Textbooks and course materials | Dependent on the location of the internship. |
| (6) Assessment and grading | Refer to the special notes for further details. |
| (7) Questions to the instructor (Office hours, etc.) | Inquire with the Academic Affairs Committee. |
| (8) Special note | This class is taught by instructors or faculty members with practical experience.<br>(Unit Requirement)<br>The specified subject allows for overlapping enrollment. It can be added to the units required for graduation.<br>(Enrollment Requirements)<br>(1) The activity must be conducted for at least 5 days (or 40 hours). However, if it is between more than 5 days (or 40 hours) and less than 8 days (or 60 hours), it counts as 1 unit; if it is 8 days (or 60 hours) or more, it counts as 2 units.<br>(2) It should ideally take place over several days during vacation periods. Students should not receive compensation (although allowances for food, transportation, and accommodation provided by the host are acceptable).<br>(3) The content should be equivalent to the curriculum level of the department and related to specialized education in physics. The components covered in this practical experience should not serve as requirements for other units or qualifications.<br>(4) If the university or research institution publicly invites (voluntary) participation, a copy of the announcement should be available. For companies, training schools, etc., the recruitment guidelines should be available, along with the name, affiliation, and contact information of the supervising authority at the host institution, along with a signed acceptance letter. Participation in "Student Education Research Accident and Injury Insurance" and "Internship, Care Experience Activity, Teaching Practice, etc., Liability Insurance" (or equivalent or greater accident and liability insurance).<br>(5) Students should be able to obtain a completion certificate issued by the organizer (instructor) or agree to have the completion certificate on a separate sheet verified by the organizer (instructor) through signature and stamp.<br>(6) Students wishing to have units accredited must submit a preliminary application to the Academic Affairs Committee before the implementation, including contact information for the internship host, contact information for the student during the internship, and documents detailing the content and objectives of the internship. Permission must be obtained in advance.<br>(7) After completing the internship, students must summarize their experiences and impressions in a few pages and submit a report to the Academic Affairs Committee, along with the documents mentioned in (5). Unit accreditation will be determined by the Academic Affairs Committee based on the alignment with the above objectives, the evaluation by the organizer, and the assessment of the report. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced seminar in physics I, II, III, IV | | 1st/2nd Semester | | | 2 |
| Doctoral program | | | | | | |

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

| | |
|---|---|
| (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced experiment in physics I, II, III, IV | | 1st/2nd Semester | | | 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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced practice in physics I, II, III, IV | | 1st/2nd Semester | | | 2 |
| Doctoral program | | | | | | |

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

| | |
|---|---|
| (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | | | 1st/2nd Semester | | | 4 |
| Doctoral program | Advanced experiment in physics V, VI, VII, VIII | | | | | |

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

| | |
|---|---|
| (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | | | 1st/2nd Semester | | | 2 |
| Doctoral program | Advanced experiment in physics Ⅸ | | | | | |

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

| | |
|---|---|
| (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | | | 1st/2nd Semester | | | 4 |
| Doctoral program | 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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | | | 1st/2nd Semester | | | 2 |
| Doctoral program | Advanced practice in physics Ⅸ | | | | | |

| 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. |

**2024 Graduate School Course Catalog**
**Graduate School of Science (Chemistry)**

＊M = master's courses, D = doctoral courses
＊NA 2024 = Courses not offered in the academic year 2024

| Course outline No. | M | D | NA 2024 | Semester | Day | Time | Course Number | Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ○ | | | 1st Semester | Fri. | 1 | M(R0221) | Advanced Inorganic Chemistry | 2 | SUGIURA Ken-ichi<br>KUBUKI Siro<br>YAMAZOE Seizi | |
| 2 | ○ | | | 2nd Semester | Tue. | 2 | M(R0222) | Advanced Geo- and Cosmochemistry | 2 | TAKEGAWA Nobuyuki<br>MOTEKI Nobuhiro<br>OURA Yasuji | |
| 3 | ○ | | | 1st Semester | Wed. | 2 | M(R0223) | Advanced Organic Chemistry | 2 | NOMURA Kotohiro<br>SOLIMAN Mehawed Abdellatif Mohamed | |
| 4 | ○ | | | 2nd Semester | Wed. | 2 | M(R0224) | Advanced Biological Chemistry | 2 | HIROTA Kouji<br>ITO Yutka<br>TAOKA Masato<br>IKEYA Teppei | |
| 5 | ○ | ○ | | 2nd Semester | Wed. | 1 | M(R0163)<br>D(R0164) | Advanced Molecula Spectroscopy | 2 | KANYA Reika | This course is offered for Physics and Chemistry majors |
| 6 | ○ | ○ | | 1st Semester | Mon. | 2 | M(R0165)<br>D(R0166) | Advanced Physical Chemistry of Condensed Matter | 2 | HIROSE Yasushi | This course is offered for Physics and Chemistry majors |
| 7 | ○ | ○ | | 1st Semester | Tue. | 2 | M(R0167)<br>D(R0168) | Advanced Theoretical Chemistry | 2 | NAKATANI Naoki | This course is offered for Physics and Chemistry majors |
| 8 | ○ | ○ | | 1st Semester | Tue. | 2 | M(R0108)<br>D(R0205) | Selected topics in Physics and chemistry Ⅱ(Atomic Physics) | 2 | TANUMA Hajime | This course is offered for Physics and Chemistry majors and also in the undergraduate program |
| 9 | ○ | ○ | | 1st Semester | Mon. | 2 | M(R0109)<br>D(R0206) | Selected topics in Physics and chemistry Ⅱ(Solid state Physics Ⅰ) | 2 | ARAHATA Emiko | This course is offered for Physics and Chemistry majors and also in the undergraduate program |
| 10 | ○ | ○ | | 1st Semester | Thu. | 1 | M(R0231)<br>D(R0232) | Advanced Lecture in Chemistry Ⅱ (Organic Reaction Mechanisms) | 2 | NOMURA Kotohiro | |
| 11 | ○ | ○ | | 1st Semester | Wed. | 1 | M(R0233)<br>D(R0237) | Advanced Lecture in Chemistry Ⅱ (Advanced Material Science) | 2 | OKA Daichi | |
| 12 | ○ | ○ | | 1st Semester | Tue. | 1 | M(R0300)<br>D(R0302) | Advanced Lecture in Chemistry Ⅱ (Functional materials chemistry) | 2 | ISHIDA Masatoshi | |
| 13 | ○ | ○ | | 2nd Semester | Fri. | 2 | M(R0299)<br>D(R0301) | Advanced Lecture in Chemistry Ⅱ (Advanced Materials Chemistry) | 2 | NOMURA Kotohiro | |
| 14 | ○ | | | 2nd Semester | 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 | External experience in Chemistry | 1・2 | Multiple instructors | |
| 16 | ○ | ○ | | Intensive course | | | M(R0825) 1 unit<br>M(R0827) 2 units<br>D(R0826) 1 unit<br>D(R0828) 2 units | Internship | 1・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 and also in the undergraduate program |
| 17 | ○ | ○ | | 1st Semester Ⅱ | Fri. | 2 | M(R0147)<br>D(R0148) | Selected topics in Physics and chemistry Ⅰ(Advanced nanoscience, surface, and interface physics I) | 1 | MIYATA Yasumitsu | This course is offered for Physics and Chemistry majors |
| | ○ | ○ | △ | | | 1 | M(R0137)<br>D(R0138) | Selected topics in physics and chemistry Ⅰ(Advanced nanoscience, surface, and interface physics Ⅱ) | 1 | YANAGI Kazuhiro | This course is offered for Physics and Chemistry majors |
| 18 | ○ | ○ | | 1st Semester Ⅱ | Thu. | 3 | M(R0151)<br>D(R0152) | Selected topics in physics and chemistry Ⅰ(Advanced soft matter physics I) | 1 | KURITA Rei | This course is offered for Physics and Chemistry majors |
| | ○ | ○ | △ | | | 3 | M(R0143)<br>D(R0144) | Selected topics in physics and chemistry Ⅰ(Advanced soft matter physics Ⅱ) | 1 | KURITA Rei | This course is offered for Physics and Chemistry majors |
| 19 | ○ | ○ | | 2nd Semester Ⅰ | Wed. | 3 | M(R0161)<br>D(R0162) | Selected topics in Physics and chemistry Ⅰ(Advanced experimental technique in physics C) | 1 | TANUMA Hajime | This course is offered for Physics and Chemistry majors |
| 20 | ○ | ○ | | 2nd Semester Ⅱ | Mon. | 3 | M(R0159)<br>D(R0160) | Selected topics in Physics and chemistry Ⅰ(Advanced experimental technique in physics D) | 1 | *AZUMA Toshiyuki | This course is offered for Physics and Chemistry majors |

| Course outline No. | M | D | NA 2024 | Semester | Day | Time | Course Number | Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| For students enrolling in April | | | | | | | | | | | |
| 21 | ○ | | | 1st Semester | Fri. | 3・4 | Ⅰ:M(R0235) | Seminar on Advanced Chemistry Ⅰ | 2 | HIROSE Yasushi<br>OKA Daichi | |
| 22 | ○ | | | 2nd Semester | Fri. | 3・4 | Ⅱ:M(R0236) | Seminar on Advanced Chemistry Ⅱ | 2 | HIROSE Yasushi<br>OKA Daichi | |
| 21 | ○ | | | 1st Semester | Mon. | 1・2 | Ⅰ:M(R0239) | Seminar on Advanced Chemistry Ⅰ | 2 | TAKEGAWA Nobuyuki<br>MOTEKI Nobuhiro | |
| 22 | ○ | | | 2nd Semester | Mon. | 1・2 | Ⅱ:M(R0240) | Seminar on Advanced Chemistry Ⅱ | 2 | TAKEGAWA Nobuyuki<br>MOTEKI Nobuhiro | |
| 21 | ○ | | | 1st Semester | Mon. | 1・2 | Ⅰ:M(R0241) | Seminar on Advanced Chemistry Ⅰ | 2 | HIROTA Kouji<br>TAOKA Masato | |
| 22 | ○ | | | 2nd Semester | Mon. | 1・2 | Ⅱ:M(R0242) | Seminar on Advanced Chemistry Ⅱ | 2 | HIROTA Kouji<br>TAOKA Masato | |
| 21 | ○ | | | 1st Semester | Mon. | 3・4 | Ⅰ:M(R0243) | Seminar on Advanced Chemistry Ⅰ | 2 | KANYA Reika | |
| 22 | ○ | | | 2nd Semester | Mon. | 5・6 | Ⅱ:M(R0244) | Seminar on Advanced Chemistry Ⅱ | 2 | KANYA Reika | |
| 21 | ○ | | | 1st Semester | Tue. | 4・5 | Ⅰ:M(R0245) | Seminar on Advanced Chemistry Ⅰ | 2 | NAKATANI Naoki | |
| 22 | ○ | | | 2nd Semester | Mon. | 4・5 | Ⅱ:M(R0246) | Seminar on Advanced Chemistry Ⅱ | 2 | NAKATANI Naoki | |
| 21 | ○ | | | 1st Semester | Mon. | 3・4 | Ⅰ:M(R0247) | Seminar on Advanced Chemistry Ⅰ | 2 | TBA | |
| 22 | ○ | | | 2nd Semester | Mon. | 3・4 | Ⅱ:M(R0248) | Seminar on Advanced Chemistry Ⅱ | 2 | TBA | |
| 21 | ○ | | | 1st Semester | Fri. | 3・4 | Ⅰ:M(R0249) | Seminar on Advanced Chemistry Ⅰ | 2 | KUBUKI Siro | |
| 22 | ○ | | | 2nd Semester | Fri. | 1・2 | Ⅱ:M(R0250) | Seminar on Advanced Chemistry Ⅱ | 2 | KUBUKI Siro | |
| 21 | ○ | | | 1st Semester | Mon. | 1・2 | Ⅰ:M(R0251) | Seminar on Advanced Chemistry Ⅰ | 2 | SUGIURA Ken-ichi<br>ISHIDA Masatoshi | |
| 22 | ○ | | | 2nd Semester | Mon. | 1・2 | Ⅱ:M(R0252) | Seminar on Advanced Chemistry Ⅱ | 2 | SUGIURA Ken-ichi<br>ISHIDA Masatoshi | |
| 21 | ○ | | | 1st Semester | Mon. | 5・6 | Ⅰ:M(R0253) | Seminar on Advanced Chemistry Ⅰ | 2 | NOMURA Kotohiro<br>SOLIMAN Mehawed Abdellatif Mohamed | |
| 22 | ○ | | | 2nd Semester | Mon. | 5・6 | Ⅱ:M(R0254) | Seminar on Advanced Chemistry Ⅱ | 2 | NOMURA Kotohiro<br>SOLIMAN Mehawed Abdellatif Mohamed | |
| 21 | ○ | | | 1st Semester | Fri. | 4・5 | Ⅰ:M(R0255) | Seminar on Advanced Chemistry Ⅰ | 2 | YAMAZOE Seizi<br>OURA Yasuji | |
| 22 | ○ | | | 2nd Semester | Fri. | 4・5 | Ⅱ:M(R0256) | Seminar on Advanced Chemistry Ⅱ | 2 | YAMAZOE Seizi<br>OURA Yasuji | |
| 21 | ○ | | | 1st Semester | Fri. | 3・4 | Ⅰ:M(R0257) | Seminar on Advanced Chemistry Ⅰ | 2 | ITO Yutka<br>IKEYA Teppei | |
| 22 | ○ | | | 2nd Semester | Fri. | 3・4 | Ⅱ:M(R0258) | Seminar on Advanced Chemistry Ⅱ | 2 | ITO Yutka<br>IKEYA Teppei | |
| 23 | | ○ | | 1st Semester | Fri. | 3・4 | Ⅲ:D(R0259) | Seminar on Advanced Chemistry Ⅲ | 2 | HIROSE Yasushi<br>OKA Daichi | |
| 24 | | ○ | | 2nd Semester | Fri. | 3・4 | Ⅳ:D(R0260) | Seminar on Advanced Chemistry Ⅳ | 2 | HIROSE Yasushi<br>OKA Daichi | |
| 23 | | ○ | | 1st Semester | Mon. | 1・2 | Ⅲ:D(R0263) | Seminar on Advanced Chemistry Ⅲ | 2 | TAKEGAWA Nobuyuki<br>MOTEKI Nobuhiro | |
| 24 | | ○ | | 2nd Semester | Mon. | 1・2 | Ⅳ:D(R0264) | Seminar on Advanced Chemistry Ⅳ | 2 | TAKEGAWA Nobuyuki<br>MOTEKI Nobuhiro | |
| 23 | | ○ | | 1st Semester | Mon. | 1・2 | Ⅲ:D(R0265) | Seminar on Advanced Chemistry Ⅲ | 2 | HIROTA Kouji<br>TAOKA Masato | |
| 24 | | ○ | | 2nd Semester | Mon. | 1・2 | Ⅳ:D(R0266) | Seminar on Advanced Chemistry Ⅳ | 2 | HIROTA Kouji<br>TAOKA Masato | |
| 23 | | ○ | | 1st Semester | Mon. | 3・4 | Ⅲ:D(R0267) | Seminar on Advanced Chemistry Ⅲ | 2 | KANYA Reika | |
| 24 | | ○ | | 2nd Semester | Mon. | 5・6 | Ⅳ:D(R0268) | Seminar on Advanced Chemistry Ⅳ | 2 | KANYA Reika | |
| 23 | | ○ | | 1st Semester | Tue. | 4・5 | Ⅲ:D(R0269) | Seminar on Advanced Chemistry Ⅲ | 2 | NAKATANI Naoki | |
| 24 | | ○ | | 2nd Semester | Mon. | 4・5 | Ⅳ:D(R0270) | Seminar on Advanced Chemistry Ⅳ | 2 | NAKATANI Naoki | |
| 23 | | ○ | | 1st Semester | Mon. | 3・4 | Ⅲ:D(R0271) | Seminar on Advanced Chemistry Ⅲ | 2 | TBA | |
| 24 | | ○ | | 2nd Semester | Mon. | 3・4 | Ⅳ:D(R0272) | Seminar on Advanced Chemistry Ⅳ | 2 | TBA | |
| 23 | | ○ | | 1st Semester | Fri. | 3・4 | Ⅲ:D(R0273) | Seminar on Advanced Chemistry Ⅲ | 2 | KUBUKI Siro | |
| 24 | | ○ | | 2nd Semester | Fri. | 1・2 | Ⅳ:D(R0274) | Seminar on Advanced Chemistry Ⅳ | 2 | KUBUKI Siro | |
| 23 | | ○ | | 1st Semester | Mon. | 1・2 | Ⅲ:D(R0275) | Seminar on Advanced Chemistry Ⅲ | 2 | SUGIURA Ken-ichi<br>ISHIDA Masatoshi | |
| 24 | | ○ | | 2nd Semester | Mon. | 1・2 | Ⅳ:D(R0276) | Seminar on Advanced Chemistry Ⅳ | 2 | SUGIURA Ken-ichi<br>ISHIDA Masatoshi | |
| 23 | | ○ | | 1st Semester | Mon. | 5・6 | Ⅲ:D(R0277) | Seminar on Advanced Chemistry Ⅲ | 2 | NOMURA Kotohiro<br>SOLIMAN Mehawed Abdellatif Mohamed | |
| 24 | | ○ | | 2nd Semester | Mon. | 5・6 | Ⅳ:D(R0278) | Seminar on Advanced Chemistry Ⅳ | 2 | NOMURA Kotohiro<br>SOLIMAN Mehawed Abdellatif Mohamed | |
| 23 | | ○ | | 1st Semester | Fri. | 4・5 | Ⅲ:D(R0279) | Seminar on Advanced Chemistry Ⅲ | 2 | YAMAZOE Seizi<br>OURA Yasuji | |
| 24 | | ○ | | 2nd Semester | Fri. | 4・5 | Ⅳ:D(R0280) | Seminar on Advanced Chemistry Ⅳ | 2 | YAMAZOE Seizi<br>OURA Yasuji | |

| Course outline No. | M | D | NA 2024 | Semester | Day | Time | Course Number | Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | | ○ | | 1st Semester | Fri. | 3・4 | Ⅲ：D(R0281) | Seminar on Advanced Chemistry III | 2 | ITO Yutka<br>IKEYA Teppei | |
| 24 | | ○ | | 2nd Semester | Fri. | 3・4 | Ⅳ：D(R0282) | Seminar on Advanced Chemistry IV | 2 | ITO Yutka<br>IKEYA Teppei | |
| 25 | ○ | | | 1st Semester | | | ⅠA：M(R0284) | Advanced Research of Chemistry IA | 2 | Multiple instructors | |
| 26 | ○ | | | 2nd Semester | | | ⅠB：M(R0285) | Advanced Research of Chemistry IB | 2 | Multiple instructors | |
| 27 | ○ | | | 1st Semester | | | ⅡA：M(R0287) | Advanced Research of Chemistry IIA | 2 | Multiple instructors | |
| 28 | ○ | | | 2nd Semester | | | ⅡB：M(R0288) | Advanced Research of Chemistry IIB | 2 | Multiple instructors | |
| 29 | | ○ | | 1st Semester | | | ⅢA：D(R0290) | Advanced Research of Chemistry IIIA | 2 | Multiple instructors | |
| 30 | | ○ | | 2nd Semester | | | ⅢB：D(R0291) | Advanced Research of Chemistry IIIB | 2 | Multiple instructors | |
| 31 | | ○ | | 1st Semester | | | ⅣA：D(R0293) | Advanced Research of Chemistry ⅣA | 2 | Multiple instructors | |
| 32 | | ○ | | 2nd Semester | | | ⅣB：D(R0294) | Advanced Research of Chemistry ⅣB | 2 | Multiple instructors | |

