京都大学　理学研究科・理学部
GRADUATE SCHOOL OF / FACULTY OF SCIENCE
KYOTO UNIVERSITY

Faculty of Science, Kyoto University
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Course Tree 2025

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The Faculty of Science has a School of Science only, which is rare in Japan. The Faculty has adopted an educational policy with the first priority placed on academic values created in a free environment. Students have no need to select a major upon admission, and can move towards cutting edge research activity through a gradual process of specialization. In this process, we aim to help students to deepen their fundamental understanding of natural sciences, and to develop the abilities required for creative application of new knowledge and for creation of new ideas by integrating this knowledge.

This course tree is shown as a systematic flow of subjects in the curriculum organized to achieve the goals above, so that students can advance their learning based on their individual academic interests and future careers. Please use the course tree together with the “Guidelines for Courses” to find your dream and acquire the academic ability to fulfill the dream.

Committee of Educational Affairs, Faculty of Science

For students planning to major in Mathematics

Fundamental knowledge of mathematics is essential for specialization in any field of natural science. It is desirable to learn these fundamental subjects in the first and second years, and it is important to learn the subject actively, rather than simply attend lectures. We also strongly recommend to use "Math Q&A Rooms" and to organize independent seminars with students. We refer to the website of the Department of Mathematics (https://www.math.kyoto-u.ac.jp) for a syllabus of each course and information on the Department.

[First year]

Linear Algebra (lecture/exercise) A and B, and Calculus (lecture/exercise) A and B (each are separate classes) are the basis of mathematics and many fields of natural science that students must acquire. In Foundations of Modern Mathematics A and B, students learn the foundations of modern mathematics based on a strict logical system through lectures and exercises.

[Second year]

Advanced Linear Algebra, Advanced Calculus I and II, Elementary Probability, Mathematical Statistics, Set Theory & Topology, Introduction to Algebra, Introduction to Geometry, Function Theory of a Complex Variable, and Introduction to Nonlinear Analysis are important to develop material from the first year and to learn certain subjects in preparation for the third and fourth years. In Advanced Calculus I and II, Advanced Linear Algebra, and Function Theory of a Complex Variable, students learn content directly connected to mathematics in first-year courses, while in Set Theory & Topology, Introduction to Algebra, and Introduction to Geometry, students learn concepts in which the level of abstraction increases from the first-year level. These courses work as a bridge to advanced subjects taught in the third and fourth years. In Exercises in Set Theory & Topology, Exercises in Basic Algebra, and Exercises in Basic Geometry, students learn with practice exercises in Set Theory & Topology, Introduction to Algebra, and Introduction to Geometry, respectively. In Exercises in Basic Analysis, students learn with practice exercises in Advanced Calculus I and II and Function Theory of a Complex Variable. In addition, in Development of Mathematics A and B, which goes from basic to advanced, new research directions in mathematics are explained. This is important in deciding on a future major.

[Third year]

Algebra I and II, Geometry I and II, Analysis I and II, Differential Equations, Function Theory of A Complex Variable, and Functional Analysis are core subjects in third-year Mathematics. These basic subjects are important for all students who want to choose any field of mathematics. In Exercises in Algebra I, Exercises in Geometry I, and Exercises in Analysis I (first semester), exercises are provided at various degrees of difficulty. In part II (second semester) of these courses, classes for exercises and reading are given independently. In the reading class, students will read mathematical journals. As real mathematics challenges, Nonlinear Analysis, Numerical Analysis, and Computer Science are also offered.

[Fourth year]

Special study course (Mathematical Science) is compulsory as graduate project work. In this course, small groups of students study from journals. In Forefront of Mathematics and Mathematical Science I and II, front-line topics of modern mathematics are explained (only for students in Advanced Studies (Mathematics)). In addition, in order to learn higher-level technical subjects, Algebraic Geometry, Theory of Number, Advanced Algebra I and II, Topology, Differential Geometry, Advanced Geometry I and II, Probability Theory, Partial Differential Equations, Advanced Analysis I, II, and III, Advanced Functional Analysis, Topics in Mathematical Sciences, and Advanced Computer Science are also offered. Students can also take Actuarial Mathematics I and II, Seminar on Actuarial Mathematics I and II, and Mathematical Finance, which discuss advanced probability and statistics.

For students planning to major in Physics

The physics curriculum is designed for achieving systematic education from basic physics to cutting-edge research. First- and second-year students study important subjects required to learn basic science, and in particular Elementary Course of Experimental Physics is strongly recommended. When choosing courses to study physics, it is important to focus on raising your basic academic skills through lectures and exercises as indicated below. Laboratory Work in Physics and Special Study Course II (Physical Science) are main courses for third- and fourth-year students, respectively. Advanced courses are offered for fourth-year students, those are useful to learn specialized topics in Laboratory Work in Physics and Special Study Course II.

Regarding syllabi for individual courses, refer to the Common Portal for All Students (https://student.iimc.kyoto-u.ac.jp/). In addition, refer to the website of Department of Physics (http://www.scphys.kyoto-u.ac.jp/education/curriculum_department.html) for overall information on courses, including the list of subjects for undergraduate students. A list of physics-related courses is also available at the end of this leaflet.

[First year]

Fundamental Physics A and B offered in individual classes are important basic lectures. More focused basic subjects, such as Thermodynamics and Advanced Dynamics are also recommended lectures for first-year students. These courses are prerequisites for all physics courses in the second to fourth years. Elementary Course of Experimental Physics is strongly recommended to acquire the experimental skills necessary for Laboratory Work in Physics A, B. In addition, it is important to learn basic mathematics in Calculus with Exercises A and B, and Linear Algebra with Exercises A and B, and to learn basic computational science in Basic Informatics (Faculty of Science) and Practice of Basic Informatics (Faculty of Science).

[Second year]

Analytical Mechanics 1 and 2, Advanced Course of Electromagnetism, Electromagnetism A, Physics of Wave and Oscillation, Quantum Mechanics A, Statistical Mechanics A, Mathematics for Physicists 1 and 2, Computational Methods in Physics 1, Exercises for Electrodynamics 1, Exercises for Physical Mathematics: These are the important courses for learning the basic academic skills for physics. Analytical Mechanics 1, Electromagnetism A, Quantum Mechanics A, and Statistical Mechanics A are especially important. Exercises for Electrodynamics 1 and Exercises for Physical Mathematics, closely linked to corresponding lectures, are offered for training basic academic skills that are in demand across physics. It is strongly recommended to take these exercises for deepen understanding of the corresponding lectures. Note, to take Quantum Mechanics A, students must have basic knowledge of waves, and thus it is strongly recommended to take Physics of Wave and Oscillation in advance. In addition, it is desirable for the same reason to learn Thermodynamics, before taking Statistical Mechanics A.

[Third year]

Laboratory Work in Physics A and B, Quantum Mechanics B and C, Electromagnetism B and C, Statistical Mechanics B and C, Continuum Mechanics, Exercises for Quantum Mechanics 1 and 2, Exercises for Electrodynamics 2, Exercises for Statistical Mechanics 1 and 2, and other courses in the 3200s. It is important to take the Laboratory Work in Physics A and B, and students are required to register for these courses. Electromagnetism B and C should be taken after completing Advanced Course of Electromagnetism and Electromagnetism A. Students must also take Statistical Mechanics A and have a basic knowledge of quantum mechanics to take Statistical Mechanics B and C. As mentioned above, exercises are given with the lectures on quantum mechanics, electromagnetism, and statistical mechanics, and it is important for students to participate in these exercises to deepen understanding of the subjects. Furthermore, third-year students are expected to obtain a wide variety of knowledge through learning of courses in the 3200s. Students can select courses depending on exercises and personal interests, or after consultation with advisors, as needed.

