# Graduate Major in Chemistry

## 【Master's Degree Program】

## 1. Outline

In the Graduate Major in Chemistry, the program provides education and research courses to understand matter-related chemical phenomena through analyses at atomic or molecular level, to create new materials based on the knowledge, and to contribute to development of society broadly. The curriculum consists of course work and laboratory-related work. The former includes foundational courses and in-depth courses in chemistry or chemistry-related fields. The latter includes courses to acquire knowledge and research skills required for successful scientists and engineers.

The Master's Degree Program is designed to cultivate individuals who possess a broad outlook based on both fundamental knowledge and advanced specialized academic ability on chemistry, and who can work independently on new problems.

## 2. Competencies Developed

We focus on the academic development of the following competencies:

- Fundamental academic ability to understand diverse findings related to chemistry
- Practical problem-solving skills based on advanced academic ability to material science
- Ability to tackle new problems independently and to explore depths of chemistry
- Ability to integral diverse ways of thinking to discover a new direction
- Communication skills applicable globally

## 3. Learning Goals

The goals of the active learning provided in the course to obtain the competencies described in the curriculum are as follows:

A) Basic learning of specialized fields in chemistry

Learning of basic understanding of chemical principles and concepts through fundamental courses (Basic Concepts of Inorganic Chemistry, Basic Concepts of Physical Chemistry, Basic Concepts of Organic Chemistry)

B) Advanced learning of chemistry

Leaning of advanced chemistry in various fields through Advanced Chemistry Courses

C) Learning to cultivate the wide perspective and initiative

Learning to acquire ability to contribute to their own research independently and basic skills for problem-solving

D) Learning of laboratory safety in chemistry

Learning to acquire ability to conduct chemical safely with preserving the environment

E) Learning to enforce communication skills

Learning to acquire skills for writing and presentation required for academic research

## 4. IGP Completion Requirements

The following requirements must be met to complete the Master's Degree Program of this major.

1. Attain a total of 30 credits or more from 400- and 500-level courses.
2. From the courses specified in the Graduate Major in Chemistry curriculum,
   - 4 credits acquired from Research Seminars in Chemistry
   - 4 credits acquired from Research-Related Courses in Chemistry
   - A minimum of 4 credits acquired from Basic Chemistry Courses (Basic Concepts series).
   - A minimum of 4 credits acquired from Advanced Chemistry Courses.
   - A minimum of 5 credits acquired from Liberal Arts and Basic Science Courses, including 2 credits or more from 400-level and one credit or more from 500-level Humanities and Social Science Courses, and 2 credits or more from Career Development Courses.
3. Pass the master's thesis review and defense.

Table M1 shows course categories and the number of credits required to complete the Master's Degree Program of this major. It also shows the required minimum credits in each course category and points to be noted when selecting the required courses and electives.

The learning goals to be obtained by students through courses are listed as “associated learning goals”. Prior to registering courses, students need to fully understand the course goals.

**Table M1. Graduate Major in Chemistry Completion Requirements**

| Course category | | <Required courses> Required credits | <Electives> Minimum credits required | Minimum credits required | Associated learning goals | Comments |
|---|---|---|---|---|---|---|
| **Liberal arts and basic science courses** | **Humanities and social science courses** | | • 2 credits from 400-level<br>• 1 credit from 500-level | 5 credits | C | |
| | **Career development courses** | | 2 credits | | C | All Graduate Attributes (GA) should be acquired. (Refer to Section 7 for the definition of GA.) |
| | **Other courses** | | | | | |
| **Core courses** | **Research seminars** | Seminar in Chemistry S1<br>Seminar in Chemistry F1<br>Seminar in Chemistry S2<br>Seminar in Chemistry F2<br>A total of 4 credits, 1 credit each from the above courses. | | 18 credits | C, D, E | |
| | **Research-related courses** | Directed Laboratory Work in Chemistry I<br>Directed Laboratory Work in Chemistry II<br>Directed Laboratory Work in Chemistry III<br>Directed Laboratory Work in Chemistry IV<br>A total of 4 credits, 1 credit each from the above courses. | | | C, D, E | |
| | **Major courses** | | • 4 credits or more from Basic Courses in Chemistry<br>• 4 credits or more from Advanced Courses in Chemistry | | A, B, C, D, E | |
| | **Major courses and Research-related courses <u>outside</u> the Graduate Major in Chemistry standard curriculum** | | | | | |

| | |
|---|---|
| **Total required credits** | **A minimum of 30 credits including those attained according to the above conditions** |
| **Note** | **・Japanese Language and Culture Courses offered to international students can be recognized as equivalent to the Humanities and Social Science Courses of the corresponding course level.**<br>**・For details of the Liberal Arts and Basic Science Courses, please refer to the relevant sections.** |

## 5. IGP Course

Table M2 shows the Core Courses of the Master's Degree Program in this major. Graduate Majors listed in the Comments column offer core courses that are recognized as equivalent to the corresponding Major Courses or Research-related Courses in the standard curriculum of this major.

