Graduate Major in Artificial Intelligence

【Master's Degree Program】

1. Outline

We aim to foster individuals who possess a wide range of basic expertise related to artificial intelligence, such as basic mathematical science, computation theory, and modeling, and can apply these specialized abilities to solve difficult problems by collaborating with members of differing backgrounds and different areas of expertise.

2. Competencies Developed

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

- Ability to solve real-world problems by applying specialized knowledge of artificial intelligence to develop new artificial intelligence technology
- Ability to grasp complicated real-world subjects in an abstract manner
- Ability to accurately express and communicate one's thoughts and research contents
- Ability to collaborate with members of differing backgrounds and specialties to solve problems

3. Learning Goals

A) Advanced courses in artificial intelligence

B) Applied courses in artificial intelligence

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. A total of 30 credits or more acquired from 400- and 500-level courses.
2. From the courses specified in the Graduate Major in Artificial Intelligence curriculum,
    - eight credits acquired from Research Seminars;
    - two credits acquired from Workshop on Artificial Intelligence I and II;
    - a minimum of eight credits acquired from Major Courses; and
    - a minimum of five credits acquired from Liberal Arts and Basic Science Courses (Three credits from the 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. Completion Requirements of the Graduate Major in Artificial Intelligence

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	C	
	Career development courses		2 credits		C, D	
	Other courses					
Core courses	**Research seminars**	Seminar on Artificial Intelligence S1 Seminar on Artificial Intelligence F1 Seminar on Artificial Intelligence S2 Seminar on Artificial Intelligence F2 A total of 8 credits, 2 credits each from the above courses.		18 credits	C, D, E	
	Research-related Courses	2 credits of Workshop on Artificial Intelligence I and II			D, E	
	Major courses		8 credits from Major Courses		A, B, C, D, E	
	Major courses and Research-related courses outside the Graduate Major in Artificial Intelligence standard curriculum					
Total required credits		**A minimum of 30 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 Artificial Intelligence

Course category		Course number	Course			Credits	Competencies	Learning goals	Comments
Research seminars	**400 level**	ART.Z491.R	◎		Seminar on Artificial Intelligence S1	0-2-0	2,3,4,5	E	
		ART.Z492.R	◎		Seminar on Artificial Intelligence F1	0-2-0	2,3,4,5	E	
	500 level	ART.Z591.R	◎		Seminar on Artificial Intelligence S2	0-2-0	2,3,4,5	E	
		ART.Z592.R	◎		Seminar on Artificial Intelligence F2	0-2-0	2,3,4,5	E	
Research-related courses	**400 level**	ART.U471.L			Internship A (Computing)	0-0-2	2,4,5	C, D, E	【School of Computing】(XCO.U471)
		ART.U481.R	◎		Workshop on Artificial Intelligence I	0-0-1	3,5	B, E	
		ART.U482.R	◎		Workshop on Artificial Intelligence II	0-0-1	3,5	B, E	
	500 level	ART.U571.L			Internship B (Computing)	0-0-2	2,4,5	C, D, E	【School of Computing】(XCO.U571)
Major courses	**400 level**	ART.T401.L		O	Analysis on Continuous Systems	2-0-0	3	A	【Mathematical and Computing Science】(MCS.T401)
		ART.T402.L			Mathematical Optimization: Theory and Algorithms	2-0-0	3	A	【Mathematical and Computing Science】(MCS.T402)
		ART.T403.L			Statistical Learning Theory	2-0-0	3,5	A	【Mathematical and Computing Science】(MCS.T403)
		ART.T404.L		E	Logical Foundations of Computing	2-0-0	3	A	【Mathematical and Computing Science】(MCS.T404)
		ART.T405.L		O	Theory of Algorithms	2-0-0	3	A	【Mathematical and Computing Science】(MCS.T405)
		ART.T406.L		E	Distributed Algorithms	2-0-0	3,5	A	【Mathematical and Computing Science】(MCS.T406)