[Fourth year]

Special Study Course II (Physical Science) P or Q is compulsory as graduate project work. It is strongly recommended for students to select the advance courses in the 4200s. These are advanced lectures on individual fields of Physical Sciences.

For students planning to major in Astrophysics

Astrophysics aims to deepen understanding of our natural world by examining phenomena in the universe using physical techniques. Subjects in astrophysics include solar activity, formation and evolution of planets, and cosmology, in which the large-scale structure and evolution of the universe are discussed. In recent years, rapid technological innovations have produced data that may overturn conventional concepts. This can promote new theory construction, computer simulation, and test of the laws of fundamental physics. New academic areas, such as the origin of life in the universe, are also emerging. Astrophysics is currently one of the most rapidly developing academic fields.

Since astrophysics covers wide topics, there is a need for varied knowledge of basic physics, from classical mechanics, electromagnetism, and fluid dynamics, to quantum mechanics, atomic/nuclear physics, and special/general relativity. Therefore, students who want to learn this field are expected to have a wide range of knowledge in mathematics and individual fields of basic physics. In addition, many recent developments in astrophysics have been promoted by observation data, and thus learning of observation methods and techniques is essential. On the basis of these standpoints, we provide the following undergraduate courses. Refer to the Common Portal for All Students (https://student.iimc.kyoto-u.ac.jp/) and the following URL for syllabi of courses.
http://www.scphys.kyoto-u.ac.jp/education/curriculum_department.html
http://www.kusastro.kyoto-u.ac.jp/kyomu/

[First year]

Given the variety of subjects in astrophysics, it is important for students to obtain a wide and balanced knowledge in the first year, without taking a short-term view based only on interest and without placing limitations on their capabilities. In addition, since theory and observation are closely related in this field, those who want to study theories should also obtain basic knowledge of observation, while those interested in observation should learn basic physics. Among subjects with designated classes, mathematics (**Calculus** and **Linear Algebra**) and physics (**Fundamental Physics** and **Elementary Course of Experimental Physics**) are important, in addition to **Basic Informatics** and **Practice of Basic Informatics**.

[Second year]

In **General Astronomy**, methods of modern astronomy and their use in study of phenomena in the universe are explained, in addition to discussion of unsolved issues. In **Astronomical Observations**, observation methods and techniques are introduced, and the process of obtaining scientific data is discussed. In the second year, it is important for students to learn basic physics and basic mathematics in **Analytical Mechanics 1 and 2, Advanced Course of Electromagnetism, Electromagnetism A, Physics of Wave and Oscillation, Quantum Mechanics A, Statistical Mechanics A, Mathematics for Physicists 1 and 2**, and **Advanced Calculus I and II**. These courses are the basis for research in astrophysics. In addition, it is extremely important to learn computer-related subjects, since computation is essential for simulation, operation of observational instruments, and processing of large amounts of observation data.

[Third year]

In **Fundamental Astrophysics I and II**, students learn basic physical phenomena in the universe, using the knowledge of basic physics obtained in the first and second years. This course also forms the basis for advanced lectures and exercises in the second semester of the third year (**Solar Physics**, **Stellar Astronomy**, and **Planetary Astrophysics**) and in the fourth year (**Galactic and Interstellar Physics** and **Observational Cosmology**). **Laboratory Work C1, 2, 3, and 4** include learning of computer-related basic knowledge and observation exercises. It is also important for students to learn basic physics (including exercises) in **Quantum Mechanics B and C**, **Electromagnetism B and C**, **Statistical Mechanics B**, and **Continuum Mechanics**.

[Fourth year]

In addition to studying the advanced subjects mentioned above, practical research exercises are performed in **Special study course**. In **S1**, mainly instrument development-related topics are treated, while **S2/3/4 and S5/6** focus on observational and theoretical research topics.

For students planning to major in Earth & Planetary Sciences (Geophysics)

Geophysics covers fields from the earth's interior to space (the solar system) that can be directly observed using satellites. The spatial structure, forms of matter, and physical mechanisms of dynamic phenomena are examined through observation, data analysis, laboratory experiments, simulations, and theory. This field is broadly divided into solid earth geophysics, fluid geophysics, and solar terrestrial physics. In recent years, "earth and planetary system science," in which the earth to the solar system is considered as one interacting system, has become common, as the study of individual fields has deepened. Interdisciplinary research fields related to mathematics, physics, and computer science are also emerging. The following is a list of recommended courses. For details of underlined courses, refer to:

https://www.kugi.kyoto-u.ac.jp/education/undergraduate/index.html

[ALL] indicates common subjects for all students.

[First year]

It is extremely important for first-year students to learn the basic material needed for understanding geophysics, including in physics (Fundamental Physics A and B [ALL] and Thermodynamics [ALL]), mathematics (Calculus [lecture and exercise] A and B [ALL], Linear Algebra [lecture and exercise] A and B [ALL], and Foundations of Modern Mathematics A and B), and information processing (Basic Informatics and Practice of Basic Informatics [ALL]). The state of the art in Geophysics (ALL) is an introductory course in which the latest research results in general geophysics are explained in a comprehensible way by multiple lecturers. In Experimental Practice of Earth Science (ALL), students are taught and experience phenomena on the Earth through experiments and observations, which they plan themselves. It is also desirable for students to study a wide range of other fields.

[Second year]

General subjects: Introduction to Geophysics I and II
Basic subjects I: Geophysical Continuum Mechanics, Advanced Geophysical Continuum Mechanics
Basic subjects II: Computational Geophysics and Computational Geophysics – Exercise, and Observational Geophysics and Observational Geophysics Laboratory A and B
Related subjects: Global Tectonics, General Geological Sciences I and II, Electromagnetism A and Exercise for Electrodynamics, Mathematics for Physicists 1, Physics of Wave and Oscillation (ALL), Analytical Mechanics 1, Quantum Mechanics A, Statistical Mechanics A, Elementary Probability (ALL), and Mathematical Statistics (ALL)

In Introduction to Geophysics I, students study the solar system and the Earth as part of this system, and in part II, the focus is on the air and oceans of the Earth and the Earth's activities. In Geophysical Continuum Mechanics and Advanced Geophysical Continuum Mechanics, which are in Basic Subjects I, students learn basic theories common to geophysics. In Basic Subjects II, students learn basic research methods (together with data analysis methods for geophysics to be studied in the third year). In Computational Geophysics and Computational Geophysics – Exercise, the aim is to understand the basics of data analysis and numerical simulation through computational exercises. In Observational Geophysics, students learn the principles of observations and applications, and through exercises, obtain observation data by themselves for analysis in areas where prominent geophysical phenomena can be observed, such as Aso and Beppu. In the second year, learning of physics and mathematics is important, and thus it is strongly recommended to study physical mathematics, which is equivalent to Mathematics for Physicists 1. Learning all of these basic subjects will permit students to advance in the field of geophysics.

