Graduate Major in Energy Science and Engineering

【Master's Degree Program】

1. Outline

This degree program takes a holistic approach to graduate education in the Interdisciplinary field of Energy Science and Engineering. It aims to develop energy science and engineering leaders of the future who can solve complex problems using technology, science and engineering.

The Master's Degree Program, for Graduate Major in Energy Science and Engineering teaches students highly technical knowledge based on fundamental disciplines such as physics, chemistry, materials, machinery, and electricity. In addition, this major provides students various skills for evaluating diverse energy-related issues from the viewpoint of multidisciplinary energy sciences, fact-finding, problem solving, and global leadership, which are necessary for innovation in a sustainable society.

2. Competencies Developed

The students will acquire,

- Highly technical knowledge in one of the energy field disciplines (i.e., physics, chemistry, materials science, mechanical engineering, energy based economics and electrical engineering)
- Fundamental technical knowledge in order to understand diverse energy-related topics
- Practical problem-solving skills based on technical knowledge in the energy field
- Ability to work proactively and investigate new energy research related themes
- Ability to find new directions on energy topics by diverse thinking
- Global technical communication skills

3. Learning Goals

The students enrolled in energy science and engineering will learn,

A) Fundamental knowledge in the field of energy science and engineering

A wide variety of energy related coursework will provide students with fundamental knowledge and allow skills development in energy-related disciplines such as physics, chemistry, materials science, mechanical engineering, energy based economics and electrical engineering.

B) Advanced knowledge in the field of energy science and engineering

A wide variety of coursework will provide students an advanced knowledge and skills about energy-related disciplines such as physics, chemistry, materials science, mechanical engineering, energy based economics and electrical engineering.

C) Interdisciplinary view in energy field and problem-solving training

By engaging in original research focused on addressing specific challenges and completing a Master's thesis, students learn to gain an overview of multidisciplinary energy sciences, identify key issues, and solve problems.

D) Understanding ethics and safety

Appreciation of the societal responsibilities as researchers and knowledge on safety concerning technology, research and development as well as ethical practices.

E) Communication Skills

Techical communication skills are developed by both domestic and international collaboration, and by acquiring the ability to evaluate research and anticipate new applications from a global point of view.

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 Energy Science and Engineering curriculum below,
   - a minimum of 21 credits acquired from major courses and research seminars
   - a minimum of 4 credits from “Interdisciplinary Scientific Principles of Energy Courses” and a minimum of 4 credits from the major courses in the department in which the student was admitted. For students in the Department of Chemistry, a minimum of 4 credits from the Chemistry Major Courses (*), and for students in the Department of Transdisciplinary Science and Engineering, a minimum of 4 credits from energy major courses in other departments (either one or more) that offer Graduate Major in Energy Science and Engineering.
   - 8 credits acquired from “Research Seminars” (Seminar in energy science Spring quarters in the 1st year (S1), Fall quarters 1st year (F1), Spring 2nd Year (S2), and Fall 2nd Year (F2)); and
   - A minimum of 5 credits acquired from Liberal Arts and Basic Science Courses (3 credits from 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 including both GAM0 and GAM1).
3. Pass the master's thesis exam and oral defense.

Table M1 shows course categories and the number of credits required to complete the Master's Degree Program in 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 objectives”. Prior to registering courses, students need to fully understand the course goals.

Table M1. Graduate Major in Energy 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-levels		C,D,E	All Graduate Attributes (GA) should be acquired. (Refer to Section 7 for the definition of GA.)
	Other courses					
Core courses	**Research seminars**	Seminar in Energy Science S1 Seminar in Energy Science F1 Seminar in Energy Science S2 Seminar in Energy Science F2 A total of 8 credits, 2 credits each from above courses.		21 credits	B,C,D,E	
	Research-related courses				B,C,D,E	
	Major courses		a minimum of 4 credits from "Interdisciplinary Scientific Principles of Energy Courses" and a minimum of 4 credits from the Major Courses in the student's department. For students in Department of Chemistry, a minimum of 4 credits from the Chemistry major courses (*), and for students in the Department of Transdisciplinary Science and Engineering, a minimum of 4 credits from energy major courses in other departments (either one or more) that offer Graduate		A,B	

			Major in Energy Science and Engineering.			
	Major courses and Research-related Courses <u>outside</u> the Graduate Major in Energy Science Engineering standard curriculum					
Total required credits		**A minimum of 30 credits including those attained according to the above conditions**				
Note		**• Japanese Language and Culture Courses offered to international students can be recognized as equivalent to the Humanities and Social Science Courses of the corresponding course level.** **• For details of the Liberal Arts and Basic Science Courses, please refer to the relevant sections.** **• For students in the Department of Chemistry, a minimum of 4 credits must come from the Chemistry Course Track marked with '(*)'.**				