**Table M2. Core Courses of the Graduate Major in Chemistry**

| Course category | | Course number | Course title | | | Credits | Compe-tencies | Learning goals | Comments |
|---|---|---|---|---|---|---|---|---|---|
| Research seminars | 400 level | CHM.Z491.R | ◎ | ★ | Seminar in Chemistry S1 | 0-1-0 | 1, 2, 3 | C, D, E | |
| | | CHM.Z492.R | ◎ | ★ | Seminar in Chemistry F1 | 0-1-0 | 1, 2, 3 | C, D, E | |
| | 500 level | CHM.Z591.R | ◎ | ★ | Seminar in Chemistry S2 | 0-1-0 | 1, 2, 3 | C, D, E | |
| | | CHM.Z592.R | ◎ | ★ | Seminar in Chemistry F2 | 0-1-0 | 1, 2, 3 | C, D, E | |
| Research-related courses | 400 level | CHM.L471.R | ◎ | ★ | Directed Laboratory Work in Chemistry I | 0-0-1 | 1, 2, 3, 4, 5 | C, D, E | |
| | | CHM.L472.R | ◎ | ★ | Directed Laboratory Work in Chemistry II | 0-0-1 | 1, 2, 3, 4, 5 | C, D, E | |
| | | CHM.A411.L | | | Environment Preservation and Chemical Safety I | 1-0-0 | 1, 5 | D | 【Chemical Science and Engineering】 (CAP .E401) |
| | | CHM.A412.L | | | Environment Preservation and Chemical Safety II | 1-0-0 | 1, 5 | D | 【Chemical Science and Engineering】 (CAP .E402) |
| | 500 level | CHM.L571.R | ◎ | ★ | Directed Laboratory Work in Chemistry III | 0-0-1 | 1, 2, 3, 4, 5 | C, D, E | |
| | | CHM.L572.R | ◎ | ★ | Directed Laboratory Work in Chemistry IV | 0-0-1 | 1, 2, 3, 4, 5 | C, D, E | |
| Major courses | 400 level | CHM.A431.B | ○ | | Laboratory Training of Synchrotron Radiation Science | 0-0-1 | 1, 5 | B, D | Advanced Chemistry Courses |
| | | CHM.A435.L | ○ | ★ | Current Chemistry I | 1-0-0 | 1, 2, 3 | B | Advanced Chemistry Courses Only for even academic years |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | CHM.A436.L | ○ | ★ | Current Chemistry II | 1-0-0 | 1, 2, 3 | B | Advanced Chemistry Courses Only for even academic years |
| | | CHM.A437.L | ○ | ★ | Current Chemistry III | 1-0-0 | 1, 2, 3 | B | Advanced Chemistry Courses Only for odd academic years |
| | | CHM.A438.L | ○ | ★ | Current Chemistry IV | 1-0-0 | 1, 2, 3 | B | Advanced Chemistry Courses Only for odd academic years |
| | | CHM.A441.L | ○ | | Recent Progress in Chemistry I | 1-0-0 | 1 | B | Advanced Chemistry Courses Only for even academic years |
| | | CHM.A442.L | ○ | | Recent Progress in Chemistry II) | 1-0-0 | 1 | B | Advanced Chemistry Courses Only for even academic years |
| | | CHM.A443.L | ○ | | Recent Progress in Chemistry III | 1-0-0 | 1 | B | Advanced Chemistry Courses Only for even academic years |
| | | CHM.A444.L | ○ | | Recent Progress in Chemistry IV | 1-0-0 | 1 | B | Advanced Chemistry Courses Only for even academic years |
| | | CHM.A445.L | ○ | | Recent Progress in Chemistry V | 1-0-0 | 1 | B | Advanced Chemistry Courses Only for even academic years |
| | | CHM.A446.L | ○ | | Recent Progress in Chemistry VI | 1-0-0 | 1 | B | Advanced Chemistry Courses Only for even academic years |
| | | CHM.A447.L | ○ | | Recent Progress in Chemistry VII | 1-0-0 | 1 | B | Advanced Chemistry Courses Only for odd academic years |
| | | CHM.A448.L | ○ | | Recent Progress in Chemistry VIII | 1-0-0 | 1 | B | Advanced Chemistry Courses Only for odd academic years |
| | | CHM.A449.L | ○ | | Recent Progress in Chemistry IX | 1-0-0 | 1 | B | Advanced Chemistry Courses Only for odd academic years |
| | | CHM.A450.L | ○ | | Recent Progress in Chemistry X | 1-0-0 | 1 | B | Advanced Chemistry Courses Only for odd academic years |
| | | CHM.A451.L | ○ | | Recent Progress in Chemistry XI | 1-0-0 | 1 | B | Advanced Chemistry Courses Only for odd academic years |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | CHM.A452.L | ○ | | Recent Progress in Chemistry XII | 1-0-0 | 1 | B | Advanced Chemistry Courses Only for odd academic years |
| | | CHM.A461.L | | | Presentation Exercises in Chemistry | 0-1-0 | 1, 3, 5 | C, E | |
| | | CHM.A462.L | | ★ | Introductory Exercises in Chemistry | 0-1-0 | 1, 2, 3, 4, 5 | C, E | |
| | | CHM.A471.B | | ★ | Materials Simulation | 2-0-0 | 1, 5 | B | 【Tokyo Tech Academy for Convergence of Materials and Informatics】 (TCM.A402) |
| | | CHM.A472.B | | ★ | Materials Informatics | 2-0-0 | 1, 5 | B | 【Tokyo Tech Academy for Convergence of Materials and Informatics】 (TCM.A402) |
| | | CHM.B401.A | ○ | ★ | Basic Concepts of Inorganic Chemistry I | 1-0-0 | 1 | A | Basic Chemistry Courses |
| | | CHM.B402.A | ○ | ★ | Basic Concepts of Inorganic Chemistry II | 1-0-0 | 1 | A | Basic Chemistry Courses |
| | | CHM.B431.B | ○ | ★ | Advanced Separation Science | 2-0-0 | 1, 5 | B | Advanced Chemistry Courses Only for odd academic years |
| | | CHM.B433.B | ○ | ★ | Catalytic Chemistry on Solid Surface | 2-0-0 | 1 | B | Advanced Chemistry Courses Only for odd academic years |
| | | CHM.B434.B | ○ | ★ | Advanced Course in Crystal Structure Science | 2-0-0 | 1 | B | Advanced Chemistry Courses |
| | | CHM.B435.B | ○ | | Global Environmental Chemistry | 2-0-0 | 1 | B | Advanced Chemistry Courses Only for even academic years |
| | | CHM.B436.B | ○ | ★ | Photochemical Reactions I | 1-0-0 | 1 | B | Advanced Chemistry Courses Only for even academic years |
| | | CHM.B437.B | ○ | ★ | Photochemical Reactions II | 1-0-0 | 1 | B | Advanced Chemistry Courses Only for odd academic years |
| | | CHM.C401.A | ○ | ★ | Basic Concepts of Physical Chemistry I | 1-0-0 | 1 | A | Basic Chemistry Courses |
| | | CHM.C402.A | ○ | ★ | Basic Concepts of Physical Chemistry II | 1-0-0 | 1 | A | Basic Chemistry Courses |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | CHM.C431.B | ○ | ★ | Advanced Physical Chemistry | 2-0-0 | 1 | B | Advanced Chemistry Courses Only for odd academic years |
| | | CHM.C432.B | ○ | ★ | Advanced Quantum Chemistry | 2-0-0 | 1 | B | Advanced Chemistry Courses Only for even academic years |
| | | CHM.D401.A | ○ | ★ | Basic Concepts of Organic Chemistry I | 1-0-0 | 1 | A | Basic Chemistry Courses |
| | | CHM.D402.A | ○ | ★ | Basic Concepts of Organic Chemistry II | 1-0-0 | 1 | A | Basic Chemistry Courses |
| | | CHM.D431.B | ○ | ★ | Advanced Bioorganic Chemistry | 2-0-0 | 1 | B | Advanced Chemistry Courses Only for odd academic years |
| | | CHM.D432.B | ○ | ★ | Advanced Organic Synthesis | 2-0-0 | 1, 5 | B | Advanced Chemistry Courses Only for odd academic years |
| | | CHM.D433.B | ○ | ★ | Advanced Organometallic Chemistry | 2-0-0 | 1 | B | Advanced Chemistry Courses Only for even academic years |
| | | CHM.D434.B | ○ | ★ | Advanced Structural Organic Chemistry | 2-0-0 | 1 | B | Advanced Chemistry Courses Only for even academic years |
| | | CHM.E401.B | ○ | ★ | Interdisciplinary scientific principles of energy 1 | 1-0-0 | 1 | A | 【Energy Science and Engineering】 (ENR.A401) |
| | | CHM.E402.B | ○ | ★ | Interdisciplinary scientific principles of energy 2 | 1-0-0 | 1 | A | 【Energy Science and Engineering】 (ENR.A402) |
| | | CHM.E405.B | ○ | ★ | Interdisciplinary energy materials science 1 | 1-0-0 | 1, 5 | B | 【Energy Science and Engineering】 (ENR.A405) |
| | | CHM.E406.B | ○ | ★ | Interdisciplinary energy materials science 2 | 1-0-0 | 1, 5 | B | 【Energy Science and Engineering】 (ENR.A406) |
| | | CHM.E410.B | | ★ | Optical properties of solids | 2-0-0 | 1, 4 | B | 【Energy Science and Engineering】 (ENR.I410) |
| | | CHM.E420.B | | ★ | Advanced Lecture on Crystal Structure and Correlation with Properties of Solids | 1-0-0 | 1, 5 | B | 【Energy Science and Engineering】 (ENR.I420) |

