Graduate Major in Chemical Science and Engineering

【Master's Degree Program】

1. Outline

Master's Degree Program in the Graduate Major in Chemical Science and Engineering aims at fostering human resources, who have basic academic skills and logical thinking ability in chemical science and engineering and related fields, and can contribute to developing environmentally-benign society by applying their science and engineering wisdom.

This Master's Degree Program aims at training international engineers and leading scientists, who can understand the relationship between "Science and Technology", "Industrials", and "Environment", acquire advanced expert knowledge in chemistry, well-rounded accomplishment, and international communication skills. In order to achieve this goal, the Master's Degree Program consists of "major course" and "research". The former contains advanced academic subjects in the fields of applied chemistry, polymer chemistry, and chemical engineering. For the latter, students acquire indispensable knowledge and education as advanced researchers.

The purpose of this Master's Degree Program contains training international leading chemistry researchers and engineers, who can understand fundamental properties and reactivities of materials in atomic/molecular level, acquire advanced knowledge of chemical engineering systems for transformation to useful materials involving polymers, and solve critical issues in any field by using expertise in chemical science and engineering.

2. Competencies Developed

In this Master's Degree Program, students will be able to acquire the following abilities:

- Systematical knowledge of science and technology focusing on materials, chemical transformation, and process system development
- Practical and problem-solving skills to promote academic research and technology development
- International communication and presentation skills to explain their research logically
- Ability to see the social trends, and find and solve current problems

3. Learning Goals

In this Master's degree program, students are expected to study the following contents to acquire the "Competencies Developed" mentioned above.

Ａ）Basic learning of specialized fields in chemical science and engineering

Learning including fundamental courses which provide wide scope of applied chemistry, macromolecular science, and chemical engineering, and introduction courses which provide basic knowledge for addressing social issues

Ｂ）Advanced learning of chemical science and engineering

Acquisition of deep specialized knowledge and applied skills through the lectures and exercises in the various optional courses including advanced fundamental learnings

C） Learning which cultivates the wide scope and initiative

Acquisition of ability to address the issues autonomously through research by using specialized knowledge and applied skills which acquired from above learnings

D） Learning to relive the social involvement

Learning of reliving studies and engineer ethics through systematic researches and development at the host agency such as institute and company, and the specialized courses made by lecturers from social communities

E） Learning to enforce communication skills

Cultivation of student’s presentation skill and sentence constitution ability to communicate importance of their research and significance of results to others logically and accurately

4. IGP Completion Requirements

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

1. A total of 32 credits or more acquired from 400- and 500-level courses.
2. Meet the completion requirements indicated in Table M1. below.
3. Pass the master's thesis review and defense.

Table M1. Graduate Major in Chemical Science and Engineering 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 •1 credit from 500-level	5 credits	D	
	Career development courses		2 credits from 400- and 500-level		C,D,E	
	Other courses					
Core courses	Research seminars	Seminar in Chemical Science and Engineering S1 Seminar in Chemical Science and Engineering F1 Seminar in Chemical Science and Engineering S2 Seminar in Chemical Science and Engineering F2 A total of 4 credits, 1 credit each from the above courses.		20 credits	B,C,D,E	
	Research-related courses		2 credits		B,C,D,E	
	Major courses		14 credits		A,B	
	Major courses and Research-related courses <u>outside</u> the Graduate Major in Chemical Science and Engineering standard curriculum					
Total required credits		A minimum of 32 credits in addition to meeting the above conditions				
Note		• Japanese Language and Culture Courses offered to International Students can be recognized as Humanities and Social Science Courses of the corresponding course level. • As for Liberal Arts and Basic Science Courses, please refer to the relevant pages.				