| Course outline No. | M | D | NA 2024 | Semester | Day | Time | Course Number | Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| For students enrolling in October | | | | | | | | | | | |
| 21 | ○ | | | 2nd Semester | Fri. | 3・4 | Ⅰ:M(R0951) | Seminar on Advanced Chemistry Ⅰ | 2 | HIROSE Yasushi<br>OKA Daichi | |
| 22 | ○ | | | 1st Semester | Fri. | 3・4 | Ⅱ:M(R0950) | Seminar on Advanced Chemistry Ⅱ | 2 | HIROSE Yasushi<br>OKA Daichi | |
| 21 | ○ | | | 2nd Semester | Mon. | 1・2 | Ⅰ:M(R0955) | Seminar on Advanced Chemistry Ⅰ | 2 | TAKEGAWA Nobuyuki<br>MOTEKI Nobuhiro | |
| 22 | ○ | | | 1st Semester | Mon. | 1・2 | Ⅱ:M(R0954) | Seminar on Advanced Chemistry Ⅱ | 2 | TAKEGAWA Nobuyuki<br>MOTEKI Nobuhiro | |
| 21 | ○ | | | 2nd Semester | Mon. | 1・2 | Ⅰ:M(R0957) | Seminar on Advanced Chemistry Ⅰ | 2 | HIROTA Kouji<br>TAOKA Masato | |
| 22 | ○ | | | 1st Semester | Mon. | 1・2 | Ⅱ:M(R0956) | Seminar on Advanced Chemistry Ⅱ | 2 | HIROTA Kouji<br>TAOKA Masato | |
| 21 | ○ | | | 2nd Semester | Mon. | 5・6 | Ⅰ:M(R0959) | Seminar on Advanced Chemistry Ⅰ | 2 | KANYA Reika | |
| 22 | ○ | | | 1st Semester | Mon. | 3・4 | Ⅱ: M(R0958) | Seminar on Advanced Chemistry Ⅱ | 2 | KANYA Reika | |
| 21 | ○ | | | 2nd Semester | Mon. | 4・5 | Ⅰ:M(R0961) | Seminar on Advanced Chemistry Ⅰ | 2 | NAKATANI Naoki | |
| 22 | ○ | | | 1st Semester | Tue. | 4・5 | Ⅱ:M(R0960) | Seminar on Advanced Chemistry Ⅱ | 2 | NAKATANI Naoki | |
| 21 | ○ | | | 2nd Semester | Mon. | 3・4 | Ⅰ: M(R0963) | Seminar on Advanced Chemistry Ⅰ | 2 | TBA | |
| 22 | ○ | | | 1st Semester | Mon. | 3・4 | Ⅱ: M(R0962) | Seminar on Advanced Chemistry Ⅱ | 2 | TBA | |
| 21 | ○ | | | 2nd Semester | Fri. | 1・2 | Ⅰ:M(R0965) | Seminar on Advanced Chemistry Ⅰ | 2 | KUBUKI Siro | |
| 22 | ○ | | | 1st Semester | Fri. | 3・4 | Ⅱ:M(R0964) | Seminar on Advanced Chemistry Ⅱ | 2 | KUBUKI Siro | |
| 21 | ○ | | | 2nd Semester | Mon. | 1・2 | Ⅰ: M(R0967) | Seminar on Advanced Chemistry Ⅰ | 2 | SUGIURA Ken-ichi<br>ISHIDA Masatoshi | |
| 22 | ○ | | | 1st Semester | Mon. | 1・2 | Ⅱ:M(R0966) | Seminar on Advanced Chemistry Ⅱ | 2 | SUGIURA Ken-ichi<br>ISHIDA Masatoshi | |
| 21 | ○ | | | 2nd Semester | Mon. | 5・6 | Ⅰ:M(R0969) | Seminar on Advanced Chemistry Ⅰ | 2 | NOMURA Kotohiro<br>SOLIMAN Mehawed Abdellatif Mohamed | |
| 22 | ○ | | | 1st Semester | Mon. | 5・6 | Ⅱ: M(R0968) | Seminar on Advanced Chemistry Ⅱ | 2 | NOMURA Kotohiro<br>SOLIMAN Mehawed Abdellatif Mohamed | |
| 21 | ○ | | | 2nd Semester | Fri. | 4・5 | Ⅰ: M(R0971) | Seminar on Advanced Chemistry Ⅰ | 2 | YAMAZOE Seizi<br>OURA Yasuji | |
| 22 | ○ | | | 1st Semester | Fri. | 4・5 | Ⅱ: M(R0970) | Seminar on Advanced Chemistry Ⅱ | 2 | YAMAZOE Seizi<br>OURA Yasuji | |
| 21 | ○ | | | 2nd Semester | Fri. | 3・4 | Ⅰ:M(R0973) | Seminar on Advanced Chemistry Ⅰ | 2 | ITO Yutka<br>IKEYA Teppei | |
| 22 | ○ | | | 1st Semester | Fri. | 3・4 | Ⅱ:M(R0972) | Seminar on Advanced Chemistry Ⅱ | 2 | ITO Yutka<br>IKEYA Teppei | |
| 23 | | ○ | | 2nd Semester | Fri. | 3・4 | Ⅲ:D(R0975) | Seminar on Advanced Chemistry Ⅲ | 2 | HIROSE Yasushi<br>OKA Daichi | |
| 24 | | ○ | | 1st Semester | Fri. | 3・4 | Ⅳ:D(R0974) | Seminar on Advanced Chemistry Ⅳ | 2 | HIROSE Yasushi<br>OKA Daichi | |
| 23 | | ○ | | 2nd Semester | Mon. | 1・2 | Ⅲ:D(R0979) | Seminar on Advanced Chemistry Ⅲ | 2 | TAKEGAWA Nobuyuki<br>MOTEKI Nobuhiro | |
| 24 | | ○ | | 1st Semester | Mon. | 1・2 | Ⅳ:D(R0978) | Seminar on Advanced Chemistry Ⅳ | 2 | TAKEGAWA Nobuyuki<br>MOTEKI Nobuhiro | |
| 23 | | ○ | | 2nd Semester | Mon. | 1・2 | Ⅲ:D(R0981) | Seminar on Advanced Chemistry Ⅲ | 2 | HIROTA Kouji<br>TAOKA Masato | |
| 24 | | ○ | | 1st Semester | Mon. | 1・2 | Ⅳ:D(R0980) | Seminar on Advanced Chemistry Ⅳ | 2 | HIROTA Kouji<br>TAOKA Masato | |
| 23 | | ○ | | 2nd Semester | Mon. | 5・6 | Ⅲ:D(R0983) | Seminar on Advanced Chemistry Ⅲ | 2 | KANYA Reika | |
| 24 | | ○ | | 1st Semester | Mon. | 3・4 | Ⅳ:D(R0982) | Seminar on Advanced Chemistry Ⅳ | 2 | KANYA Reika | |
| 23 | | ○ | | 2nd Semester | Mon. | 4・5 | Ⅲ:D(R0985) | Seminar on Advanced Chemistry Ⅲ | 2 | NAKATANI Naoki | |
| 24 | | ○ | | 1st Semester | Tue. | 4・5 | Ⅳ:D(R0984) | Seminar on Advanced Chemistry Ⅳ | 2 | NAKATANI Naoki | |
| 23 | | ○ | | 2nd Semester | Mon. | 3・4 | Ⅲ:D(R0987) | Seminar on Advanced Chemistry Ⅲ | 2 | TBA | |
| 24 | | ○ | | 1st Semester | Mon. | 3・4 | Ⅳ:D(R0986) | Seminar on Advanced Chemistry Ⅳ | 2 | TBA | |
| 23 | | ○ | | 2nd Semester | Fri. | 1・2 | Ⅲ:D(R0989) | Seminar on Advanced Chemistry Ⅲ | 2 | KUBUKI Siro | |
| 24 | | ○ | | 1st Semester | Fri. | 3・4 | Ⅳ:D(R0988) | Seminar on Advanced Chemistry Ⅳ | 2 | KUBUKI Siro | |
| 23 | | ○ | | 2nd Semester | Mon. | 1・2 | Ⅲ:D(R0991) | Seminar on Advanced Chemistry Ⅲ | 2 | SUGIURA Ken-ichi<br>ISHIDA Masatoshi | |
| 24 | | ○ | | 1st Semester | Mon. | 1・2 | Ⅳ:D(R0990) | Seminar on Advanced Chemistry Ⅳ | 2 | SUGIURA Ken-ichi<br>ISHIDA Masatoshi | |
| 23 | | ○ | | 2nd Semester | Mon. | 5・6 | Ⅲ:D(R0993) | Seminar on Advanced Chemistry Ⅲ | 2 | NOMURA Kotohiro<br>SOLIMAN Mehawed Abdellatif Mohamed | |
| 24 | | ○ | | 1st Semester | Mon. | 5・6 | Ⅳ:D(R0992) | Seminar on Advanced Chemistry Ⅳ | 2 | NOMURA Kotohiro<br>SOLIMAN Mehawed Abdellatif Mohamed | |
| 23 | | ○ | | 2nd Semester | Fri. | 4・5 | Ⅲ:D(R0995) | Seminar on Advanced Chemistry Ⅲ | 2 | YAMAZOE Seizi<br>OURA Yasuji | |
| 24 | | ○ | | 1st Semester | Fri. | 4・5 | Ⅳ:D(R0994) | Seminar on Advanced Chemistry Ⅳ | 2 | YAMAZOE Seizi<br>OURA Yasuji | |

| Course outline No. | M | D | NA 2024 | Semester | Day | Time | Course Number | Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | | ○ | | 2nd Semester | Fri. | 3・4 | Ⅲ：D(R0997) | Seminar on Advanced Chemistry Ⅲ | 2 | ITO Yutka<br>IKEYA Teppei | |
| 24 | | ○ | | 1st Semester | Fri. | 3・4 | Ⅳ：D(R0996) | Seminar on Advanced Chemistry Ⅳ | 2 | ITO Yutka<br>IKEYA Teppei | |
| 25 | ○ | | | 2nd Semester | | | ⅠA：M(R0941) | Advanced Research of Chemistry ⅠA | 2 | Multiple instructors | |
| 26 | ○ | | | 1st Semester | | | ⅠB：M(R0940) | Advanced Research of Chemistry ⅠB | 2 | Multiple instructors | |
| 27 | ○ | | | 2nd Semester | | | ⅡA：M(R0943) | Advanced Research of Chemistry ⅡA | 2 | Multiple instructors | |
| 28 | ○ | | | 1st Semester | | | ⅡB：M(R0942) | Advanced Research of Chemistry ⅡB | 2 | Multiple instructors | |
| 29 | | ○ | | 2nd Semester | | | ⅢA：D(R0945) | Advanced Research of Chemistry ⅢA | 2 | Multiple instructors | |
| 30 | | ○ | | 1st Semester | | | ⅢB：D(R0944) | Advanced Research of Chemistry ⅢB | 2 | Multiple instructors | |
| 31 | | ○ | | 2nd Semester | | | ⅣA：D(R0947) | Advanced Research of Chemistry ⅣA | 2 | Multiple instructors | |
| 32 | | ○ | | 1st Semester | | | ⅣB：D(R0946) | Advanced Research of Chemistry ⅣB | 2 | Multiple instructors | |

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

| Instructor(s) | Note |
|---|---|
| SUGIURA Ken-ichi, KUBUKI Shiro, YAMAZOE Seiji | |

| | |
|---|---|
| (1) Course policies and topics | In this academic year, Kubuki provides the first seven lectures, and Yamazoe provides the latter seven lectures. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | <Lectures by Kubuki><br>1) To explain the relationship between structures and physical properties of inorganic solid materials such as metal, ionic solids, and glass-ceramics.<br>2) To explain electrical, magnetic, and optical properties of inorganic solid materials.<br><br><Lectures by Yamazoe><br>To learn fundamental knowledge of X-ray absorption spectroscopy (X-ray absorption fine structure: XAFS) and its applications.<br>To learn how to understand mechanistic aspects of functional materials based on the local geometry and its electronic structure obtained from XAFS, as providing some practical examples. |
| (3) Course schedule, subject matter, and classroom activities | <1st half (Kubuki)><br>1. Crystal structure (1): Notification of crystal structures (ccp, hcp, and bcc)<br>2. Crystal structure (2): Lattice, unit cell, and 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, anti-ferromagnetism, and ferrimagnetism<br>6. Superconductivity: Discovery and theory of superconductivity<br>7. Summary<br><br><2nd half (Yamazoe)><br>8. Historical backgrounds of XAS, and synchrotron radiation facility<br>9. Fundamentals of XAS: XANES<br>10. Fundamentals of XAS: EXAFS<br>11. XAFS measurement<br>12. XAFS analysis<br>13. XAFS application I<br>14. XAFS application II<br><br>15. Either Kubuki or Yamazoe provides a more advanced lecture. |
| (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><br><Yamazoe><br>Review every lecture and prepare for the next lecture in advance. |
| (5) Textbooks and course materials | <Kubuki><br>L. Smart and E. Moore "Solid State Chemistry -an introduction" (Chapman and Hall)<br><br><Yamazoe><br>None. |
| (6) Assessment and grading | Total score is of the average of each instructor’s evaluation. If one of the rating is less than 60%, the credit may not be provided.<br><Kubuki> Rating by the assigned reports (100%)<br><Yamazoe> Rating by the assigned reports (100%) |
| (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced Geo- and Cosmochemistry | R0222 | 2nd | Tue. | 2 | 2 |
| Doctoral program | - | - | | | | |

| Instructor(s) | Note |
|---|---|
| TAKEGAWA Nobuyuki, MOTEKI Nobuhiro, OURA Yasuji | |

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|---|---|
| (1) Course policies and topics | This lecture covers physical and chemical processes that govern the formation and circulation of matters in the universe and on the Earth. The first half of the lecture focuses on the Earth's atmosphere and hydrosphere. The second half of the lecture focuses on the formation of matters in the universe and the solar system. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The goal is to understand important chemical processes in the solar system and on the 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 spectroscopy<br>2. Photochemical processes in the atmosphere<br>3. Basics of aerosol thermodynamics<br>4. Growth of aerosol by condensation<br>5. Geochemical cycles in the atmosphere and the oceans<br>6. Radiative transfer in the atmosphere<br>7. Elementary process of radiative transfer: Emission and absorption<br>8. Elementary process of radiative transfer: Scattering<br>9. Radiative effects of greenhouse gases<br>10. Radiative effects of cloud and aerosol<br>11. Radiochemistry-1 (Nuclear stability, radioactive decay)<br>12. Radiochemistry-2 (Nuclear reactions)<br>13. Nucleosynthesis-1 (Thermonuclear fusion)<br>14. Nucleosynthesis-2 (Neutron capture)<br>15. Naturally occurring radionuclides (Nuclear reactions by cosmic rays)<br><br>The above schedule may be changed depending on the progress of the course. |
| (4) Outside-class activities and assignments | Work presented in the class is assigned. |
| (5) Textbooks and course materials | Handouts are distributed in the class. Reference books are indicated in the class as needed. |
| (6) Assessment and grading | Attendance (20%), Final report (80%) |
| (7) Questions to the instructor (Office hours, etc.) | No office hours are arranged. If you have any questions, please make an appointment in advance by e-mail. Contact via Kibako is also acceptable. |
| (8) Special note | |

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

| Instructor(s) | Note |
|---|---|
| NOMURA Kotohiro, ABDELLATIF Mohamed Mehawed | |

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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, supramolecular 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 15 lectures including the following topics 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.<br>Nomura: ktnomura@tmu.ac.jp<br>Abdellatif: Mohamed-soliman@tmu.ac.jp |
| (8) Special note | |

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

| Instructor(s) | Note |
|---|---|
| HIROTA Kouji, ITO Yutaka, TAOKA Masato, IKEYA Teppei | |

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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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced Molecular Spectroscopy | R0163 | 2nd | Wed. | 1 | 2 |
| Doctoral program | Advanced Molecular Spectroscopy | R0164 | | | | |

| Instructor(s) | Note |
|---|---|
| KANYA Reika | 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<br>02. Electron scattering by atoms<br>03. Green function<br>04. Lippmann-Schwinger equation<br>05. Differential cross section<br>06. Partial wave analysis<br>07. Partial wave analysis by numerical calculations<br>08. Intermediate summary<br>09. Born approximation<br>10. Electron scattering by molecules and the independent atom model<br>11. Effect of molecular vibration<br>12. Molecular scattering curve and radial distribution function<br>13. Analyses of electron diffraction images 1<br>14. Analyses of electron diffraction images 2<br>15. 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 | If you want to take classes in English, please contact the instructor by email (kanya@tmu.ac.jp) at least one week before the first lecture. The classes in English will be held at the first period on Friday in the second semester. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| 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 |
|---|---|
| HIROSE Yasushi | 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 homework (or semester exam). |
| (7) Questions to the instructor (Office hours, etc.) | Questions and concerns are accepted by e-mail. |
| (8) Special note | Scientific calculator is used for exercise during the lecture. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced Theoretical Chemistry | R0167 | 1st | Tue. | 2 | 2 |
| Doctoral program | Advanced Theoretical Chemistry | R0168 | | | | |

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

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| (1) Course policies and topics | In this course, an advanced lecture series about “molecular electronic structure theory”, one of the topics in “quantum chemistry”, is provided. Particularly, it is focused on the practical methods to compute electronic structures (such that energy, geometry, and properties of molecules).<br>It is able to predict the physical properties with the extremely high accuracy in recent quantum chemistry. On the other hand, it is also applied for large molecular systems such as proteins and nano-materials, with an appropriate approximation. In this lecture series, such these state-of-the-art methods and their applications are overviewed, too. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | To learn advanced and practical knowledge about quantum chemistry and computational chemistry which can be applied for own research topics.<br>To 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 | The lecture series consists of 15 sessions including some exercieses.<br>[01] Introduction, Review of quantum chemistry<br>[02] Hartree-Fock energy<br>[03] Hamiltonian matrix elements<br>[04] Spin eigenfunctions<br>[05] Configuration interaction (CI)<br>[06] Lagrange multiplier<br>[06] Exercise 1<br>[07] Rayleigh-Schrödinger perturbation theory (RSPT)<br>[08] Møller-Plesset perturbation theory (MP)<br>[09] Exercise 2<br>[10] Linux commands for beginner’s<br>[11] Z-matrix and cartesian coordinates<br>[12] Exercise 3<br>[13] Density functional theory (DFT)<br>[14] Practical guide for quantum chemistry<br>[15] Exercise 4<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 lectures. |
| (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 mini-quiz in the lecture (20%). |
| (7) Questions to the instructor (Office hours, etc.) | Office-hour is not arranged, but questions are welcome through e-mail (naokin@tmu.ac.jp). In the e-mail, please specify your name in the subject and use an e-mail address which can be replied through internet (an e-mail including special characters which only available for mobile phone is not acceptable). |
| (8) Special note | In the exercise, please bring your laptop PC in which MS office is installed. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| 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 |
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| NOMURA Kotohiro | |

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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.<br>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: 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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced Lecture in Chemistry II (Advanced Material Science) | R0233 | 1st | Wed. | 1 | 2 |
| Doctoral program | Advanced Lecture in Chemistry II (Advanced Material Science) | R0237 | | | | |

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

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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. Optical properties and transparent conducting oxides<br>6. Mixed anion oxides<br>7. Electron correlation<br>8. Metal-to-insulator transition<br>9. Phenomenology of superconductivity<br>10. Superconductivity in cuprates<br>11. Oxide superconductors discovered after cuprates<br>12. Magnetism in oxides<br>13. Dielectric properties of oxides<br>14. Multiferroic oxides<br>15. Summary and exercise |
| (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 | Participation (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced Lecture in Chemistry II (Functional Materials Chemistry) | R0300 | 1st | Tue. | 1 | 2 |
| Doctoral program | Advanced Lecture in Chemistry II (Functional Materials Chemistry) | R0302 | | | | |

| Instructor(s) | Note |
|---|---|
| ISHIDA Masatoshi, KAWASOKO Hideyuki | |

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| (1) Course policies and topics | In this course, advanced lectures are provided on the fundamental principles governing the functions of structures and properties of various materials, from the perspectives of both organic and inorganic chemistry. This includes recent advancements in material applications.<br>During the first half of the lecture series, we will discuss fundamental physical and chemical properties of organic materials focusing on aspects e.g., electronic conductivity, photoelectric conversion, emission, and photochemical reactions. This is relevant due to the growing importance of organic materials exhibiting exceptional functionality across diverse fields, including quantum information, environmental energy, and medical applications.<br>During the second half of the lecture series, we will discuss that crystalline inorganic solids exhibit a variety of electrical, magnetic, dielectric, thermal, and optical properties, and behind those features, there is a diversity of crystal structures that correspond to the three-dimensional arrangement of atoms. Focusing on the diversity of such crystal structures. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | 1) Learn the design principles of advanced organic molecular materials with various functions, and develop the ability to elucidate photophysical processes and structural relationships.<br>2) Be able to explain the parameters that characterize the crystal structure of inorganic solids.<br>3) Be able to explain the atomic arrangement in typical crystal structures of inorganic solids. |
| (3) Course schedule, subject matter, and classroom activities | The lecture consists of 15 sessions. Each topic will be covered in both the first and second halves of the course, offering a comprehensive overview.<br>1: Introduction of photochemistry<br>2: Basics of optical functional materials<br>3: Spectroscopy of organic materials<br>4: Bio-Imaging<br>5: Light emitting devices<br>6: Solar cells<br>7: Photocatalysts<br>8: Summary (first half)<br>9: Basics of Crystallography<br>10: Structure of elemental solids<br>11: CsCl type/NaCl type structures and their derived structures<br>12: ZnS type structure and its derived structures<br>13: NiAs type structure and its derived structures<br>14: Perovskite structure and its derived structures<br>15: Spinel-type structure, corundum-type structure, and their derived structures |
| (4) Outside-class activities and assignments | First half of the lecture: Report assignments given during class must be submitted by the deadline after the lecture.<br>Second half of the lecture: After each lecture, students will be required to submit a summary of the lecture content (approximately 800 characters) as a report assignment. Furthermore, students will be required to submit an exercise assignment to review the content of the seven lectures as a final report assignment. |
| (5) Textbooks and course materials | First half of the lecture: Lecture handouts will be distributed during the lecture.<br>Second half of the lecture: Text “Crystal Chemistry of Fine Ceramics” by F. S. Galasso, translated by Seiki Kato and Keizo Uematsu, Agne Technology Center. |
| (6) Assessment and grading | First half of the lecture: In principle, a comprehensive evaluation will be made based on the degree of participation in the class, assignment reports, presentations, etc.<br>Second half of the lecture: In principle, grades will be evaluated based on each report assignment and final report assignment. |
| (7) Questions to the instructor (Office hours, etc.) | First half of the lecture: If you contact us in advance by email, we will accept your request at any time.<br>Second half of the lecture: Office hours will not be scheduled. Questions regarding the lecture content will be accepted via email. If you would like to ask questions directly outside of class hours, please contact us via email in advance so we can adjust the schedule. |
| (8) Special note | First half of the lecture: If it is difficult to hold a face-to-face lecture in a lecture room, the lecture may be conducted online using Zoom, etc. If you have a computer or tablet, please bring it with you.<br>Second half of the lecture: During the lecture, we plan to distribute materials as appropriate and use both slides and blackboard materials. If it is not possible to conduct a lecture face-to-face in a lecture room due to the influence of the new coronavirus, lecture materials and reports may be distributed via Kibaco, etc., and the lecture may be conducted via video distribution such as Zoom. |

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

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

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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 (10 lectures), presentation of literature reviews concerning advanced materials chemistry and discussion (5 lectures). The person in the presentation (students) should discuss in advance to gain better understanding in the backgrounds as well as knowledge.<br><br>Lectures will be provided in English. |
| (4) Outside-class activities and assignments | Review thoroughly the contents of each lecture. |
| (5) Textbooks and course materials | Hand out will be distributed. |
| (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| 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><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.) | For questions, call or email.<br>Office: TEL: 0422-33-3249 E-mail: koe@icu.ac.jp |
| (8) Special note | |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | External Experience in Chemistry | R0295 / 1 cre.<br>R0297 / 2 cre. | Intensive course | - | - | 1 or 2 |
| Doctoral program | External Experience in Chemistry | R0296 / 1 cre.<br>R0298 / 2 cre. | | | | |

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

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|---|---|
| (1) Course policies and topics | To have an external experience or a voluntary work related to advanced chemistry. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | To acquire a wide range of academic abilities throughout the external experiences or voluntary work related to advanced education in chemistry. |
| (3) Course schedule, subject matter, and classroom activities | Content equivalent to the curriculum level of the graduate school including practical training or research activity program of 30 hours or more provided by other department or external organization (limited to that with clear accreditation criteria). |
| (4) Outside-class activities and assignments | Depending on the host organization. |
| (5) Textbooks and course materials | Depending on the host organization. |
| (6) Assessment and grading | 5-point rating incorporating by training diary, report, and evaluation from the host organization. |
| (7) Questions to the instructor (Office hours, etc.) | Contact to N. Nakatani (academic affairs committee in chemistry), accepted at any time through e-mail (naokin@tmu.ac.jp). |
| (8) Special note | (Credit hours)<br>- 1 or 2 depending on the training hours and the accreditation criteria of the host organization.<br>- Duplicate enrollment is allowed if the content is different.<br>- The credits can be included in those required for graduation.<br><br>(Notes)<br>- Course registration cannot be made at the beginning of the semester, as the course enrollment is approved upon request from the student.<br>- Make a preliminary application to your supervisor at least 6 weeks before the start date of the training, and receive permission from your supervisor for the content of the training.<br>- In principle, the training must be arranged during the break season. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Internship | R0825 / 1 cre.<br>R0827 / 2 cre. | Intensive course | - | - | 1 or 2 |
| Doctoral program | Internship | R0826 / 1 cre.<br>R0828 / 2 cre. | | | | |