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 Energy Science and Engineering

Course category		Course number	Course title			Credits	Competencies	Learning goals	Comments
Research seminars	400 level	ENR.Z491.R	◎		Seminar in energy science S1	0-0-2	1,3,4,5	A,B,C	
		ENR.Z492.R	◎		Seminar in energy science F1	0-0-2	1,3,4,5	A,B,C	
	500 level	ENR.Z591.R	◎		Seminar in energy science S2	0-0-2	1,3,4,5	A,B,C	
		ENR.Z592.R	◎		Seminar in energy science F2	0-0-2	1,3,4,5	A,B,C	
Research-related courses	400 level	ENR.E491.L			Environment Preservation and Chemical Safety I	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.E401) Chemical Science and Engineering Course Track
		ENR.E492.L			Environment Preservation and Chemical Safety II	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.E402) Chemical Science and Engineering Course Track
		ENR.E493.L			Advanced Internship in Chemical Science and Engineering I	0-0-1	2,3,5	B,D	【Chemical Science and Engineering】(CAP.E411) Chemical Science and Engineering Course Track (for students affiliated with the Department of Chemical Science and Engineering only)
		ENR.E494.L			Advanced Internship in Chemical Science and Engineering II	0-0-2	2,3,5	B,D	【Chemical Science and Engineering】(CAP.E412) Chemical Science

									and Engineering Course Track (for students affiliated with the Department of Chemical Science and Engineering only)
		ENR.E495.L			Presentation Practice	0-1-0	3,5	E or B,D	【Chemical Science and Engineering】 (CAP.E422) Chemical Science and Engineering Course Track (for students affiliated with the Department of Chemical Science and Engineering only)
	500 level	ENR.B502.L			Energy innovation co-creative project	0-0-1	1,2,3,4,5	A,C,E	
		ENR.B503			Energy Engineering Internship A	0-0-1	2,3,5	C,D,E	Course outside the standard curriculum
		ENR.B504			Energy Engineering Internship B	0-0-2	2,3,5	C,D,E	Course outside the standard curriculum
		ENR.H591.L			Researcher Ethics and Engineer Ethics	1-0-0	1,3,5	D or B,D	【Chemical Science and Engineering】 (CAP.E521) Chemical Science and Engineering Course Track (for students affiliated with the Department of Chemical Science and Engineering only)
		ENR.B511.L		★	Energy Off-Campus Project S A	0-0-1	1,5	B,C,E	
		ENR.B512.L		★	Energy Off-Campus Project S B	0-0-1	1,5	B,C,E	
		ENR.B513.L		★	Energy Off-Campus Project S C	0-0-1	1,5	B,C,E	
		ENR.B514.L		★	Energy Off-Campus Project S D	0-0-1	1,5	B,C,E	
		ENR.B515.L		★	Energy Off-Campus Project L A	0-0-2	1,3,5	B,C,E	

		ENR.B516.L		★	Energy Off-Campus Project L B	0-0-2	1,3,5	B,C,E	
		ENR.B517.L		★	Energy Off-Campus Project L C	0-0-2	1,3,5	B,C,E	
		ENR.B518.L		★	Energy Off-Campus Project L D	0-0-2	1,3,5	B,C,E	
		ENR.B519.L		★	Energy International Workshop A	0-0-1	1,3	C,E	
		ENR.B520.L		★	Energy International Workshop B	0-0-1	1,3	C,E	
		ENR.B521.L		★	Energy International Workshop C	0-0-1	1,3	C,E	
		ENR.B522.L		★	Energy International Workshop D	0-0-1	1,3	C,E	
Major courses	**400 level**	Interdisciplinary Principles of Energy Courses 400 Level							
		ENR.A401.A	○	★	Interdisciplinary scientific principles of energy 1	1-0-0	1,4,5	A,C	
		ENR.A402.A	○	★	Interdisciplinary scientific principles of energy 2	1-0-0	1,4,5	A,C	
		ENR.A403.A	○	★	Interdisciplinary principles of energy devices 1	1-0-0	1,5	A,C	
		ENR.A404.A	○	★	Interdisciplinary principles of energy devices 2	1-0-0	1,4,5	A,C	
		ENR.A405.A	○	★	Interdisciplinary Energy Materials Science 1	1-0-0	1,4,5	A,C	
		ENR.A406.A	○	★	Interdisciplinary Energy Materials Science 2	1-0-0	1,4,5	A,C	
		ENR.A407.A	○	★	Energy system theory	1-0-0	1,4	A,C	
		ENR.A408.A	○	★	Economy of energy system	1-0-0	1,4,5	A,C	
		ENR.B430.L			Advanced Science and Technology in Energy and Environment	2-0-0	1,5	A,C	
		ENR.B431.L		★	Recent technologies of fuel cells, solar cells, batteries and energy system	1-0-0	1,2,3,4,5	A,C	Open also to Tokyo Tech Summer Program participants
		ENR.B432.L		★	Technologies for Energy and Resource Utilization	1-0-0	1,2,3	A,C,D	【Global Engineering for Development, Environment and Society】 (GEG.E404)
		ENR.B433.L		★	Project Design & Management S	0-1-1	2,3,5	B,C,E	【Global