[Third year]

Laboratory Work in Earth & Planetary Sciences (DA, DB, DC, and DD)
Basic subjects II: Data analysis method in geophysical problems
Basic subjects III: Mechanics of Elastic Solids, Physics of Earth Materials, Geophysical Fluid Dynamics, Electrodynamics of Ionized Gases
Special subjects I: Solid Earth Geophysics A and B, Physical Oceanography I, Meteorology I, Climate Physics, Geomagnetism & Aeronomy
Related subjects: Numerical Analysis, Continuum Mechanics, Electromagnetism C, Introduction to Practical Data Science

Students in the third year should engage in a wide range of learning that is not limited to specific fields of geophysics. If interested in mathematical physics in geophysics, students should focus on physics and mathematics, even in the third year, and then take advanced geophysics courses based on this knowledge. In contrast, if interested in observational sciences, students should learn a wide range of observation-related advanced subjects beyond the boundaries of geophysics.

[Fourth year]

Special study course II (Earth & Planetary Sciences) (T1, T2, and T3)
Advanced subjects II: Subjects in the 4400s

In the Advanced Studies course, students select one of T1 (electromagnetism), T2 (atmosphere/hydrosphere), and T3 (solids).

For students planning to major in Earth & Planetary Sciences (Geology and Mineralogy)

The aims of geology and mineralogy are to examine ongoing phenomena on earth, as well as the 4.6 billion-year history of the Earth. Research on materials, such as minerals, rocks, fossils, and strata, is a characteristic of this field. The Earth & Planetary Sciences course allows students, including those who had fewer opportunities to study geoscience in the past, to learn the basics of research and specific methods in geoscience and earth & planetary sciences by the end of the fourth year.

The major research areas in Geology and Mineralogy are:

(1) Studies of components and development of materials making up the Earth and other planets, such as rocks, minerals, and meteorites, by analyzing the conditions and structures of these materials on a scale ranging from the atomic level (nanometers) to the global level (several tens of thousands of meters).

(2) Chronology/isotope chemistry and deformation analysis in long-term crust/mantle transition and changes of the supracrustal environment.

(3) History of changes in the supracrustal environment, including biological evolution.

(4) Development of the earth and solar system over 4.6 billion years and the evolution and function of organisms, using information on the age of materials and the physicochemical environment at the time of formation through chemical and isotope analysis of the materials.

[First year]

Since Earth & Planetary Sciences is a wide field covering various phenomena in the geosphere, students in the first year are expected to learn broad natural science and other subjects. In addition, it is important that first-year students take geology courses, such as Introduction to Earth Science A and B, Experimental Practice of Earth Science, and Birth and Evolution of the Earth, which are provided as basic subjects in geoscience for all students.

[Second year]

For second-year students, it is strongly recommended to take General Geological Sciences I and II, which cover the above research areas (1) to (4) in the first and second semesters. These courses are based on basic geoscience knowledge obtained in the first year. Field Earth Science and Materials of the Earth and Solar System should also be taken, as well as advanced courses in the Faculty of Science (in the 2500s), such as Global Tectonics, Chemistry for the Solar System, Evolution of Biosphere, and Basic Exercises in Geoscience. Students can learn research areas (1) to (4) and other recent topics by taking these lectures and exercises in the first and second years.

[Third year]

Laboratory Work E and other subjects in the 3500s

Laboratory Work E is a course to which we attach a great deal of importance for third-year students. The laboratory work is provided with assistance from many advisors, which allows students to obtain skills for field study and instrumental analysis that are useful for research in every geoscience field, and especially in geological science. Methods of Geological Mapping and Instrumental Analysis for Geology I and II are bundled with Laboratory Work E1 and E2. The lectures and exercises (in the 3500s and 4500s) are designed so that students can gradually strengthen their expertise from the third to fourth years. Four basic courses in the first semester, Introduction to Earth and Planetary History, Introduction to Science of Earth and Planetary Materials, Introduction to Geological Processes of Earth and Planetary Surfaces, and Introduction to Geological Processes of Earth and Planetary Interiors are essential as basic knowledge for students who want to learn the fields of geology and mineralogy, and thus it is recommended to take all of these courses. In the second semester, more specialized lectures, experiments, and exercises are offered to allow each student a choice depending on their goals and interests. We prefer that students learn as many subjects as possible in a balanced manner. In addition, it is strongly recommended to take Field Excursion for Geological Sciences IA, IB, and II, which provides the opportunity to perform field exercises.

[Fourth year]

Advanced Studies (Earth & Planetary Sciences) (compulsory course) and courses in the 4500s

For fourth-year students, these courses are compulsory. Advanced Studies T11 to T16 provide topics to allow students to show their achievements based on their four years of study at the university. Individual advanced studies courses are closely related to seminars at the graduate school and instruction is mainly based on these seminars. Therefore, students participate in seminars in most of these courses.

Advanced second- to fourth-year courses are also useful for students who hope to specialize in geology or mineralogy, and students should learn these fields based on individual interests.

For students planning to major in Chemistry

Chemistry is the study of all materials in the natural world. Students should understand the principles that determine the basic properties of a material; systematically study the conditions, nature and changes of a material; and learn techniques to develop materials with new functions. Students who plan to major in Chemistry should also learn a wide range of natural sciences, including basic physics, mathematics, biological sciences, geoscience and space science. Students who wish to stand on the frontier of chemical research will certainly need basic knowledge in fields other than chemistry. Therefore, obtaining basic knowledge of natural science in a broad perspective is an important goal of learning in the first and second years.

[First year]

Chemistry courses that are common for all students are designed to teach basic knowledge and techniques for general chemistry. Basic Physical Chemistry (Quantum theory), Basic Physical Chemistry (Thermodynamics), and Basic Organic Chemistry I and II are important basic courses. Basic Physical Chemistry provides essential knowledge for learning of Inorganic Chemistry in the second to fourth years. In addition, it is important to learn basic mathematics, such as linear algebras and calculus, for learning Basic physical chemistry. For students with a deeper interest in physical chemistry, Introduction to Theoretical Chemistry is recommended. Frontier in Chemistry is a course conducted in a seminar format by researchers in the Chemical program, while Chemical Laboratory at Uji Campus introduces recent research results in an easily understandable way for first-year students. Chemistry lectures in English are given by overseas lecturers and provide a good opportunity to develop communication ability in English, which is important because students who work in the chemistry field will need English skills. Since learning of chemistry is mainly based on experiments, it is also strongly recommended that students take Fundamental Chemical Experiments and other experimental courses.

[Second year]

Physical Chemistry I (Quantum Chemistry), Physical Chemistry II, Exercises in Physical Chemistry A, Inorganic Chemistry I, Organic Chemistry IA and IB, Biochemistry I, Quantum Chemistry I, and Analytical Chemistry I are all important for second-year students to obtain the basic knowledge required for systemic learning of chemistry, and students are encouraged to take all these courses. The courses offer more systematic learning based on Basic Physical Chemistry (Quantum Theory), Basic Physical Chemistry (Thermodynamics), and Basic Organic Chemistry I and II, which are taken by first-year students. Students with sufficient ability can take third-year courses in advance. For students who plan to pursue a master's degree in graduate school, it is important to acquire balanced solid basic knowledge in the first and second years. Introduction to Chemical Experiments is designed to allow students to learn basic techniques for study of chemical phenomena of materials.