		ART.T407.L		O	High Performance Computing	2-0-0	1,2,3,4	A	【Mathematical and Computing Science】(MCS.T407)
		ART.T421.L			Human Computer Interaction	2-0-0	3,4,5	A	【Computer Science】(CSC.T421)
		ART.T434.L			International Project for System Development	0-0-2	1,2,3	B,E	【Computer Science】(CSC.T434)
		ART.T451.L			Mathematics of Discrete Systems	2-0-0	3,5	A	
		ART.T458.L			Machine Learning	2-0-0	3	A	
		ART.T460.L			Speech Information Processing	2-0-0	3,5	A	
		ART.T462.L		O	Complex Networks	2-0-0	3,5	A	
		ART.U472.L			English Presentation Skills A (Computing)	2-0-0	2	E	【School of Computing】(XCO.U472)
	500 level	ART.T541.L			Intelligent Systems	2-0-0	3,5	A	
		ART.T542.L			Studies of Social and Economic Systems	2-0-0	1,2,3,4,5	A	
		ART.T543.L			Bioinformatics	2-0-0	3,4	A	
		ART.T546.L			Design Theory in Biological Systems	2-0-0	3	A	
		ART.T548.L			Advanced Artificial Intelligence	2-0-0	3	A	

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.

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 Artificial Intelligence that can be recognized as Career Development Courses

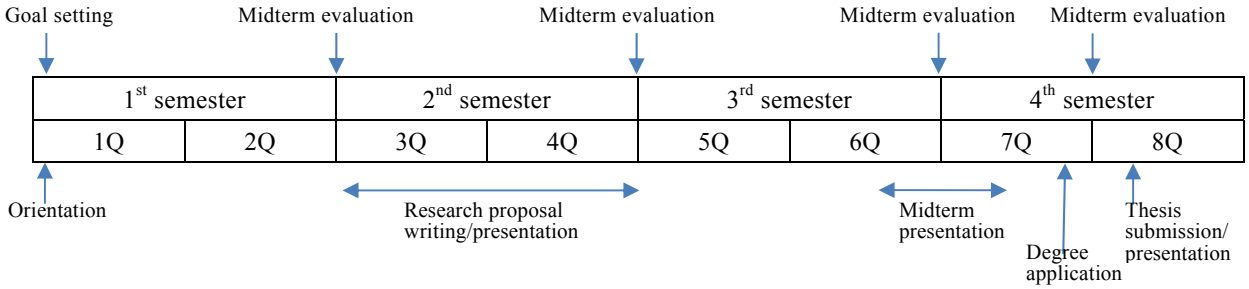
Course category	Course number	Course			Credits	GA*	Learning goals	Comments
Courses that can be recognized as Career Development Courses	ART.T434.L			International Project for System Development	0-0-2	C1M	B,E	
	ART.U471.L			Internship A (Computing)	0-0-2	C0M, C1M	C,D,E	
	ART.U472.L			English Presentation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

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'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 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 artificial intelligence.

• 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 aim to develop individuals who have the ability to apply their expertise in artificial intelligence, define complicated real-world problems precisely, and lead a team of members of differing backgrounds and specialties to solve problems.

2. Competencies Developed

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

- Ability to pioneer and define new problems in the field of artificial intelligence, and to formulate a research plan
- Ability to grasp complicated real-world subjects in an abstract manner and discern its essence
- Ability to lead a team of members of differing backgrounds and specialties to solve problems
- Ability to disseminate research findings internationally and to lead the field of artificial intelligence

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. A total of 24 credits or more acquired from 600-level courses.
2. From the courses specified in the Graduate Major in Artificial Intelligence 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. Completion Requirement of the Graduate Major in Artificial Intelligence

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	
	Other courses					
Core courses	Research seminars	Seminar on Artificial Intelligence S3 Seminar on Artificial Intelligence F3 Seminar on Artificial Intelligence S4 Seminar on Artificial Intelligence F4 Seminar on Artificial Intelligence S5 Seminar on Artificial Intelligence 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 <u>outside</u> the Graduate Major in Artificial Intelligence 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 Artificial Intelligence

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

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.