• ◎:Required course, ○:Restricted elective, ★:Classes in English

• Competencies: 1 = Specialist skills, 2 = Liberal arts skills, 3 = Communication skills, 4 = Applied skills (inquisitive thinking and/or problem-finding skills), 5 = Applied skills (practical and/or problem-solving skills)

•【 】Course offered by another graduate major

• The character preceding the three digits in the course number denotes the course's subdiscipline (i.e., "D" represents the subdiscipline code in the course number ABC.D400.R): A: Basic Chemistry, B: Inorganic/Analytical Chemistry, C: Physical Chemistry, D: Organic Chemistry, E: Energy Chemistry, L: Research Related Courses, Z: Research Seminars

## 6. IGP Courses that can be counted as Humanities and Social Science Courses

None

## 7. IGP Courses that can be counted as Career Development Courses

In order to fulfill the completion requirements for the master's degree program, students must attain at least 2 credits in Career Development Courses, and should satisfy all of the Graduate Attributes (GA) specified in Table MA-1 of the "Career Development Courses" (Liberal Arts and Basic Science Courses) in the Guide to Graduate Education and International Graduate Program. Students will be evaluated in regards to GA achievements at the time of their degree completion. As to the courses with more than one GA, the number of GA stipulated for the courses is considered to be acquired regardless of the credits received for the courses.
Major Courses that enable students to acquire GA and that are recognized as equivalent to Career Development Courses are listed in Table M3 below.
However, it must be noted that credits attained from these courses can be counted towards the completion requirements of master's degree program, either for the Major Courses or for the Career Development Courses (i.e., not for both). Nevertheless, even in the cases from those mentioned above where attained credits pertaining to these courses are not considered as Career Development Courses, their associated GAs are always considered to have been acquired.