5. IGP Courses

Table M2. Core Courses of the Graduate Major in Chemical Science and Engineering

Course category		Course number	Course			Credits	Competencies	Learning goals	Comments
Research seminars	400 level	CAP.Z491.R	◎		Seminar in Chemical Science and Engineering S1	0-1-0	2,3,5	A,C,E	
		CAP.Z492.R	◎		Seminar in Chemical Science and Engineering F1	0-1-0	2,3,5	A,C,E	
	500 level	CAP.Z591.R	◎		Seminar in Chemical Science and Engineering S2	0-1-0	2,3,5	A,C,E	
		CAP.Z592.R	◎		Seminar in Chemical Science and Engineering F2	0-1-0	2,3,5	A,C,E	
Research-related courses	400 level	CAP.E433.L			Advanced Statistical Analysis I	0-1-0	3,5	C,D	
		CAP.E434.L			Advanced Statistical Analysis II	0-1-0	3	C,D	
		CAP.E431.L			Introduction to Academic Writing S1	0-1-0	1,2,4,5	E	
		CAP.E432.L			Introduction to Academic Writing F1	0-1-0	1	E	
		CAP.E411.L			Advanced Internship in Chemical Science and Engineering I	0-0-1	1,2,5	B,D	
		CAP.E412.L			Advanced Internship in Chemical Science and Engineering II	0-0-2	1,2,5	B,D	
		CAP.E451.L			Research Methodology in Chemical Science and Engineering I	0-1-0	2,3,5	C,D	
		CAP.E551.L			Research Methodology in Chemical Science and Engineering II	0-1-0	2,3,5	C,D	
Major courses	400 level	CAP.A421.L			Advanced Design of Organic Reaction Processes I	1-0-0	3,5	B	
		CAP.A422.L			Advanced Design of Organic Reaction Processes II	1-0-0	3,5	B	
		CAP.A462.L		O	Advanced Solid State Chemistry II	1-0-0	3	B	
		CAP.A464.L		E	Advanced Molecular Design of Metal Complexes II	1-0-0	3,5	B	
		CAP.A466.L		E	Advanced Bioinorganic Chemistry II	1-0-0	3	B	
		CAP.C411.L			Chemical Engineering for Advanced Materials and Chemicals Processing I	1-0-0	3,5	A	
		CAP.C423.L		□	Computational Fluid Dynamics	1-0-0	3,5	B	

		CAP.C431.L			Chemical Engineering for Advanced Materials and Chemicals Processing II	1-0-0	3	A	
		CAP.C441.L		□	Transport Phenomena and Operation	2-0-0	1,3,4,5	B	
		CAP.C442.L		□	Advanced Separation Operation	2-0-0	1,3	B	
		CAP.I473.L		E	Nanotechnology and Nanoscience	2-0-0	3	B	
		CAP.I434.L		□	Advanced Nano-Materials Chemistry I	1-0-0	3	B	
		CAP.I471.L		O	Coordination Chemistry	2-0-0	3	B	
		CAP.I472.L		O	Advanced Catalytic Chemistry	2-0-0	3	B	
		CAP.I474.L		O	Fundamental Electrochemistry	2-0-0	3	B	【Energy Science and Engineering】(ENR.H416)
		CAP.I475.L		O	Organic Molecular and Macromolecular Chemistry	2-0-0	3	B	【Energy Science and Engineering】(ENR.H417)
		CAP.I476.L		E	Inorganic Materials Science	2-0-0	3,5	B	【Energy Science and Engineering】(ENR.H418)
		CAP.I477.L		E	Organic Electrode Process	2-0-0	3,5	B	【Energy Science and Engineering】(ENR.H419)
		CAP.I444.L		□	Advanced Nano-Materials Chemistry II	1-0-0	3	B	
		CAP.P467.L		O	Advanced Course of Polymer Chemistry A	1-0-0	3	B	
		CAP.P468.L		O	Advanced Course of Polymer Chemistry B	1-0-0	3	B	
		CAP.P461.L		O	Advanced Course in Organic and Soft Materials Chemistry A	1-0-0	3	B	【Materials Science and Engineering】(MAT.P461)
		CAP.P462.L		O	Advanced Course in Organic and Soft Materials Chemistry B	1-0-0	3	B	【Materials Science and Engineering】(MAT.P462)
		CAP.P465.L			Advanced Course in Physical Properties of Organic Materials A	1-0-0	3	B	【Materials Science and Engineering】(MAT.P465)

