Graduate Major in Nuclear Engineering

【Master's Degree Program】

1. Outline

Growing attention has been placed on nuclear energy as an ultimate measure for reduction of fossil fuel consumption and CO_2 emission. Under the circumstances of global warming and the price hike of oil, gas and coal, a number of countries have been considering the implementation of nuclear power plants. The key factor of the nuclear energy development is the development of human resources. Our original course of international nuclear engineering has been established in 1993. Since then, a number of students have joined us from many countries and graduated from our course. They are actively contributing to the development of industries and technologies in Japan or in their own countries. This graduate course provides with core curriculum for nuclear reactor engineering and fuel cycle technologies and also covers extended nuclear energy, such as beam, accelerator, plasma sciences, nuclear fusion, energy and environment, and social relations.

2. Competencies Developed

The curriculum is structured to allow students to acquire advanced specialized knowledge of nuclear engineering, broad vision and education, and a strong sense of ethics and responsibility based on the systematic or comprehensive knowledge of science and engineering learned in the Undergraduate Program. It also enables students to acquire more advanced specialized knowledge, logical dialogue skills, writing skills, practical problem-solving ability, and creativity through Research Seminars and master's thesis research.

3. Learning Goals

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

・High specialized knowledge to understand the essence of problems in nuclear engineering

・Mastery of skills to solve practical problems by the use of the high specialized knowledge

・Mastery of skills for solutions and creative research and development with high ethics and societal responsibilities by the use of the specialized knowledge and high degree of sophistication

・Mastery of skills to deploy discussions with academic presentations and scientific communications in English

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 Nuclear Engineering curriculum,
    - 8 credits acquired from Research Seminars;
    - a minimum of 21 credits acquired from courses of Research Seminars, Research-Related Courses, and Major Courses
    - 8 credits acquired from required Major Courses
    - 5 credits acquired from restricted selective Major Courses
    - a minimum of 5 credits acquired from Liberal Arts and Basic Science Courses (3 credits from the Humanities and Social Science Courses of which 2 credits must be from 400-level courses and 1 credit from 500-level courses, and 2 credits from Career Development Courses).
3. Pass the master's thesis review and defense.

Table M1. Graduate Major in Nuclear 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	B	
	Career development courses		2 credits		C	
	Other courses				B	
Core courses	Research seminars	Seminar in Nuclear Engineering S1 Seminar in Nuclear Engineering F1 Seminar in Nuclear Engineering S2 Seminar in Nuclear Engineering F2 A total of 8 credits, 2 credits each from the above courses.		21 credits	B,D,E,F	
	Research-related courses				B	
	Major courses	8 credits	A total of 5 credits from Restricted electives Group A		A, B	
	Major courses and Research-related Courses <u>outside</u> the Graduate Major in Nuclear Engineering standard curriculum				B	
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 Nuclear Engineering