									Engineering for Development, Environment and Society】(GEG.P451)
		ENR.B434.L		★	Project Design & Management F	0-1-1	2,3,4,5	B,C,E	【Global Engineering for Development, Environment and Society】(GEG.P452)
		ENR.B435.L		★	The economics and systems analysis of environment, resources and technology	1-0-0	1,4,5	A,B	【Global Engineering for Development, Environment and Society】(GEG.S402)
		ENR.B436.L			Special lecture of economics and politics in energy	1-0-0	1,4,5	A,C	
		ENR.B437.L		★	Energy & Environment-1	1-0-0	1,5	A,B,E	【Global Engineering for Development, Environment and Society】(GEG.E421) Open also to Tokyo Tech Summer Program participants
		ENR.B438.L		★	Materials simulation	2-0-0	1,5	B	【Tokyo Tech Academy for Convergence of Materials and Informatics】(TCM.A402)
		ENR.B440.L		★	Materials Informatics	2-0-0	1,5	B	【Tokyo Tech Academy for Convergence of Materials and Informatics】(TCM.A404)
		ENR.B450.L		★	Marketing for Value Creation	1-0-0	1,4,5	B	【Tokyo Tech Academy of Energy and Informatics

									Program】(ENI.H401)
		ENR.B451.L		★	Finance and Data Analysis in Energy Markets	1-0-0	1,4,5	B	【Tokyo Tech Academy of Energy and Informatics Program】(ENI.H402)
		ENR.B452.L		★	Economic Development and Energy Policies	1-0-0	1,4,5	**B**	【Tokyo Tech Academy of Energy and Informatics Program】(ENI.H403)
		Chemistry Course Track 400 Level							
		ENR.I401.L		★	(*)Basic Concepts of Inorganic Chemistry I	1-0-0	1	A	【Chemisty】(CHM.B401)
		ENR.I404.L		★	(*)Basic Concepts of Inorganic Chemistry Ⅱ	1-0-0	1	A	【Chemisty】(CHM.B402)
		ENR.I402.L		★	(*)Basic Concepts of Physical Chemistry Ⅰ	1-0-0	1	A	【Chemistry】(CHM.C401)
		ENR.I405.L		★	(*)Basic Concepts of Physical Chemistr Ⅱ	1-0-0	1	A	【Chemisty】(CHM.C402)
		ENR.I403.L		★	(*)Basic Concepts of Organic Chemistry Ⅰ	1-0-0	1	A	【Chemistry】(CHM.D401)
		ENR.I406.L		★	(*)Basic Concepts of Organic Chemistry Ⅱ	1-0-0	1	A	【Chemisty】(CHM.D402)
		ENR.I410.L		★	Optical properties of solids	2-0-0	1,4	B	
		ENR.I420.L		★	Advanced Lecture on Crystal Structure and Correlation with Properties of Solids	1-0-0	1,5	B	
		ENR.I422.L			Global Environmental Chemistry	2-0-0	1	B	【Chemisty】(CHM.B435)
		ENR.I423.L		★	Advanced Physical Chemistry	2-0-0	1	B	【Chemistry】(CHM.C431)
		ENR.I424.L		★	Advanced Quantum Chemistry	2-0-0	1	B	【Chemistry】(CHM.C432)
		ENR.I425.L		★	Advanced Organic Synthesis	2-0-0	1,5	B	【Chemistry】(CHM.D432)
		ENR.I426.L		★	Advanced Organometallic Chemistry	2-0-0	1	B	【Chemistry】(CHM.D433)
		ENR.I427.L		★	Photochemical Reactions I	1-0-0	1	B	【Chemisty】(CHM.B436)
		ENR.I428.L		★	Photochemical Reactions II	1-0-0	1	B	【Chemistry】(CHM.B437)