		CAP.P466.L			Advanced Course in Physical Properties of Organic Materials B	1-0-0	3	B	【Materials Science and Engineering】(MAT.P466)
		CAP.P463.L			Advanced Course in Surface Properties of Organic Materials A	1-0-0	3	B	【Materials Science and Engineering】(MAT.P463)
		CAP.P464.L			Advanced Course in Surface Properties of Organic Materials B	1-0-0	3	B	【Materials Science and Engineering】(MAT.P464)
		CAP.P473.L			Soft Materials Physics	1-0-0	1, 3	B	【Materials Science and Engineering】(MAT.P403)
		CAP.P474.L			Soft Materials Functional Physics	1-0-0	2, 3	B	【Materials Science and Engineering】(MAT.P404)
		CAP.P475.L		O	Soft Materials Chemistry I	1-0-0	3	B	【Materials Science and Engineering】(MAT.P411)
		CAP.P476.L		O	Soft Materials Chemistry II	1-0-0	3	B	【Materials Science and Engineering】(MAT.P412)
		CAP.I451.L			Organic and Bioorganic Chemistry	2-0-0	3,5	B, D	【Life Science and Technology】(LST.A402)
		CAP.I453.L			Design of Bioactive Molecules	2-0-0	3	B, D	【Life Science and Technology】(LST.A405)
		CAP.I455.L			Science of Metabolism	2-0-0	3,4,5	B, D	【Life Science and Technology】(LST.A407)
		CAP.I454.L			Biomolecular Engineering	2-0-0	1,3,5	B, D	【Life Science and Technology】(LST.A411)
		CAP.I452.L			Biomaterial Science and Engineering	2-0-0	1,3,4,5		【Life Science and Technology】(LST.A412)

	500 level	CAP.A562.L		O	Advanced Chemistry of Transition Metal Complexes II	1-0-0	3	B	
		CAP.A521.L		O	Advanced Molecular Design for Organic Synthesis I	1-0-0	3,5	B	
		CAP.A571.L			Advanced Chemical Materials for Energy Issues I	1-0-0	3,4,5	B	【Energy Science and Engineering】(ENR.H501)
		CAP.A572.L			Advanced Chemical Materials for Energy Issues II	1-0-0	3,4,5	B	【Energy Science and Engineering】(ENR.H502)
		CAP.C511.L		□	Life Cycle Engineering	2-0-0	3,5	B	
		CAP.C521.L		□	Chemical Engineering in Global Business	1-0-0	1,2,3,5	B,D	
		CAP.C531.L		□	Advanced Chemical Equipment Design	2-0-0	3,5	B	
		CAP.C532.L		□	Advanced Specific Environmental Process	2-0-0	3,4	B	
		CAP.C541.L		□	Advanced Nanoscale Chemical Process	2-0-0	1,3,4,5	B	
		CAP.I547.L			Advanced Process Dynamics and Control	1-0-0	3,5	B	
		CAP.I551.L			Environmental Microbiology	2-0-0	1,3,4,5	B,D	【Life Science and Technology】(LST.A503)

Note：

・◎：Required course, ○：Restricted elective, O：odd academic years, E：even academic years

・□：Course is recognized as an Academy for Co-creative Education of Environment and Energy Science, Leading Graduate School (ACEEES) course.

• Competencies: 1 = Intercultural skills; 2 = Communication skills; 3 = Specialist skills; 4 = Critical thinking skills; 5 = Practical and/or problem-solving skills

・【 】Course offered under 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 (Applied chemistry), C (Chemical engineering), P (Polymer science), I (Interdisciplinary science and technology), E (Others), Z (Research seminars).

6. IGP Courses That Can be Recognized as Humanities and Social Science Courses

None

7. IGP Courses That Can be Recognized as Career Development Courses

As a general rule, students who would like their Career Development Courses to contribute to completion requirements of their master's degree program need to satisfy all of the specified Graduate Attributes ("GA"), including the attainment of at least two course credits, listed in Table MA-1 of the "Guide to Graduate Education and International Graduate Program (Liberal Arts and Basic Science Courses) - Career Development Courses". The status of the GA will be evaluated at the time of degree completion.

In addition to Career Development Courses, there are Major Courses that can also be recognized as such — shown below in Table M3 — which may go toward fulfilling the GA requirements.

However, note that when the corresponding Major Courses are recognized and accredited as Career Development Courses, their credits cannot be counted a second time (as Major Courses) towards degree completion requirements.

Table M3. Courses of the Graduate Major in Chemical Science and Engineering that can be recognized as Career Development Courses