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

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|---|---|
| (1) Course policies and topics | To have a work experience for 5 days (or 40 hours) or more at a company, government agency, NPO, etc. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | To improve practical abilities (knowledge/techniques) from the work experience including advanced knowledge and techniques in chemistry. |
| (3) Course schedule, subject matter, and classroom activities | This subject is intended for graduate students.<br><br>Participants will undergo work experience for a period of 5 days (or 40 hours) or more according to the program provided by the implementing agency. However, work experience must be conducted for at least half of the participating dates for credit recognition.<br><br>During the training, please follow the instructions of the implementing agency's employees and staff. |
| (4) Outside-class activities and assignments | Gather information about the implementing agency using literature, the Internet, etc. |
| (5) Textbooks and course materials | Depending on the host organization. |
| (6) Assessment and grading | 5-point rating incorporating by training diary, report, and evaluation from the host organization. |
| (7) Questions to the instructor (Office hours, etc.) | Contact to N. Nakatani (academic affairs committee in chemistry), accepted at any time through e-mail (naokin@tmu.ac.jp). |
| (8) Special note | (Credit hours)<br>- Depending on the length of the internship.<br>1 credit: 5 days (or 40 hours) or more, up to 8 days (or 60 hours)<br>2 credit: 8 days (or 60 hours) or more: 2 credit<br>- Duplicate enrollment is allowed if the content is different.<br>- The credits can be included in those required for graduation.<br><br>(Notes)<br>1. In principle, the internship must be arranged during the break season.<br>2. Content must be equivalent to the curriculum level of the graduate school and related to advanced education in chemistry. A part of the internship should not be a requirement for accreditation of other course credit or qualification.<br>3. If a university or research institute freely invites participates from outside, a copy of the information flyer must be available. In the case of company, training school, etc., the agreement of acceptance indicating the name, affiliation, and contact information of instructor with his/her seal and signature. Must be enrolled in "Personal Accident Insurance for Students Pursuing Education and Research" and "Liability Insurance for Internship, Nursing training, and Teaching training, etc." (or accident and liability insurances with equivalent or higher quality).<br>4. A certificate of completion issued by the instructor must be obtained, or the instructor agrees to provide his/her signature and seal for confirmation to a university's certificate format.<br>5. Make a preliminary application to the academic affairs committee (N. Nakatani) with the documents in paragraph 3 containing the contact information of the host organization and the student, contents and purpose of the internship, to obtain permission.<br>6. After the internship, the student must compile a summary of the content, impressions, and training log into a several pages of report, and submit it to the academic affairs committee with the documents in paragraph 4. Accreditation will be made by the academic affairs committee, based on the compatibility with the purpose, the evaluation by the instructor, and the score of the report. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Seminar on Advanced Chemistry I | | 1st | - | - | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
|---|---|
| | The course is provided in 2nd semester for students of fall enrollment |

| | |
|---|---|
| (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>1. Review of each laboratory's specialized topics and explanation of future seminar plans<br>2. Detailed reading of introductory foreign-language literature1 related to the theme of the course<br>3. Introductory foreign-language literature 1 on the theme of your specialty<br>4. Detailed reading of introductory foreign-language literature 2 in accordance with the theme of your specialty<br>5. Explanation of introductory foreign-language literature 2 in accordance with the theme of your specialty<br>6. Detailed reading of introductory foreign-language literature 3 in accordance with the theme of your specialty<br>7. Explanation of introductory foreign-language literature 3 in accordance with the theme of the specialty<br>8. Detailed reading of related paper 1<br>9. Explanation of related paper 1<br>10. Detailed reading of related paper 2<br>11. Commentary on related paper 2<br>12. Detailed reading of related paper 3<br>13. Explanation of related paper 3<br>14. Summary of basic knowledge acquired<br>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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Seminar on Advanced Chemistry II | | 2nd | - | - | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
|---|---|
| | The course is provided in 1st semester for students of fall enrollment |

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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>1. Review of each laboratory's specialized topics and explanation of future seminar plans<br>2. Detailed reading of introductory foreign-language literature1 related to the theme of the course<br>3. Introductory foreign-language literature 1 on the theme of your specialty<br>4. Detailed reading of introductory foreign-language literature 2 in accordance with the theme of your specialty<br>5. Explanation of introductory foreign-language literature 2 in accordance with the theme of your specialty<br>6. Detailed reading of introductory foreign-language literature 3 in accordance with the theme of your specialty<br>7. Explanation of introductory foreign-language literature 3 in accordance with the theme of the specialty<br>8. Detailed reading of related paper 1<br>9. Explanation of related paper 1<br>10. Detailed reading of related paper 2<br>11. Commentary on related paper 2<br>12. Detailed reading of related paper 3<br>13. Explanation of related paper 3<br>14. Summary of basic knowledge acquired<br>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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | | | 1st | - | - | 2 |
| Doctoral program | Seminar on Advanced Chemistry III | | | | | |

| Instructor(s) | Note |
|---|---|
| | The course is provided in 2nd semester for students of fall enrollment |

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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 contents of the program include 15 sessions which 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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | | | 2nd | - | - | 2 |
| Doctoral program | Seminar on Advanced Chemistry IV | | | | | |

| Instructor(s) | Note |
|---|---|
| | The course is provided in 1st semester for students of fall enrollment |

| | |
|---|---|
| (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 contents of the program include 15 sessions which 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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced Research of Chemistry IA | R0284<br>R0941 | 1st | - | - | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | The course is provided in 2nd semester for students of fall enrollment |

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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>1. Overview of research conducted in each laboratory<br>2. Establishment of a research theme and research plan (Part 1): Literature review and problem search<br>3. Establishment of a research theme and research plan (Part 2): Setting subject<br>4. Establishment of a research theme and research plan (Part 3): Research planning<br>5. Mastering experimental and computational methods necessary for research (Part 1): Investigation of experimental and computational methods<br>6. Mastering experimental and computational methods necessary for research (Part 2): Conducting experiments and calculations<br>7. Mastering experimental and computational methods necessary for research (Part 3): Reconfirming problems<br>8. Interim debriefing on research plan and experimental and computational methods<br>9. Preliminary experiments (Part 1): Investigations for conducting preliminary experiments<br>10. Preliminary experiments (Part 2): Conducting experiments<br>11. Preliminary experiments (Part 3): Discussion of problems<br>12. Preliminary experiments (Part 4): Re-experimentation based on the results of the study<br>13. Data analysis and organization of preliminary experiments (Part 1)<br>14. Data analysis and organization of preliminary experiments (Part 2)<br>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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced Research of Chemistry IB | R0285<br>R0940 | 2nd | - | - | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | The course is provided in 1st semester for students of fall enrollment |

| | |
|---|---|
| (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>1. Overview of research conducted in each laboratory<br>2. Research planning for basic experiments (Part 1): Literature review and problem search<br>3. Research planning for basic experiments (Part 2): Setting subject<br>4. Research planning for basic experiments (Part 3): Research planning<br>5. Conducting Basic Experiments (Part 1): Investigations for conducting basic experiments<br>6. Conducting Basic Experiments (Part 2): Conducting Experiments<br>7. Conducting Basic Experiments (Part 3): Examining Problems<br>8. Conducting basic experiments (Part 4): Re-experimentation based on the results of the study<br>9. Conducting basic experiments (Part 5): Summary of basic experiments<br>10. Interim debriefing of basic experiments<br>11. Data analysis and organization of basic experiments (Part 1)<br>12. Data analysis and organization of basic experiments (Part 2): Organizing Analysis Results<br>13. Discussion of basic experiment results (Part 1): Comparison with literature, etc.<br>14. Discussion of basic experiment results (Part 2): Discussion of results<br>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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced Research of Chemistry IIA | R0287<br>R0943 | 1st | - | - | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | The course is provided in 2nd semester for students of fall enrollment |

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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 | 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>1. Confirmation of outline of applied experiments to be conducted in Advanced Research of Chemistry IIA.<br>2. Research planning for applied experiments (Part 1): Literature Review and problem search<br>3. Research planning for applied experiments (Part 2): Setting subject<br>4. Research planning for applied experiments (Part 3): Research planning<br>5. Conducting applied experiments (Part 1): Investigations for conducting applied experiments<br>6. Conducting applied experiments (Part 2): Conducting Experiment<br>7. Conducting applied experiments (Part 3): Examining problems<br>8. Conducting applied experiments (Part 4): Re-experimentation based on the results of the study<br>9. Conducting applied experiments (Part 5): Summary of applied experiments<br>10. Interim debriefing of applied experiments<br>11. Data analysis and organization of applied experiments (Part 1)<br>12. Data Analysis and organization of applied experiments (Part 2): organizing analysis results<br>13. Discussion of applied experimental results (Part 1): Comparison with literature, etc.<br>14. Discussion of applied experimental results (Part 2): Discussion of results<br>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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced Research of Chemistry IIB | R0288<br>R0942 | 2nd | - | - | 2 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | The course is provided in 1st semester for students of fall enrollment |

| | |
|---|---|
| (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 | 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>1. Confirmation of outline of applied experiments to be conducted in Advanced Research of Chemistry IIB.<br>2. Research planning for advanced experiments (Part 1): Literature Review and problem search<br>3. Research planning for advanced experiments (Part 2): Setting subject<br>4. Research planning for advanced experiments (Part 3): Research planning<br>5. Conducting advanced experiments (Part 1): Investigations for conducting advanced experiments<br>6. Conducting advanced experiments (Part 2): Conducting Experiment<br>7. Conducting advanced experiments (Part 3): Examining problems<br>8. Conducting advanced experiments (Part 4): Re-experimentation based on the results of the study<br>9. Conducting advanced experiments (Part 5): Summary of advanced experiments<br>10. Interim debriefing of advanced experiments<br>11. Data analysis and organization of advanced experiments (Part 1)<br>12. Data Analysis and organization of advanced experiments (Part 2): organizing analysis results<br>13. Discussion of advanced experimental results (Part 1): Comparison with literature, etc.<br>14. Discussion of advanced experimental results (Part 2): Discussion of results<br>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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | | | 1st | - | - | 2 |
| Doctoral program | Advanced Research of Chemistry IIIA | R0290<br>R0945 | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | The course is provided in 2nd semester for students of fall enrollment |

| | |
|---|---|
| (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | | | 2nd | - | - | 2 |
| Doctoral program | Advanced Research of Chemistry IIIB | R0291<br>R0944 | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | The course is provided in 1st semester for students of fall enrollment |

| | |
|---|---|
| (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | | | 1st | - | - | 2 |
| Doctoral program | Advanced Research of Chemistry IVA | R0293<br>R0947 | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | The course is provided in 2nd semester for students of fall enrollment |

| | |
|---|---|
| (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | | | 2nd | - | - | 2 |
| Doctoral program | Advanced Research of Chemistry IVB | R0294<br>R0946 | | | | |

| Instructor(s) | Note |
|---|---|
| Multiple instructors | The course is provided in 1st semester for students of fall enrollment |

| | |
|---|---|
| (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 | |

**2024 Graduate School Course Catalog**
**Graduate School of Science (Biological Sciences)**

＊M = master's courses, D = doctoral courses
＊NA 2024 = Courses not offered in the academic year 2024

| Course outline No. | M | D | NA 2024 | Semester | Day | Time | Course Number | Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ○ | ○ | | 2nd Semester | Thu. | 1 | M(R0359) D(R0360) | Advanced Lecture on Biological Information | 2 | SAKAI Takaomi<br>WEITEMIER Adam Zachary | Physiological biochemistry of the brain and nervous system, molecular biology |
| 2 | ○ | ○ | | 1st Semester | Fri. | 1 | M(R0363) D(R0364) | Advanced Lecture on Biochemistry | 2 | KAWAHARA Hiroyuki<br>OKAMOTO Takashi | Biochemistry of protein metabolism |
| 3 | ○ | ○ | | 1st Semester | Thu. | 1 | M(R0369) D(R0370) | Advanced Lecture on Developmental Biology | 2 | FUKUDA Kimiko<br>TAKATORI Naohito | Modern developmental biology |
| 4 | ○ | ○ | | 2nd Semester | Fri. | 1 | M(R0371) D(R0372) | Advanced Lecture on Molecular Biology | 2 | EHIRA Shigeki<br>HARUTA Shin | Basics and practice of genomic science |
| | ○ | ○ | △ | | | 1 | M(R0751) D(R0752) | Advanced Lecture on Evolutionary Genetics | 2 | TAMURA Koichiro<br>TAKAHASHI Aya<br>NOZAWA Masafumi | Evolutionary biology from the perspective of genetics and ecology |
| | ○ | ○ | △ | | | 1 | M(R0753) D(R0754) | Advanced Lecture on Ecology | 2 | SUZUKI Jun-ichiro | Modern ecology with examples of basic research |
| | ○ | ○ | △ | | | 1 | M(R0755) D(R0756) | Advanced Lecture on Cell Biology | 2 | KANEGAE Takeshi<br>NARIKAWA Rei | Light sensing and environmental adaptation of plants |
| | ○ | ○ | △ | | | 1 | M(R0757) D(R0758) | Advanced Lecture on Taxonomy | 2 | MURAKAMI Noriaki<br>EGUCHI Katsuyuki | Phylogenetic evolution and diversity of plants and insects |
| 5 | ○ | ○ | | Summer intensive | Other | | M(R0377) D(R0378) | Advanced Lecture on Biological Sciences | 2 | ＊YOKOMIZO Hiroyuki | Basic statistical analysis using RStudio for biological systems |
| 6 | ○ | ○ | | Summer intensive | Other | | M(R0365) D(R0366) | Advanced Lecture on Biological Sciences | 2 | ＊FUKASAWA Keita | An introduction to R programming language for biological systems |
| 7 | ○ | ○ | | 2nd Semester Ⅱ | Fri. | 2 | M(R0391) D(R0392) | Special Lecture on Genetic Information | 1 | TAMURA Koichiro<br>TAKAHASHI Aya<br>NOZAWA Masafumi | Population genetics and molecular evolution |
| 8 | ○ | ○ | | 1st Semester Ⅱ | Fri. | 2 | M(R0393) D(R0394) | Special Lecture on Ecological Science | 1 | SUZUKI Jun-ichiro<br>CRONIN Adam | Animal behavior and society, renewal of plant communities |
| 9 | ○ | ○ | | 1st Semester Ⅰ | Fri. | 1 | M(R0397) D(R0398) | Special Lecture on Responses to Environment | 1 | KANEGAE Takeshi<br>NARIKAWA Rei | Environmental response and speciation of plants |
| 10 | ○ | ○ | | 2nd Semester Ⅰ | Tue. | 1 | M(R0373) D(R0374) | Special Lecture on Systematics and Evolution | 1 | MURAKAMI Noriaki<br>EGUCHI Katsuyuki | Phylogenetic evolution of plants and animals |
| | ○ | ○ | △ | | | 1 | M(R0385) D(R0386) | Special Lecture on Cellular communication□ | 1 | SAKAI Takaomi<br>WEITEMIER Adam Zachary | Physiology and biochemistry of the brain |
| | ○ | ○ | △ | | | 2 | M(R0383) D(R0384) | Special Lecture on Biomolecules | 1 | KAWAHARA Hiroyuki<br>OKAMOTO Takashi | Cell differentiation and development |
| | ○ | ○ | △ | | | 1 | M(R0399) D(R0400) | Special Lecture on Developmental and Regenerative Biology | 1 | FUKUDA Kimiko<br>TAKATORI Naohito | Modern developmental biology research and presentation methods |
| | ○ | ○ | △ | | | 2 | M(R0389) D(R0390) | Special Lecture on Cell Biology | 1 | EHIRA Shigeki<br>HARUTA Shin | The latest of genetics and molecular biology |
| 11 | ○ | ○ | | Summer intensive | | | M(R0401) D(R0402) | Special Lecture on Biological Sciences | 1 | Multiple instructors | The continuous education of modern biology |
| 12 | ○ | ○ | | Summer intensive | | | M(R0761) D(R0762) | Special Lecture on Cell Biology | 1 | ＊OTSUKA Shigeto | |
| 13 | ○ | ○ | | Winter intensive | | | M(R0701) D(R0702) | Special Lecture on Ecological Science | 1 | ＊ONODA Yusuke | |
| 14 | ○ | ○ | | Summer intensive | | | M(R0703) D(R0704) | Special Lecture on Ecological Science | 1 | ＊KOSHIKAWA Shigeyuki | |
| 15 | ○ | ○ | | Summer intensive | | | M(R0351) D(R0352) | Special Lecture on Cell Biology | 1 | ＊KUME Kazuhiko | |
| 16 | ○ | ○ | | Winter intensive | | | M(R0355) D(R0356) | Special Lecture on Biomolecules | 1 | ＊SUGIMURA Kaoru | |
| 17 | ○ | ○ | | Summer intensive | | | M(R0413) D(R0414) | Special Lecture on Biological Sciences | 1 | ＊ISHIGAMI Akihito<br>＊HARA Takahiko | Digest of the latest biomedical research 1 |
| 18 | ○ | ○ | | Summer intensive | | | M(R0415) D(R0416) | Special Lecture on Biological Sciences | 1 | ＊INOUE Azusa<br>＊MIURA Yuri<br>＊UENO Kohei<br>＊NONAKA Takashi | Digest of the latest biomedical research 2 |
| 19 | ○ | ○ | | Summer intensive | | | M(R0417) D(R0418) | Special Lecture on Biological Sciences | 1 | ＊MARUYAMA Chiaki<br>＊YOSHITANI Hikari<br>＊MIYADO Kenji<br>＊SOMEYA Yuichi | Digest of the latest biomedical research 3 |
| 20 | ○ | ○ | | Summer intensive | | | M(R0421) D(R0422) | English for Biology | 2 | ＊IIJIMA Yuka | English for science: listening and speaking |
| 21 | ○ | ○ | | Winter intensive | | | M(R0423) D(R0424) | English for Biology | 2 | ＊NAKAMURA Reina | How to write English papers |
| 22 | ○ | ○ | | 1st Semester | Mon. | 4 | M(R0425) D(R0426) | Special Course in Biology Ⅱ | 2 | ＊ Elisabeth Zielinska | Nature talk, Science and Culture |
| 23 | ○ | ○ | | 2nd Semester | Mon. | 3 | M(R0427) D(R0428) | Special Course in Biology Ⅱ | 2 | ＊ Elisabeth Zielinska | How to create a Persuasive Presentation |
| 24 | ○ | ○ | | 2nd Semester | Mon. | 4 | M(R0429) D(R0430) | Special Course in Biology Ⅱ | 2 | ＊ Elisabeth Zielinska | Nature talk Ⅱ |
| 25 | ○ | ○ | | 2nd Semester Ⅰ | Fri. | 2 | M(R0433) D(R0434) | Special Course in Biology Ⅰ | 1 | ANDO Kanae<br>CRONIN Adam<br>WEITEMIER Adam Zachary | Technique for Research Communication Course in English |
| 26 | ○ | ○ | | Summer intensive | | | M(R0439) D(R0440) | Special Course in Biology Ⅰ | 1 | TAMURA Koichiro<br>NOZAWA Masafumi | Computer Practice: Basics |
| | ○ | ○ | △ | | | 1 | M(R0441) D(R0442) | Special Course in Biology Ⅰ | 1 | FUKUDA Kimiko<br>TAKATORI Naohito<br>ASADA Akiko | Computer Practice: Application |
| 27 | ○ | ○ | | Summer intensive | | | M(R0431) D(R0432) | Special Course in Biological Sciences Ⅰ | 1 | EHIRA Shigeki | Modern Biology Recurrent Practice 1 |
| 28 | ○ | ○ | | Summer intensive | | | M(R0361) D(R0362) | Special Course in Biological Sciences Ⅰ | 1 | EGUCHI Katsuyuki | Modern Biology Recurrent Practice 2 |
| 29 | ○ | ○ | | 1st Semester | Tue. | 2 | M(R0443) D(R0444) | Biology course in planning and management 1 | 1 | HARUTA Shin<br>Multiple instructors | Biology Course in Planning and Management |
| 30 | ○ | ○ | | 1st Semester | Tue. | 1 | M(R0445) D(R0446) | Biology course in planning and management 1 | 1 | HARUTA Shin<br>Multiple instructors | Biology Course in Planning and Management |
| 31 | ○ | ○ | | 1st Semester | Tue. | 3 | M(R0447) D(R0448) | Biology course in international research experiences 1 | 1 | FUKUDA Kimiko<br>TAKAHASHI Aya<br>Multiple instructors | raining for developing global leadership skills |
| 32 | ○ | ○ | | 1st Semester | Tue. | 3 | M(R0449) D(R0450) | Biology course in international research experiences 1 | 1 | FUKUDA Kimiko<br>TAKAHASHI Aya<br>Multiple instructors | raining for developing global leadership skills |
| 33 | ○ | ○ | | 1st Semester | Wed. | 1 | M(R0451) D(R0452) | Biology course in research evaluation 1 | 1 | SUZUKI Jun-ichiro<br>Multiple instructors | Evaluation of research proposals and applications |
| 34 | ○ | ○ | | 2nd Semester | Tue. | 2 | M(R0453) D(R0454) | Biology course in research evaluation 2 | 1 | SUZUKI Jun-ichiro<br>Multiple instructors | Evaluation of research presentation |