Course category		Course number			Course	Credits	Competencies	Learning goals	Comments
Research seminars	400 level	NCL.Z491.R	◎	★	Seminar in Nuclear Engineering S1	0-2-0	1,2,3,4,5	A,B,D,F	
		NCL.Z492.R	◎	★	Seminar in Nuclear Engineering F1	0-2-0	1,2,3,4,5	A,D,F	
	500 level	NCL.Z591.R	◎	★	Seminar in Nuclear Engineering S2	0-2-0	1,2,3,4,5	A,D,F	
		NCL.Z592.R	◎	★	Seminar in Nuclear Engineering F2	0-2-0	1,2,3,4,5	A,D,F	
Research-related courses	500 level	NCL.I501.L			Internship in Nuclear Engineering I	0-0-1	2,4,5	B	
		NCL.I502.L			Internship in Nuclear Engineering II	0-0-2	2,4,5	B	
		NCL.I503.L			Internship in Nuclear Reactor Decommissioning I	0-0-1	2,4,5	B	
		NCL.I504.L			Internship in Nuclear Reactor Decommissioning II	0-0-2	2,4,5	B	
		NCL.I505.L		★	International Internship in Nuclear Engineering I	0-0-2	1,2,3,4,5	B	
		NCL.I506.L		★	International Internship in Nuclear Engineering II	0-0-2	1,2,3,4,5	B	
		NCL.I507.L		★	International Internship in Nuclear Engineering III	0-0-2	1,2,3,4,5	B	
		NCL.I508.L		★	International Internship in Nuclear Engineering IV	0-0-2	1,2,3,4,5	B	
Major courses	400 level	NCL.A401.L		★	Laser and Particle‐Beam Technology and Its Medical Applications	2-0-0	3	A	
		NCL.A402.L		★	Nuclear Fusion Reactor Engineering	2-0-0	3	A	
		NCL.B401.L		★ □	Radiation Biology and Medicine	2-0-0	3	A	For ACEEES
		NCL.C401.R	◎	★ □	Nuclear Fuel Cycle Engineering	2-0-0	3	A	For ACEEES

		NCL.C402.L		★	Radioactive Waste Management and Disposal Engineering	1-0-0	3	A	
		NCL.C403.L		★	Nuclear Chemical Engineering	1-0-0	3	A	
		NCL.D401.A	○	★	Experiments for Materials related to Decommissioning A	0-0-1	3,5	A	Either NCL.D401.A or NCL.D402.A can be earned.
		NCL.D402.A	○	★	Experiments for Materials related to Decommissioning B	0-0-1	3,5	A	Either NCL.D401.A or NCL.D402.A can be earned.
		NCL.D403.A	○	★	Experiment on Severe Accident Engineering	1-0-1	3,5	A	
		NCL.D404.L			Nuclear Reactor Decommissioning	1-0-0	3	A	
		NCL.D405.A	○	★	Experiments for Nuclear Fuel Debris and Back‐end Fuel Cycle A	0-0-1	3	A	Either NCL.D405.A or NCL.D406.A can be earned.
		NCL.D406.A	○	★	Experiments for Nuclear Fuel Debris and Back‐end Fuel Cycle B	0-0-1	3	A	Either NCL.D405.A or NCL.D406.A can be earned.
		NCL.F401.L			Ethics for Nuclear System Development	1-0-0	2,3,4,5	B	
		NCL.F402.L			Acts and Regulations on Atomic Energy	1-0-0	3,5	B	
		NCL.N401.L		★ □	Basic Nuclear Physics	2-0-0	3,5	A	For ACEEES
		NCL.N402.R	◎	★ □	Neutron Transport Theory	1-1-0	3,5	A	For ACEEES
		NCL.N403.L		★ □	Nuclear Materials and Structures	2-0-0	3	A	For ACEEES
		NCL.N404.A	○	★	Thermal‐Hydraulics and Radiation‐Measurement Laboratory	0-0-1	3,5	A	
		NCL.N405.L		★ □	Nuclear Reactor Thermal-hydraulics	2-0-0	3	A	For ACEEES
		NCL.N406.R	◎	★ □	Nuclear Reactor Theory	1-1-0	3,5	A	For ACEEES
		NCL.N407.R	◎	★ □	Nuclear Safety Engineering	2-0-0	3	A	For ACEEES
		NCL.N408.A	○	★	Nuclear Reactor Physics Laboratory	0-0-2	2,3,5	A	