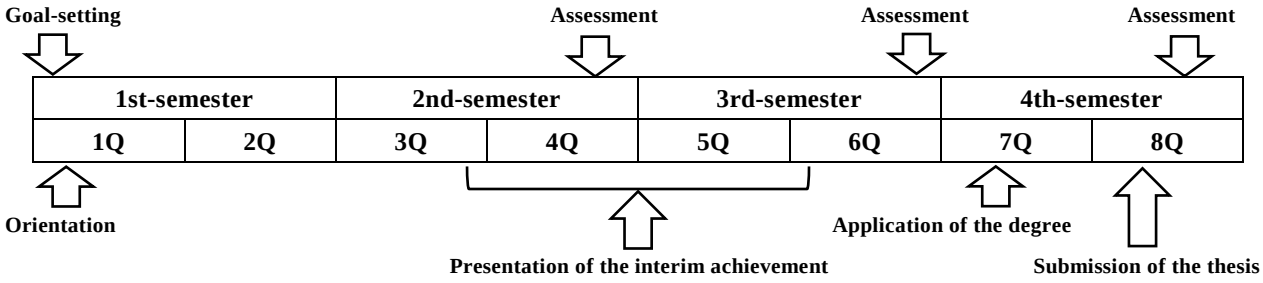
Course category	**Course number**	**Course**			**Credits**	**GA***	**Learning goals**	**Comments**
can be recognized as Career Development Courses	CAP.E411.L			Advanced Internship in Chemical Science and Engineering I	0-0-1	C1M	D	
	CAP.E412.L			Advanced Internship in Chemical Science and Engineering II	0-0-2	C1M	D	

To satisfy the Career Development requirement, credits may be acquired from courses listed above as well as from those listed under Career Development Courses (see the Liberal Arts and Basic Science Courses Guide).

＊GA：Graduate Attribute

8. Research Related to the Completion of Master Theses

The research related to the completion of a master thesis, aims at acquiring the basic abilities through an entire research process including goal-setting, problem resolution and basic communications. The following diagram represents a typical example before the final examination. The supervisor makes an assessment of the academic achievements, and reviews an individual course plan with respect to the research orientation and the progress.



・Presentation of the interim achievement

This presentation is for the deeper understanding of own research project with respect to the background, goal and significance.

・Criteria of the examination

Master thesis should contain new and original idea that could contribute to academic or industrial developments in applied chemistry.

・Process of the examination

The final examination is conducted as an oral presentation of the master thesis after a peer-review.

【Doctoral Degree Program】

1. Outline

The purpose of this Doctoral Degree Program is training international leading chemistry researchers and engineers who can understand fundamental properties and reactivities of materials in the atomic/molecular level, acquire highly advanced knowledge of chemical engineering systems for transformation to useful materials involving polymers, acquire an ability for advanced and creative academic research and technology development by using wide range of expertise in chemical science and engineering, possess a vision to establish a novel research field, and contribute to develop environmentally-benign society.

2. Competencies Developed

In this Doctoral Degree Program, students will be able to acquire the following abilities:

- Ability to develop creative academic research and novel technology by highly advanced knowledge in chemical science and engineering
- Ability to understand and elucidate essential fundamental properties, reactivities, and functions of materials in the atomic/molecular level by using highly advanced knowledge in chemical science and engineering
- Creativity to establish a novel research field by using the knowledge in human studies and social science
- Leadership to present guidelines for environmentally-friendly society

3. Learning Goals

In this Doctoral degree program, students are expected to study the following contents to acquire the "Competencies Developed" mentioned above.

Ａ） Acquisition of the advanced specialized knowledge of chemical science and engineering

Acquisition of the world-class specialized knowledge of applied chemistry, macromolecular science, and chemical engineering, and deepening and sharpening of the acquired knowledge through the research seminars

Ｂ） Acquisition of specialized knowledge in interdisciplinary field

Acquisition of ability to expand research into interdisciplinary field by utilizing and applying acquired specialized knowledge in student's own specialized field

Ｃ） Learning of critical thinking skills and practical skills in chemical science and engineering

Acquisition of ability to build and practice leading-edge research theme in student's own research field through academic writing of thesis

Ｄ） Learning to relive the social involvement

Learning of reliving studies and engineer ethics through systematic researches and development at the host agency such as institute and company, and the specialized courses made by lecturers from social communities

Ｅ） Learning to enforce logical thinking and communication skills

Training ability to present student's own research domestically and internationally, and cultivation of the logical

thinking and communication skills to develop an argument with researchers and engineers in various research fields

4. IGP Completion Requirements

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

1. A total of 24 credits or more acquired from 600-level courses.
2. Meet the completion requirements indicated in Table D1. below.
3. Pass the doctoral thesis review and defense.