For Graduate Attributes, refer to the Guide to the Career Development Courses.
The Graduate Attributes of the Master's Degree Program are as follows:
GA0M: You can clearly plan your own career and recognize the abilities necessary for realizing it while considering ethics and relevance to societal problems.
GA1M: You can acquire the knowledge, skills, and ethics necessary for realizing your planned career and contribute to societal problem-solving while collaborating with other experts.

**Table M3. Courses of the Graduate Major in Chemistry recognized as equivalent to Career Development Courses**

| Course category | Course number | Course title | | | Credits | GA* | Learning goals | Comments |
|---|---|---|---|---|---|---|---|---|
| **Courses that can be counted as Career Development Courses** | XIP.A401 | | ★ | Special International Practice in Science | 0-2-0 | GA1M | | Common Course of School of Science Outside the Graduate Major in Chemistry standard curriculum |
| | CHM.A461.L | | | Presentation Exercises in Chemistry | 0-1-0 | GA0M | C, E | |

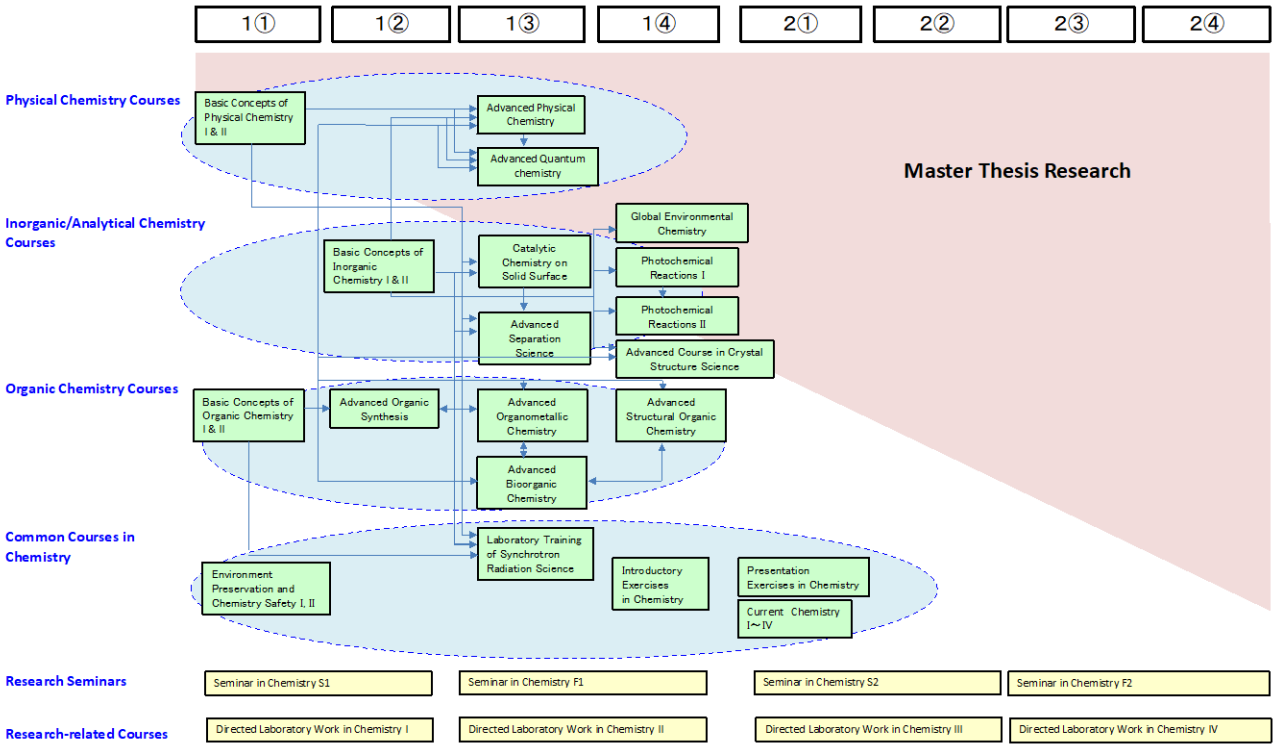
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CHM.A462.L | | ★ | Introductory Exercises in Chemistry | 0-1-0 | GA1M | C, E | |

★: Classes in English

**Credits in Career Development Courses must be attained from among the above-listed courses and those listed as such in the Liberal Arts and Basic Science Courses Guide.**