[Third year]

Physical Chemistry IIIA and IIIB, Inorganic Chemistry IIA and IIB, Analytical Chemistry II, Organic Chemistry II and III, Biochemistry II and III, Quantum Chemistry II, Solid State Physics & Chemistry I and II, Chemical Mathematics, Statistical Mechanics of Chemical Systems, Methods of Chemical Experiments I and II, Exercises in Physical Chemistry B and C, Exercises in Inorganic and Solid State Chemistry, Exercises in Biochemistry, and Exercises in Computational Chemistry

These courses are taken by third-year students as the core for chemistry in the university and allow students to learn many interesting aspects of chemistry. Exercises are given in each course to allow students to deepen their understanding of lectures and obtain practical knowledge. Completing these exercises is strongly recommended because understanding is significantly deepened by solving practice problems. Chemical Laboratory A and B are important to develop skills and views of matter, which are necessary for chemical research, and these courses are recommended for all students in Chemistry. After students join a laboratory in the fourth year or after graduation, they will be engaged in cutting-edge research in one field of chemistry, but are unlikely to perform experiments in other fields. Therefore, gaining experience over a wide array of experiments is important.

[Fourth year]

Physical Chemistry IV, Organic Chemistry IV, Inorganic Chemistry III, Biochemistry IV, and Exercises in Organic Chemistry

These courses can be selected by fourth-year students depending on individual interest and level of learning. In the fourth year, students also take Special study course II (Chemistry) (in the 5600s), which is compulsory for graduation work. In Special study course II (Chemistry), students perform graduate project work through learning in seminars and direct instruction by advisors, depending on the research area of each laboratory. Students learn organization of a laboratory notebook and data, presentation skills, and other methods of scientific research, as well as techniques for experiments and theoretical calculations.

The course tree has a broad flow. Students can obtain fruitful and interesting information by voluntarily planning their learning to achieve individual goals. Please do not hesitate to ask the instructors of Chemistry courses to find out about the subjects of these courses.

For students planning to major in Biological Sciences

Biological Sciences has grown strongly in recent years, and emergence of areas overlapping with other natural sciences has also been significant. The Biological Sciences program consists of three departments: Zoology, Botany, and Biophysics. Education in the university has been developed through cooperation among these departments and the related faculties and graduate schools.

[First year]

It is desirable to take Biology courses provided as common for all students. Frontiers of Biology is taught by instructors from multiple faculties, and provides students who have no knowledge of biology with a good opportunity to learn about trends in Biological Sciences in the 21st century. Introduction to Biology and Life Science is taught by instructors from the three departments and the Graduate School of Biostudies, and enables students who did not learn biology in high school to experience the best parts of cutting-edge research in Biological Sciences. Students who want to learn biology above a basic level in the first semester can get the basics to understand advanced biological subjects in Fundamentals of Organismal and Population Biology and Fundamentals of Cell and Molecular Biology, which are offered in the second semester. Interdisciplinary Sciences course also includes lectures of biological sciences. The lectures of other natural science courses are also often useful for learning Biological Sciences, and students should also choose to pursue courses in the humanities, social science, and foreign languages. Students do not necessarily need to learn all subjects in individual classes.

[Second year]

In Biological Sciences, research is performed on molecules, cells, and organisms including phylogeny, species, population, community, and ecosystem. Molecular Biology I and II, Cell Biology I and II, Basic Developmental and Regenerative Biology, and Plant Physiology are offered as major basic courses for second-year students with a focus on molecules and cells. In these courses, a systematic understanding of organisms at the molecular level is obtained. In Biomolecular Science I and II, students learn more about biomolecules, such as proteins. In contrast, Plant Phylogeny and Taxonomy I, Biological Oceanography, and Invertebrate Zoology are offered as courses on organisms viewed at higher levels.

Exercises for second-year students are included in Fundamental Experiments of Biology, and Marine Biology with Laboratory & Field Work 1 and 3. Students will learn basic methods common to Biological Sciences research in Fundamental Experiments of Biology. Pre-registration is required for Marine Biology with Laboratory & Field Work 1 and 3. Registration is accepted by the Biological Sciences office in the Faculty of Science in June and January for Marine Biology with Laboratory & Field Work 1 and 3, respectively. The schedule will be announced later. The contents of Fundamental Experiments of Biology are shown below.

E2 courses for Biological Sciences (for first- and second-year students)

In Biological Sciences, it is important to become familiar with lectures and discussions

conducted in English. Therefore, it is recommended that first- and second-year students learn E2 courses, in which the basics of Biological Sciences can be learned in English.

Fundamental Experiments in Organismal Biology (2 credits in the first semester)

This course is offered to enable students to experience a wide range of Biological Sciences research. At the organism and higher level, animals from insects to primates and plants including pteridophytes and spermatophytes with high morphological diversity are examined. Researchers who are experts in individual areas provide lectures and directions on exercises, with the aim of enabling students to understand the characteristics and handling of individual species.

Fundamental Experiments in Cellular and Molecular Biology (4 credits in the second semester)

This course prepares students to understand the basics of biology and basic experimental techniques. Observations with various types of microscopes and simple experiments are performed using cells from microorganisms, yeast, fungi, and plants, and with cultured cells. In addition, simple analyses, such as genotyping and measurement of enzyme activity, are performed by extracting nucleic acids and proteins from microorganisms.

[Third year]

Courses for third-year students at the molecular and cellular level include Developmental Biology I and II, Plant Molecular Physiology, Neurobiology, Immunobiology, Molecular Functions in Biological Systems, Genome Science, Molecular Signaling in Biological Systems, Chromosome Biology, Molecular Biophysics, Plant Molecular Genetics I and II, Mechanism for Genome Stability, and Bioinformatics. Courses at the organism or higher level are Animal Systematics, Plant Phylogeny and Taxonomy II, Ethology, Anthropology 1 and 2, Ecology I and II, Limnology, Environmental Ecology, Mathematical Biology, Biotic Interactions, and Conservation Biology. These are advanced courses on individual fields of Biological Sciences. Seminars and exercises in individual fields include Seminars in Biological Science, Laboratory work in Biological Science, Marine Biology with Laboratory & Field Work 2 and 4, Field Work in Biological Science 1 and 2, Limnology, Field Course, and Laboratory course on Stable Isotope Analysis. Students will acquire knowledge about individual topics in lectures, while learning basic research methods for individual fields in exercises. Students should also develop the ability to obtain cutting-edge research information by reading the latest English-language journal articles in Seminars in Biological Science. Note that pre-registration is required to participate in these seminars and exercises.

[Fourth year]

Special Study CourseII (Biological Sciences) focuses on a research topic in which the student is interested. Students should be engaged in this work while experiencing cutting-edge Biological Sciences research.

Informatics-related subjects provided by the Faculty of Science

Numerical computation, simulation, and data analysis using computers play an important role in modern scientific research. Theoretical topics such as computer science and numerical analysis, which utilize computers, are the basis of scientific research and have been intensively studied. Computers are indispensable in modern society, and it is important for students of the Faculty of Science, whatever major they may choose, to learn those interdisciplinary subjects that are related to informatics and computer usage. In addition to the subject categorization into five majors (Mathematical Sciences, Physics and Astrophysics, Earth & Planetary Sciences, Chemistry, and Biological Sciences), we provide another cross-sectional category "informatics-related subjects," which will be useful for students of either of the five majors.

