Graduate Major in Computer Science

【Master's Degree Program】

1. Outline

We cultivate individuals who have broad expertise in advanced theories and technologies relating to information infrastructure, information systems, and information services that are indispensable to modern society. Our students will become individuals who use this knowledge to contribute to the world by not only presenting solutions to problems that have given due consideration to the impact they will have on people and society, but also by developing and implementing these solutions.

2. Competencies Developed

After completing the program, students will acquire the following competencies:

- Deep expertise in cutting-edge hardware and software necessary for information infrastructure, information systems, and information services as well as logical reasoning skills
- Extensive education and ethical values for building systems useful to society with a firm understanding of what is required by people and society
- Ability to grasp the essence of problems and solve these with a flexible mindset based on expertise
- Communication and leadership skills for making international contributions

3. Learning Goals

A) Advanced courses in computer science

B) Applied courses in computer science

C) Courses for developing broad perspectives and self-determination

D) Courses for learning social relations and science and engineering ethics

E) Courses for improving communicative competence

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 Computer Science curriculum,
    - eight credits acquired from Research Seminars;
    - two credits acquired from Workshop on Computer Science I and II;
    - a minimum of eight credits from Major Courses across more than or equal to three groups of A, B, C and D,

or a minimum of eight credits from Major Courses across group B and E; and

- a minimum of five credits acquired from Liberal Arts and Basic Science Courses (Three credits from Humanities and Social Science Courses of which two credits must be from 400-level courses and one credit from 500-level courses, and two credits 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. Completion Requirements of the Graduate Major in Computer Science

<table>
<tr><th colspan="2">Course category</th><th><Required courses>
Required credits</th><th><Electives>
Minimum credits required</th><th>Minimum credits required</th><th>Associated learning goals</th><th>Comments</th></tr>
<tr><td rowspan="3">Liberal arts and basic science courses</td><td>Humanities and social science courses</td><td></td><td>•2 credits from 400-level
•1 credit from 500-level</td><td rowspan="3">5 credits</td><td>C</td><td></td></tr>
<tr><td>Career development courses</td><td></td><td>2 credits</td><td>C,D</td><td>All Graduate Attributes (GA) should be acquired. (Refer to Section 7 for the definition of GA.)</td></tr>
<tr><td>Other courses</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Core courses</td><td>Research seminars</td><td>Seminar on Computer Science S1
Seminar on Computer Science F1
Seminar on Computer Science S2
Seminar on Computer Science F2

A total of 8 credits, 2 credits each from the above courses.</td><td></td><td rowspan="3">18 credits</td><td>C,D,E</td><td></td></tr>
<tr><td>Research-related courses</td><td>2 credits of Workshop on Computer Science I and II</td><td></td><td>D,E</td><td></td></tr>
<tr><td>Major courses</td><td></td><td>8 credits from Major Courses across more than or equal to three groups of A, B, C and D, or 8 credits from Major Courses across group B and E</td><td>A,B,C,D,E</td><td></td></tr>
<tr><td>Major courses and Research-related courses <u>outside</u> the Graduate Major in Computer Science standard curriculum</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Total required credits</td><td colspan="5">A minimum of 30 credits including those attained according to the above conditions</td></tr>
<tr><td colspan="2">Note</td><td colspan="5">・For further details of the completion requirements, ask Head of Graduate Studies in Computer Science.
・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.
・For details of the Liberal Arts and Basic Science Courses, please refer to the relevant sections.</td></tr>
</table>