		NCL.N409.L		★	Nuclear Energy Systems	2-0-0	3	A	
		NCL.F451.L			Nuclear Engineering Science I	2-0-0	3	A	
		NCL.F452.L			Nuclear Engineering Science II	2-0-0	3,5	A	
		NCL.F453.L			Low Carbon Sociology	2-0-0	2,4,5	B	
		NCL.F454.L			Safety and Regional Symbiosis for Nuclear Energy	2-0-0	2,4,5	B	
		NCL.M401.L			Medical Accelerators and Reactors	1-0-0	3	A	
		NCL.U401.L		★ ●	Measurement of Environmental Radiation	1-0-1	2,4,5	A	Only for U-ATOM students
		NCL.U402.L		★ ●	Simulation of Severe Nuclear Accidents	1-1-0	3,5	A	Only for U-ATOM students
		NCL.U403.L		★ ●	Environmental Dynamics of Radioactive Nuclides	1-1-0	3,5	A	Only for U-ATOM students
		NCL.F403.L		★	Global Nuclear Security	2-0-0	3	B	
	500 level	NCL.D501.L			Special Lecture on Reactor Decommissioning	1-0-0	3	A,B	
		NCL.O501.L			Special Lecture on Nuclear Engineering I	1-0-0	1,3	A,B	
		NCL.O502.L		★	Special Lecture on Nuclear Engineering II	1-0-0	1,3	A,B	
		NCL.O503.L		★	Special Lecture on Nuclear Engineering III	1-0-0	1,3	A,B	
		NCL.O504.L		★	Special Lecture on Nuclear Engineering IV	1-0-0	1,3	A,B	
		NCL.O505.L		★	Special Lecture on Nuclear Engineering V	1-0-0	1,3	A,B	
		NCL.O506.L		★	Special Lecture on Nuclear Engineering VI	1-0-0	1,3	A,B	
		NCL.O507.L		★	Special Lecture on Nuclear Engineering VII	1-0-0	1,3	A,B	
		NCL.O508.L		★	Special Lecture on Nuclear Engineering VIII	1-0-0	1,3	A,B	
		NCL.U501.L		★ ●	Nuclear Dojo 1	1-0-0	1,2,4	A	Only for U-ATOM students
		NCL.U502.L		★ ●	Nuclear Dojo 2	1-0-0	3,4	A	Only for U-ATOM students
		NCL.U503.L		★ ●	Nuclear Dojo 3	1-0-0	1,3,4,5	A	Only for U-ATOM students

		NCL.U504.L		●	Nuclear Engineering Volunteer Activities I	0-0-1	2,4,5	B	Only for U-ATOM students
		NCL.U505.L		●	Nuclear Engineering Volunteer Activities II	0-0-1	2,4,5	B	Only for U-ATOM students
		NCL.U506.L		★ ●	English in a Global World	1-0-0	1,2,5	B	Priority in U-ATOM students
		NCL.U507.L		★ ●	International Relations of Nuclear Technology	1-0-0	1,2,4,5	B	Priority in U-ATOM students
		NCL.U508.L		★ ●	International Political Economy and Energy Strategy	1-0-0	1,2,4,5	B	Priority in U-ATOM students
		NCL.U509.L		★ ●	French Language and Culture	1-0-0	1,2	B	Priority in U-ATOM students
		NCL.U510.L		★ ●	Basic International Law and Diplomacy	1-0-0	1,4	B	Priority in U-ATOM students
		NCL.U511.L		★ ●	History of Research, Development and Utilization of Nuclear Energy	1-0-0	1,3	B	Priority in U-ATOM students

Note：

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

・●：Course is recognized as an Academy for Global Nuclear Safety and Security Agent, Leading Graduate School (U-ATOM) 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 (Nuclear fusion and accelerator engineering), B (Radiation biology and medicine), C (Nuclear fuel cycle engineering), D (Nuclear reactor decommissioning engineering), F (Basic nuclear engineering), I (Internships), M (Medical engineering), N (Nuclear reactor engineering), O (Wide and advanced nuclear engineering), U (Leading Graduate School (U-ATOM) subjects), 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 Nuclear Engineering that can be recognized as Career Development Courses