| Course outline No. | M | D | NA 2024 | Semester | Day | Time | Course Number | Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | ○ | ○ | | Summer intensive | | | M(R0455) D(R0456) | Practice in Biological Sciences (Radioisotope Techniques) | 1 | OKAMOTO Takashi SAITO Taro ASANO Tsunaki | Basic techniques for handling radiolabeled compounds |
| 36 | ○ | ○ | | At all times | | | M(R0693) D(R0694) | External experience in Biological Sciences 1 | 1 | Multiple instructors | |
| 37 | ○ | ○ | | At all times | | | M(R0695) 2 units D(R0696) 2 units M(R0411) 1 unit D(R0412) 1 unit | External experience in Biological Sciences 2 | 1or2 | Multiple instructors | |
| 38 | ○ | ○ | | At all times | Other | | M(R0931) 2 units D(R0932) 2 units M(R0929) 1 unit D(R0930) 1 unit | Internship | 1or2 | Multiple instructors | |
| 39 | ○ | ○ | | 1st Semester | Fri. | 5 | M(R0457) D(R0458) | Special Seminar in Biological Sciences 1 | 1 | Multiple instructors | The latest issues in Biological Sciences (department seminar) |
| 40 | ○ | ○ | | 2nd Semester | Fri. | 5 | M(R0459) D(R0460) | Special Seminar in Biological Sciences 2 | 1 | Multiple instructors | The latest issues in Biological Sciences (department seminar) |
| 41 | ○ | ○ | | 2nd Semester I | Tue. | 1 | M(R0705) D(R0706) | Special Lecture on Biological Sciences | 1 | KAWAHARA Hiroyuki NARIKAWA Rei | No online registration<br>A retake is not allowed for students who took this course in the undergraduate program.<br>The approval of the Academic Affairs Committee of the Graduate School is required.<br>Special Lecture in Biochemistry<br>Course in English<br>This course is also offered in the undergraduate program. |
| 42 | ○ | ○ | | 2nd Semester I | Tue. | 2 | M(R0707) D(R0708) | Special Lecture on Biological Sciences | 1 | ANDO Kanae | No online registration<br>A retake is not allowed for students who took this course in the undergraduate program.<br>The approval of the Academic Affairs Committee of the Graduate School is required.<br>Special Lecture in Molecular Biology1<br>Course in English<br>This course is also offered in the undergraduate program. |
| 43 | ○ | ○ | | 2nd Semester I | Wed. | 1 | M(R0731) D(R0732) | Special Lecture on Biological Sciences | 1 | TAMURA Koichiro TAKAHASHI Aya | No online registration<br>A retake is not allowed for students who took this course in the undergraduate program.<br>The approval of the Academic Affairs Committee of the Graduate School is required.<br>Special Lecture in Genetics<br>Course in English<br>This course is also offered in the undergraduate program.<br>This course is also offered in the undergraduate program. |
| 44 | ○ | ○ | | 2nd Semester I | Wed. | 2 | M(R0353) D(R0354) | Special Lecture on Biological Sciences | 1 | KANEGAE Takeshi OHTANI Tetsuhisa | No online registration<br>A retake is not allowed for students who took this course in the undergraduate program.<br>The approval of the Academic Affairs Committee of the Graduate School is required.<br>Special Lecture in Physiology<br>Course in English<br>This course is also offered in the undergraduate program. |
| 45 | ○ | ○ | | 2nd Semester I | Thu. | 1 | M(R0735) D(R0736) | Special Lecture on Biological Sciences | 1 | HARUTA Shin EHIRA Shigeki | No online registration<br>A retake is not allowed for students who took this course in the undergraduate program.<br>The approval of the Academic Affairs Committee of the Graduate School is required.<br>Special Lecture in Microbiology<br>Course in English<br>This course is also offered in the undergraduate program. |
| 46 | ○ | ○ | | 2nd Semester I | Thu. | 2 | M(R0669) D(R0670) | Special Lecture on Biological Sciences | 1 | WEITEMIER Adam Zachary | No online registration<br>A retake is not allowed for students who took this course in the undergraduate program.<br>The approval of the Academic Affairs Committee of the Graduate School is required.<br>Special Lecture in Scientific Writing<br>Course in English<br>This course is also offered in the undergraduate program. |
| 47 | ○ | ○ | | 2nd Semester I | Fri. | 1 | M(R0733) D(R0734) | Special Lecture on Biological Sciences | 1 | WEITEMIER Adam Zachary | No online registration<br>A retake is not allowed for students who took this course in the undergraduate program.<br>The approval of the Academic Affairs Committee of the Graduate School is required.<br>Special Lecture in Physiology1<br>Course in English<br>This course is also offered in the undergraduate program. |
| 48 | ○ | ○ | | 2nd Semester II | Fri. | 1 | M(R0749) D(R0750) | Special Lecture on Biological Sciences | 1 | WEITEMIER Adam Zachary | No online registration<br>A retake is not allowed for students who took this course in the undergraduate program.<br>The approval of the Academic Affairs Committee of the Graduate School is required.<br>Special Lecture in Physiology2<br>Course in English<br>This course is also offered in the undergraduate program. |
| 49 | ○ | ○ | | 2nd Semester I | Mon. | 1 | M(R0009) D(R0010) | Special Lecture on Biological Sciences | 1 | MURAKAMI Noriaki EGUCHI Katsuyuki | No online registration<br>A retake is not allowed for students who took this course in the undergraduate program.<br>The approval of the Academic Affairs Committee of the Graduate School is required.<br>Special Lecture in Taxonomy<br>Course in English<br>This course is also offered in the undergraduate program. |

| Course outline No. | M | D | NA 2024 | Semester | Day | Time | Course Number | Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | ○ | ○ | | 2nd Semester I | Mon. | 2 | M(R0715) D(R0716) | Special Lecture on Biological Sciences | 1 | CRONIN Adam | No online registration<br>A retake is not allowed for students who took this course in the undergraduate program.<br>The approval of the Academic Affairs Committee of the Graduate School is required.<br>Special Lecture in Evolutionary Biology 1<br>Course in English<br>This course is also offered in the undergraduate program. |
| 51 | ○ | ○ | | Summer intensive | | | M(R0737) D(R0738) | Special Lecture on Biological Sciences | 1 | *WAGO Haruhisa | No online registration<br>A retake is not allowed for students who took this course in the undergraduate program.<br>The approval of the Academic Affairs Committee of the Graduate School is required.<br>Special Lecture on Biology (Immunobiology)<br>This course is also offered in the undergraduate program. |
| 52 | ○ | ○ | | Summer intensive | | | M(R0739) D(R0740) | Special Lecture on Biological Sciences | 1 | *SONOIKE Kintake | No online registration<br>A retake is not allowed for students who took this course in the undergraduate program.<br>The approval of the Academic Affairs Committee of the Graduate School is required.<br>Light stress and defense mechanisms in plants<br>This course is also offered in the undergraduate program. |
| 53 | ○ | ○ | | Summer intensive | | | M(R0725) D(R0726) | Special Lecture on Biological Sciences | 1 | *Stephen Lindemann | Course in English<br>This course is also offered in the undergraduate program. |
| 54 | ○ | ○ | | Summer intensive | | | M(R0727) D(R0728) | Special Lecture on Biological Sciences | 1 | *Stephen Lindemann | Course in English<br>This course is also offered in the undergraduate program. |
| 55 | ○ | ○ | | Summer intensive | | | M(R0719) D(R0720) | Special Lecture on Biological Sciences | 1 | *Diego Tavares Vasques | Students are not allowed to retake this course if already taken last year.<br>Course in English<br>This course is also offered in the undergraduate program. |
| 56 | ○ | ○ | | Summer intensive | | | M(R0729) D(R0730) | Special Lecture on Biological Sciences | 1 | *Ben Wallen | Students are not allowed to retake this course if already taken last year.<br>Course in English<br>This course is also offered in the undergraduate program. |
| 57 | ○ | ○ | | Summer intensive | | | M(R0357) D(R0358) | Special Lecture on Biological Sciences | 1 | *Parvin Shahrestani | Course in English<br>This course is also offered in the undergraduate program. |
| 58 | ○ | ○ | | Summer intensive | | | M(R0367) D(R0368) | Special Lecture on Biological Sciences | 1 | *Parvin Shahrestani | Course in English<br>This course is also offered in the undergraduate program. |
| 59 | ○ | ○ | | 1st Semester | Mon. | 1 | M(R0461) D(R0462) | Seminar in Biological Sciences 1 (Molecular Neurobiology 1) | 2 | ANDO Kanae<br>SAITO Taro<br>ASADA Akiko | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Mon. | 1 | M(R0463) D(R0464) | Seminar in Biological Sciences 2 (Molecular Neurobiology 1) | 2 | ANDO Kanae<br>SAITO Taro<br>ASADA Akiko | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Mon. | 2 | M(R0465) D(R0466) | Seminar in Biological Sciences 1 (Molecular Neurobiology 2) | 2 | ANDO Kanae<br>SAITO Taro<br>ASADA Akiko | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Mon. | 2 | M(R0467) D(R0468) | Seminar in Biological Sciences 2 (Molecular Neurobiology 2) | 2 | ANDO Kanae<br>SAITO Taro<br>ASADA Akiko | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Fri. | 3 | M(R0469) D(R0470) | Seminar in Biological Sciences 1 (Molecular Neurobiology 3) | 2 | ANDO Kanae<br>SAITO Taro<br>ASADA Akiko | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Fri. | 3 | M(R0471) D(R0472) | Seminar in Biological Sciences 2 (Molecular Neurobiology 3) | 2 | ANDO Kanae<br>SAITO Taro<br>ASADA Akiko | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Fri. | 4 | M(R0473) D(R0474) | Seminar in Biological Sciences 1 (Molecular Neurobiology 4) | 2 | ANDO Kanae<br>SAITO Taro<br>ASADA Akiko | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Fri. | 4 | M(R0475) D(R0476) | Seminar in Biological Sciences 2 (Molecular Neurobiology 4) | 2 | ANDO Kanae<br>SAITO Taro<br>ASADA Akiko | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Wed. | 6 | M(R0477) D(R0478) | Seminar in Biological Sciences 1 (Neurobiology 1) | 2 | WEITEMIER Adam Zachary | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Wed. | 6 | M(R0479) D(R0480) | Seminar in Biological Sciences 2 (Neurobiology 1) | 2 | WEITEMIER Adam Zachary | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Wed. | 7 | M(R0481) D(R0482) | Seminar in Biological Sciences 1 (Neurobiology 2) | 2 | WEITEMIER Adam Zachary | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Wed. | 7 | M(R0483) D(R0484) | Seminar in Biological Sciences 2 (Neurobiology 2) | 2 | WEITEMIER Adam Zachary | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Tue. | 4 | M(R0485) D(R0486) | Seminar in Biological Sciences 1(Plant Development and Physiology 1) | 2 | OKAMOTO Takashi<br>FURUKAWA Toshiko<br>KINOSHITA Atsuko | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Tue. | 4 | M(R0487) D(R0488) | Seminar in Biological Sciences 2(Plant Development and Physiology 1) | 2 | OKAMOTO Takashi<br>FURUKAWA Toshiko<br>KINOSHITA Atsuko | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Tue. | 5 | M(R0489) D(R0490) | Seminar in Biological Sciences 1(Plant Development and Physiology 2) | 2 | OKAMOTO Takashi<br>FURUKAWA Toshiko<br>KINOSHITA Atsuko | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Tue. | 5 | M(R0491) D(R0492) | Seminar in Biological Sciences 2(Plant Development and Physiology 2) | 2 | OKAMOTO Takashi<br>FURUKAWA Toshiko<br>KINOSHITA Atsuko | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Fri. | 3 | M(R0493) D(R0494) | Seminar in Biological Sciences 1(Plant Development and Physiology 3) | 2 | OKAMOTO Takashi<br>FURUKAWA Toshiko<br>KINOSHITA Atsuko | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Fri. | 3 | M(R0495) D(R0496) | Seminar in Biological Sciences 2(Plant Development and Physiology 3) | 2 | OKAMOTO Takashi<br>FURUKAWA Toshiko<br>KINOSHITA Atsuko | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Fri. | 4 | M(R0497) D(R0498) | Seminar in Biological Sciences 1(Plant Development and Physiology 4) | 2 | OKAMOTO Takashi<br>FURUKAWA Toshiko<br>KINOSHITA Atsuko | Seminar offered at respective research laboratories |

| Course outline No. | M | D | NA 2024 | Semester | Day | Time | Course Number | Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 60 | ○ | ○ | | 2nd Semester | Fri. | 4 | M(R0499) D(R0500) | Seminar in Biological Sciences 2(Plant Development and Physiology 4) | 2 | OKAMOTO Takashi FURUKAWA Toshiko KINOSHITA Atsuko | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Mon. | 1 | M(R0501) D(R0502) | Seminar in Biological Sciences 1 (Plant environmental responses 1) | 2 | KANEGAE Takeshi NARIKAWA Rei | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Mon. | 1 | M(R0503) D(R0504) | Seminar in Biological Sciences 2 (Plant environmental responses 1) | 2 | KANEGAE Takeshi NARIKAWA Rei | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Mon. | 2 | M(R0505) D(R0506) | Seminar in Biological Sciences 1 (Plant environmental responses 2) | 2 | KANEGAE Takeshi NARIKAWA Rei | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Mon. | 2 | M(R0507) D(R0508) | Seminar in Biological Sciences 2 (Plant environmental responses 2) | 2 | KANEGAE Takeshi NARIKAWA Rei | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Mon. | 1 | M(R0509) D(R0510) | Seminar in Biological Sciences 1 (Cytogenetics 1) | 2 | SAKAI Takaomi ASANO Tsunaki TAKEO Satomi | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Mon. | 1 | M(R0511) D(R0512) | Seminar in Biological Sciences 2 (Cytogenetics 1) | 2 | SAKAI Takaomi ASANO Tsunaki TAKEO Satomi | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Mon. | 2 | M(R0513) D(R0514) | Seminar in Biological Sciences 1 (Cytogenetics 2) | 2 | SAKAI Takaomi ASANO Tsunaki TAKEO Satomi | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Mon. | 2 | M(R0515) D(R0516) | Seminar in Biological Sciences 2 (Cytogenetics 2) | 2 | SAKAI Takaomi ASANO Tsunaki TAKEO Satomi | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Mon. | 1 | M(R0517) D(R0518) | Seminar in Biological Sciences 1 (Evolutionary Genetics 1) | 2 | TAMURA Koichiro TAKAHASHI Aya NOZAWA Masafumi TACHIKI Yuya | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Mon. | 1 | M(R0519) D(R0520) | Seminar in Biological Sciences 2 (Evolutionary Genetics 1) | 2 | TAMURA Koichiro TAKAHASHI Aya NOZAWA Masafumi TACHIKI Yuya | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Mon. | 2 | M(R0521) D(R0522) | Seminar in Biological Sciences 1 (Evolutionary Genetics 2) | 2 | TAMURA Koichiro TAKAHASHI Aya NOZAWA Masafumi TACHIKI Yuya | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Mon. | 2 | M(R0523) D(R0524) | Seminar in Biological Sciences 2 (Evolutionary Genetics 2) | 2 | TAMURA Koichiro TAKAHASHI Aya NOZAWA Masafumi TACHIKI Yuya | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Mon. | 1 | M(R0525) D(R0526) | Seminar in Biological Sciences 1 (Molecular Genetics 1) | 2 | EHIRA Shigeki | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Mon. | 1 | M(R0527) D(R0528) | Seminar in Biological Sciences 2 (Molecular Genetics 1) | 2 | EHIRA Shigeki | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Mon. | 2 | M(R0529) D(R0530) | Seminar in Biological Sciences 1 (Molecular Genetics 2) | 2 | EHIRA Shigeki | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Mon. | 2 | M(R0531) D(R0532) | Seminar in Biological Sciences 2 (Molecular Genetics 2) | 2 | EHIRA Shigeki | Seminar offered at respective research laboratories |
| | ○ | ○ | △ | | | 1 | M(R0533) D(R0534) | Seminar in Biological Sciences 1 (Animal Ecology 1) | 2 | TBA | Seminar offered at respective research laboratories |
| | ○ | ○ | △ | | | 4 | M(R0535) D(R0536) | Seminar in Biological Sciences 2 (Animal Ecology 1) | 2 | TBA | Seminar offered at respective research laboratories |
| | ○ | ○ | △ | | | 2 | M(R0537) D(R0538) | Seminar in Biological Sciences 1 (Animal Ecology 2) | 2 | TBA | Seminar offered at respective research laboratories |
| | ○ | ○ | △ | | | 5 | M(R0539) D(R0540) | Seminar in Biological Sciences 2 (Animal Ecology 2) | 2 | TBA | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Fri. | 3 | M(R0541) D(R0542) | Seminar in Biological Sciences 1 (Plant Ecology 1) | 2 | SUZUKI Jun-ichiro | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Fri. | 3 | M(R0543) D(R0544) | Seminar in Biological Sciences 2 (Plant Ecology 1) | 2 | SUZUKI Jun-ichiro | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Fri. | 4 | M(R0545) D(R0546) | Seminar in Biological Sciences 1 (Plant Ecology 2) | 2 | SUZUKI Jun-ichiro | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Fri. | 4 | M(R0547) D(R0548) | Seminar in Biological Sciences 2 (Plant Ecology 2) | 2 | SUZUKI Jun-ichiro | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Fri. | 6 | M(R0549) D(R0550) | Seminar in Biological Sciences 1 (Plant Ecology 3) | 2 | SUZUKI Jun-ichiro | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Fri. | 6 | M(R0551) D(R0552) | Seminar in Biological Sciences 2 (Plant Ecology 3) | 2 | SUZUKI Jun-ichiro | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Wed. | 6 | M(R0561) D(R0562) | Seminar in Biological Sciences 1(Developmental Biology 1) | 2 | FUKUDA Kimiko TAKATORI Naohito | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Wed. | 6 | M(R0563) D(R0564) | Seminar in Biological Sciences 2(Developmental Biology 1) | 2 | FUKUDA Kimiko TAKATORI Naohito | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Wed. | 7 | M(R0565) D(R0566) | Seminar in Biological Sciences 1(Developmental Biology 2) | 2 | FUKUDA Kimiko TAKATORI Naohito | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Wed. | 7 | M(R0567) D(R0568) | Seminar in Biological Sciences 2(Developmental Biology 2) | 2 | FUKUDA Kimiko TAKATORI Naohito | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Tue. | 6 | M(R0569) D(R0570) | Seminar in Biological Sciences 1(Developmental Biology 3) | 2 | FUKUDA Kimiko TAKATORI Naohito | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Tue. | 6 | M(R0571) D(R0572) | Seminar in Biological Sciences 2(Developmental Biology 3) | 2 | FUKUDA Kimiko TAKATORI Naohito | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Tue. | 5 | M(R0577) D(R0578) | Seminar in Biological Sciences 1 (Systematic Zoology 1) | 2 | EGUCHI Katsuyuki CRONIN Adam YOSHIDA Takahiro | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Tue. | 4 | M(R0579) D(R0580) | Seminar in Biological Sciences 2 (Systematic Zoology 1) | 2 | EGUCHI Katsuyuki CRONIN Adam YOSHIDA Takahiro | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Tue. | 6 | M(R0581) D(R0582) | Seminar in Biological Sciences 1 (Systematic Zoology 2) | 2 | EGUCHI Katsuyuki CRONIN Adam YOSHIDA Takahiro | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Tue. | 5 | M(R0583) D(R0584) | Seminar in Biological Sciences 2 (Systematic Zoology 2) | 2 | EGUCHI Katsuyuki CRONIN Adam YOSHIDA Takahiro | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Fri. | 3 | M(R0585) D(R0586) | Seminar in Biological Sciences 1 (Systematic Botany 1) | 2 | MURAKAMI Noriaki KATO Hidetoshi | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Fri. | 3 | M(R0587) D(R0588) | Seminar in Biological Sciences 2 (Systematic Botany 1) | 2 | MURAKAMI Noriaki KATO Hidetoshi | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Fri. | 4 | M(R0589) D(R0590) | Seminar in Biological Sciences 1 (Systematic Botany 2) | 2 | MURAKAMI Noriaki KATO Hidetoshi | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Fri. | 4 | M(R0591) D(R0592) | Seminar in Biological Sciences 2 (Systematic Botany 2) | 2 | MURAKAMI Noriaki KATO Hidetoshi | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Mon. | 5 | M(R0593) D(R0594) | Seminar in Biological Sciences 1 (Environmental Microbiology 1) | 2 | HARUTA Shin | Seminar offered at respective research laboratories |