5. IGP Courses

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 Computer Science

Course category		Course number	Course title			Credits	Competencies	Learning goals	Comments
Research seminars	400 level	CSC.Z491.R	◎		Seminar on Computer Science S1	0-2-0	2,3,4,5	E	
		CSC.Z492.R	◎		Seminar on Computer Science F1	0-2-0	2,3,4,5	E	
	500 level	CSC.Z591.R	◎		Seminar on Computer Science S2	0-2-0	2,3,4,5	E	
		CSC.Z592.R	◎		Seminar on Computer Science F2	0-2-0	2,3,4,5	E	
Research-related courses	400 level	CSC.U471.L			Internship A (Computing)	0-0-2	2,4,5	C,D,E	【School of Computing】(XCO.U471)
		CSC.U481.R	◎		Workshop on Computer Science I	0-0-1	3,5	B,E	
		CSC.U482.R	◎		Workshop on Computer Science II	0-0-1	3,5	B,E	
	500 level	CSC.U571.L			Internship B (Computing)	0-0-2	2,4,5	C,D,E	【School of Computing】(XCO.U571)
Major courses	400 level	CSC.T405.B	B ○	O	Theory of Algorithms	2-0-0	3	A	【Mathematical and Computing Science】(MCS.T405)
		CSC.T406.A	A ○	E	Distributed Systems	2-0-0	3,5	A	【Mathematical and Computing Science】(MCS.T406)
		CSC.T407.A	A ○	O	High Performance Computing	2-0-0	1,2,3,4	A	【Mathematical and Computing Science】(MCS.T407)
		CSC.T416.B	B ○	E	Logic and Computation	2-0-0	3	A	【Mathematical and Computing Science】(MCS.T416)
		CSC.T418.A	A ○	O	Practical Parallel Computing	2-0-0	3,5	A,B	Mathematical and Computing Science】(MCS.T418)
		CSC.T421.D	D ○	O	Human Computer Interaction	2-0-0	3,4,5	A	
		CSC.T422.B	B ○	E	Mathematical Theory of Programs	2-0-0	3,5	A	

		CSC.T425.B	B ○		Concurrent System Theory	2-0-0	3,4,5	A	
		CSC.T426.B	B ○	O	Software Design Methodology	2-0-0	2,3,4,5	A	
		CSC.T431.A	A ○		Advanced System Software	2-0-0	3	A	
		CSC.T433.A	A ○		Advanced Computer Architecture	2-0-0	3	A	
		CSC.T434.B	B ○		International Project for System Development	0-0-2	1,2,3	B,E	
		CSC.T438.B	B ○		Distributed Algorithms	2-0-0	3,5	A	
		CSC.T458.C	C ○	O	Machine Learning	2-0-0	3	A	【Artificial Intelligence】(ART.T458)
		CSC.T462.C	C ○		Complex Networks	2-0-0	3,5	A	【Artificial Intelligence】(ART.T462)
		CSC.T463.D	D ○	O	Computer Graphics	2-0-0	3	A	【Artificial Intelligence】(ART.T463)
		CSC.T464.C	C ○		Information Organization and Retrieval	2-0-0	3	A	【Artificial Intelligence】(ART.T464)
		CSC.T479.C	C ○		Introduction to Using Computation and Data	2-0-0	3,5	A	【School of Computing】(XCO.T479)
		CSC.T496.L		E	Advanced Topics in Computing AE	2-0-0	1,3	B	【School of Computing】(XCO.T496)
		CSC.T497.L		O	Advanced Topics in Computing AO	2-0-0	1,3	B	【School of Computing】(XCO.T497)
		CSC.T498.L		E	Advanced Topics in Computing BE	2-0-0	1,3	B	【School of Computing】(XCO.T498)
		CSC.T499.L		O	Advanced Topics in Computing BO	2-0-0	1,3	B	【School of Computing】(XCO.T499)
		CSC.U472.L			English Presentation Skills A (Computing)	2-0-0	2	E	【School of Computing】(XCO.U472)
	500 level	CSC.T502.B	B ○		Functional Programming	2-0-0	3	A	【Mathematical and Computing Science】(MCS.T502)
		CSC.T503.B	B ○	O	Programming Language Design	2-0-0	2,3	A	【Mathematical and Computing Science】(MCS.T503)
		CSC.T521.A	A ○		Cloud Computing and Parallel Processing	2-0-0	3	A	
		CSC.T523.D	D ○		Advanced Data Engineering	2-0-0	3,5	A	
		CSC.T524.A	A ○		Dependable Computing	2-0-0	3	A	
		CSC.T526.B	B ○	E	High Performance Scientific Computing	2-0-0	3,5	A	