Students of the Faculty of Science are asked to study both theory and practice of computing in a balanced way, in order to be able to utilize computers for solving scientific problems. Through these informatics-related subjects, students will learn not only concrete methods for numerical calculation and data analysis but also fundamental topics: efficiency and limitation in computing, the relation between numerical computation and symbolic manipulation of formulas, and even what is computation and how correct computation can be implemented.

[Subjects for First-Year Students]

- Basic Informatics (Faculty of Science) and Practice of Basic Informatics (Faculty of Science)

In these subjects, students learn basic information processing. It is strongly recommended for all students to take these subjects, which include basic topics that will be useful for learning other informatics-related subjects in later years. Note that there are many subjects provided for students of any Faculty under similar names of "Basic Informatics" and "Practice of Basic Informatics" as Liberal Arts and Sciences Courses, but students of the Faculty of Science have to take Basic Informatics (Faculty of Science) and Practice of Basic Informatics (Faculty of Science) in order to get credits for Specialized Basic Education in the Faculty of Science.

Informatics-related subjects in the second or later years are classified into three categories. The first category is "Computational science", which includes theoretical subjects and practical exercises in individual majors required to conduct numerical simulations using computers. The second one is "Statistics/data science", which includes subjects on fundamental theories in statistics and probability for data analysis, where students learn the skill of data analysis through topics from various areas. The third one is "Computer science", which includes subjects on theoretical aspects of the fundamental properties of computing.

[Subjects for Second-Year Students]

- Computational science: Foundations of Numerical Computation (Liberal Arts and Sciences Courses), Computer Graphics Exercise (Liberal Arts and Sciences Courses), Computational Methods in Physics 1 (Physics), Computational Geophysics (Geophysics), Computational Geophysics - Exercise (Geophysics)
- Statistics/data science: Introductory Statistics (Liberal Arts and Sciences Courses), Elementary Probability (Liberal Arts and Sciences Courses), Statistics and Artificial Intelligence (Liberal Arts and Sciences Courses), Mathematical Statistics (Liberal Arts and Sciences Courses)
- Computer science: Fundamentals of Computer Science (Liberal Arts and Sciences Courses)

[Subjects for Third-Year Students]

- Computational science: Numerical Analysis (Mathematics), Computational Methods in Physics 2 (Physics), Electronics (Physics), Experimental Physics 1 and 2 (Physics), Exercises in Computational Chemistry (Chemistry)
- Statistics/data science: Methods of Chemical Experiments I (Chemistry), Statistical Mechanics of Chemical Systems (Chemistry), Data analysis method in geophysical problems (Geophysics), Experiment on Sedimentology and Structural Geology (Geology and Mineralogy), Bioinformatics (Bioscience), Introduction to Practical Data Science (Interdisciplinary)
- Computer science: Computer Science (Mathematics)

In Laboratory Work in individual majors, students will also learn high-level computer skills and information processing.

[Subjects for Fourth-Year Students]

- Computational science: Topics in Mathematical Sciences (Mathematics)
- Statistics/data science: Data Assimilation A and B (Interdisciplinary)
- Computer science: Advanced Computer Science (Mathematics)

In graduate project work (Special Study Course), students will also learn advanced-level computer skills and information processing.

School of Science, Faculty of Science, Kyoto University

Diploma Policy of the Faculty of Science

DP1:	DP2:	DP3:	DP4:	DP5:
1. The student has acquired core knowledge in science.	2. The student has developed an affinity for the integration of individual pieces of scientific knowledge, for the independent exploration and assimilation of new knowledge, and for the creative application of that knowledge.	3. The student has the ability to utilize his/her knowledge in order to find scientific solutions to the challenges of contemporary science and technology.	4. The student understands the significance of science and has the ability to work towards its advancement.	5. The student has acquired the broad vision and sophistication necessary to deal with scientific problems and has the ability to communicate with people from diverse cultures and backgrounds.

Progress to the forefront of research via gradual specialization

	Mathematical Science	Physics and Astrophysics	Earth & Planetary Sciences	Chemistry	Biological Sciences
Fourth-Year Students (Applied Courses)	Special Study Course (Mathematical Science) Forefront of Mathematics and Mathematical Science I·II	Special Study Course II (P, Q, S)	Special Study Course II (Earth & Planetary Sciences) (T)	Special Study Course II (Chemistry)	Special Study Course II (Biological Sciences)
Third-Year Students (Development Courses)	Algebra I·II, Exercises in Algebra I·II Geometry I·II, Exercises in Geometry I·II Analysis I·II, Exercises in Analysis I·II Functional Analysis, Numerical Analysis Differential Equations, Computer Science Function Theory of A Complex Variable Nonlinear Analysis	Laboratory Work (A,B,C) Condensed Matter Physics Elementary Particle Physics Nuclear Physics Astrophysics	Laboratory Work (D,E) Geomagnetism & Aeronomy Meteorology·Climate Physics·Physical Oceanography Solid Earth Geophysics Introduction to Earth and Planetary History Introduction to Science of Earth and Planetary Materials Introduction to Geological Processes of Earth and Planetary Surfaces Introduction to Geological Processes of Earth and Planetary Interiors	Chemical Laboratory A·B Physical Chemistry IIIA·IIIB Inorganic Chemistry IIA·IIB Solid State Physics & Chemistry I·II Organic Chemistry II·III Biochemistry II·III Quantum Chemistry II Analytical Chemistry II	Laboratory Work in Biological Science Seminars in Biological Science Advanced Courses on Molecular and Cellular Biology Advanced Biological Courses at the Organism Level and Higher