| Course outline No. | M | D | NA 2024 | Semester | Day | Time | Course Number | Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 60 | ○ | ○ | | 2nd Semester | Mon. | 5 | M(R0595) D(R0596) | Seminar in Biological Sciences 2 (Environmental Microbiology 1) | 2 | HARUTA Shin | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Mon. | 6 | M(R0597) D(R0598) | Seminar in Biological Sciences 1 (Environmental Microbiology 2) | 2 | HARUTA Shin | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Mon. | 6 | M(R0599) D(R0600) | Seminar in Biological Sciences 2 (Environmental Microbiology 2) | 2 | HARUTA Shin | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Fri. | 3 | M(R0601) D(R0602) | Seminar in Biological Sciences 1 (Cellular Biochemistry 1) | 2 | KAWAHARA Hiroyuki OHTANI Tetsuhisa YOKOTA Naoto | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Fri. | 3 | M(R0603) D(R0604) | Seminar in Biological Sciences 2 (Cellular Biochemistry 1) | 2 | KAWAHARA Hiroyuki OHTANI Tetsuhisa YOKOTA Naoto | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Fri. | 4 | M(R0605) D(R0606) | Seminar in Biological Sciences 1 (Cellular Biochemistry 2) | 2 | KAWAHARA Hiroyuki OHTANI Tetsuhisa YOKOTA Naoto | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Fri. | 4 | M(R0607) D(R0608) | Seminar in Biological Sciences 2 (Cellular Biochemistry 2) | 2 | KAWAHARA Hiroyuki OHTANI Tetsuhisa YOKOTA Naoto | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Mon. | 1 | M(R0435) D(R0436) | Seminar in Biological Sciences 1 (Stem Cell Modulation 1) | 2 | HARA Takahiko | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Mon. | 1 | M(R0437) D(R0438) | Seminar in Biological Sciences 2 (Stem Cell Modulation 1) | 2 | HARA Takahiko | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Mon. | 2 | M(R0573) D(R0574) | Seminar in Biological Sciences 1(Stem Cell Modulation2) | 2 | HARA Takahiko | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Mon. | 2 | M(R0575) D(R0576) | Seminar in Biological Sciences 2(Stem Cell Modulation2) | 2 | HARA Takahiko | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Mon. | 1 | M(R0921) D(R0922) | Seminar in Biological Sciences 1 (Molecular Regulation of Aging 1) | 2 | ISHIGAMI Akihito | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Mon. | 1 | M(R0923) D(R0924) | Seminar in Biological Sciences 2 (Molecular Regulation of Aging 1) | 2 | ISHIGAMI Akihito | Seminar offered at respective research laboratories |
| 59 | ○ | ○ | | 1st Semester | Mon. | 2 | M(R0925) D(R0926) | Seminar in Biological Sciences 1 (Molecular Regulation of Aging 2) | 2 | ISHIGAMI Akihito | Seminar offered at respective research laboratories |
| 60 | ○ | ○ | | 2nd Semester | Mon. | 2 | M(R0927) D(R0928) | Seminar in Biological Sciences 2 (Molecular Regulation of Aging 2) | 2 | ISHIGAMI Akihito | Seminar offered at respective research laboratories |
| 61 | ○ | ○ | | At all times | | | M(R0609) D(R0610) | Special Experiment in Biological Sciences (Experimental Techniques 1) | 1 | Multiple instructors | Basic experimental methods in each field of biological science This course is open to students of other majors. |
| 61 | ○ | ○ | | At all times | | | M(R0611) D(R0612) | Special Experiment in Biological Sciences (Experimental Techniques 2) | 1 | Multiple instructors | Basic experimental methods in each field of biological science This course is open to students of other majors. |
| 61 | ○ | ○ | | At all times | | | M(R0613) D(R0614) | Special Experiment in Biological Sciences (Experimental Techniques 3) | 1 | Multiple instructors | Basic experimental methods in each field of biological science This course is open to students of other majors. |
| 61 | ○ | ○ | | At all times | | | M(R0615) D(R0616) | Special Experiment in Biological Sciences (Experimental Techniques 4) | 1 | Multiple instructors | Basic experimental methods in each field of biological science This course is open to students of other majors. |
| 61 | ○ | ○ | | At all times | | | M(R0617) D(R0618) | Special Experiment in Biological Sciences (Experimental Techniques 5) | 1 | Multiple instructors | Basic experimental methods in each field of biological science This course is open to students of other majors. |
| 61 | ○ | ○ | | At all times | | | M(R0619) D(R0620) | Special Experiment in Biological Sciences (Experimental Techniques 6) | 1 | Multiple instructors | Basic experimental methods in each field of biological science This course is open to students of other majors. |
| 62 | ○ | ○ | | At all times | | | M(R0621) D(R0622) | Special Practice in Biological Sciences (Research Techniques 1) | 2 | Multiple instructors | Various experimental methods in each field of biological science and practical research methods |
| 62 | ○ | ○ | | At all times | | | M(R0623) D(R0624) | Special Practice in Biological Sciences (Research Techniques 2) | 2 | Multiple instructors | Various experimental methods in each field of biological science and practical research methods |
| 62 | ○ | ○ | | At all times | | | M(R0625) D(R0626) | Special Practice in Biological Sciences (Research Techniques 3) | 2 | Multiple instructors | Various experimental methods in each field of biological science and practical research methods |
| 62 | ○ | ○ | | At all times | | | M(R0627) D(R0628) | Special Practice in Biological Sciences (Research Techniques 4) | 2 | Multiple instructors | Various experimental methods in each field of biological science and practical research methods |
| 62 | ○ | ○ | | At all times | | | M(R0629) D(R0630) | Special Practice in Biological Sciences (Research Techniques 5) | 2 | Multiple instructors | Various experimental methods in each field of biological science and practical research methods |
| 62 | ○ | ○ | | At all times | | | M(R0631) D(R0632) | Special Practice in Biological Sciences (Research Techniques 6) | 2 | Multiple instructors | Various experimental methods in each field of biological science and practical research methods |
| 63 | ○ | ○ | | 1st Semester | Thu. | 6・7 | M(R0633) D(R0634) | Advanced Experimental Techniques in Biological Sciences 1 (Molecular Neurobiology) | 2 | ANDO Kanae SAITO Taro ASADA Akiko | Advanced research technologies in different branches of biological sciences |
| 64 | ○ | ○ | | 2nd Semester | Thu. | 6・7 | M(R0635) D(R0636) | Advanced Experimental Techniques in Biological Sciences 2(Molecular Neurobiology) | 2 | ANDO Kanae SAITO Taro ASADA Akiko | Advanced research technologies in different branches of biological sciences |
| 63 | ○ | ○ | | 1st Semester | Thu. | 6・7 | M(R0637) D(R0638) | Advanced Experimental Techniques in Biological Sciences 1 (Neurobiology ) | 2 | WEITEMIER Adam Zachary | Advanced research technologies in different branches of biological sciences |
| 64 | ○ | ○ | | 2nd Semester | Thu. | 6・7 | M(R0639) D(R0640) | Advanced Experimental Techniques in Biological Sciences 2 (Neurobiology ) | 2 | WEITEMIER Adam Zachary | Advanced research technologies in different branches of biological sciences |
| 63 | ○ | ○ | | 1st Semester | Thu. | 6・7 | M(R0641) D(R0642) | Advanced Experimental Techniques in Biological Sciences 1(Plant Development and Physiology) | 2 | OKAMOTO Takashi FURUKAWA Toshiko KINOSHITA Atsuko | Advanced research technologies in different branches of biological sciences |
| 64 | ○ | ○ | | 2nd Semester | Thu. | 6・7 | M(R0643) D(R0644) | Advanced Experimental Techniques in Biological Sciences 2(Plant Development and Physiology) | 2 | OKAMOTO Takashi FURUKAWA Toshiko KINOSHITA Atsuko | Advanced research technologies in different branches of biological sciences |
| 63 | ○ | ○ | | 1st Semester | Thu. | 6・7 | M(R0645) D(R0646) | Advanced Experimental Techniques in Biological Sciences 1 (Plant environmental responses) | 2 | KANEGAE Takeshi NARIKAWA Rei | Advanced research technologies in different branches of biological sciences |
| 64 | ○ | ○ | | 2nd Semester | Thu. | 6・7 | M(R0647) D(R0648) | Advanced Experimental Techniques in Biological Sciences 2 (Plant environmental responses) | 2 | KANEGAE Takeshi NARIKAWA Rei | Advanced research technologies in different branches of biological sciences |
| 63 | ○ | ○ | | 1st Semester | Thu. | 6・7 | M(R0649) D(R0650) | Advanced Experimental Techniques in Biological Sciences 1(Cytogenetics) | 2 | SAKAI Takaomi ASANO Tsunaki TAKEO Satomi | Advanced research technologies in different branches of biological sciences |
| 64 | ○ | ○ | | 2nd Semester | Thu. | 6・7 | M(R0651) D(R0652) | Advanced Experimental Techniques in Biological Sciences 2(Cytogenetics) | 2 | SAKAI Takaomi ASANO Tsunaki TAKEO Satomi | Advanced research technologies in different branches of biological sciences |
| 63 | ○ | ○ | | 1st Semester | Thu. | 6・7 | M(R0653) D(R0654) | Advanced Experimental Techniques in Biological Sciences 1 (Evolutionary Genetics) | 2 | TAMURA Koichiro TAKAHASHI Aya NOZAWA Masafumi TACHIKI Yuya | Advanced research technologies in different branches of biological sciences |

| Course outline No. | M | D | NA 2024 | Semester | Day | Time | Course Number | Course Name | Credit Hours | Instructor(s) | Note (enrollment requirements, subject matter, etc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | ○ | ○ | | 2nd Semester | Thu. | 6・7 | M(R0655) D(R0656) | Advanced Experimental Techniques in Biological Sciences 2 (Evolutionary Genetics) | 2 | TAMURA Koichiro TAKAHASHI Aya NOZAWA Masafumi TACHIKI Yuya | Advanced research technologies in different branches of biological sciences |
| 63 | ○ | ○ | | 1st Semester | Thu. | 6・7 | M(R0657) D(R0658) | Advanced Experimental Techniques in Biological Sciences 1 (Molecular Genetics) | 2 | EHIRA Shigeki | Advanced research technologies in different branches of biological sciences |
| 64 | ○ | ○ | | 2nd Semester | Thu. | 6・7 | M(R0659) D(R0660) | Advanced Experimental Techniques in Biological Sciences 2(Molecular Genetics) | 2 | EHIRA Shigeki | Advanced research technologies in different branches of biological sciences |
| 63 | ○ | ○ | △ | | | 6・7 | M(R0661) D(R0662) | Advanced Experimental Techniques in Biological Sciences 1(Animal Ecology) | 2 | TBA | Advanced research technologies in different branches of biological sciences |
| 64 | ○ | ○ | △ | | | 6・7 | M(R0663) D(R0664) | Advanced Experimental Techniques in Biological Sciences 2 (Animal Ecology) | 2 | TBA | Advanced research technologies in different branches of biological sciences |
| 63 | ○ | ○ | | 1st Semester | Thu. | 6・7 | M(R0665) D(R0666) | Advanced Experimental Techniques in Biological Sciences 1(Plant Ecology) | 2 | SUZUKI Jun-ichiro | Advanced research technologies in different branches of biological sciences |
| 64 | ○ | ○ | | 2nd Semester | Thu. | 6・7 | M(R0667) D(R0668) | Advanced Experimental Techniques in Biological Sciences 2 (Plant Ecology) | 2 | SUZUKI Jun-ichiro | Advanced research technologies in different branches of biological sciences |
| 63 | ○ | ○ | | 1st Semester | Thu. | 6・7 | M(R0673) D(R0674) | Advanced Experimental Techniques in Biological Sciences 1(Developmental Biology) | 2 | FUKUDA Kimiko TAKATORI Naohito | Advanced research technologies in different branches of biological sciences |
| 64 | ○ | ○ | | 2nd Semester | Thu. | 6・7 | M(R0675) D(R0676) | Advanced Experimental Techniques in Biological Sciences 2(Developmental Biology) | 2 | FUKUDA Kimiko TAKATORI Naohito | Advanced research technologies in different branches of biological sciences |
| 63 | ○ | ○ | | 1st Semester | Thu. | 6・7 | M(R0677) D(R0678) | Advanced Experimental Techniques in Biological Sciences 1(Systematic Zoology) | 2 | EGUCHI Katsuyuki CRONIN Adam YOSHIDA Takahiro | Advanced research technologies in different branches of biological sciences |
| 64 | ○ | ○ | | 2nd Semester | Thu. | 6・7 | M(R0679) D(R0680) | Advanced Experimental Techniques in Biological Sciences 2(Systematic Zoology) | 2 | EGUCHI Katsuyuki CRONIN Adam YOSHIDA Takahiro | Advanced research technologies in different branches of biological sciences |
| 63 | ○ | ○ | | 1st Semester | Thu. | 6・7 | M(R0681) D(R0682) | Advanced Experimental Techniques in Biological Sciences 1 (Systematic Botany) | 2 | MURAKAMI Noriaki KATO Hidetoshi | Advanced research technologies in different branches of biological sciences |
| 64 | ○ | ○ | | 2nd Semester | Thu. | 6・7 | M(R0683) D(R0684) | Advanced Experimental Techniques in Biological Sciences 2 (Systematic Botany) | 2 | MURAKAMI Noriaki KATO Hidetoshi | Advanced research technologies in different branches of biological sciences |
| 63 | ○ | ○ | | 1st Semester | Thu. | 6・7 | M(R0685) D(R0686) | Advanced Experimental Techniques in Biological Sciences 1(Environmental Microbiology) | 2 | HARUTA Shin | Advanced research technologies in different branches of biological sciences |
| 64 | ○ | ○ | | 2nd Semester | Thu. | 6・7 | M(R0687) D(R0688) | Advanced Experimental Techniques in Biological Sciences 2 (Environmental Microbiology) | 2 | HARUTA Shin | Advanced research technologies in different branches of biological sciences |
| 63 | ○ | ○ | | 1st Semester | Thu. | 6・7 | M(R0689) D(R0690) | Advanced Experimental Techniques in Biological Sciences 1(Cellular Biochemistry) | 2 | KAWAHARA Hiroyuki OHTANI Tetsuhisa YOKOTA Naoto | Advanced research technologies in different branches of biological sciences |
| 64 | ○ | ○ | | 2nd Semester | Thu. | 6・7 | M(R0691) D(R0692) | Advanced Experimental Techniques in Biological Sciences 2(Cellular Biochemistry) | 2 | KAWAHARA Hiroyuki OHTANI Tetsuhisa YOKOTA Naoto | Advanced research technologies in different branches of biological sciences |
| 63 | ○ | ○ | | 1st Semester | Thu. | 6・7 | M(R0407) D(R0408) | Advanced Experimental Techniques in Biological Sciences 1 (Stem Cell Modulation) | 2 | HARA Takahiko | Advanced research technologies in different branches of biological sciences |
| 64 | ○ | ○ | | 2nd Semester | Thu. | 6・7 | M(R0409) D(R0410) | Advanced Experimental Techniques in Biological Sciences 2 (Stem Cell Modulation) | 2 | HARA Takahiko | Advanced research technologies in different branches of biological sciences |
| 63 | ○ | ○ | | 1st Semester | Thu. | 6・7 | M(R0741) D(R0742) | Advanced Experimental Techniques in Biological Sciences 1(Molecular Regulation of Aging) | 2 | ISHIGAMI Akihito | Advanced research technologies in different branches of biological sciences |
| 64 | ○ | ○ | | 2nd Semester | Thu. | 6・7 | M(R0743) D(R0744) | Advanced Experimental Techniques in Biological Sciences 2(Molecular Regulation of Aging) | 2 | ISHIGAMI Akihito | Advanced research technologies in different branches of biological sciences |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Advanced Lecture on Biological Information | M(R0359) | 2nd Semester | Thu. | 1 | 2 |
| Doctoral program | Advanced Lecture on Biological Information | D(R0360) | | | | |

| Instructor(s) | Note |
|---|---|
| Takaomi Sakai, Adam Weitemier | |

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| (1) Course policies and topics | Through research papers, the lecture will introduce the background of the neural basis that has been clarified through studies using various laboratory animals, and will also include the latest research results. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The latest findings on bioinformation, such as the origin of the cranial nervous system, synaptic structure, synaptic transmission, behavioral control by the cranial nervous system, aging and basal metabolism, etc. will be studied. |
| (3) Course schedule, subject matter, and classroom activities | 1. Learning & Memory 1 (T. Sakai)<br>2. Learning & Memory 2 (T. Sakai)<br>3. Learning & Memory 3 (T. Sakai)<br>4. Learning & Memory 4 (T. Sakai)<br>5. Learning & Memory 5 (T. Sakai)<br>6. Learning & Memory 6 (T. Sakai)<br>7. Learning & Memory 7 (T. Sakai)<br>8. Learning & Memory 8 (T. Sakai)<br>9. Non-associative learning 1 (A. Weitemier)<br>10. Non-associative learning 2 (A. Weitemier)<br>11. Classical Conditioning 1 (A. Weitemier)<br>12. Classical Conditioning 2 (A. Weitemier)<br>13. Instrumental Conditioning 1 (A. Weitemier)<br>14. Instrumental Conditioning 2 (A. Weitemier)<br>15. Brain reward system and Addiction (A. Weitemier)<br>16. Psychiatric Disorders (A. Weitemier) |
| (4) Outside-class activities and assignments | Students are expected to prepare for and review the class and work on reports and other assignments. |
| (5) Textbooks and course materials | Handouts and other materials will be distributed as appropriate.<br>For review: Bear, Mark F., Barry W. Connors, and Michael A. Paradiso. Neuroscience: Exploring the Brain<br>Copies may be found in the English Mini-library |
| (6) Assessment and grading | Evaluation will be made comprehensively based on class attitude, reports, etc. |
| (7) Questions to the instructor (Office hours, etc.) | No specific office hours are set. If you want to ask questions directly, please make an appointment in advance by e-mail or kibaco messages. |
| (8) Special note | Students can take this course in English. Those who wish to take the course in English should contact the lecturers. Lectures by Weitemier will be conducted in English only,<br>A note on the lecture by Sakai will be given in the first lecture. |

| Program | Graduate School of Science | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| | Course Name | Course Number | | | | |
| Master's program | Advanced Lecture on Biochemistry | R0363 | 1st | Fri | 1 | 2 |
| Doctoral program | Advanced Lecture on Biochemistry | R0364 | | | | |

| Instructor(s) | Note |
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| Kawahara and Okamoto | |

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| (1) Course policies and topics | How Breakthrough Discoveries Are Made - Primarily Conducting Research Paper Reading |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Much of the current research in biochemistry and molecular cell biology is based on the findings of past researchers. Learning the process will be useful not only in advancing current graduate research topics but also in broadly understanding problem setting and how to solve them. Students will not only increase their knowledge, but will also learn from past successes in a way that can be used for future research. |
| (3) Course schedule, subject matter, and classroom activities | [1st half]<br>The objective of this research is to select several original papers that reported epoch-making discoveries in biochemistry and molecular cell biology, and to approach the contents of these papers in the form of a paper lecture. I would like to present a wide range of papers covering molecular biology, cell biology, and biochemistry, from classical papers (such as biosynthesis of membrane proteins) to recent papers (such as Professor Yamanaka's iPS cells). A discussion leader was appointed for each lecture, and the leader explained the background, presentation of data, and consideration of each paper. At the same time, with all participants, 1) What was the author's perspective on starting the study? 2) What were the problems to be solved? 3) How did the author approach the problem? deepen discussions on. Each discussion leader must prepare a presentation. All participants are also asked to prepare for the paper. For this purpose, at the time of the first lecture, an extra copy of the target paper (approximately 7 papers) is distributed to all students, and at the time of the second lecture, a discussion leader corresponding to each paper is determined.<br>[2nd half]<br>You will introduce and discuss papers on the developmental phenomena of organisms, tissues, and cells that are covered in your research topics. |
| (4) Outside-class activities and assignments | Preparation and review of the research papers are required. |
| (5) Textbooks and course materials | [1st half]<br>Copies of important papers describing landmark discoveries in biochemistry and molecular cell biology, many of which were Nobel Prize-winning studies, will be distributed in advance. Relevant documentation should also be distributed as appropriate.<br>[2nd half]<br>The paper is distributed. |
| (6) Assessment and grading | Students are given a comprehensive evaluation of their attitudes toward teaching, mini-reports, and reports. The performance evaluation of this subject will be based on attendance, achievement of literature introduction, and questions and answers. We particularly value their active participation in the exercise. |
| (7) Questions to the instructor (Office hours, etc.) | Questions are answered as needed after adjusting the schedule by mail.<br>Kawahara: hkawa@tmu.ac.jp (9-488)<br>Okamoto: okamoto-takashi@tmu.ac.jp (8-320) |
| (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 | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| | Course Name | Course Number | | | | |
| Master's program | Advanced Lecture on Developmental Biology | R0369 | 1st | Thr | 1 | 2 |
| Doctoral program | Advanced Lecture on Developmental Biology | R0370 | | | | |

| Instructor(s) | Note |
|---|---|
| Fukuda and Takatori | |

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|---|---|
| (1) Course policies and topics | [Advanced Developmental Biology]<br>The aim is to acquire knowledge of the latest developmental biology, and to acquire the ability to read English papers critically and to introduce and present them accurately. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | -Ability to understand the structure of a paper and read critically<br>-Ability to introduce articles accurately and ask questions<br>-Acquiring the latest knowledge of developmental biology |
| (3) Course schedule, subject matter, and classroom activities | Learn how to compose, read, and present scientific papers.<br>Excellent papers on developmental biology are taken u. Articles which each person has read are presented, and questions and answers are carried out. Each person is required to make at least two announcements. Discussion is required of all participants at the presentation.<br>In response to students' requests, lectures on the latest developmental biology and discussions on their research are held. |
| (4) Outside-class activities and assignments | Read papers and prepare for presentations outside of class. |
| (5) Textbooks and course materials | There are no textbooks. Instructors will introduce the articles. |
| (6) Assessment and grading | The participation challenge and attitude to the class are mainly evaluated. |
| (7) Questions to the instructor (Office hours, etc.) | Students can Contact Dr. Fukuda (kokko@tmu.ac.jp) or Dr. Takatori (takatori-naohito1@tmu.ac.jp) via e-mail. |
| (8) Special note | Students can take this course in English. Those who wish to take the course in English should contact the class staff. |

| 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 Molecular Biology | R0371 | — | — | 2nd | Fri | 1 | 2 |
| Doctoral program | Advanced Lecture on Molecular Biology | R0372 | Advanced Lecture on Molecular Biology | R372 | | | | |

| Instructor(s) | Note |
|---|---|
| Ehira, Ohbayashi, and Haruta | |

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|---|---|
| (1) Course policies and topics | The theme is the latest research of molecular biology for microorganisms.<br>Shigeki Ehira (microbial molecular physiology), Ryudo Ohbayashi (genome microbiology), and Shin Haruta (environmental microbiology) are in charge. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Understand the basics and applications of molecular biology and genome science. |
| (3) Course schedule, subject matter, and classroom activities | Advances in sequencing have now revealed the genome structure of many organisms, and molecular biology and genome science techniques are now widely used, from basic fields such as transcriptional analysis and identification of essential genes to medical and industrial fields. And, various metaomics analysis technology such as metagenome analysis which analyzes DNA of microbial community in the environment is developed. In this lecture, we introduce the latest research in several fields of molecular biology and genome science, focusing on the study of microorganisms.<br>Some outside researchers are invited to give an omnibus lecture.<br><br>・microbial ecology<br>・microbial population dynamics<br>・difficult-to-culture microbes<br>・symbiosis<br>・survival strategy<br>・cell-to-cell communication<br>・horizontal gene transfer<br>・regulation of gene expression<br>・regulation of metabolism<br>・cell differentiation<br>・environmental acclimation<br>・metabolic design<br>・genome editing<br>・synthetic biology |
| (4) Outside-class activities and assignments | Students are required to read relevant research articles. |
| (5) Textbooks and course materials | No text specified. |
| (6) Assessment and grading | Evaluate by active participation in class and reports. |
| (7) Questions to the instructor (Office hours, etc.) | We don't set office hours, but if you want to ask a question directly, we will accept it anytime, so please make an appointment by email in advance. |
| (8) Special note | Students can take this course in English. Those who wish to take the course in English should contact the lecturers. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lecture on Genetic Information | R0391 | 2nd II | Fri | 2 | 1 |
| Doctoral program | Special Lecture on Genetic Information | R0392 | | | | |

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

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|---|---|
| (1) Course policies and topics | Population Genetics and Evolutionary Genetics: Learn how to analyze the genetic variation in populations and molecular phylogeny from theoretical aspects, which underlie many biological disciplines, including genome-scale analysis, systems biology, and conservation biology. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Students are expected to learn the basic concepts of population genetics and evolutionary genetics, and gain practical knowledge for data analysis. |
| (3) Course schedule, subject matter, and classroom activities | Learning the theoretical basis of genetic variation in populations is essential for many biological disciplines, including genome-scale analysis, systems biology, and conservation biology. In this lecture, the concepts of molecular ecology, population genetics, and evolutionary genetics are outlined, along with practical examples applied to actual research and data analysis. |
| (4) Outside-class activities and assignments | Students are required to review each class and work on assignments. Students are also expected to read papers in which the theory of population genetics and evolutionary genetics is applied practically. |
| (5) Textbooks and course materials | Handouts will be distributed in each class. |
| (6) Assessment and grading | Evaluation is based on the degree of participation, quiz during the class, assignments, etc. |
| (7) Questions to the instructor (Office hours, etc.) | Questions are always welcome, so please make an appointment in advance by email to Tamura (ktamura@tmu.ac.jp), Takahashi (ayat[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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lecture on Ecological Science | R0393 | 1 | F | 2 | 1 |
| Doctoral program | Special Lecture on Ecological Science | R0394 | | | | |

| Instructor(s) | Note |
|---|---|
| SUZUKI Jun-ichiro<br>CRONIN Adam | Animal behavior and society, renewal of plant communities |