		CSC.T527.B	B ○		Fault Tolerant Distributed Algorithms	2-0-0	3	A	
		CSC.T543.C	C ○		Bioinformatics	2-0-0	3,4	A	【Artificial Intelligence】(ART.T543)
		CSC.T547.D	D ○		Multimedia Information Processing	2-0-0	3	A	【Artificial Intelligence】(ART.T547)
		CSC.T548.C	C ○		Advanced Artificial Intelligence	2-0-0	3	A	【Artificial Intelligence】(ART.T548)

Note：
- ◎：Required course, ○：Restricted elective, O：odd academic years, E：even academic years
- □：Course recognized as equivalent to that of the Academy for Co-creative Education of Environment and Energy Science (ACEEES).
- Competencies: 1 = Intercultural skills; 2 = Communication skills; 3 = Specialist skills; 4 = Critical thinking skills; 5 = Practical and/or problem-solving skills
- 【 】Course offered by another graduate major

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 cannot be counted more than once as Major Courses or Career Development Courses towards the completion requirements for the master's degree program.

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

The Graduate Attributes of the Master's Degree Program are listed in Table MA-1 as follows:

C0M: Able to delineate one's career plan clearly and recognize the skills necessary to materialize the plan, also considering its relations to the society

C1M: Able to utilize its own expertise to the development of academia and technology, and work with others with different expertise to contribute to problem-solving

Table M3. Courses of the Graduate Major in Computer Science recognized as equivalent to Career Development Courses

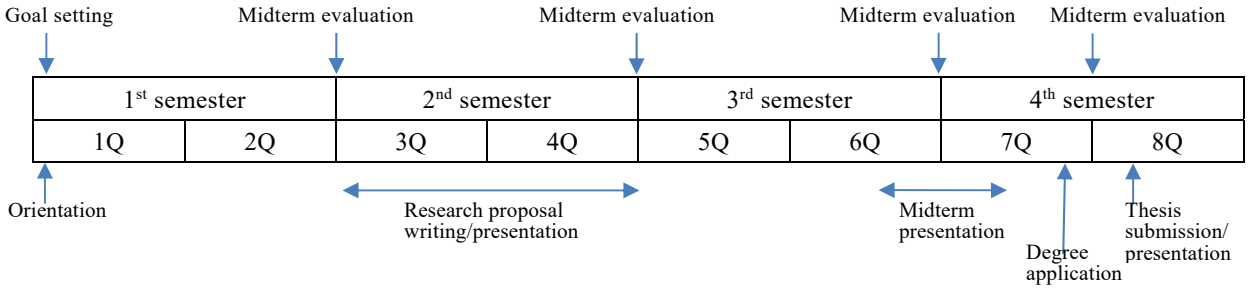
Course category	Course number	Course title	Credits	GA*	Learning goals	Comments
Courses that can be counted as Career Development Courses	CSC.T434.L	International Project for System Development	0-0-2	C0M, C1M	B,E	
	CSC.U471.L	Internship A (Computing)	0-0-2	C0M, C1M	C,D,E	【School of Computing】(XCO.U471)
	CSC.U472.L	English Presentation Skills A (Computing)	2-0-0	C1M	E	【School of Computing】(XCO.U472)
	CSC.U571.L	Internship B (Computing)	0-0-2	C0M, C1M	C,D,E	【School of Computing】(XCO.U571)

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. Research Related to the Completion of Master's Theses

The students acquire abilities for setting and solving problems, and improve their communication skills through accomplishing their Master's thesis. A rough schedule to take their Master's degree is shown in the figure below.