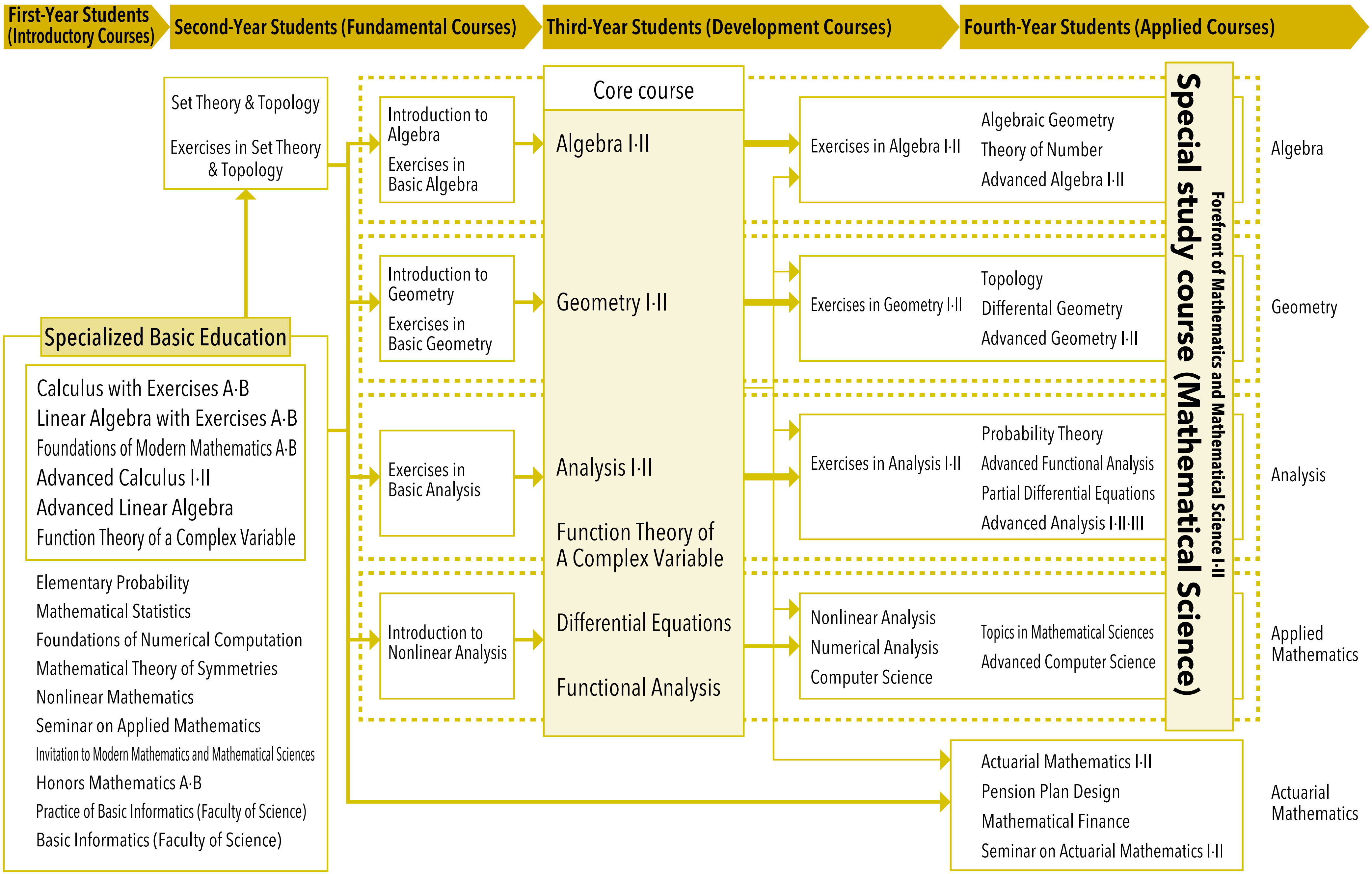
Major Selection

Second-Year Students (Fundamental Courses)	**Mathematics** Advanced Linear Algebra, Advanced Calculus I·II, Function Theory of a Complex Variable, Introduction to Nonlinear Analysis, Introduction to Algebra, Introduction to Geometry, Set Theory & Topology, Various Exercises **Physics** Analytical Mechanics, Electromagnetism, Quantum Mechanics, Statistical Mechanics, Physical Mathematics **Earth & Planetary Sciences** Introduction to Geophysics, Geophysical Continuum Mechanics, General Geological Sciences, Global Tectonics **Chemistry** Physical Chemistry I, Inorganic Chemistry, Organic Chemistry IA·IIB, Biochemistry I, Quantum Chemistry I, Analytical Chemistry I, Introduction to Chemical Experiments **Biological Sciences** Advanced Courses on Molecular and Cellular Biology, Advanced Biological Courses at the Organism Level and Higher, Fundamental Experiments of Organismal Biology, Fundamental Experiments of Cellular and Molecular Biology

Gradual Specialization

First-Year Students (Introductory Courses)	**Liberal Arts and Sciences Courses** Humanities and Social Sciences Group Natural Sciences Group: Specialized Basic Education (Calculus, Linear Algebra, Fundamental Physics A·B, Elementary Course of Experimental Physics, Introduction to Earth Science, Experimental Practice in Earth Science, Basic Physical Chemistry, Basic Organic Chemistry I, Fundamental Chemical Experiments, Frontiers of Biology, Introduction to Biology and Life Science, Fundamentals of Organismal and Population Biology, Fundamental Experiments of Cellular and Molecular Biology, Experimental Practice in Biology) Languages Group Seminars in Liberal Arts and Sciences Group Informatics Group, Health and Sports, Career Development, Interdisciplinary Sciences Group

School of Science, Faculty of Science, Kyoto University Mathematical Science



School of Science, Faculty of Science, Kyoto University — Physics and Astrophysics

First-Year Students (Introductory Courses)		Second-Year Students (Fundamental Courses)		Third-Year Students (Development Courses)		Fourth-Year Students (Applied Courses)	

General Education and Foreign Language Curriculum

Physics Curriculum

Core Courses

First-Year		Second-Year		Third-Year		Fourth-Year	
Fundamental Physics A	Advanced Dynamics	Analytical Mechanics 1	Analytical Mechanics 2	Continuum Mechanics			
	Fundamental Physics B	Advanced Course of Electromagnetism	Electromagnetism A	Electromagnetism B	Electromagnetism C		
		Physics of Wave and Oscillation	Quantum Mechanics A	Quantum Mechanics B	Quantum Mechanics C	Advanced Quantum Mechanics 1	Advanced Quantum Mechanics 2
Thermodynamics			Statistical Mechanics A	Statistical Mechanics B	Statistical Mechanics C		Advanced Statistical Mechanics
		Mathematics for Physicists 1	Mathematics for Physicists 2		Special Subjects in Mathematical Physics 1	Special Subjects in Mathematical Physics 2	
			Exercises for Physical Mathematics Exercises for Electrodynamics 1	Exercises for Electrodynamics 2 Exercises for Quantum Mechanics 1 Exercises for Statistical Mechanics 1	Exercises for Quantum Mechanics 2 Exercises for Statistical Mechanics 2		
Elementary Course of Experimental Physics		Experimental Course on Modern Physics		Laboratory Work in Physics A, B, C	Laboratory Work in Physics A, B, C		

Special Study Course
Condensed Matter Physics (Q), Particle and Nuclear Physics, Cosmology and Astrophysics (P), Astronomy and Astrophysics (S)

First-Year		Second-Year		Third-Year	
Low-Temperature Science A	Soft Matter Physics				Frontiers of Physics
	Modern Particle Physics			Scientific English (Physics)	
	Introduction to General Astronomy			Elementary Solid State Physics 1	Elementary Solid State Physics 2
			Computational Methods in Physics 1	Electronics Computational Methods in Physics 2 Experimental Physics 1	Experimental Physics 2

Astrophysics Courses

Second-Year		Third-Year		Fourth-Year
General Astronomy	Astronomical Observations	Fundamental Astrophysics I Fundamental Astrophysics II	Solar Physics Planetary Astrophysics Stellar Astronomy	Galactic and Interstellar Physics Observational Cosmology

Advanced Courses

1a (Magnetism and Introduction to Superconductivity) · 1b (Superfluidity and Superconductivity)
2a (Soft Matters) ·2b (Plasma and Interface)
3a (Quantum Optics) ·3b (Solid State Spectroscopy)

Nuclear Physics 1·2
Elementary Particle Physics 1·2
Gravitation, Advanced Gravitation
Introduction to Astrophysics

Galactic and Interstellar Physics
Observational Cosmology

School of Science, Faculty of Science, Kyoto University

Earth & Planetary Sciences

First-Year Students (Introductory Courses)

Foreign Language
(English, etc.)