***GA: Graduate Attributes**

## 8. Overview of Curriculum System



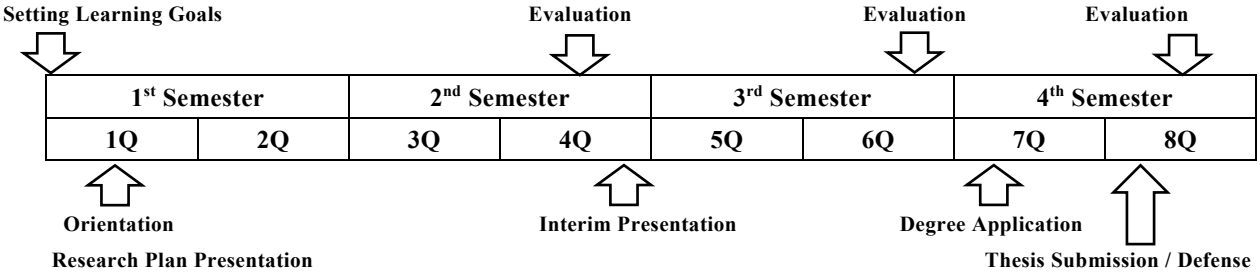

## 9. Example of a Standard Curriculum

| | Inorganic/Analytical Chemistry Courses | Physical Chemistry Courses | Organic Chemistry Courses | Common Courses in Chemistry | Research Seminars Research-related Courses |
|---|---|---|---|---|---|
| 400 level | ・Basic Concepts of Inorganic Chemistry I, II<br>・Advanced Separation Science<br>・Global Environmental Chemistry<br>・Catalytic Chemistry on Solid Surface<br>・Advanced Course in Crystal Structure Science<br>・Photochemistry Reactions I<br>・Photochemistry Reactions II | ・Basic Concepts of Physical Chemistry I, II<br>・Advanced Physical Chemistry<br>・Advanced Quantum Chemistry | ・Basic Concepts of Organic Chemistry I, II<br>・Advanced Organic Synthesis<br>・Advanced Bioorganic Chemistry<br>・Advanced Organometallic Chemistry<br>・Advanced Structural Organic Chemistry | ・Environment Preservation and Chemical Safety I<br>・Environment Preservation and Chemical Safety II<br>・Laboratory Training of Synchrotron Radiation Science<br>・Current Chemistry<br>・Presentation Exercises in Chemistry<br>・Introductory Exercises in Chemistry | ・Seminar in Chemistry S1<br>・Seminar in Chemistry F1<br>・Directed Laboratory Work in Chemistry I<br>・Directed Laboratory Work in Chemistry II |
| 500 level | | | | | ・Seminar in Chemistry S2<br>・Seminar in Chemistry F2<br>・Directed Laboratory Work in Chemistry III<br>・Directed Laboratory Work in Chemistry IV |

## 10. Research Related to the Completion of Master Theses

In the master thesis research, students will acquire and improve their problem setting and solving abilities, and communication and presentation skills. The important courses are related to the research on a thesis under the supervision of a faculty member, in which each student can develop their ability to apply their accumulated knowledge and skills to a research topic. They will learn how to organize and present their ideas in a logical way through preparation and presentation of the master thesis.

**Study Plan**




**• Presentation of the research plan and the interim achievement**

A research plan presentation on 1Q and an interim presentation on 4Q are examined to clarify the background and the objective of the research in terms of career development.

**• The criteria for examination**

Following requirements must be met.

1. The thesis must be a self-written paper, which includes novel knowledge and concept as well as original discussion.
2. The main part of the thesis must have been presented at an academic conference.

**• The thesis review procedure**

The review committee consists of at least three faculty members of the chemistry course. The final judgment is carried out after reviewing the thesis and the presentation by the candidate. The examination for the candidate who enters the PhD course is made by at least five faculty members.

## 【Doctoral Degree Program】

### 1. Outline

The purpose of the program is to train young talents to have a broad knowledge of both fundamental and specialized issues related to materials, to encourage them to become leaders of a specialized field related to Chemistry and to contribute natural science and applied fields.

### 2. Competencies Developed

We focus on the academic development of the following competencies:

- Have a broad and deep knowledge of Chemistry related topics, and can utilize this knowledge to approach new chemical problems
- Lead research at the frontiers of chemical sciences with a strong sense of responsibility and ethics
- Integrate the results of various fields related to materials research from a chemistry point of view, and actively use this knowledge
- Demonstrate international leadership in the field of study

### 3. Learning Goals

The curriculum will help to develop these competencies using the following approaches:

A) Study advanced challenges

Using the specialized skills from the master program, identifies new, important scientific problems and able to solve them

B) Able to integrate different fields of knowledge and organize them into new systems

C) Achieve international leadership in the study fields

### 4. IGP Completion Requirements

The following requirements must be met to complete the Doctoral Degree Program of this major.

1. Attain a total of 24 credits or more from 600-level courses.
2. From the courses specified in the Graduate Major in Chemistry curriculum,
   - 12 credits acquired from Research Seminars in Chemistry
   - 1 credit acquired from Advanced Exercises in Chemistry
   - A minimum of 18 credits acquired from Core Courses of the Graduate Major in Chemistry
   - A minimum of 6 credits acquired from Liberal Arts and Basic Science Courses
     (2 credits from Humanities and Social Science Courses, and 4 credits from Career Development Courses)
3. At least one paper published in a good peer-reviewed journal in the subject of the doctoral thesis. As a general rule, the student should be the first author. A paper accepted for publication is considered to be equivalent to published papers.
4. Pass the doctoral thesis review and defense.

Table D1 shows course categories and the number of credits required to complete the Doctoral Degree Program of this major. It also shows the required minimum credits in each course category and points to be noted when selecting the required courses and electives.

The learning goals to be obtained by students through courses are listed as “associated learning goals”. Prior to registering courses, students need to fully understand the course goals.

**Table D1. Graduate Major in Chemistry Completion Requirements**

| **Course category** | | **<Required courses> Required credits** | **<Electives> Minimum credits required** | **Minimum credits required** | **Associated learning goals** | **Comments** |
|---|---|---|---|---|---|---|
| **Liberal arts and basic science courses** | **Humanities and social science courses** | | 2 credits | 6 credits | B | |
| | **Career development courses** | | 4 credits | | B, C | All Graduate Attributes (GA) should be acquired. (Refer to Section 7 for the definition of GA.) |
| | **Other courses** | | | | | |
| **Core courses** | **Research seminars** | Seminar in Chemistry S3<br>Seminar in Chemistry F3<br>Seminar in Chemistry S4<br>Seminar in Chemistry F4<br>Seminar in Chemistry S5<br>Seminar in Chemistry F5<br>A total of 12 credits, 2 credits each from the above courses. | | 18 credits | A, B | |
| | **Research-related courses** | | | | A, B | |
| | **Major courses** | Advanced Exercise in Chemistry, 1 credit | | | A, B, C | |
| | **Major courses and Research-related courses <u>outside</u> the Graduate Major in Chemistry standard curriculum** | | | | | |
| **Total required credits** | | **A minimum of 24 credits including those attained according to the above conditions** | | | | |
| **Note** | | **・Japanese Language and Culture Courses offered to international students can be recognized as equivalent to the Humanities and Social Science Courses of the corresponding course level.<br>・For details of the Liberal Arts and Basic Science Courses, please refer to the relevant sections.** | | | | |