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|---|---|
| (1) Course policies and topics | Methods in Animal Ecology, Plant Community Ecology<br>Students will learn different approaches to studying animal ecology, and matter production and inter-specific interactions in plant communities |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In these lectures, students will develop their ability to study independently, think logically, and communicate in English. |
| (3) Course schedule, subject matter, and classroom activities | Methods in Animal Ecology (Cronin).<br>1: Introduction to approaches for the study of animal ecology.<br>2: Direct approaches: observational, comparative, and experimental studies.<br>3: Indirect approaches: molecular and theoretical studies.<br>4: Discussion and synthesis.<br><br>Studies on plant communities: review of fundamental literature and their reviews (Suzuki).<br>5: Introduction; Matter production and interspecific interactions in plant communities.<br>6: Research reviews; matter production in plant communities.<br>7: Research reviews; interspecific interactions in plant communities.<br>8: Discussion; Perspectives of studies on plant community. |
| (4) Outside-class activities and assignments | Students must learn the target and cited papers and prepare presentations and essays. |
| (5) Textbooks and course materials | Student will be given appropriate material (Cronin).<br>Students will receive handouts through kibaco (Suzuki). |
| (6) Assessment and grading | Evaluation will be based on both active participation in class and reports (Cronin).<br><br>The evaluation will be based on the presentation of the target paper (60%) and mutual assessments on the presentation (40%) (Suzuki). |
| (7) Questions to the instructor (Office hours, etc.) | If you need advice or have questions, please email (first half: adam.cronin@tmu.ac.jp, second half: jsuzuki@tmu.ac.jp). |
| (8) Special note | Students attending the course should have already taken Ecology and Advanced Ecology courses at university. The first half of this course will be given in English. The second half will be given in principally in Japanese with the handouts and slides written in English. |

| Program | Graduate School of Science | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Responses to Environment | R0397 | 1st I | Fri | 2 | 1 |
| Doctoral program | Special Lecture on Responses to Environment | R0398 | | | | |

| Instructor(s) | Note |
|---|---|
| Kanegae and Narikawa | |

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|---|---|
| (1) Course policies and topics | One of the most significant functions of living organisms is to respond to surrounding environmental information. The purpose of this class is to understand the physiological responses and phenomena related to the environment focusing on the light signal that evolved in various organisms such as plants and cyanobacteria and to understand various methods to analyze photoreceptor molecules. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Part 1: This course will introduce recent research on light sensing in plants. At the end of this course, students will be able to explain how light as environment information is accepted by plant photoreceptors and how information is expressed.<br>Part 2: In this course, students will understand the methods to analyze the photoreceptors in vitro, which would be applicable to the other proteins. |
| (3) Course schedule, subject matter, and classroom activities | Classes are conducted using Zoom.<br>Please confirm the URL up to kibaco by the day before.<br>[Part 1]<br>1. Post-transcriptional regulation of photomorphogenesis<br>2. Molecular mechanisms of plant photoperiodism<br>3. RNA modification and flowering<br>4. Review and discussion<br>[Part 2]<br>1. Cloning and mutagenesis<br>2. Protein purification<br>3. Spectroscopy<br>4. Various biochemical and biophysical studies |
| (4) Outside-class activities and assignments | Homework will be given after each class or you should review the last lecture every week. |
| (5) Textbooks and course materials | Text: Handouts will be provided.<br>[Part 1] Lecture materials will be uploaded to kibaco '資料' by the day before. Please download it before class starts. |
| (6) Assessment and grading | Assessment: The mean score from Part 1 and Part 2 will be the final grade.<br>Parts 1 & 2: Class participation/discussion 30%, Quiz or Report submission 70 % |
| (7) Questions to the instructor (Office hours, etc.) | Particular office hour is not set. For queries, please make an appointment via e-mail. |
| (8) Special note | This class will be offered in Japanese (Class may be offered in English).<br>Those who wish to take the course in English should contact the class lecturer. |

| Program | Graduate School of Science | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Systematics and Evolution | R0373 | 2nd I | Tue | 1 | 1 |
| Doctoral program | Special Lecture on Systematics and Evolution | R0374 | | | | |

| Instructor(s) | Note |
|---|---|
| Murakami and Eguchi | |

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|---|---|
| (1) Course policies and topics | Phylogenetics]<br>Deepen understanding of the field by introducing recent research to explore issues of animal and plant diversity and evolution. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Learn the thought processes by which researchers use information to understand the lineage and evolution of living organisms. |
| (3) Course schedule, subject matter, and classroom activities | Eguchi)<br>Southeast Asia is considered the most species-diverse region in the world. In many animal groups, however, the speciation is poorly understood. There is also a lack of knowledge about the geographical genetic structure and origin of individual species and lineages. This lecture presents recent research on species classification and phylogeography of terrestrial invertebrates in Southeast Asia.<br>(MURAKAMI)<br>Many species of ferns have stopped sexual reproduction and have become asexual, called apogamy. And, though it is difficult to distinguish by the form. The presence of many hidden species with distinct reproductive isolation is also characteristic of ferns. This paper outlines our research on apogamous and hidden species of fern plants, and discusses it with students. |
| (4) Outside-class activities and assignments | To deepen understanding of research by reading short papers and expressing opinions on research directions and issues. It is necessary to make a small report on the main points and impressions of the lecture at home. |
| (5) Textbooks and course materials | The lecture proceeds mainly on the handout, and references and papers, etc. are introduced as appropriate. |
| (6) Assessment and grading | Evaluate based on participation in classes and reports. |
| (7) Questions to the instructor (Office hours, etc.) | Questions are always welcome, so please make an appointment in advance by email.<br>Eguchi: antist@tmu.ac.jp<br>Murakami: nmurak@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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lecture on Cell Biology | M(R0351) | Summer intensive | .Sep 5,6 | 2-5 | 1 |
| Doctoral program | Special Lecture on Cell Biology | D(R0352) | | | | |

| Instructor(s) | Note |
|---|---|
| KUME Kazuhiko | |

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| (1) Course policies and topics | This lecture will be given intensively during the summer.<br>Content: "Sleep and Wakefulness in Animals<br>Dates: Thursday, September 5 - Friday, September 6 |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In this lecture, students will learn a wide range of knowledge about the role of sleep in animals, as well as the neural circuits and molecular mechanisms that regulate sleep and wakefulness. In recent years, sleep research using *Drosophila*, which has well-developed genetics, has made remarkable progress, and it has become clear that the sleep regulation mechanisms are very similar to those of mammals, including humans. In this lecture, I will introduce the state-of-the-art sleep research using *Drosophila* as well as mammals, and explain the latest findings on sleep/wake mechanisms. |
| (3) Course schedule, subject matter, and classroom activities | The lecture schedule is as follows.<br>Part 1 - Part 2: The Role of Sleep<br>Part 3 – 6: Regulatory mechanisms of sleep and wakefulness<br>Part 7 – 8: Sleep research using Drosophila |
| (4) Outside-class activities and assignments | Students work on assignments given during the lecture and write reports. |
| (5) Textbooks and course materials | Printed materials will be distributed as appropriate. |
| (6) Assessment and grading | Evaluation will be made by report. |
| (7) Questions to the instructor (Office hours, etc.) | Questions outside of lecture hours will be answered by e-mail due to intensive lectures given by outside lecturers. Questions should be sent to Takaomi Sakai (sakai-takaomi@tmu.ac.jp). |
| (8) Special note | This course is given mostly in Japanese.<br>Detailed information on the date and time of the class will be announced in August using kibaco and the Graduate School Class Information in the Information Forum of the Department of Life Sciences. If you have any other questions about the class, please contact Takaomi Sakai (sakai-takaomi@tmu.ac.jp). |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lecture on Biomolecules | M(R0355) | Winter Intensive | | | 1 |
| Doctoral program | Special Lecture on Biomolecules | D(R0356) | | | | |

| Instructor(s) | Note |
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| Kaoru Sugimura | |

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|---|---|
| (1) Course policies and topics | Introduction to Quantitative Biology<br>Kaoru Sugimura (Associate professor, Department of Bioinformatics and Systems Biology, Faculty of Science, The University of Tokyo)<br>This lecture will be held on November 13th and 14th, 2024. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | This lecture aims to nurture quantitative perspectives in biology.<br>Through the lecture, students are expected to acquire quantitative views of cells by estimating the "numbers" related to cells. In addition, students will be introduced to mathematical models that quantitatively express cells and the methods for quantitative measurements. Furthermore, cutting-edge topics that apply quantitative measurements and mathematical modeling will be introduced. |
| (3) Course schedule, subject matter, and classroom activities | This lecture will cover the following topics in quantitative biology.<br>November 13th<br>(1) Cell biology in numbers<br>(2) Image analysis of cells and tissues<br>November 14th<br>(3) Mathematical modeling in cell biology<br>(4) Mechanical measurements in cells and tissues<br>(5) Recent research topics in quantitative biology. |
| (4) Outside-class activities and assignments | Review thoroughly the contents of each lecture. |
| (5) Textbooks and course materials | The lecture will be done using PowerPoint. Handouts will be provided when necessary. |
| (6) Assessment and grading | Evaluation will be based on participation. |
| (7) Questions to the instructor (Office hours, etc.) | Please contact the instructor via Google Forms. |
| (8) Special note | This course will be mostly taught in Japanese. |

| Program | Graduate School of Science | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| | Course Name | Course Number | | | | |
| Master's program | Special Course in Biology Ⅱ (English for Biology) | R0421 | Summer Intensive | Sep 3,4,7 | 1-5 | 2 |
| Doctoral program | Special Course in Biology Ⅱ (English for Biology) | R0422 | | | | |

| 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 practise 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 practised. The class will be conducted in English using an interactive workshop style for active listening and speaking practice.<br>1. Introduction to English for Specific Purposes<br>2. Professional self-introduction<br>3. Numbers, Mathematical expressions<br>4. Laboratory equipment, Tables and graphs<br>5. Dictation<br>6. Listening and summarizing science news podcast<br>7. Listening and speaking practice: Prosody<br>8. Recitation and self-analysis<br>9. Genre analysis: Science news<br>10. Your science news podcast<br>11. Presentation skills and pronunciation<br>12. Useful expressions for presentations and Q&A sessions<br>13. How to chair an academic session<br>14. Slides and script writing<br>15. Oral presentations |
| (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 books:<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.) | Via 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 | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| | 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 | | | | |

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

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|---|---|
| (1) Course policies and topics | Academic Writing |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The goal of this course is to acquire the basic knowledge and skills that students need to write empirical scientific RAs and abstracts in English. The course is for students who are currently writing or are preparing to write empirical scientific research articles (RAs) for academic journals, abstracts for international conferences, theses, and/or dissertations. |
| (3) Course schedule, subject matter, and classroom activities | Students will learn important aspects of empirical scientific RAs that consist of Introduction, Methods, Results, and Discussion (IMRaD). They will also analyze empirical scientific RAs from their fields of study for the structure and language features of RAs in order to prepare them to write RAs and/or abstracts effectively for publication. In this course, students will be writing on their own research. The class will be conducted mainly in English.<br><br>Note: For the RA analysis, students will collect and submit electronic copies of five RAs that meet all the requirements below:<br><br>a. Original RAs **Reviews are not acceptable.<br>b. Full-length RAs **NOT letters or short communications<br>c. RAs on or related to the students' own research<br>d. RAs published in well-respected journals<br>e. RAs that consist of the following sections: Introduction, Methodology, Results, and Discussion. (Since these are typical names of sections that appear in empirical scientific RAs, the names of the sections in your RAs do not have to exactly match those section names. For example, the Methodology section may be labeled as "Methods" or "Procedure" in some RAs.)<br><br>Lesson 1: Course Orientation<br>Lesson 2: Basics of Academic Writing, Paragraphing (1)<br>Lesson 3: Paragraphing (2)<br>Lesson 4: English for Specific Purposes / OCHA / PAIL<br>Lesson 5: Structure of a Research Article (RA), Introduction (1)<br>Lesson 6: Introduction (2)<br>Lesson 7: Introduction (3), Methodology (1)<br>Lesson 8: Methodology (2)<br>Lesson 9: Corpus / Concordance<br>Lesson 10: Results & Discussion (1)<br>Lesson 11: Results & Discussion (2)<br>Lesson 12: Results & Discussion (3)<br>Lesson 13: Title / Abstract (1)<br>Lesson 14: Abstract (2)<br>Lesson 15: Other Topics in RA Writing / Review |
| (4) Outside-class activities and assignments | Students are expected to prepare for and review each class and work on assignments according to the instructor’s directions. |
| (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 | Class work / active class participation: 25%<br>Short writing and other assignments: 45%<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 Reina Nakamura.<br>Students are 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 problems.<br><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. The selected articles will relate to different fields of biology. |
| (3) Course schedule, subject matter, and classroom activities | **1. Introduction;** selection of articles dealing with:<br>**2. Biology of living organisms –** structure, activities, distribution, space, and time.<br>**3. Biochemistry -** the application of chemistry to study biological processes at the cellular and molecular levels.<br>**4. Biodiversity –** talking about different kinds of life found in one area, e.g., animals, plants, fungi, and microorganisms.<br>**5. Cell Biology –** the study of cell structure and function.<br>**6. Developmental Biology –** an exploration of how animals and plants grow and develop.<br>**7. Ecology –** we will try to understand the vital connections between plants, animals, and the world around them.<br>**8. Evolutionary Biology –** analysis of the evolutionary processes and patterns, especially concerning the diversity of organisms and how they change over time.<br>**9. Genetics –** we will seek to understand the patterns of inheritance of specific traits relating to genes and genetic information.<br>**10. Gene Science –** research dealing with understanding fundamental units of heredity.<br>**11. Genome Science –** looking into the science of an organism's complete set of genetic information.<br>**12. Molecular Biology –** the study of the molecular basis of biological activity.<br>**13. Neuroscience** - focusing on the brain and its impact on behavior and cognitive functions**.**<br>**14. Taxonomy –** how can we name, describe, and classify organisms that include all the world's plants, animals, and microorganisms?<br>**15. 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 | Mini tests and class contribution (10%), end semester 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 her 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 nervousness so that other English speakers can better perceive and understand you. At the same time, we will work on pronunciation (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 class, learn to tell stories, incorporate AI in your presentations, have fun, and learn a lot. I look forward to your attendance. Some classes will be conducted online using Zoom. |
| (3) Course schedule, subject matter, and classroom activities | Content:<br>1. How do you start your presentation?<br>2. Online presentations; AI – what to do and what not to do (online).<br>3. Effective Presentations – required elements.<br>4. Language used in presentations/vowels and intonation. A story with a twist (homework).<br>5. Dealing with questions – emphases, rhythm, and stress in speaking.<br>6. Body language: “Fake it till you make it.” Introducing the topic of your research (homework).<br>7. Six principles of a good presentation.<br>8. Body, posture, and personal space. Presenting an experiment (homework).<br>9. Dress for presentations.<br>10. PechaKucha (20X20) and 3MT – how to time your delivery. Why is your research important? (homework).<br>11. Poster presentations at TMU and elsewhere. Theory.<br>12. Poster presentations – practice.<br>13. How to prepare a good presentation on your research topic and deliver it in 20 min. (homework)<br>14. Repeating, recapping, rephrasing, and active listening. Being persuasive.<br>15. Summary and conclusions. |
| (4) Outside-class activities and assignments | Some homework/short, 3 to 5-slide 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>eekly presentations (50%), final presentation (50%). |
| (7) Questions to the instructor (Office hours, etc.) | The lecturer of this course is Ms. Elizabeth Zielinska (eliedutmu@tmu.ac.jp). You can contact her 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 problems.<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. The selected articles will relate to different fields of biology. |
| (3) Course schedule, subject matter, and classroom activities | **1. Introduction;** selection of articles dealing with:<br>**2. Biology of living organisms –** structure, activities, distribution, space, and time.<br>**3. Biochemistry -** the application of chemistry to study biological processes at the cellular and molecular levels.<br>**4. Biodiversity –** talking about different kinds of life found in one area, e.g., animals, plants, fungi, and microorganisms.<br>**5. Cell Biology –** the study of cell structure and function.<br>**6. Developmental Biology –** an exploration of how animals and plants grow and develop.<br>**7. Ecology –** we **will try to understand the vital connections between plants, animals, and the world around them.**<br>**8. Evolutionary Biology –** analysis of the evolutionary processes and patterns, especially concerning the diversity of organisms and how they change over time.<br>**9. Genetics –** we will seek to understand the patterns of inheritance of specific traits relating to genes and genetic information.<br>**10. Gene Science** – research dealing with understanding fundamental units of heredity.<br>**11. Genome Science –** looking into the science of an organism's complete set of genetic information.<br>**12. Molecular Biology –** the study of the molecular basis of biological activity.<br>**13. Neuroscience -** focusing on the brain and its impact on behavior and cognitive functions.<br>**14. Taxonomy –** how can we name, describe, and classify organisms that include all the world's plants, animals, and microorganisms?<br>**15. 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 | Mini tests and class contribution (10%), end semester 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 her by e-mail. |
| (8) Special note | |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Course in Biology Ⅰ | R0433 | 2 | F | 2 | 1 |
| Doctoral program | Special Course in Biology Ⅰ | R0434 | | | | |

| Instructor(s) | Note |
|---|---|
| ANDO Kanae<br>CRONIN Adam<br>WEITEMIER Adam Zachary | Technique for Research Communication Course in English |

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| (1) Course policies and topics | During graduate training, it is anticipated that students will make new research discoveries. The ability to effectively communicate research findings to a broad audience can enhance the placement of students toward productive positions within their research community. The purpose of this course is to train and support TMU graduate students in the preparation and delivery of oral presentations. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | At the end of the course, students will be able to effectively share their research through conference-style presentations (15 min talk) and within a 3-minute "elevator pitch". Students will also share and peer-review their presentations with students at partner universities abroad via Collaborative Online International Learning (COIL). |
| (3) Course schedule, subject matter, and classroom activities | Format: Didactic lecture & student presentation<br><br>Tentative schedule:<br><br>I. Conference style<br>1. Introduction to presentation<br>2. Lecture (presentation slides)<br>3. Lecture (presentation delivery)<br>4. Prepare presentation & rehearsal<br>5. Conference-style presentation (students play roles of speakers, chairs, referees)<br><br>II. 3-min talk<br>6. Lecture (3-min talk)<br>7. Exchange talks via COIL<br>8. Exchange talks via COIL |
| (4) Outside-class activities and assignments | [Out of class activity requirement] Students will have to work on their presentations and comment on others. |
| (5) Textbooks and course materials | Text book and Required Supplies:<br>Science Research Writing: For Native And Non-native Speakers Of English (second Edition) ISBN: 978-1786347848<br>Handout will be distributed in the class. |
| (6) Assessment and grading | Assessment: Class participation & presentation 100%. |
| (7) Questions to the instructor (Office hours, etc.) | Email to Kanae Ando (k_ando@tmu.ac.jp), Adam Cronin (adam-l@tmu.ac.jp ) and Adam Weitemier (aweitem@tmu.ac.jp ). |
| (8) Special note | This course includes COIL (collaborative online international learning) with classes from partner universities. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| 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 | | | | |

| Instructor(s) | Note |
|---|---|
| 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 10 2-5 periods (4 classes)<br>Day 2: Wednesday, April 17 2-5 periods (4 classes)<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 | 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 |
|---|---|
| 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 | Wed | 1 | 1 |
| Doctoral program | Biology Course in Planning and Management 2 | R0446 | Biology Course in Planning and Management 2 | R446 | | | | |

| Instructor(s) | Note |
|---|---|
| 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 | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| | 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 | | | | |

| Instructor(s) | Note |
|---|---|
| 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 |
|---|---|
| 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 |
|---|---|
| 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 |
|---|---|
| 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 | External experience in Biological Sciences 1 | R0693— | — | — | As Needed | — | — | 1 or 2 |
| Doctoral program | External experience in Biological Sciences 1 | R0694— | | — | | | | |

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

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|---|---|
| (1) Course policies and topics | External experience in Biological Sciences |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | This course is to encourage students to acquire to work experience, activity, and practical training outside the university at companies, government offices, various organizations, etc., and credits are granted if certain requirements are met. Students find their own host institutions. The practical work experience must be related to biology, generally 30 hours or more in duration, and must be approved by the host institution. There are several other requirements for approval, so prospective students should consult with a member of the Academic Affairs Committee. |
| (3) Course schedule, subject matter, and classroom activities | The course will be offered at the request of the student. Students must submit a preliminary application to the Academic Affairs Committee at least 6 weeks prior to the start of the course for approval. After the preliminary application is approved, the course will be offered as a new course. |
| (4) Outside-class activities and assignments | The out-of-class learning will be required. |
| (5) Textbooks and course materials | Printouts will be given out if necessary. |
| (6) Assessment and grading | Evaluation will be based on the practical training logbook and practical training report submitted to the instructor in charge, as well as oral examination and confirmation. |
| (7) Questions to the instructor (Office hours, etc.) | If you have any questions, please contact Dr. Kanae Ando (k_ando@tmu.ac.jp), a member of the Graduate School Academic Affairs Committee. |
| (8) Special note | Students will need to find their own internship hosts. |

| 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 Biological Sciences 2 | R0695 (2units)— | — | —R0411 (1unit) | As Needed | — | — | 1 or 2 |
| Doctoral program | External experience in Biological Sciences 2 | R0696 (2units)— | | —R412 (1unit) | | | | |