Basic Mathematics
(Calculus, Linear Algebra, Information Processing, etc.)

Basic Physics
(Mechanics, Thermodynamics, Electromagnetism, etc.)

Introductory Courses in Earth & Planetary Sciences
- Introduction to Earth Science A·B (Liberal Arts and Sciences courses)
- The State of the Art in Geophysics (Liberal Arts and Sciences courses)
- Birth and Evolution of the Earth (Liberal Arts and Sciences courses)
- Experimental Practice of Earth Science (Liberal Arts and Sciences courses)

Basic Chemistry

Basic Biology

Second-Year Students (Fundamental Courses)

Foreign Language (English, etc.)

Basic Mathematics
(Probability Statistics, Numerical Analysis, Physical Mathematics, etc.)

Basic Physics
(Analytical Mechanics, Statistical Mechanics, Quantum Mechanics, etc.)

Introduction to Geophysics
- Introduction to Geophysics I·II

Geophysics Basic Education I
- Geophysical Continuum Mechanics, Advanced Geophysical Continuum Mechanics

Geophysics Basic Education II
- Computational Geophysics, Computational Geophysics - Exercise
- Observational Geophysics, Observational Geophysics Laboratory
- Data Analysis Method in Geophysical Problems*

*: 3rd year students First semester

Interdisciplinary Geophysics Geology and Mineralogy
- Global Tectonics (Geophysics·Geology and Mineralogy)

General Geology And Mineralogy
- General Geological Sciences I·II

Geology and Mineralogy Basic Education I
- Chemistry for the Solar System
- Field Earth Science

Geology and Mineralogy Basic Education II
- Materials of Earth and Solar System
- Evolution of Biosphere
- Basic Exercise in Geoscience

Third-Year Students (Development Courses)

Geophysics Basic Education III
- Electrodynamics of Ionized Gases
- Geophysical Fluid Dynamics
- Mechanics of Elastic Solids
- Physics of the Earth Materials*

*: Second semester

Laboratory Work in Earth & Planetary Sciences DA·DB

Geophysics Specialized Educaiton I
- Geomagnetism & Aeronomy
- Climate Physics*
- Meteorology I
- Physical Oceanography I
- Solid Earth Geophysics A
- Solid Earth Geophysics B*

*: First semester

Laboratory Work in Earth & Planetary Sciences DC·DD

Electromagnetism → / Atmosphere and Oceanography → / Solid Earth →

Laboratory Work in Earth & Planetary Sciences·Field work
- Laboratory Work in Earth & Planetary Sciences E1
  - Methods of Geological Mapping and Instrumental Analysis for Geology I
  - Field Excursion for Geological Sciences IA
- Laboratory Work in Earth & Planetary Sciences E2
  - Methods of Geological Mapping and Instrumental Analysis for Geology II
  - Field Excursion for Geological Sciences IB
  - Field Excursion for Geological Sciences II

Geology and Mineralogy Basic Education III
- Introduction to Earth and Planetary History
- Introduction to Science of Earth and Planetary Materials
- Introduction to Geological Processes of Earth and Planetary Surfaces
- Introduction to Geological Processes of Earth and Planetary Interiors

Geology and Mineralogy Specialized Educaiton I
- Geotectonics I
- Petrology
- Mineralogy
- Paleontology I
- Tectonics of East Asia and West Pacific
- Introduction to Geo-and Cosmo-chemistry
- Experiment on Geotectonics I
- Experiment on Petrology
- Experiment on Mineralogical Sciences
- Experiment on Sedimentology and Structural Geology
- Experiment on Historical Geology
- Exercise on Geo-and Cosmo-chemistry

Fourth-Year Students (Applied Courses)

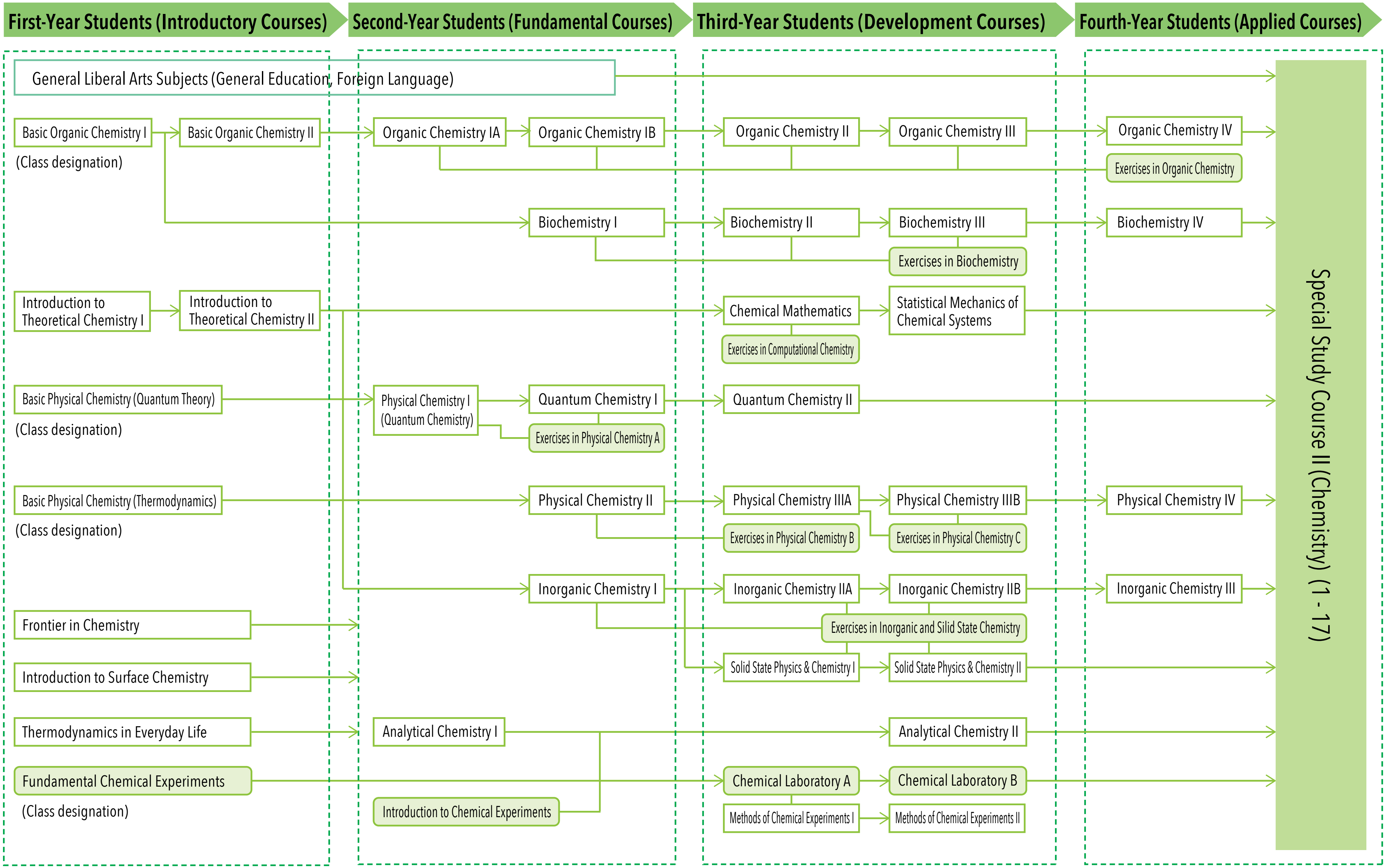
Geophysics Specialized Educaiton II
- Solar Terrestrial Physics
- Meteorology II
- Physical Oceanography II
- Hydrology
- Geodesy, Active Tectonics
- Seismology, Geothermal Study
- Volcanology