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 Artificial Intelligence that can be recognized as Career Development Courses in the Academic Leader Program (ALP)

Course category	Course number	Course			Credits	GA*	Learning goals	Comments
Courses that can be recognized as Career Development Courses	ART.U671.L			Internship C (Computing)	0-0-2	A1D,A2D, A3D	C,D,E	
	ART.U672.L			English Presentation Skills B (Computing)	2-0-0	A2D,A3D	E	
	ART.U681.L			Forum on Artificial Intelligence S3	0-0-1	A0D,A1D, A2D	B,C,D	
	ART.U682.L			Forum on Artificial Intelligence F3	0-0-1	A1D,A2D, A3D	B,C,D	
	ART.U683.L			Forum on Artificial Intelligence S4	0-0-1	A0D,A1D, A2D	B,C,D	
	ART.U684.L			Forum on Artificial Intelligence F4	0-0-1	A1D,A2D, A3D	B,C,D	
	ART.U685.L			Forum on Artificial Intelligence S5	0-0-1	A0D,A1D, A2D	B,C,D	
	ART.U686.L			Forum on Artificial Intelligence F5	0-0-1	A1D,A2D, A3D	B,C,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).

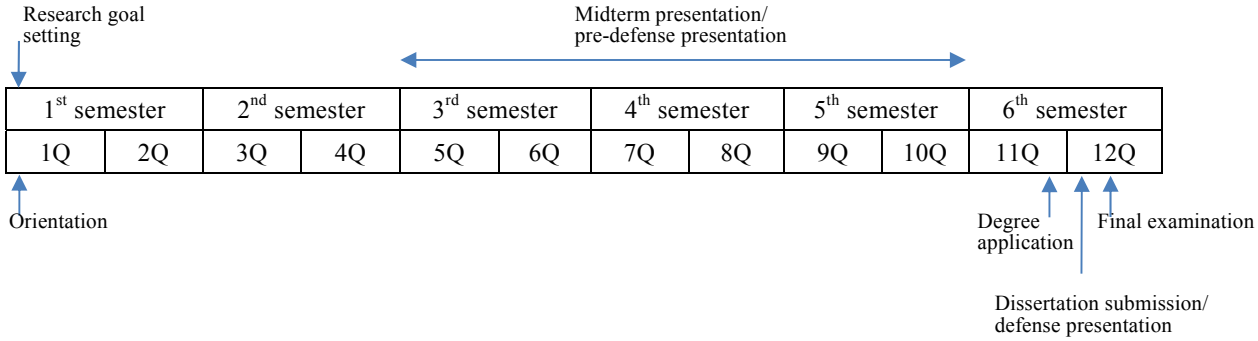
＊GA: Graduate Attribute

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

Course category	Course number	Course			Credits	GA*	Learning goals	Comments
Courses that can be recognized as Career Development Courses	ART.U671.L			Internship C (Computing)	0-0-2	P1D,P2D, P3D	C,D,E	
	ART.U672.L			English Presentation Skills B (Computing)	2-0-0	P2D,P3D	E	
	ART.U681.L			Forum on Artificial Intelligence S3	0-0-1	P0D,P1D, P2D	B,C,D	
	ART.U682.L			Forum on Artificial Intelligence F3	0-0-1	P1D,P2D, P3D	B,C,D	
	ART.U683.L			Forum on Artificial Intelligence S4	0-0-1	P0D,P1D, P2D	B,C,D	
	ART.U684.L			Forum on Artificial Intelligence F4	0-0-1	P1D,P2D, P3D	B,C,D	
	ART.U685.L			Forum on Artificial Intelligence S5	0-0-1	P0D,P1D, P2D	B,C,D	
	ART.U686.L			Forum on Artificial Intelligence F5	0-0-1	P1D,P2D, P3D	B,C,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 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 artificial intelligence.

• 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.