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

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|---|---|
| (1) Course policies and topics | External experience in Biological Sciences 2 |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | This course is to encourage students to acquire to work experience, activity, and practical training outside the university at companies, government offices, various organizations, etc., and credits are granted if certain requirements are met. Students find their own host institutions. The practical work experience must be related to biology, generally 30 hours or more in duration, and must be approved by the host institution. There are several other requirements for approval, so prospective students should consult with a member of the Academic Affairs Committee. |
| (3) Course schedule, subject matter, and classroom activities | The course will be offered at the request of the student. Students must submit a preliminary application to the Academic Affairs Committee at least 6 weeks prior to the start of the course for approval. After the preliminary application is approved, the course will be offered as a new course. |
| (4) Outside-class activities and assignments | The out-of-class learning will be required. |
| (5) Textbooks and course materials | Printouts will be given out if necessary. |
| (6) Assessment and grading | Evaluation will be based on the practical training logbook and practical training report submitted to the instructor in charge, as well as oral examination and confirmation. |
| (7) Questions to the instructor (Office hours, etc.) | If you have any questions, please contact Dr. Kanae Ando (k_ando@tmu.ac.jp), a member of the Graduate School Academic Affairs Committee. |
| (8) Special note | Students will need to find their own internship hosts. |

| 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 (2unit) | R0931 | Internship (1units) | R0929 | As Needed | — | — | 1 or 2 |
| Doctoral program | Internship (2unit) | R0932— | Internship (1units) | R0930 | | | | |

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

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|---|---|
| (1) Course policies and topics | Students will work at their internship workplace, such as companies, administrative agencies, and NPO. Students must secure their own internship employer. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Gain knowledge and skills from a planned work experience in the student's chosen career fields.. |
| (3) Course schedule, subject matter, and classroom activities | Students will spends five days (40 hours) or more at their internship placement. The internships should be taken during between semesters. |
| (4) Outside-class activities and assignments | Research about the internship placement. |
| (5) Textbooks and course materials | Depends on internship placement. |
| (6) Assessment and grading | Log of Work Activities, reports, evaluation from Internship Advisors. |
| (7) Questions to the instructor (Office hours, etc.) | Email to graduate program committee members. |
| (8) Special note | 1unit: 5 days（40h） or more, less than 8 days（60h), one credit<br>2 units: 8 days (60 h) or more, two credits,<br>Students should submit a detailed internship plan more than six weeks before the start date. |

| 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) |
|---|---|
| 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 | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| | 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 | | | | |

| 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 | | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Biological Sciences | R0705 | 2nd I | Tue | 1 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0706 | | | | |

| Instructor(s) | Note |
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| Kawahara and Narikawa | This course is a common course with the undergraduate program. |

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| (1) Course policies and topics | Various biological phenomena are highly regulated by protein dynamics and extracellular signals such as light. In the first half of this class, we will discuss about the ubiquitin-dependent protein degradation system, which is critical for cell cycle progression. We will also focus on ubiquitin-related human diseases including carcinogenesis, neuro-degeneration, immune disorders, and diabetes. In the latter half, we will learn photobiology by reading scientific papers focused on light matters. We will focus on light responsive systems of various organisms. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | In the first half of the class, students will understand the roles of ubiquitin system in cell proliferation and its related diseases. In the later half, students will understand the scientific field of photobiology. In addition, students will learn how to read scientific papers especially focusing on interpretation of figures. |
| (3) Course schedule, subject matter, and classroom activities | First half：presented by Dr. Kawahara<br>１：Roles of ubiquitin-dependent protein degradation system in cell cycle control.<br>２：Ubiquitination machinery in eukaryotic cells.<br>３：Ubiquitin-mediated protein quality control in viral immunity (antigen presentation).<br>４：Ubiquitin-dependent proteolysis and onset of diabetes.<br>Second half：presented by Dr. Narikawa<br>５：Photobiology 1: Bacterial photoperception<br>６：Photobiology 2: Eel fluorescent protein I<br>７：Photobiology 3: Eel fluorescent protein II<br>８：Photobiology 4: Visual system of mantis shrimp |
| (4) Outside-class activities and assignments | Both in the first half and the second half, you should review the last lecture content. |
| (5) Textbooks and course materials | 「Essential Cell Biology, 4th edition」, 「Molecular Biology of the Cell」<br>Document materials will be distributed. |
| (6) Assessment and grading | Judged from report, examination and/or class attitude. |
| (7) Questions to the instructor (Office hours, etc.) | Office hours:<br>Particular office hours are not set. Please make an appointment via e mail if you want to visit my office for a query or concern. A query by email is also acceptable.<br>Kawahara：hkawa@tmu.ac.jp（Room 9-488）<br>Narikawa：narikawa.rei@tmu.ac.jp（Room 8-324） |
| (8) Special note | This lecture is for students who cannot speak Japanese and graduated from other university.<br>Authorization from curriculum coordinator is required before taking this lecture.<br>Consider your research area to choose 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 | 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. |
| (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>Class participation 40%, Presentation 40%, Final report 20% |
| (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 | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lecture on Biological Sciences | R0731 | 2nd I | Wed | 1 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0732 | | | | |

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

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| (1) Course policies and topics | This course covers some current research topics in evolutionary genetics. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | By the end of the class, students should understand how research proceeds in the field and learn how logical discussions are conducted. Also students should be able to develop their own ideas and opinions related to the topics. |
| (3) Course schedule, subject matter, and classroom activities | Following topics will be discussed in the class:<br>1. Genes involved in speciation (AT)<br>2. Evolution of adaptive traits (AT)<br>3. Genome-wide genetic mapping (AT)<br>4. Genes in conflict (AT)<br>5. Evolution of sex chromosomes (KT)<br>6. Evolution of physiological traits (KT)<br>7. Evolution of meiotic recombination (KT)<br>8. Reviews (AT & KT) |
| (4) Outside-class activities and assignments | Students are expected to review and conduct self-learning on materials related to the topics as out-of-classwork. |
| (5) Textbooks and course materials | Handouts will be provided before or during the class. |
| (6) Assessment and grading | Final grade will be determined by class participation. |
| (7) Questions to the instructor (Office hours, etc.) | Particular office hour is not allocated, but students can make appointments by email. |
| (8) Special note | This course is provided for students who have not graduated from Tokyo Metropolitan University.<br>Permission of the curriculum coordinator (Dr. Fukuda) is necessary for the registration. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lecture on Biological Sciences | R0353 | 2nd | Wed. | 2 | 1 |
| Doctoral program | | | | | | |

| Instructor(s) | Note |
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| Tetsuhisa Otani, Takeshi Kanegae | |

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| (1) Course policies and topics | One of the most significant functions of living organisms is to respond to surrounding environmental information. The purpose of this class is to understand the physiological phenomena exhibited by animals and plants, primarily to acquire knowledge about physiological changes in response to information on the external environment. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Part 1: This course will provide opportunity to learn the physiology of epithelia, with particular emphasis on epithelial barrier and homeostasis. Students will be introduced to cutting-edge topics in epithelial biology, accompanied with historical reflections of the research field.<br>Part 2: At the end of this course, students will be able to explain how light as environmental information is accepted by plant photoreceptors and how information is expressed. |
| (3) Course schedule, subject matter, and classroom activities | [Part 1] Animal physiology<br>1. Epithelial barrier and intercellular junctions<br>2. Epithelial packing and paracellular transport<br>3. Epithelial homeostasis<br>4. Cell competition<br><br>[Part 2] Plant physiology<br>5. Diversity of photoreceptors<br>6. Adaptation to environmental light conditions<br>7. Transcriptional regulation of photomorphogenesis<br>8. Post-transcriptional regulation of photomorphogenesis |
| (4) Outside-class activities and assignments | Homework will be given after each class and you are expected to review the last lecture every week. |
| (5) Textbooks and course materials | Lecture materials will be uploaded to kibaco by the day before. |
| (6) Assessment and grading | Assessment: The mean score from Part 1 and Part 2 will be the final grade.<br>Part 1: Presentation and discussion 20 %, Quiz or Report submission 80 %.<br>Part 2: Quiz or Report submission 40 %, Examination 60 %. |
| (7) Questions to the instructor (Office hours, etc.) | Particular office hour is not set. For queries, please make an appointment via e-mail. |
| (8) Special note | Part 2: Basic knowledge of plant physiology is a prerequisite for [Part 2]. |

| Program | Graduate School of Science | Graduate School of Science and Engineering | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| | Course Name | Course Number | | | | |
| Master's program | Special Lecture on Biological Sciences | R0736 | 2nd I | Thu | 1 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0737 | | | | |

| Instructor(s) | Note |
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| Haruta and Ehira | This course is a common course with the undergraduate program. |

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| (1) Course policies and topics | (Course description)<br>This special lecture is the classes for the students of department of biological sciences, dealing with basic knowledge in environmental microbiology and microbial genetics. Students will be strongly encouraged to ask questions and express opinions. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | (Course objectives)<br>The aims of this course are to learn phylogenetic and physiological diversity of microorganisms. You will learn the role of microorganisms in natural environments and relationships between microbe-microbe, microbe-plant, microbe-animal, and microbe-human. You will also learn mechanisms of bacterial responses to environmental changes. |
| (3) Course schedule, subject matter, and classroom activities | (Class contents)<br>First half: Shin HARUTA<br>1. Phylogeny of Bacteria and Archaea<br>2. Diversity of Bacteria and Archaea<br>3. Microbial ecology<br>4. Applied microbiology<br>Second half: Shigeki EHIRA<br>5. Bacterial genome<br>6. Acclimation to environmental changes in bacteria<br>7. Cellular differentiation in bacteria<br>8. Synthetic biology<br>Students are expected to prepare each lecture by reading texts or research articles. |
| (4) Outside-class activities and assignments | Students are expected to prepare each lecture by reading texts or research articles. |
| (5) Textbooks and course materials | (Text book)<br>Hand-outs will be provided in the class.<br>Books for reference:<br>Brock: Biology of Microorganisms (Madigan et al., Pearson Edu.)<br>Microbiology: An Evolving Science (Slonczewski & Foster, W. W. Norton & Company) |
| (6) Assessment and grading | (Evaluation)<br>Evaluation will be based on a final report. Presentation and discussion in the class are also considered. |
| (7) Questions to the instructor (Office hours, etc.) | (Office hours)<br>By appointment through e-mail |
| (8) Special note | This class is for graduates of other universities.<br>The permission of curriculum coordinator (Dr. Ando) is required for the registration.<br>Discuss with your supervisor and class teachers in advance. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lecture in Scientific Writing | M(R0669) | 2nd Semester I | Thu | 2 | 1 |
| Doctoral program | Special Lecture in Scientific Writing | D(R0670 | | | | |

| Instructor(s) | Note |
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| Adam Weitemier | |

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| (1) Course policies and topics | A majority of scientific communication is done through writing, much of which is in the form of scientific publications. Since English is the language used by most scientific journals, it is essential to be able to effectively read and navigate through English scientific publications. It is also essential to be able to write about scientific information in a style that is understandable and acceptable for English language scientific journals. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | The aims of this course are to 1) improve students' ability and confidence in effectively navigating among the sections of an English language scientific report and 2) to familiarize students with English scientific writing styles from the perspectives of reading and writing. |
| (3) Course schedule, subject matter, and classroom activities | TENTATIVE COURSE OUTLINE:<br><br>1. Experimental Design and Paper Structure; References<br>2. Introduction Section<br>3. Methods Section<br>4. Results Section<br>5. Discussion Section<br>6. Peer Review I<br>7. Peer Review II<br>8. Class Review and Discussion<br><br>Online activities will be frequent. Some activities will require access to Google Docs. Holding a Google account is not necessary. |
| (4) Outside-class activities and assignments | The class assignment is a writing sample on a student-chosen topic. |
| (5) Textbooks and course materials | Sample publications will be distributed throughout the course.<br><br>For further independent reference, students may refer to the books:<br><br>理系英語のライティングVer2. （理系たまごシリーズ）<br>or<br>Science Research Writing: For Native And Non-native Speakers Of English (second Edition) ISBN: 978-1786347848<br><br>available in the English Mini-Library |
| (6) Assessment and grading | Participation 50%, Effort 35%, Assignment 15% |
| (7) Questions to the instructor (Office hours, etc.) | The instructor can be reached at aweitem[at]tmu.ac.jp<br>or through the kibaco class page messages. |
| (8) Special note | This course invites participation from all students and honors student diversity and different points of view.<br>Active participation in the class is essential.<br>This course will be taught in English. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lecture in Physiology1: Neurobiology of the Norepinephrine System | M(R0733) | 2nd Semester I | Fri | 1 | 1 |
| Doctoral program | Special Lecture in Physiology1: Neurobiology of the Norepinephrine System | D(R0734) | | | | |

| Instructor(s) | Note |
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| Adam Weitemier | |

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| (1) Course policies and topics | 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><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 | 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 | Presentation preparation out of class. |
| (5) Textbooks and course materials | Research articles and supplementary readings will be distributed throughout the course.<br>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. |
| (6) Assessment and grading | Class participation 50%, Assigned Work 20%, Presentation 30% |
| (7) Questions to the instructor (Office hours, etc.) | Available for questions/comments via KIBACO online system<br>E-mail to aweitem@tmu.ac.jp for questions or an appointment. |
| (8) Special note | 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.<br>Active participation in the class is essential. This course is offered in English. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lecture in Physiology2: Neurobiology and the Environment | M(R0733) | 2nd Semester II | Fri | 1 | 1 |
| Doctoral program | Special Lecture in Physiology2: Neurobiology and the Environment | D(R0734) | | | | |

| Instructor(s) | Note |
|---|---|
| Adam Weitemier | |

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| (1) Course policies and topics | The brain and supporting systems are dependent on environmental conditions for maintaining normal function. As we review fundamental knowledge about the brain, we will consider the various ways in which it is vulnerable to changes made to the environment by human activity, including emissions of toxins and pollutants, and changes in our surroundings.<br><br>The class will consist of informative lecture and communicative activities. Research on the impacts of environmental pollutants on nervous system function is ongoing. Therefore, in this class we will hold discussions that consider the history, latest findings and preventative measures considered in the current research literature. Students will do their own research on mechanistic, health and preventative viewpoints of an environmental issue that impacts nervous system function. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | Students will gain an informed perspective on the interaction of nervous system physiology and the environment. They will strengthen inquiry and critical thinking skills through discussion and research activities. |
| (3) Course schedule, subject matter, and classroom activities | [Tentative]<br>1. Introduction<br>2. Study Perspectives; Course task<br>3. Brain Defenses; Discussion<br>4. Mechanisms of Damage; Discussion<br>5. Homeostasis; Discussion<br>6. Stress; Discussion<br>7. Management; Student presentations<br>8. Solutions; Student presentations |
| (4) Outside-class activities and assignments | Students will be asked to search for articles and scientific papers to prepare for in-class discussion and presentation. |
| (5) Textbooks and course materials | Research articles to be distributed throughout the course.<br>General background on the nervous system 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' should be your basic study guide. |
| (6) Assessment and grading | Class participation 50%, Quizzes 20%, Research Motivation 30% |
| (7) Questions to the instructor (Office hours, etc.) | Available for questions/comments via KIBAKO online system<br>E-mail to aweitem@tmu.ac.jp for questions or an appointment. |
| (8) Special note | Previous knowledge of general neuroscience or physiology will be helpful.<br>This course is independent from the 2nd Semester I (後期 I) course taught by Dr. Weitemier. If you wish to take both courses, please register for them separately.<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 | | | | |
| Master's program | Special Lecture on Biological Sciences | R0009 | 2nd I | Mon | 1 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0010 | | | | |

| Instructor(s) | Note |
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| Murakami and Eguchi | This course is a common course with the undergraduate program. |

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| (1) Course policies and topics | Phylogenetic evolution, phylogeography<br>This course will deepen students' understanding of animal and plant diversity, evolution, geographic distribution, and their causes, focusing on the research being conducted by the faculty members themselves. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | To deepen understanding of how researchers formulate a research theme, plan and conduct research, and to apply this understanding to the planning and execution of the participant's own research. |
| (3) Course schedule, subject matter, and classroom activities | （Murakami） Research on the origins of the geographical distribution of wild plants in the Japanese archipelago using DNA information (plant molecular phylogeography), research on the symbiosis and co-evolution of wild angiosperms and their pollinating insects in the Izu Islands, and ferns that grow only in the gametophyte generation will be introduced and discussed by the participants to further their understanding of these topics.<br>（Eguchi）. We will present our findings on the discovery of cryptic species, classification, and geographic genetic structure of insects, arachnids, and polypods in Southeast Asia. We will also introduce our overseas field research sites, including how we conduct our research in the field and how we have established an international collaborative research system. |
| (4) Outside-class activities and assignments | (Murakami.) Review of the distributed handouts is mandatory.<br>（Eguchi.） Ask students to read a short paper and express their opinions on the research orientation, issues, etc. to deepen their understanding of the research. |
| (5) Textbooks and course materials | Lectures will be given mainly by handouts, and references and papers will be introduced as necessary. |
| (6) Assessment and grading | Evaluation will be based on class participation and reports. |
| (7) Questions to the instructor (Office hours, etc.) | （Murakami) If you would like to ask questions, please make an appointment in advance by emailing nmurak@tmu.ac.jp<br>（Eguchi.） If you wish to ask questions in person, please make an appointment in advance by e-mail (antist@tmu.ac.jp) as we accept questions at any time. |
| (8) Special note | This course is a graduate course for graduates of other universities (it is also a course for undergraduates of this university). Application for enrollment requires permission from Graduate School Academic Affairs (Fukuda). Students who wish to enroll in this course should consult with their advisor and the instructor in charge of the course in advance.<br>The method and content of the course may change depending on the prevalence of COVID-19. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lecture on Biological Sciences | R0715 | 2 | M. | 2 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0716 | | | | |

| Instructor(s) | Note |
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| CRONIN Adam | |

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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 behaviour 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.<br><br>This class is for graduates of other universities. The permission of curriculum coordinator (Dr. Fukuda) is required for the registration. Discuss with your supervisor and class teachers in advance. |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lecture on Biological Sciences | R0725 | Summer Intensive | . Sep 9, 10, | 1-4 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0726 | | | | |

| Instructor(s) | Note |
|---|---|
| Steve Lindemann | |

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| (1) Course policies and topics | Course title: Fermentation Microbiology<br>Instructor: Dr. Steve Lindemann<br>Email: lindemann@purdue.edu [preferred]<br>Class Location: 11-103<br>September 9, 10, 11, 12th (9&10: R0725/0726, 11&12: R0727/R0728. Please register for both.)<br>Times: 8:50-10:20; 10:30-noon; 13:00-14:30; 14:40-16:10<br>[Course description]<br>This course focuses on understanding the principles of microbial ecology important to understanding fermentations. Although we will focus on food and beverage fermentations, we will also consider industrial fermentations and the bioengineering required to make microbes serve societal goals. The course will integrate concepts of microbial ecology, bioenergetics, and biotechnology. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | By the end of this course, students will be able to:<br>• Comprehend basic principles of community ecology and their application to microbes<br>• Describe the microbial ecology of common food and beverage fermentations<br>• Articulate the concept of the microbial cell factory<br>• Identify genetic and environmental approaches to control the products, rate, and yield of bioconversion<br>• Understand microbial metabolic pathways and how they are engineered<br>• Read primary literature relevant to fermentation biotechnology |
| (3) Course schedule, subject matter, and classroom activities | Course Schedule<br>Lecture Date and Time Slot Topic Assignment for Class<br>1 9/9: 8:50-10:20 Introduction to the course and traditional fermentations TBD<br>2 9/9: 10:30-12:00 Microbial growth kinetics and measurement TBD<br>3 9/9: 13:00-14:30 Thermodynamics of microbial life TBD<br>4 9/9: 14:40 -16:10 Paper discussion 1 TBD<br>5 9/10: 8:50-10:20 Exam 1; Microbial community ecology<br>Glycolytic fermentations to ethanol and lactate TBD<br>6 9/10: 10:30-12:00 The TCA cycle and acid fermentations TBD<br>7 9/10: 13:00-14:30 Constraints on microbial growth TBD<br>8 9/10: 14:40-16:10 Paper discussion 2 TBD<br>9 9/11: 8:50-10:20 Microbial ecology of food and beverage fermentations TBD<br>10 9/11: 10:30-12:00 Viruses and host viral defense systems TBD<br>11 9/11: 13:00-14:30 DNA replication and gene expression in prokaryotes and eukaryotes TBD<br>12 9/11:14:40-16:10 Paper discussion 3 TBD<br>13 9/12: 8:50-10:20 Exam 3; The molecular cell factory, mutations and mutagenesis TBD<br>14 9/12: 10:30-12:00 Molecular cloning approaches TBD<br>15 9/12: 13:00-14:30 Transformations and phage biology TBD<br>16 9/12: 14:40-16:10 Exam 4, paper discussion 4 TBD<br>16 9/19 Fermentation Paper Due by 11:59 pm<br><br>Due Dates and Late Work: Deadlines are an unavoidable part of being a professional and this course is no exception. Course requirements must be completed and posted or submitted on or before the specified due date and delivery time deadline.<br>All assignments are due by 11:59 pm on the due date listed on the schedule. Due dates and delivery time deadlines are defined as that used in Toyko, Japan. To encourage you to stay on schedule, due dates have been established for each assignment; 20% of the total points will be deducted per day for assignments received after the deadline. Extensions for exceptional circumstances may be requested in writing and are granted at the sole discretion of the instructor. |
| (4) Outside-class activities and assignments | Fermentation Paper: Students will complete an in-depth analysis of one fermentation process performed industrially (food/beverage or non-food applications are both acceptable). This paper will be a maximum of 10 pages, double spaced, and comprehensively describe the process, including 1) organism/strain selection and/or design, as well as interactions among members, if applicable, 2) physical reactor design, the rationale for these choices, and the contribution to the fermentation outcome, 3) description of the process (including how product is recovered). A more detailed rubric for the paper will be provided by the first lecture period. |