## 5. IGP Courses

Table D2 shows the Core Courses of the Doctoral Degree Program of this major. Graduate Majors listed in the Comments column offer core courses that are recognized as equivalent to the corresponding Major Courses or Research-related Courses in the standard curriculum of this major.

**Table D2. Core Courses of the Graduate Major in Chemistry**

| Course category | | Course number | Course title | | | Credits | Compe-tencies | Learning goals | Comments |
|---|---|---|---|---|---|---|---|---|---|
| Research seminars | 600 level | CHM.Z691.R | ◎ | ★ | Seminar in Chemistry S3 | 0-2-0 | 1, 2, 3, 4 | A, B | |
| | | CHM.Z692.R | ◎ | ★ | Seminar in Chemistry F3 | 0-2-0 | 1, 2, 3, 4 | A, B | |
| | | CHM.Z693.R | ◎ | ★ | Seminar in Chemistry S4 | 0-2-0 | 1, 2, 3, 4 | A, B | |
| | | CHM.Z694.R | ◎ | ★ | Seminar in Chemistry F4 | 0-2-0 | 1, 2, 3, 4 | A, B | |
| | | CHM.Z695.R | ◎ | ★ | Seminar in Chemistry S5 | 0-2-0 | 1, 2, 3, 4 | A, B | |
| | | CHM.Z696.R | ◎ | ★ | Seminar in Chemistry F5 | 0-2-0 | 1, 2, 3, 4 | A, B | |
| Major courses | 600 level | CHM.A641.L | | ★ E | Colloquium on Advanced Chemistry I | 1-0-0 | 1, 2 | A, B, C | |
| | | CHM.A642.L | | ★ E | Colloquium on Advanced Chemistry II | 1-0-0 | 1, 2 | A, B, C | |
| | | CHM.A643.L | | ★ O | Colloquium on Advanced Chemistry III | 1-0-0 | 1, 2 | A, B, C | |
| | | CHM.A644.L | | ★ O | Colloquium on Advanced Chemistry IV | 1-0-0 | 1, 2 | A, B, C | |
| | | CHM.A651.L | | | Laboratory Training of Advanced Chemistry I | 0-0-1 | 1, 2, 3, 4, 5 | C | |
| | | CHM.A652.L | | | Laboratory Training of Advanced Chemistry II | 0-0-1 | 1, 2, 3, 4, 5 | C | |
| | | CHM.A653.L | | | Laboratory Training of Advanced Chemistry III | 0-0-1 | 1, 2, 3, 4, 5 | C | |
| | | CHM.A654.L | | | Laboratory Training of Advanced Chemistry IV | 0-0-1 | 1, 2, 3, 4, 5 | C | |
| | | CHM.A661.L | | ★ | Basic Exercises in Global Presentation | 0-1-0 | 1, 2, 3 | C | |
| | | CHM.A662.L | | ★ | Advanced Exercises in Global Presentation | 0-1-0 | 1, 2, 3 | C | |
| | | CHM.L670.R | ◎ | ★ | Advanced Exercise in Chemistry | 0-1-0 | 1, 2, 3, 4, 5 | A, B, C | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | CHM.L671.L | | ★ | Advanced Laboratory Work in Chemistry I | 0-0-1 | 1, 2, 3, 4, 5 | A, B | |
| | | CHM.L672.L | | ★ | Advanced Laboratory Work in Chemistry II | 0-0-1 | 1, 2, 3, 4, 5 | A, B | |
| | | CHM.L673.L | | ★ | Advanced Laboratory Work in Chemistry III | 0-0-1 | 1, 2, 3, 4, 5 | A, B | |
| | | CHM.L674.L | | ★ | Advanced Laboratory Work in Chemistry IV | 0-0-1 | 1, 2, 3, 4, 5 | A, B | |
| | | CHM.L675.L | | ★ | Advanced Laboratory Work in Chemistry V | 0-0-1 | 1, 2, 3, 4, 5 | A, B | |
| | | CHM.L676.L | | ★ | Advanced Laboratory Work in Chemistry VI | 0-0-1 | 1, 2, 3, 4, 5 | A, B | |
| | | CHM.E601.L | | ★ | InfoSyEnergy-outreach | 0-0-1 | | | 【Tokyo Tech Academy of Energy and Informatics】(ENI.A601) |
| | | CHM.E611.L | | ★ | InfoSyEnergy-international forum 1 | 0-0-2 | | | 【Tokyo Tech Academy of Energy and Informatics】(ENI.B611) |
| | | CHM.E612.L | | ★ | InfoSyEnergy-international forum 2 | 0-0-2 | | | 【Tokyo Tech Academy of Energy and Informatics】(ENI.B612) |
| | | CHM.E613.L | | ★ | InfoSyEnergy-international forum 3 | 0-0-2 | | | 【Tokyo Tech Academy of Energy and Informatics】(ENI.B613) |
| | | CHM.E614.L | | | InfoSyEnergy-joint research project 1 | 0-0-2 | | | 【Tokyo Tech Academy of Energy and Informatics】(ENI.C611) |
| | | CHM.E615.L | | | InfoSyEnergy-joint research project 2 | 0-0-4 | | | 【Tokyo Tech Academy of Energy and Informatics】(ENI.C612) |
| | | CHM.E616.L | | ★ | InfoSyEnergy-international field work-short term | 0-0-2 | | | 【Tokyo Tech Academy of Energy and Informatics】(ENI.C616) |
| | | CHM.E617.L | | ★ | InfoSyEnergy-international field work-long term | 0-0-4 | | | 【Tokyo Tech Academy of Energy and Informatics】(ENI.C617) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | CHM.L681.L | | | Cooperative Education through Research Internships of Chemistry | 0-0-4 | 1, 3, 4, 5 | C | |