• Research proposal writing and presentation

To clarify the background and objectives of their research topic, the students are required to write a research proposal during 3Q~4Q, then are required to give a presentation of their proposals. Those who have finished their proposal and have taken more than or equal to 8 credits from the core courses of their major are allowed to take 600-level major courses. Note that, however, those credits of 600-level courses are not considered for the completion requirements of Master's degree.

• Qualification of Master's theses

Master's theses must be written by the students themselves and contain an original new idea contributing to advances in computer science or technology in computer engineering.

• Judging procedure of Master's theses

The judging committee of Master's theses consists of at least three professors. The submitted theses are evaluated by the committee members before the defense presentation. The final decision is made after the defense presentation. The judgement is done by more than or equal to five members of the committee for the students who continue their study in the Doctoral degree program.

【Doctoral Degree Program】

1. Outline

We cultivate individuals who have broad expertise in advanced theories and technologies relating to information infrastructure, information systems, and information services that are indispensable to modern society. Our students will become individuals who use this knowledge to contribute to the world by not only presenting solutions to problems that have given due consideration to the impact they will have on people and society, but also by developing and implementing these solutions.

2. Competencies Developed

After completing the program, students will acquire the following competencies:

- Ability to pioneer new fields of learning based on broad, deep expertise in information infrastructure, information systems, and information services
- Ability to discover new problems
- Ability to objectively evaluate the situation in one's own field of expertise from both a technical perspective as well as a broad social perspective
- Strong leadership skills necessary to successfully conduct international joint research and development

3. Learning Goals

A) Courses for developing ability to find and solve problems

B) Courses for developing creativity and communicative competence

C) Courses for developing leadership ability

D) Courses for developing entrepreneurship

E) Courses for developing negotiation ability

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 Computer Science curriculum,
    - Twelve credits acquired from Research Seminars;
    - a minimum of six credits acquired from Liberal Arts and Basic Science Courses

      (Two credits from Humanities and Social Science Courses, and four credits from Career Development Courses).
3. Pass the PhD dissertation 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. Completion Requirements of the Graduate Major in Computer Science

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	All Graduate Attributes (GA) should be acquired. (Refer to Section 7 for the definition of GA.)
	Other courses					
Core courses	**Research seminars**	Seminar on Computer Science S3 Seminar on Computer Science F3 Seminar on Computer Science S4 Seminar on Computer Science F4 Seminar on Computer Science S5 Seminar on Computer Science F5 A total of twelve credits, two credits each from the above courses.		12 credits	A,B,C,D,E	
	Research-related courses					
	Major courses					
	Major courses and Research-related courses outside the Graduate Major in Computer Science standard curriculum					
Total required credits		**A minimum of 24 credits including those attained according to the above conditions**				
Note		**・For further details of the completion requirements, ask Head of Graduate Studies in Computer Science.** **・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.** **・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 Computer Science

Course category		Course number			Course title	Credits	Competencies	Learning goals	Comments
Research seminars	600 level	CSC.Z691.R	◎		Seminar on Computer Science S3	0-2-0	2,3,4,5	A,B	
		CSC.Z692.R	◎		Seminar on Computer Science F3	0-2-0	2,3,4,5	A,B	
		CSC.Z693.R	◎		Seminar on Computer Science S4	0-2-0	2,3,4,5	A,B	
		CSC.Z694.R	◎		Seminar on Computer Science F4	0-2-0	2,3,4,5	A,B	
		CSC.Z695.R	◎		Seminar on Computer Science S5	0-2-0	2,3,4,5	A,B	
		CSC.Z696.R	◎		Seminar on Computer Science F5	0-2-0	2,3,4,5	A,B	
Research-related courses	600 level	CSC.U671.L			Internship C (Computing)	0-0-2	2,4,5	C,D,E	【School of Computing】(XCO.U671)
		CSC.U672.L			English Presentation Skills B (Computing)	2-0-0	2	E	【School of Computing】(XCO.U672)
		CSC.U681.L			Forum on Computer Science S3	0-0-1	1,2,4,5	B,C,D	
		CSC.U682.L			Forum on Computer Science F3	0-0-1	1,2,4,5	B,C,D	
		CSC.U683.L			Forum on Computer Science S4	0-0-1	1,2,4,5	B,C,D	
		CSC.U684.L			Forum on Computer Science F4	0-0-1	1,2,4,5	B,C,D	
		CSC.U685.L			Forum on Computer Science S5	0-0-1	1,2,4,5	B,C,D	
		CSC.U686.L			Forum on Computer Science F5	0-0-1	1,2,4,5	B,C,D	
Major courses	600 level	CSC.T673.L			Advanced Topics of Computing C	2-0-0	1,3	B	【School of Computing】(XCO.T673)
		CSC.T674.L			Advanced Topics of Computing D	2-0-0	1,3	B	【School of Computing】(XCO.T674)