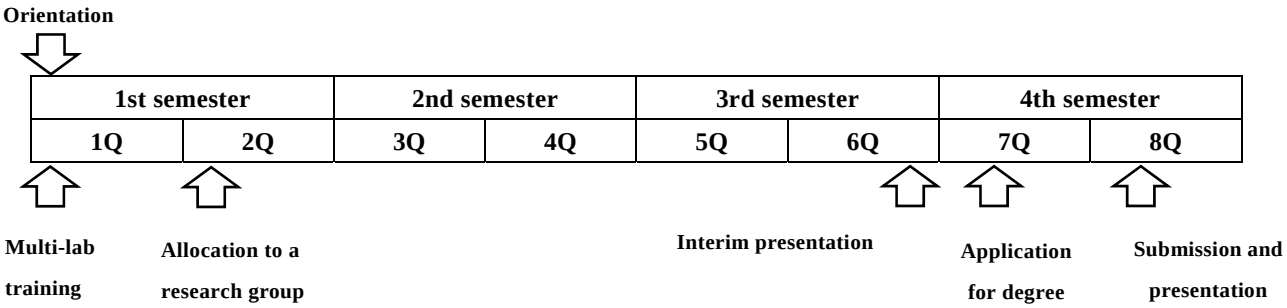
Course category	**Course number**	**Course**			**Credits**	**GA***	**Learning goals**	**Comments**
can be recognized as Career Development Courses	NCL.F401.L			Ethics for Nuclear System Development	1-0-0	C0M, C1M	C	
	NCL.F402.L			Acts and Regulations on Atomic Energy	1-0-0	C1M	C	

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

In the research related to the completion of master thesis, the students experience a series of research processes, and acquire abilities to identify, to investigate, and to solve new issues. The procedure is as follows:



・interim presentation

On the 6th quarter, an interim presentation is examined to clarify background and objective of the research in terms of career formation.

・criterion for judgment

Master thesis must be the original including new scientific knowledge in the nuclear engineering or valuable knowledge contributed to the progress of the nuclear engineering.

・judgement procedure of master thesis

The referee board consists of more than 3 referees. After the pre-review by the referees, the thesis is finally evaluated though the oral presentation. A student wishing to go on to the doctor course is examined by 5 referees.

【Doctoral Degree Program】

1. Outline

Growing attention has been placed on nuclear energy as an ultimate measure for reduction of fossil fuel consumption and CO2 emission. Under the circumstances of global warming and the price hike of oil, gas and coal, a number of countries have been considering the implementation of nuclear power plants. The key factor of the nuclear energy development is the development of human resources. Our original course of international nuclear engineering has been established in 1993. Since then, a number of students have joined us from many countries and graduated from our course. They are actively contributing to the development of industries and technologies in Japan or in their own countries. This graduate course provides with core curriculum for nuclear reactor engineering and fuel cycle technologies and also covers extended nuclear energy, such as beam, accelerator, plasma sciences, nuclear fusion, energy and environment, and social relations.

2. Competencies Developed

The curriculum is designed to allow students to polish what they have learned in the Master's Program, including advanced specialized knowledge of nuclear engineering, broad vision and education, a sense of ethics and social responsibility, logical dialogue skills, writing skills, practical problem-solving skills, and creativity. Furthermore, it enables students to acquire the abilities to discover problems and research them, to create new knowledge, to disseminate, to pioneer and lead new fields, and to develop leadership with which they can play an active role in international society.

3. Learning Goals

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

・Competence as a global leader in the nuclear engineering fields

・Abilities to create and to disseminate new knowledge by the use of the advanced specialized knowledge of nuclear engineering

・Abilities to identify, to investigate, and to solve new issues under the deep understanding of the nuclear engineering

・Ability to conduct innovative research and development in an ethical manner and societal responsibilities

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 Nuclear Engineering curriculum,
    - a minimum of 18 credits acquired from courses of Research Seminars, Research-Related Courses, and Major Courses
    - 12 credits acquired from Research Seminars (If the student completes the doctor study in less

than 12 quarters, the required credit is reduced according to the number of spent quarters.)