Note:

• ◎:Required course, ○:Restricted elective, ★: Classes in English, O: odd academic years, E: even academic years

• Competencies: 1 = Specialist skills, 2 = Liberal arts skills, 3 = Communication skills, 4 = Applied skills (inquisitive thinking and/or problem-finding skills), 5 = Applied skills (practical and/or problem-solving skills)

• The character preceding the three digits in the course number denotes the course's subdiscipline (i.e., "D" represents the subdiscipline code in the course number ABC.D600.R). A: Basic Chemistry, B: Inorganic/Analytical Chemistry, C: Physical Chemistry D: Organic Chemistry, E: Energy Chemistry, L: Research Related Courses, Z: Research Seminars

## 6. IGP Courses that can be counted as Humanities and Social Science Courses

None

## 7. IGP Courses that can be counted as Career Development Courses

In order to fulfill the completion requirements for the doctoral degree program, students must attain at least 4 credits in Career Development Courses, and should satisfy all of the Graduate Attributes (GA) specified in Table A-1 or A-2 of the “Career Development Courses” (Liberal Arts and Basic Science Courses) in the Guide to Graduate Education and International Graduate Program. Students will be evaluated in regards to GA achievements at the time of their degree completion. As to the courses with more than one GA, the number of GA stipulated for the courses is considered to be acquired regardless of the credits received for the courses.

Major Courses that enable students to acquire GA and that are recognized as equivalent to Career Development Courses are listed in Table D3 below.

However, it must be noted that credits attained from these courses can be counted towards the completion requirements of master’s degree program, either for the Major Courses or for the Career Development Courses (i.e., not for both). Nevertheless, even in the cases from those mentioned above where attained credits pertaining to these courses are not considered as Career Development Courses, their associated GAs are always considered to have been acquired.

For Graduate Attributes, refer to the Guide to the Career Development Courses.

The Graduate Attributes of the Doctoral Degree Program are as follows:

GA0D: You can clearly design your own career and contribute to realizing scientific, technological, or social innovation through a comprehensive understanding of the knowledge, skills, social responsibilities and ethics required to become an active member of academia and/or industry.

GA1D: You can lead in realizing scientific, technological, or social innovation by acquiring the advanced leadership skills, entrepreneurial skills, knowledge and expertise, and by developing social responsibility necessary for materializing your designed career.

**Table D3. Courses of the Graduate Major in Chemistry recognized as equivalent to Career Development Courses**

| Course category | Course number | Course title | Credits | GA* | Learning goals | Comments |
|---|---|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Courses that can be counted as Career Development Courses** | XIP.A601 | | ★ | Advanced International Practice in Science | 0-2-0 | GA1D | | Common Course of School of Science Outside the Graduate Major in Chemistry standard curriculum |
| | CHM.A651.L | | | Laboratory Training of Advanced Chemistry I | 0-0-1 | GA1D | C | |
| | CHM.A652.L | | | Laboratory Training of Advanced Chemistry II | 0-0-1 | GA1D | C | |
| | CHM.A653.L | | | Laboratory Training of Advanced Chemistry III | 0-0-1 | GA1D | C | |
| | CHM.A654.L | | | Laboratory Training of Advanced Chemistry IV | 0-0-1 | GA1D | C | |
| | CHM.A661.L | | ★ | Basic Exercises in Global Presentation | 0-1-0 | GA1D | C | |
| | CHM.A662.L | | ★ | Advanced Exercises in Global Presentation | 0-1-0 | GA1D | C | |
| | CHM.L681.L | | | Cooperative Education through Research Internships of Chemistry | 0-0-4 | GA1D | C | |