Table D1. Graduate Major in Chemical Science and Engineering 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		C,D,E	
	Other courses					
Core courses	**Research seminars**	Seminar in Chemical Science and Engineering S3 Seminar in Chemical Science and Engineering F3 Seminar in Chemical Science and Engineering S4 Seminar in Chemical Science and Engineering F4 Seminar in Chemical Science and Engineering S5 Seminar in Chemical Science and Engineering F5 A total of 12 credits, 2 credits each from the above courses.		16 credits	A,B,C,D,E	
	Research-related courses				C,D,E	
	Major courses				A,B,C,D	
	Major courses and Research-related Courses <u>outside</u> the Graduate					

	Major in Chemical Science and Engineering standard curriculum					
Total required credits	**A minimum of 24 credits in addition to meeting the above conditions**					
Note	**・Japanese Language and Culture Courses offered to International Students can be recognized as Humanities and Social Science Courses of the corresponding course level.** **・As for Liberal Arts and Basic Science Courses, please refer to the relevant pages.**					

5. IGP Courses

Table D2. Core Courses of the Graduate Major in Chemical Science and Engineering

Course category		**Course number**	**Course**			**Credits**	**Competencies**	**Learning goals**	**Comments**
Research seminars	**600 level**	CAP.Z691.R	◎		Seminar in Chemical Science and Engineering S3	0-1-1	2,3,5	A,C,E	
		CAP.Z692.R	◎		Seminar in Chemical Science and Engineering F3	0-1-1	2,3,5	A,C,E	
		CAP.Z693.R	◎		Seminar in Chemical Science and Engineering S4	0-1-1	2,3,5	A,C,E	
		CAP.Z694.R	◎		Seminar in Chemical Science and Engineering F4	0-1-1	2,3,5	A,C,E	
		CAP.Z695.R	◎		Seminar in Chemical Science and Engineering S5	0-1-1	2,3,5	A,C,E	
		CAP.Z696.R	◎		Seminar in Chemical Science and Engineering F5	0-1-1	2,3,5	A,C,E	
Major courses	**600 level**	CAP.E611.L			Academic Writing Practice I	0-1-0	1,5	E	
		CAP.E612.L			Academic Writing Practice II	0-1-0	1,5	E	
		CAP.E621.L			Problem-Solving Program in Chemical Science and Engineering I	0-0-1	1,2,4	B,E	
		CAP.E622.L			Problem-Solving Program in Chemical Science and Engineering II	0-0-1	1,2,4	B,E	
		CAP.E623.L			Problem-Solving Program in Chemical Science and Engineering III	0-0-1	1,2,4	B,E	
		CAP.E624.L			Problem-Solving Program in Chemical Science and Engineering IV	0-0-1	1,2,4	B,E	
		CAP.E631.L			Chemical Science and Engineering Off-Campus Project I	0-0-1	1,2,5	B,D	

		CAP.E632.L			Chemical Science and Engineering Off-Campus Project II	0-0-2	1,2,5	B,D	
		CAP.E633.L			Chemical Science and Engineering Off-Campus Project III	0-0-4	1,2,5	B,D	
		CAP.E634.L			Chemical Science and Engineering Off-Campus Project IV	0-0-6	1,2,5	B,D	
		CAP.I.686.L			International scientific presentation A	0-0-1	2,3	B,C,E	【Energy Science and Engineering】(ENR.E604)
		CAP.I.687.L			International scientific presentation B	0-0-1	2,3	B,C,E	【Energy Science and Engineering】(ENR.E605)
		CAP.I.688.L			International scientific presentation C	0-0-1	2,3	B,C,E	【Energy Science and Engineering】(ENR.E606)
		CAP.I.692.L			Academic Writing A	1-0-0	2,4	B,E	【Energy Science and Engineering】(ENR.E610)
		CAP.I.693.L			Academic Writing B	1-0-0	1,2,4	B,E	【Energy Science and Engineering】(ENR.E611)
		CAP.I.694.L			International energy project	0-0-2	1,2,4,5	B,E	【Energy Science and Engineering】(ENR.E612)

Note：

・◎：Required course, ○：Restricted elective, O：odd academic years, E：even academic years

・□：Course is recognized as an Academy for Co-creative Education of Environment and Energy Science, Leading Graduate School (ACEEES) course.

• Competencies: 1 = Intercultural skills; 2 = Communication skills; 3 = Specialist skills; 4 = Critical thinking skills; 5 = Practical and/or problem-solving skills

•【 】Course offered under 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 (Applied chemistry), C (Chemical engineering), P (Polymer science), I (Interdisciplinary science and technology), E (Others), Z (Research seminars).

6. IGP Courses That Can be Recognized as Humanities and Social Science Courses

None

7. IGP Courses That Can be Recognized as Career Development Courses

As a general rule, students who would like their Career Development Courses to contribute to completion requirements of their doctoral degree program need to satisfy all of the specified Graduate Attributes ("GA"), including the attainment of at least four course credits, listed in Table A-1 or A-2 of the "Guide to Graduate Education and International Graduate Program (Liberal Arts and Basic Science Courses) - Career Development Courses". The status of the GA will be evaluated at the time of degree completion.