Note：
- ◎：Required course，○：Restricted elective，O：odd academic years，E：even academic years
- □：Course recognized as equivalent to that of the Academy for Co-creative Education of Environment and Energy Science (ACEEES).
- Competencies: 1 = Intercultural skills; 2 = Communication skills; 3 = Specialist skills; 4 = Critical thinking skills; 5 = Practical and/or problem-solving skills
- 【 】Course offered by another graduate major

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 Tables D3-1 and D3-2 below.

However, it must be noted that credits attained from these courses cannot be counted more than once as Major Courses or Career Development Courses towards the completion requirements for the doctoral degree program.

For Graduate Attributes, refer to the Guide to the Career Development Courses.
The Graduate Attributes of the Academic Leader Program (ALP) are listed in Table A-1 as follows:

- A0D: You will be able to precisely draw your own career plan and self-train yourself to acquire the skills required for attaining your goals in the academic field
- A1D: You will be able to ascertain the true nature of phenomena, master the secret of learning, and lead the pioneering of a new academic discipline or research area
- A2D: You will be able to understand the position of academia in society, and adequately explain the academic progress to members of society, which is the stakeholder
- A3D: You will be able to nurture junior students in educational institutions, inculcating in them an interest in academics and enabling them to later join in the pioneering of new academic disciplines or research areas

The Graduate Attributes of the Productive Leader Program (PLP) are listed in Table A-2 as follows:

- P0D: You will be able to precisely draw your own career plan and self-train yourself to acquire the skills required for attaining your goals in the industry, etc.
- P1D: You will be able to precisely grasp the needs of society and detect its problems, and lead the future developments in science and technology
- P2D: While leading teams consisting of members with varied specialties and value systems, you will be able to create products and enterprises that bring forth new values in the society
- P3D: Through the project, you will be able to nurture junior students, enabling them to later join in the development of next generation society and industry

Table D3-1. Courses of the Graduate Major in Computer Science recognized as equivalent to Career Development Courses in the Academic Leader Program (ALP)

Course category	Course number	Course title	Credits	GA*	Learning goals	Comments
Courses that can be counted as Career Development Courses	CSC.U671.L	Internship C (Computing)	0-0-2	A1D,A2D, A3D	C,D,E	【School of Computing】(XCO.U671)
	CSC.U672.L	English Presentation Skills B (Computing)	2-0-0	A2D,A3D	E	【School of Computing】(XCO.U672)
	CSC.U681.L	Forum on Computer Science S3	0-0-1	A0D,A1D, A2D	B,C,D	
	CSC.U682.L	Forum on Computer Science F3	0-0-1	A1D,A2D, A3D	B,C,D	
	CSC.U683.L	Forum on Computer Science S4	0-0-1	A0D,A1D, A2D	B,C,D	
	CSC.U684.L	Forum on Computer Science F4	0-0-1	A1D,A2D, A3D	B,C,D	
	CSC.U685.L	Forum on Computer Science S5	0-0-1	A0D,A1D, A2D	B,C,D	
	CSC.U686.L	Forum on Computer Science F5	0-0-1	A1D,A2D, A3D	B,C,D	