Special Study Course II (Earth & Planetary Sciences) T01 – T03

Geology and Mineralogy Specialized Educaiton II
- Geotectonics II
- Experiment on Geotectonics II
- Metamorphic Petrology
- Advanced Mineralogy, Practice of Mineralogy
- Sedimentology, Paleontology II, Experiment on Paleontology
- Theories of Tectonics

Special Study Course II (Earth & Planetary Sciences) T11 – T16

Chemistry


First-Year Students (Introductory Courses)
Second-Year Students (Fundamental Courses)
Third-Year Students (Development Courses)
Fourth-Year Students (Applied Courses)
General Liberal Arts Subjects (General Education, Foreign Language)
Basic Organic Chemistry I
Basic Organic Chemistry II
(Class designation)
Organic Chemistry IA
Organic Chemistry IB
Organic Chemistry II
Organic Chemistry III
Organic Chemistry IV
Exercises in Organic Chemistry
Biochemistry I
Biochemistry II
Biochemistry III
Biochemistry IV
Exercises in Biochemistry
Introduction to Theoretical Chemistry I
Introduction to Theoretical Chemistry II
Chemical Mathematics
Statistical Mechanics of Chemical Systems
Exercises in Computational Chemistry
Basic Physical Chemistry (Quantum Theory)
(Class designation)
Physical Chemistry I (Quantum Chemistry)
Quantum Chemistry I
Quantum Chemistry II
Exercises in Physical Chemistry A
Basic Physical Chemistry (Thermodynamics)
(Class designation)
Physical Chemistry II
Physical Chemistry IIIA
Physical Chemistry IIIB
Physical Chemistry IV
Exercises in Physical Chemistry B
Exercises in Physical Chemistry C
Inorganic Chemistry I
Inorganic Chemistry IIA
Inorganic Chemistry IIB
Inorganic Chemistry III
Exercises in Inorganic and Silid State Chemistry
Solid State Physics & Chemistry I
Solid State Physics & Chemistry II
Frontier in Chemistry
Introduction to Surface Chemistry
Thermodynamics in Everyday Life
Analytical Chemistry I
Analytical Chemistry II
Fundamental Chemical Experiments
(Class designation)
Introduction to Chemical Experiments
Chemical Laboratory A
Chemical Laboratory B
Methods of Chemical Experiments I
Methods of Chemical Experiments II
Special Study Course II (Chemistry) (1 - 17)

School of Science, Faculty of Science, Kyoto University **Biological Sciences**

First-Year Students (Introductory Courses)	Second-Year Students (Fundamental Courses)	Third-Year Students (Development Courses)	Fourth-Year Students (Applied Courses)

First-Year Students (Introductory Courses)

Biology Specialized Basic Education

(Frontiers of Biology, Introduction to Biology and Life Science, Fundamentals of Organismal and Population Biology, Fundamentals of Cell and Molecular Biology, etc.)

/ Liberal Arts and General Education

Second-Year Students (Fundamental Courses)

Fundamental Experiments of Organismal Biology / Fundamental Experiments of Cellular and Molecular Biology

Biology Specialized Basic Education
Liberal Arts and General Education

Advanced Courses on Molecular and Cellular Biology

Molecular Biology I·II
Cell Biology I·II
Bio Molecular Science I·II
Basic Developmental and Regenerative Biology
Plant Physiology

Advanced Biological Courses at the Organism Level and Higher

Plant Phylogeny and Taxonomy I
Biological Oceanography
Invertebrate Zoology

Advanced Courses in Chemistry, Physics, Methematics and Geophysics depending on your interests

Third-Year Students (Development Courses)

Laboratory Work in Biological Science A – E / Seminars in Biological Science A·B

Advanced Courses on Molecular and Cellular Biology

Molecular Signalings in Biological Systems, Bioinformatics, Developmental Biology I·II, Neuro Biology, Plant Molecular Physiology, Mechanism for Genome Stability, Plant Molecular Genetics I and II, Molecular Functions in Biological Systems, Immunobiology, Molecular Biophysics, Chromosome Biology, Genome Science

Advanced Biological Courses at the Organism Level and Higher

Plant Phylogeny and Taxonomy II, Animal Systematics, Anthropology 1·2, Biotic Interactions, Ecology I·II, Limnology, Environmental Ecology, Ethology, Mathematical Biology, Conservation Biology

Advanced Courses in Chemistry, Physics, Methematics and Geophysics depending on your interests

Fourth-Year Students (Applied Courses)

Special Study Course II (Biological Sciences) 1

Department of Zoology

Systematic Zoology
Animal Ecology
Physical Anthropology
Primate Behavioral Ecology
Ethology
Immunobiology
Animal Developmental and Evolutionary Biology
Stress Response Biology

Department of Botany

Plant Phylogeny and Taxonomy
Plant Physiology
Chronobiology
Plant Molecular Genetics
Plant Molecular Physiology

Department of Biophysics

Structural Biology
Molecular Physiology
Genome Integrity and control
Neurobiology
Quantitative Cell Biology
Cell Dynamics of Animal Morphogenesis
Theoretical Biophysics

Spring Intensive Experimental Courses / Summer Intensive Experimental Courses

School of Science, Faculty of Science, Kyoto University Informatics-Related Subjects

First-Year Students (Introductory Courses)		Second-Year Students (Fundamental Courses)		Third-Year Students (Development Courses)		Fourth-Year Students (Applied Courses)
Basic Informatics (Faculty of Science)	Computational science	Foundations of Numerical Computation	Computational Methods in Physics 1 (Physics) Computational Geophysics (Geophysics)	Computational Methods in Physics 2 (Physics) Electronics (Physics)	Numerical Analysis (Mathematics)	Topics in Mathematical Sciences (Mathematics)
	Computational science	Computer Graphics Exercise	Computational Geophysics –Exercise (Geophysics)	Experimental Physics 1 (Physics) Exercises in Computational Chemistry (Chemistry)	Experimental Physics 2 (Physics)	
Practice of Basic Informatics (Faculty of Science)	Statistics/data science	Introductory Statistics	Statistics and Artificial Intelligence	Data analysis method in geophysical problems (Geophysics) Bioinformatics (Biosciences) Methods of Chemical Experiments I (Chemistry)	Introduction to Practical Data Science (Interdisciplinary) Experiment on Sedimentology and Structural Geology (Geology and Mineralogy) Statistical Mechanics of Chemical Systems (Chemistry)	Data Assimilation A (Interdisciplinary) Data Assimilation B (Interdisciplinary)
	Statistics/data science	Elementary Probability	Mathematical Statistics			
	Computer science	Fundamentals of Computer Science		Computer Science (Mathematics)		Advanced Computer Science (Mathematics)
	General			Core Course/Laboratory Work/Experiments/ Exercises for individual majors		Special Study Course for individual majors