In addition to Career Development Courses, there are Major Courses that can also be recognized as such — shown below in Table D3 — which may go toward fulfilling the GA requirements.

However, note that when the corresponding Major Courses are recognized and accredited as Career Development Courses, their credits cannot be counted a second time (as Major Courses) towards degree completion requirements.

Table D3-1. Courses of the Graduate Major in Chemical Science and Engineering that can be recognized as Career Development Courses in the Academic Leader Program (ALP)

Course category	**Course number**	**Course**			**Credits**	**GA***	**Learning goals**	**Comments**
can be recognized as Career Development Courses	CAP.E631.L			Chemical Science and Engineering Off-Campus Project I	0-0-1	A1D, A2D, A3D	D	
	CAP.E632.L			Chemical Science and Engineering Off-Campus Project II	0-0-2	A1D, A2D, A3D	D	
	CAP.E633.L			Chemical Science and Engineering Off-Campus Project III	0-0-4	A1D, A2D, A3D	D	
	CAP.E634.L			Chemical Science and Engineering Off-Campus Project IV	0-0-6	A1D, A2D, A3D	D	

To satisfy the Career Development requirement, credits may be acquired from courses listed above as well as from those listed under Career Development Courses (see the Liberal Arts and Basic Science Courses Guide).

＊GA：Graduate Attribute

Table D3-2. Courses of the Graduate Major in Chemical Science and Engineering that can be recognized as Career Development Courses in the Productive Leader Program (PLP)

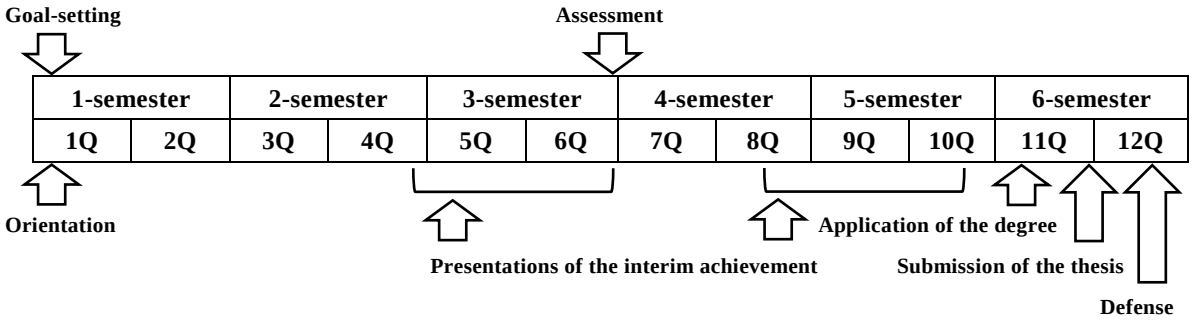
Course category	Course number	Course			Credits	GA*	Learning goals	Comments
can be recognized as Career Development Courses	CAP.E631.L			Chemical Science and Engineering Off-Campus Project I	0-0-1	P1D, P2D, P3D	D	
	CAP.E632.L			Chemical Science and Engineering Off-Campus Project II	0-0-2	P1D, P2D, P3D	D	
	CAP.E633.L			Chemical Science and Engineering Off-Campus Project III	0-0-4	P1D, P2D, P3D	D	
	CAP.E634.L			Chemical Science and Engineering Off-Campus Project IV	0-0-6	P1D, P2D, P3D	D	

To satisfy the Career Development requirement, credits may be acquired from courses listed above as well as from those listed under Career Development Courses (see the Liberal Arts and Basic Science Courses Guide).

＊GA：Graduate Attribute

8. Research Related to the Completion of Doctoral Theses

The research related to the completion of a doctoral thesis, aims at acquiring comprehensive ability including goal-setting, problem resolution and international communication at higher level. The following diagram represents a typical example before the final examination.



・Criteria of the examination

Doctoral thesis should be genuinely the work of the candidate containing originality and significance that could contribute to academic or industrial developments in applied chemistry.

・Process of the examination

The doctoral thesis is reviewed by faculty members of the board who can judge the thesis from academic or technical viewpoints. The board can contain external experts from other universities or companies. After submission of the thesis and a public presentation by the candidate, the thesis will be peer-reviewed by the board. The final examination (defense) is conducted for an assessment of the thesis.