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

Table D3-2. Courses of the Graduate Major in Computer Science recognized as equivalent to Career Development Courses in the Productive Leader Program (PLP)

Course category	Course number	Course title	Credits	GA*	Learning goals	Comments
Courses that can be counted as Career Development Courses	CSC.U671.L	Internship C (Computing)	0-0-2	P1D,P2D, P3D	C,D,E	【School of Computing】(XCO.U671)
	CSC.U672.L	English Presentation Skills B (Computing)	2-0-0	P2D,P3D	E	【School of Computing】(XCO.U672)
	CSC.U681.L	Forum on Computer Science S3	0-0-1	P0D,P1D, P2D	B,C,D	
	CSC.U682.L	Forum on Computer Science F3	0-0-1	P1D,P2D, P3D	B,C,D	
	CSC.U683.L	Forum on Computer Science S4	0-0-1	P0D,P1D, P2D	B,C.D	
	CSC.U684.L	Forum on Computer Science F4	0-0-1	P1D,P2D, P3D	B,C.D	
	CSC.U685.L	Forum on Computer Science S5	0-0-1	P0D,P1D, P2D	B,C.D	
	CSC.U686.L	Forum on Computer Science F5	0-0-1	P1D,P2D, P3D	B,C.D	

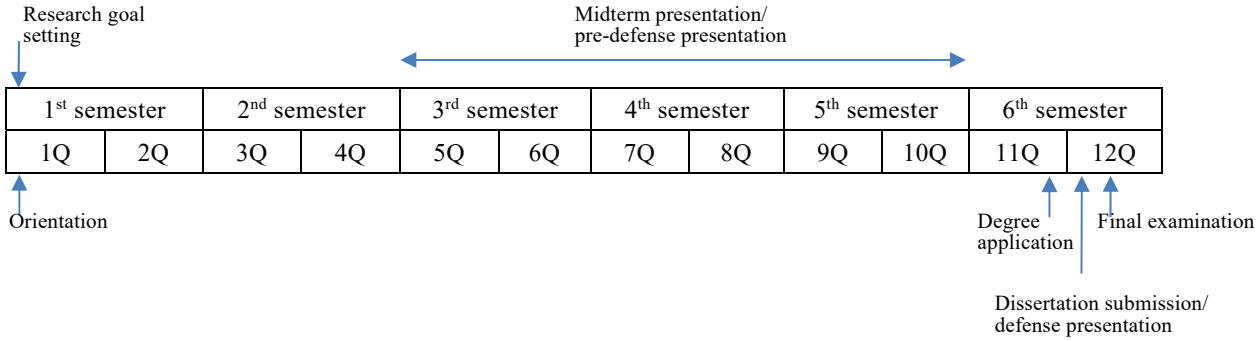
Credits in Career Development Courses must be attained from among the above-listed courses and those listed as such in the Liberal Arts and Basic Science Courses Guide.

＊GA: Graduate Attributes

Students enrolled in the educational program for leading graduate schools or in the Tokyo Tech Academy for Leadership (ToTAL) 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. Research Related to the Completion of Doctoral Dissertations

The students acquire abilities for setting and solving problems, and improve their communication skills, particularly in their second language. through accomplishing their Doctoral dissertation. A rough schedule to take their Doctoral degree is shown in the figure below.



• Qualification of Doctoral dissertations

Doctoral dissertations must be written by the students themselves and contain an original new idea contributing to advances in computer science or technology in computer engineering.

• Judging procedure of Doctoral dissertations

The judging committee of Doctoral dissertations consists of at least five professors. After the midterm presentation and pre-defense presentation, the submitted dissertations are evaluated by the committee members before the defense presentation. The final decision is made after the final examination where the students' English proficiency and the knowledge in their specialized field are judged.