• a minimum of 6 credits acquired from Major Courses; and

• 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. Give the oral presentation in English in the interim presentation meeting.

4. Pass the doctoral thesis review and defense.

5. Achieve the score of 730 or more in TOEIC standard in an external official English language test.

Table D1. Graduate Major in Nuclear 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	C	
	Career development courses		4 credits		C	
	Other courses					
Core courses	**Research seminars**	Seminar in Nuclear Engineering S3 Seminar in Nuclear Engineering F3 Seminar in Nuclear Engineering S4 Seminar in Nuclear Engineering F4 Seminar in Nuclear Engineering S5 Seminar in Nuclear Engineering F5 A total of 12 credits, 2 credits each from the above courses.		18 credits	A, B	
	Research-related courses				B	
	Major courses		6 credits		A, B	
	Major courses and Research-related courses <u>outside</u> the Graduate Major in					

	Nuclear 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 Nuclear Engineering

Course category		**Course number**	**Course**			**Credits**	**Competencies**	**Learning goals**	**Comments**
Research seminars	**600 level**	NCL.Z691.R	◎	★	Seminar in Nuclear Engineering S3	0-2-0	1,2,3,4,5	A, D, F	
		NCL.Z692.R	◎	★	Seminar in Nuclear Engineering F3	0-2-0	1,2,3,4,5	A, D, F	
		NCL.Z693.R	◎	★	Seminar in Nuclear Engineering S4	0-2-0	1,2,3,4,5	A, D, F	
		NCL.Z694.R	◎	★	Seminar in Nuclear Engineering F4	0-2-0	1,2,3,4,5	A, D, F	
		NCL.Z695.R	◎	★	Seminar in Nuclear Engineering S5	0-2-0	1,2,3,4,5	A, D, F	
		NCL.Z696.R	◎	★	Seminar in Nuclear Engineering F5	0-2-0	1,2,3,4,5	A, D, F	
Research-related courses	**600 level**	NCL.I601.L		★	Nuclear Engineering Off-Campus Project	0-0-4	1,2,3,4,5	B	
Major courses	**600 level**	NCL.A601.L		★	Special Lecture on Accelerator and Fusion Reactor Technology I	1-0-0	3	A	
		NCL.A602.L		★	Special Lecture on Accelerator and Fusion Reactor Technology II	1-0-0	3	A	
		NCL.A603.L		★	Special Lecture on Accelerator and Fusion Reactor Technology III	1-0-0	3	A	
		NCL.C601.L		★	Special Lecture on Nuclear Fuel Cycle I	1-0-0	3	A	
		NCL.C602.L		★	Special Lecture on Nuclear Fuel Cycle II	1-0-0	3	A	
		NCL.C603.L		★	Special Lecture on Nuclear Fuel Cycle III	1-0-0	3	A	
		NCL.C604.L		★	Nuclear Fuel Cycle Engineering Special	0-0-2	3	A	

					Laboratory				
		NCL.N601.L		★	Special Lecture on Nuclear Reactor Technology I	1-0-0	3	A	
		NCL.N602.L		★	Special Lecture on Nuclear Reactor Technology II	1-0-0	3	A	
		NCL.N603.L		★	Special Lecture on Nuclear Reactor Technology III	1-0-0	3	A	
		NCL.N604.L		★	Thermal - Hydraulics and Radiation - Measurement Special Laboratory	0-0-2	3,5	A,D	
		NCL.N605.L		★	Nuclear Reactor Physics Special Laboratory	0-0-2	3,5	A,D	
		NCL.N606.L		★	Nuclear Material Special Laboratory	0-0-2	3	A,D	
		NCL.N607.L		★	Severe Accident Special Laboratory	0-0-2	3,5	A,D	
		NCL.U601.L		★ ●	Nuclear Dojo 4	1-0-0	3,4	A	Only for U-ATOM students
		NCL.U602.L		★ ●	Nuclear Dojo 5	1-0-0	3,4	A	Only for U-ATOM students
		NCL.U603.L		★ ●	Nuclear Dojo 6	1-0-0	1,2,3,4,5	A	Only for U-ATOM students
		NCL.U604.L		★ ●	Nuclear Security Training	1-1-0	3,5	A	Only for U-ATOM students
		NCL.U605.L		★ ●	Risk Communication I	1-0-0	2,5	B	Priority in U-ATOM students
		NCL.U606.L		★ ●	Risk Communication II	1-0-0	2,5	B	Priority in U-ATOM students
		NCL.U607.L		★ ●	Basics of Philosophy	1-0-0	1,2,5	B	Priority in U-ATOM students
		NCL.U608.L		★ ●	Basics of Culture and Civilization	1-0-0	1	B	Priority in U-ATOM students