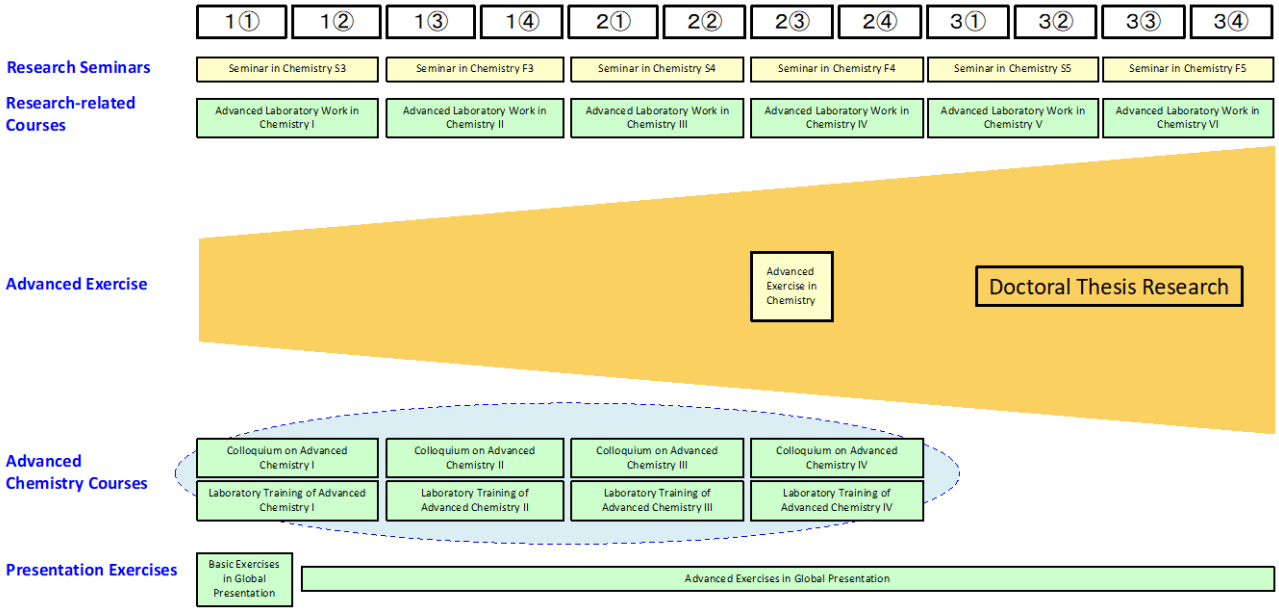
★: Classes in English

**Credits in Career Development Courses must be attained from among the above-listed courses and those listed as such in the Liberal Arts and Basic Science Courses Guide.**

***GA: Graduate Attributes**

Students enrolled in the educational program for leading graduate schools, the Tokyo Tech Academy for Leadership (ToTAL) or three WISE programs (Tokyo Tech Academy for Convergence of Materials and Informatics (TAC-MI), Tokyo Tech Academy for Super Smart Society (SSS) and Tokyo Tech Academy of Energy and Informatics (ISE)) may be offered courses recognized as equivalent to Career Development Courses besides those listed as such in the “Liberal Arts and Basic Science Courses” in the Guide to Graduate Education and International Graduate Program. For details about available courses or completion requirements, please refer to the Study Guide of the Academy that offers the relevant program.

## 8. Overview of Curriculum System

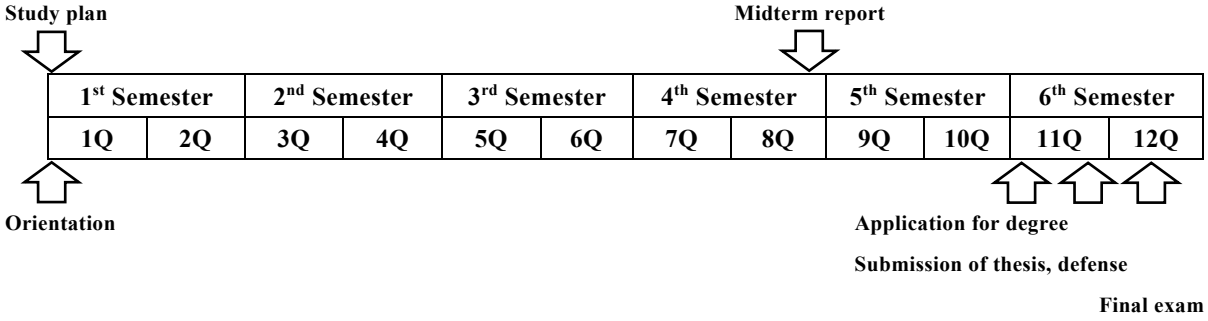



## 9. Example of a Standard Curriculum

| | Research Seminars | Research-related Courses | Advanced Exercise | Advanced Chemistry Courses | Presentation Exercise |
|---|---|---|---|---|---|
| 600 level | Seminar in Chemistry S3<br>Seminar in Chemistry F3<br>Seminar in Chemistry S4<br>Seminar in Chemistry F4<br>Seminar in Chemistry S5<br>Seminar in Chemistry F5 | Advanced Laboratory Work in Chemistry I<br>Advanced Laboratory Work in Chemistry II<br>Advanced Laboratory Work in Chemistry III<br>Advanced Laboratory Work in Chemistry IV<br>Advanced Laboratory Work in Chemistry V<br>Advanced Laboratory Work in Chemistry VI | Advanced Exercise in Chemistry | Laboratory Training of Advanced Chemistry I<br>Laboratory Training of Advanced Chemistry II<br>Laboratory Training of Advanced Chemistry III<br>Laboratory Training of Advanced Chemistry IV<br>Colloquium on Advanced Chemistry I<br>Colloquium on Advanced Chemistry II<br>Colloquium on Advanced Chemistry III<br>Colloquium on Advanced Chemistry IV | Basic Exercise in Global Presentation<br>Advanced Exercise in Global Presentation |

## 10. Research Related to the Completion of Doctoral Theses

Through the doctoral thesis research, the candidate should discover new problem of significant importance in international scientific enterprise, and develop the abilities for pointing out the issues to be solved, analyzing the situations, and proposing the solution. At the same time, communication skills are also gained to publish the results nationally and internationally. The doctoral thesis, the thesis presentation and the final exam are based on the compilation of these achievements.




The criteria for examination

Following requirements must be met for the qualification:

1. The thesis should be original and is confirmed to be the world level of research which would contribute to the development of the academic field of chemistry.
2. The subject of the doctoral thesis should be published as at least one paper in a good peer-reviewed journal. As a general rule, the student should be the first author. A paper accepted for publication is considered to be equivalent to published papers.