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| (5) Textbooks and course materials | OpenStax Microbiology (https://openstax.org/details/books/microbiology) is the required textbook for the course.<br>Technology and Courtesy in the Classroom: Modern consumer electronics have myriad uses in academic life; consequently, their presence is expected in the classroom. Indeed, much of the course will require in-class use of computers to practice what is being taught via lecture. However, electronic devices also carry with them the potential to disrupt the learning process of the user or neighboring students.<br>Use of personal electronic devices is discouraged for note-taking, as data suggests it is an inferior method to handwriting for comprehension and a risk for distraction (http://journals.sagepub.com/doi/abs/10.1177/0956797614524581). Though their use remains at the student's discretion, all personal electronics (including cell phones) must remain in silent mode during class to avoid disrupting instruction or disturbing other students. |
| (6) Assessment and grading | Final grades in this course will be assigned according to the following weights:<br>Daily Exams: 60%, Fermentation Paper: 20% , Participation and Discussion: 20%<br>Exams: Daily exams (non-comprehensive, except for that conceptual understanding of prior material may be required as a foundation) will be administered. The first midterm exam will cover the basics of fermentation, microbial growth, genetics, genomics, and enzyme section of the course, whereas the second will predominantly cover genetic engineering approaches.<br>Participation and Discussion: Participation at each session is worth 1% of the total grade; discussion of papers is worth an additional 2% for each discussion section. |
| (7) Questions to the instructor (Office hours, etc.) | Instructor: Dr. Steve Lindemann<br>Email: lindemann@purdue.edu [preferred] Office Hours: By appointment<br><br>Office Hours: The compressed nature of the course makes the scheduling of office hours challenging; however, I will remain accessible by email and will attempt to make arrangements for out-of-class meetings as possible. Please send any meeting requests by email or make arrangements in-person in class.<br><br>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. R0725/0726 is the first half (day 1 and 2) and R0727/R0728 is the second half (day 3 and 4).<br><br>Attendance and Absences: Because of the greatly compressed nature of this course, excused absences cannot typicaly be granted. In extreme circumstances, absences may be excused with instructor, which will require submission of appropriate documentation upon return. It is the responsibility of the student to make arrangements for any missed notes, quizzes or assignments. In the case of an emergency, please inform me as soon as possible and provide appropriate documentation upon return to class.<br><br>Use of Copyrighted Materials: Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. Always assume the materials presented by an instructor are protected by copyright unless the instructor has stated otherwise. Students enrolled in, and authorized visitors to, the course are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally.<br><br>NOTE: This syllabus is subject to change at any time |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
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| Master's program | Special Lecture on Biological Sciences | R0727 | Summer Intensive | . Sep 11, 12, | 1-4 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0728 | | | | |

| Instructor(s) | Note |
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| Steve Lindemann | |

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| (1) Course policies and topics | Course title: Fermentation Microbiology<br>Instructor: Dr. Steve Lindemann<br>Email: lindemann@purdue.edu [preferred]<br>Class Location: 11-103<br>September 9, 10, 11, 12th (9&10: R0725/0726, 11&12: R0727/R0728. Please register for both.)<br>Times: 8:50-10:20; 10:30-noon; 13:00-14:30; 14:40-16:10<br>[Course description]<br>This course focuses on understanding the principles of microbial ecology important to understanding fermentations. Although we will focus on food and beverage fermentations, we will also consider industrial fermentations and the bioengineering required to make microbes serve societal goals. The course will integrate concepts of microbial ecology, bioenergetics, and biotechnology. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | By the end of this course, students will be able to:<br>• Comprehend basic principles of community ecology and their application to microbes<br>• Describe the microbial ecology of common food and beverage fermentations<br>• Articulate the concept of the microbial cell factory<br>• Identify genetic and environmental approaches to control the products, rate, and yield of bioconversion<br>• Understand microbial metabolic pathways and how they are engineered<br>• Read primary literature relevant to fermentation biotechnology |
| (3) Course schedule, subject matter, and classroom activities | Course Schedule<br>Lecture Date and Time Slot Topic Assignment for Class<br>1 9/9: 8:50-10:20 Introduction to the course and traditional fermentations TBD<br>2 9/9: 10:30-12:00 Microbial growth kinetics and measurement TBD<br>3 9/9: 13:00-14:30 Thermodynamics of microbial life TBD<br>4 9/9: 14:40 -16:10 Paper discussion 1 TBD<br>5 9/10: 8:50-10:20 Exam 1; Microbial community ecology<br>Glycolytic fermentations to ethanol and lactate TBD<br>6 9/10: 10:30-12:00 The TCA cycle and acid fermentations TBD<br>7 9/10: 13:00-14:30 Constraints on microbial growth TBD<br>8 9/10: 14:40-16:10 Paper discussion 2 TBD<br>9 9/11: 8:50-10:20 Microbial ecology of food and beverage fermentations TBD<br>10 9/11: 10:30-12:00 Viruses and host viral defense systems TBD<br>11 9/11: 13:00-14:30 DNA replication and gene expression in prokaryotes and eukaryotes TBD<br>12 9/11:14:40-16:10 Paper discussion 3 TBD<br>13 9/12: 8:50-10:20 Exam 3; The molecular cell factory, mutations and mutagenesis TBD<br>14 9/12: 10:30-12:00 Molecular cloning approaches TBD<br>15 9/12: 13:00-14:30 Transformations and phage biology TBD<br>16 9/12: 14:40-16:10 Exam 4, paper discussion 4 TBD<br>16 9/19 Fermentation Paper Due by 11:59 pm<br><br>Due Dates and Late Work: Deadlines are an unavoidable part of being a professional and this course is no exception. Course requirements must be completed and posted or submitted on or before the specified due date and delivery time deadline.<br>All assignments are due by 11:59 pm on the due date listed on the schedule. Due dates and delivery time deadlines are defined as that used in Toyko, Japan. To encourage you to stay on schedule, due dates have been established for each assignment; 20% of the total points will be deducted per day for assignments received after the deadline. Extensions for exceptional circumstances may be requested in writing and are granted at the sole discretion of the instructor. |
| (4) Outside-class activities and assignments | Fermentation Paper: Students will complete an in-depth analysis of one fermentation process performed industrially (food/beverage or non-food applications are both acceptable). This paper will be a maximum of 10 pages, double spaced, and comprehensively describe the process, including 1) organism/strain selection and/or design, as well as interactions among members, if applicable, 2) physical reactor design, the rationale for these choices, and the contribution to the fermentation outcome, 3) description of the process (including how product is recovered). A more detailed rubric for the paper will be provided by the first lecture period. |

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| (5) Textbooks and course materials | OpenStax Microbiology (https://openstax.org/details/books/microbiology) is the required textbook for the course.<br>Technology and Courtesy in the Classroom: Modern consumer electronics have myriad uses in academic life; consequently, their presence is expected in the classroom. Indeed, much of the course will require in-class use of computers to practice what is being taught via lecture. However, electronic devices also carry with them the potential to disrupt the learning process of the user or neighboring students.<br>Use of personal electronic devices is discouraged for note-taking, as data suggests it is an inferior method to handwriting for comprehension and a risk for distraction (http://journals.sagepub.com/doi/abs/10.1177/0956797614524581). Though their use remains at the student's discretion, all personal electronics (including cell phones) must remain in silent mode during class to avoid disrupting instruction or disturbing other students. |
| (6) Assessment and grading | Final grades in this course will be assigned according to the following weights:<br>Daily Exams: 60%, Fermentation Paper: 20% , Participation and Discussion: 20%<br>Exams: Daily exams (non-comprehensive, except for that conceptual understanding of prior material may be required as a foundation) will be administered. The first midterm exam will cover the basics of fermentation, microbial growth, genetics, genomics, and enzyme section of the course, whereas the second will predominantly cover genetic engineering approaches.<br>Participation and Discussion: Participation at each session is worth 1% of the total grade; discussion of papers is worth an additional 2% for each discussion section. |
| (7) Questions to the instructor (Office hours, etc.) | Instructor: Dr. Steve Lindemann<br>Email: lindemann@purdue.edu [preferred] Office Hours: By appointment<br><br>Office Hours: The compressed nature of the course makes the scheduling of office hours challenging; however, I will remain accessible by email and will attempt to make arrangements for out-of-class meetings as possible. Please send any meeting requests by email or make arrangements in-person in class.<br><br>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. R0725/0726 is the first half (day 1 and 2) and R0727/R0728 is the second half (day 3 and 4).<br><br>Attendance and Absences: Because of the greatly compressed nature of this course, excused absences cannot typicaly be granted. In extreme circumstances, absences may be excused with instructor, which will require submission of appropriate documentation upon return. It is the responsibility of the student to make arrangements for any missed notes, quizzes or assignments. In the case of an emergency, please inform me as soon as possible and provide appropriate documentation upon return to class.<br><br>Use of Copyrighted Materials: Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. Always assume the materials presented by an instructor are protected by copyright unless the instructor has stated otherwise. Students enrolled in, and authorized visitors to, the course are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally.<br><br>NOTE: This syllabus is subject to change at any time |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lecture on Biological Sciences | R0719 | Summer Intensive | Aug 16, 19. | 2-5 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0720 | | | | |

| Instructor(s) | Note |
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| Diego Tavares Vasques * | |

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| (1) Course policies and topics | Course Title: Introduction to Plants Systematics and Taxonomy<br>Instructor: Diego Tavares Vasques<br>Dates: Aug 16 & Aug 19,<br>2, 3, 4 &5 periods<br>Please email Dr. Kanae Ando (k_ando@tmu.ac.jp) for questions.<br><br>Course Objectives/Overview<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.<br>Keywords<br>Plant diversity, evolution, systematics, Plant taxonomy<br>植物多様性、進化論、系統分類学、植物分類学 |
| (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><br>Keywords<br>Plant diversity, evolution, systematics, Plant taxonomy<br>植物多様性、進化論、系統分類学、植物分類学 |
| (3) Course schedule, subject matter, and classroom activities | Day 1 (2限、3限、4限、5限)<br>Unit 1: Introductions, and Plants Systematics<br>-Course explanation<br>-Concept of evolution in Biology<br>-Introduction to plants' diversity<br>-Evidences of Evolution<br>-History and definition of Taxonomy and Systematics<br>Unit 2: Herbaria<br>Practice 1: Herbaria construction<br>Groups division and projects decision/ planning<br><br>Day2 (2限、3限、4限、5限)<br>Extra Practice: Visit to the Makino Herbarium (this practice may not be done, depending on the availability of the herbarium at the day)<br>Unit 3: Plant Systematic Studies<br>-Introduction to some research on the field of plant systematics<br>-Phylogenetic tree reconstruction<br>Practice 2: Reading and Drawing Phylogenies<br>Groups presentation<br><br>Teaching Methods<br>Day 1 focus on learning of basic concepts, such as natural selection, adaptation, plant taxonomy and systematics. Students will learn what are phylogenetic trees and how plants diversity is organized in taxonomic categories. We will have a practice class on how to produce herbarium specimens.<br>On day 2, students will be introduced to the diversity of mosses and ferns, while discussing changes in the life history of land plants and while learning how to describe sterile structures (i.e., leaves and stem) in the body of these plants. We will have a practice on reading and drawing of phylogenetic trees. The last two periods will be dedicated for short oral presentations on the taxonomy and systematics of the taxonomical family groups were assigned to.<br><br>Final project |

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| | Students will work in groups on designing a simple research project proposal under the topic "NATURAL HISTORY COLLECTIONS AND THE FUTUR OF TAXONOMY' |
| (4) Outside-class activities and assignments | Further instructions will be uploaded to https://dtvasques.wordpress.com/ |
| (5) Textbooks and course materials | Required Textbook<br>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><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 | Method of Evaluation<br>Class participation - 30%<br>Final project (final presentation and report) - 70% |
| (7) Questions to the instructor (Office hours, etc.) | Dr. Diego Tavares Vasques<br>The University of Tokyo – Graduate School of Sciences, Koishikawa Botanical Garden<br>dtvasques@g.ecc.u-tokyo.ac.jp<br><br>Dr. Kanae Ando<br>k_ando@tmu.ac.jp |
| (8) Special note | This course is given in English. This is an intensive summer lecture.<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.<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.<br><br>For questions, please email to Dr. Kanae Ando (k_ando@tmu.ac.jp) |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
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| Master's program | Special Lecture on Biological Sciences | R0729 | Summer Intensive | Sep 3, 4 | TBA | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0730 | | | | |

| Instructor(s) | Note |
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| Benjamin Warren * | |

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| (1) Course policies and topics | Course Title – Hearing<br>Instructor: Dr. Ben Warren<br>University of Leicester, Leicestershire, UK<br>Date: September 3rd & 4th.<br><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. |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | 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.<br>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 presentation |
| (3) Course schedule, subject matter, and classroom activities | Course Objectives<br>Upon completion of the course, students are expected to:<br>1. 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.<br>2. To understand the biomechanical strategies that ears employ to increase their sensitivity to quiet sound, tune their ears to frequencies of interest and detect the amplitude of sound.<br>3. Understand the 'arms race' between insects and bats and the different strategies employed between them.<br>4. Understand the main types and causes of hearing loss and state-of-the-art research in hearing loss.<br>5. Understand the scientific process of discovery and to critically interpret scientific findings.<br>6. Presentation skills and power analysis.<br><br>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. Summary of Lectures<br><br>Methods of Instruction:<br>This course will consist of 10 lectures, 2 guided journal clubs. This combination of learning approaches will allow students to test and refine their knowledge. |
| (4) Outside-class activities and assignments | Final project<br>Students will work in groups on designing a simple research project proposal under the topic<br>"NATURAL HISTORY COLLECTIONS AND THE FUTUR OF TAXONOMY'<br>Further instructions will be uploaded to https://dtvasques.wordpress.com/<br><br>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 |

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| | 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 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, 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, Blockley et al., 2021, Journal of Neuroscience https://www.biorxiv.org/content/10.1101/2021.11.25.470017v1 |
| (6) Assessment and grading | Grading plan/Evaluation:<br>Final multiple choice exam 100% |
| (7) Questions to the instructor (Office hours, etc.) | This course will be given online.<br>For questions, please email to Dr. Kanae Ando (k_ando@tmu.ac.jp). |
| (8) Special note | If you took the summer course taught by Dr. Warren in 2023, please do not register for this course. The contents are similar.<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.<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.<br><br>For questions, please email to Dr. Kanae Ando (k_ando@tmu.ac.jp) |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
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| Master's program | Special Lecture on Biological Sciences | R0357 | Summer Intensive | Aug 6,7 | 1-4 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0358 | | | | |

| Instructor(s) | Note |
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| Parvin Shahrestani * | |

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| (1) Course policies and topics | [Instructor] Parvin Shahrestani<br>[Course subtitle] Biology of Aging<br>[Tentative date] August 6, 7, 8, & 9 (R0357/R0358: Aug 6&7, R0367/0368: Aug 8&9. You need to sign up for both R0357 and R0367 to get credits)<br><br>[Course description]<br>This course will cover biological changes in cells, tissues, organs and the whole body associated with aging. Theories of aging will be discussed with primary emphasis on mammals.<br><br>[Objectives]<br>The goals of this course are that students will learn the following major ideas in the biology of aging:<br>a. Aging involves changes at the cellular and molecular levels. In humans, tissues and organ systems change with age.<br>Upon completion of this course students should be able to:<br>1. Explain the processes associated with cell growth, cell division, and cell homeostasis.<br>2. Describe the processes involved in gene expression.<br>3. Describe the normal functions of our organ systems, including our senses.<br>4. Differentiate between normal function, aging, and age-related disease of organ systems.<br>5. Relate changes in organ system functions to cellular and molecular damage and to evolutionary theories of aging.<br>6. Distinguish among theories of aging that are rooted in cellular function (eg. replicative senescence, telomere shortening, oxidative stress) |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | b. The fields of demography and evolutionary biology have made substantial contributions to our understanding of when, why, and how organisms age.<br>Upon completion of this course students should be able to:<br>1. Analyze graphs and tables of age-related disease prevalence.<br>2. Compare and contrast aging in humans with various non-human organisms, including model organisms.<br>3. Explain why we age through evolutionary theories for aging.<br>4. Summarize the experimental tests of the evolutionary theories for aging.<br>5. Summarize the current state of knowledge about the genetics of aging.<br>6. Analyze the constraints imposed by life history tradeoffs on modulating aging (including caloric restriction experiments).<br><br>c. As with any growing field in science, aging research faces lack of consensus among scientists. Aging and longevity affect individuals and societies.<br>Upon completion of this course students should be able to:<br>1. Use the proper language that scientists apply when studying aging and longevity in various fields (eg. Cell biology, demography, evolutionary biology, gerontology, geriatrics).<br>2. Compare and contrast theories related to aging and longevity.<br>3. Describe the current state of research for modulating aging in humans and other organisms.<br>4. Describe the impacts of aging and of modulating aging on individuals and societies.<br>5. Retrieve articles about aging from a variety of online sources.<br>6. Read and discuss research articles written by experts in aging research. |
| (3) Course schedule, subject matter, and classroom activities | [Tentative Course Schedule]<br>1. Discussion on “what is aging?”<br>2. Normal functions of cells, tissues, organs and organ systems<br>3. Aging of organ systems part 1<br>4. Aging of organ systems part 2<br>5. Aging of organ systems part 3<br>6. Age-related diseases part 1<br>7. Age-related diseases part 2<br>8. Comparative biology of aging<br>9. Theories of aging<br>10. Evolutionary biology of aging part 1<br>11. Evolutionary biology of aging part 2<br>12. Evidence for evolutionary biology of aging<br>13. Genetics and genomics of aging<br>14. Microbiome, immunity and aging |

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| | 15. Revisiting discussion on “what is aging?” |
| (4) Outside-class activities and assignments | [out of class activity requirement]<br>Students should complete all required reading assignments prior to coming to the class meeting. |
| (5) Textbooks and course materials | [Textbooks/Materials]<br>There is no textbook for this course. Reading materials will be provided by the instructor. Students will also search for relevant primary literature |
| (6) Assessment and grading | [Assessment]<br>Students will be graded on in-class active participation, in-class discussions, in-class presentations, and quizzes. |
| (7) Questions to the instructor (Office hours, etc.) | [Office hour]<br>To be announced. |
| (8) Special note | This course MUST be taken in conjunction with R0367/R0368.<br>For more incormation, email Dr. Kanae Ando: k_ando@tmu.ac.jp<br>For questions, please email to Dr. Kanae Ando (k_ando@tmu.ac.jp) |

| Program | Course Name | Course Number | Semester | Day | Time | Credit Hours |
|---|---|---|---|---|---|---|
| Master's program | Special Lecture on Biological Sciences | R0367 | Summer Intensive | Aug 8, 9 | 1-4 | 1 |
| Doctoral program | Special Lecture on Biological Sciences | R0368 | | | | |

| Instructor(s) | Note |
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| Parvin Shahrestani* | |

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| (1) Course policies and topics | [Instructor] Parvin Shahrestani<br>[Course subtitle] Biology of Aging<br>[Tentative date] August 6, 7, 8, & 9 (R0357/R0358: Aug 6&7, R0367/0368: Aug 8&9. You need to sign up for both R0357 and R0367 to get credits)<br><br>[Course description]<br>This course will cover biological changes in cells, tissues, organs and the whole body associated with aging. Theories of aging will be discussed with primary emphasis on mammals.<br><br>[Objectives]<br>The goals of this course are that students will learn the following major ideas in the biology of aging:<br>a. Aging involves changes at the cellular and molecular levels. In humans, tissues and organ systems change with age.<br>Upon completion of this course students should be able to:<br>1. Explain the processes associated with cell growth, cell division, and cell homeostasis.<br>2. Describe the processes involved in gene expression.<br>3. Describe the normal functions of our organ systems, including our senses.<br>4. Differentiate between normal function, aging, and age-related disease of organ systems.<br>5. Relate changes in organ system functions to cellular and molecular damage and to evolutionary theories of aging.<br>6. Distinguish among theories of aging that are rooted in cellular function (eg. replicative senescence, telomere shortening, oxidative stress) |
| (2) Knowledge/skills to be acquired and learning objectives/course goals | b. The fields of demography and evolutionary biology have made substantial contributions to our understanding of when, why, and how organisms age.<br>Upon completion of this course students should be able to:<br>1. Analyze graphs and tables of age-related disease prevalence.<br>2. Compare and contrast aging in humans with various non-human organisms, including model organisms.<br>3. Explain why we age through evolutionary theories for aging.<br>4. Summarize the experimental tests of the evolutionary theories for aging.<br>5. Summarize the current state of knowledge about the genetics of aging.<br>6. Analyze the constraints imposed by life history tradeoffs on modulating aging (including caloric restriction experiments).<br><br>c. As with any growing field in science, aging research faces lack of consensus among scientists. Aging and longevity affect individuals and societies.<br>Upon completion of this course students should be able to:<br>1. Use the proper language that scientists apply when studying aging and longevity in various fields (eg. Cell biology, demography, evolutionary biology, gerontology, geriatrics).<br>2. Compare and contrast theories related to aging and longevity.<br>3. Describe the current state of research for modulating aging in humans and other organisms.<br>4. Describe the impacts of aging and of modulating aging on individuals and societies.<br>5. Retrieve articles about aging from a variety of online sources.<br>6. Read and discuss research articles written by experts in aging research. |
| (3) Course schedule, subject matter, and classroom activities | [Tentative Course Schedule]<br>1. Discussion on “what is aging?”<br>2. Normal functions of cells, tissues, organs and organ systems<br>3. Aging of organ systems part 1<br>4. Aging of organ systems part 2<br>5. Aging of organ systems part 3<br>6. Age-related diseases part 1<br>7. Age-related diseases part 2<br>8. Comparative biology of aging<br>9. Theories of aging<br>10. Evolutionary biology of aging part 1<br>11. Evolutionary biology of aging part 2<br>12. Evidence for evolutionary biology of aging<br>13. Genetics and genomics of aging<br>14. Microbiome, immunity and aging |

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| | 15. Revisiting discussion on “what is aging?” |
| (4) Outside-class activities and assignments | [out of class activity requirement]<br>Students should complete all required reading assignments prior to coming to the class meeting. |
| (5) Textbooks and course materials | [Textbooks/Materials]<br>There is no textbook for this course. Reading materials will be provided by the instructor. Students will also search for relevant primary literature |
| (6) Assessment and grading | [Assessment]<br>Students will be graded on in-class active participation, in-class discussions, in-class presentations, and quizzes. |
| (7) Questions to the instructor (Office hours, etc.) | [Office hour]<br>To be announced. |
| (8) Special note | This course MUST be taken in conjunction with R0357/R0358.<br>For more incormation, email Dr. Kanae Ando: k_ando@tmu.ac.jp<br>For questions, please email to Dr. Kanae Ando (k_ando@tmu.ac.jp) |

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

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

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| (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 | The implementation is not always following the timetables, so please contact your supervisor.<br>Students should take the courses offered by their own laboratories. |

| Program | Graduate School of Science | | Semester | Day | Time | Credit |
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| | 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 | | | | |

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

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| (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. |

| Program | Graduate School of Science | | Semester | Day | Time | Credit |
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| | 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 | | | | |

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

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| (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. Ando (k_ando@tmu.ac.jp). |
| (8) Special note | Students must obtain permission from their academic advisors and the Educational Affairs Committee. |

| Program | Graduate School of Science | | Semester | Day | Time | Credit |
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| | 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 | | | | |

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

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| (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. Ando (k_ando@tmu.ac.jp). |
| (8) Special note | Students must obtain permission from their academic advisors and the Educational Affairs Committee. |

| Program | Graduate School of Science | | Semester | Day | Time | Credit |
|---|---|---|---|---|---|---|
| | 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 | | | | |

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

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| (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 | 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 | | Semester | Day | Time | Credit |
|---|---|---|---|---|---|---|
| | 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 | | | | |

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

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| (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. |