		NCL.U610.L		★ ●	Global Nuclear Internship in Japan	0-2-0	2,3,4,5	B	Only for U-ATOM students
		NCL.U611.L		★ ●	Global Nuclear Internship in Foreign Countries 1	0-2-0	2,3,4	B	Only for U-ATOM students
		NCL.U612.L		★ ●	Global Nuclear Internship in Foreign Countries 2	0-2-0	2,3,4	B	Only for U-ATOM students
		NCL.U613.L		★ ●	Arts and Human	1-0-0	1	B	Priority in U-ATOM students

Note：

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

・●：Course is recognized as an Academy for Global Nuclear Safety and Security Agent, Leading Graduate School (U-ATOM) 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 (Nuclear fusion and accelerator engineering), C (Nuclear fuel cycle engineering), I (Internships), N (Nuclear reactor engineering), U (Leading Graduate School (U-ATOM) subjects), Z (Research seminars).

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

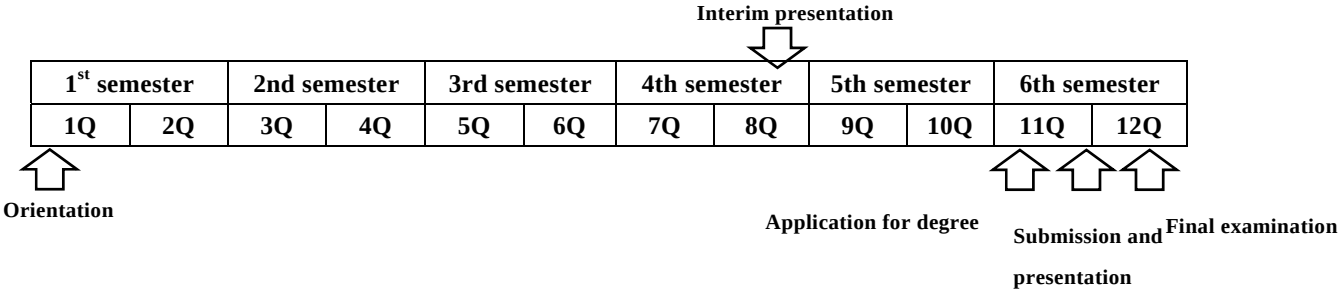
None

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

None

8. Research Related to the Completion of Doctoral Theses

In the research related to the completion of doctoral thesis, the students acquire abilities to solve and to discover problems through the learning design and process. English communication skill equal to or higher than TOEIC 730 is also required.



・interim presentation

On the 8th[h] quarter, an interim presentation is examined to clarify target and completion for the research.

・criterion for judgment

Doctoral thesis must be the original including creative and new scientific knowledge in the nuclear engineering, and its main part must be published or have equivalent level in the international scientific journals.

・judgement procedure of doctoral thesis

The referee board consists of more than 5 referees. After the oral presentation and the pre-review by the referees, the thesis is finally evaluated. Scholastic ability is also examined in the finale examination.