		ENR.I429.L		★	Advanced Structual Organic Chemistry	2-0-0	1	B	【Chemisty】(CHM.D434)
		ENR.I431.L			Laboratory Training of Synchrotron Radiation Science	0-0-1	1,5	B,D	【Chemistry】(CHM.A431)
		ENR.I435.L		★	Current Chemistry I	1-0-0	1,2,3	B,D	【Chemistry】(CHM.A435)
		ENR.I436.L		★	Current Chemistry II	1-0-0	1,2,3	B	【Chemistry】(CHM.A436)
		ENR.I437.L		★	Current Chemistry III	1-0-0	1,2,3	B	【Chemistry】(CHM.A437)
		ENR.I438.L		★	Current Chemistry IV	1-0-0	1,2,3	B	【Chemistry】(CHM.A438)
		ENR.I441.L		★	Advanced Separation Science	2-0-0	1,5	B	【Chemistry】(CHM.B431)
		ENR.I442.L		★	Catalytic Chemistry on Solid Surface	2-0-0	1	B	【Chemistry】(CHM.B433)
		ENR.I443.L		★	Advanced Course in Crystal Structure Science	2-0-0	1	B	【Chemistry】(CHM.B434)
		ENR.I444.L		★	Advanced Bioorganic Chemistry	2-0-0	1	B	【Chemistry】(CHM.D431)
		ENR.I461.L			Recent Progress in Chemistry I	1-0-0	1	B	【Chemistry】(CHM.) A441 Only for even academic years
		ENR.I462.L			Recent Progress in Chemistry II	1-0-0	1	B	【Chemistry】(CHM.) A442 Only for even academic years
		ENR.I463.L			Recent Progress in Chemistry III	1-0-0	1	B	【Chemistry】(CHM.) A443 Only for even academic years
		ENR.I464.L			Recent Progress in Chemistry IV	1-0-0	1	B	【Chemistry】(CHM.) A444 Only for even academic years
		ENR.I465.L			Recent Progress in Chemistry V	1-0-0	1	B	【Chemistry】(CHM.) A445 Only for even academic years
		ENR.I466.L			Recent Progress in Chemistry VI	1-0-0	1	B	【Chemistry】(CHM.) A446 Only for even academic years

		ENR.I467.L			Recent Progress in Chemistry VII	1-0-0	1	B	【Chemistry】 (CHM.) A447 Only for odd academic years
		ENR.I468.L			Recent Progress in Chemistry VIII	1-0-0	1	B	【Chemistry】 (CHM.) A448 Only for odd academic years
		ENR.I469.L			Recent Progress in Chemistry IX	1-0-0	1	B	【Chemistry】 (CHM.) A449 Only for odd academic years
		ENR.I470.L			Recent Progress in Chemistry X	1-0-0	1	B	【Chemistry】 (CHM.) A450 Only for odd academic years
		ENR.I471.L			Recent Progress in Chemistry XI	1-0-0	1	B	【Chemistry】 (CHM.) A451 Only for odd academic years
		ENR.I472.L			Recent Progress in Chemistry XII	1-0-0	1	B	【Chemistry】 (CHM.) A452 Only for odd academic years
		Mechanical Engineering Course Track 400 Level							
		ENR.K401.L		★	Mechanics of Composite Materials	1-0-0	1	A	【Mechanical Engineering】 (MEC.C431)
		ENR.K402.L		★	Solid Dynamics	1-0-0	1,5	A	【Mechanical Engineering】 (MEC.C433)
		ENR.K411.L		★	Advanced Sound and Vibration Measurement	1-0-0	1	A	【Mechanical Engineering】 (MEC.D431)
		ENR.K412.L		★	Thermodynamics of Nonequilibrium Systems	1-0-0	1	A	【Mechanical Engineering】 (MEC.E431)
		ENR.K413.L		★	Properties of Solid Materials	1-0-0	1	A	【Mechanical Engineering】 (MEC.E432)
		ENR.K414.L		★	Advanced Thermal-Fluids Measurement	1-0-0	1,5	A	【Mechanical Engineering】 (MEC.E433)
		ENR.K421.L		★	Computational Fluid Dynamics	1-0-0	1	A	【Mechanical

									Engineering】(MEC.F431)
		ENR.K422.L		★	Mechanical Processing	1-0-0	1	A	【Mechanical Engineering】(MEC.G431)
		ENR.K430.L		★	Advanced course of turbulent flow and control	1-0-0	1,5	A	
		ENR.K431.L		★	Metalforming	1-0-0	1	A	【Mechanical Engineering】(MEC.G432)
		ENR.K440.L		★	Advanced course of radiation transfer	1-0-0	1,5	A	
		ENR.K441.L		★	Advanced Mechanical Elements	1-0-0	1,4,5	A	【Mechanical Engineering】(MEC.H431)
		ENR.K450.L		★	Advanced course of combustion physics	1-0-0	1,5	A	
		ENR.K461.L		★	Mechatronics Device and Control	1-0-0	1,3,5	A	【Mechanical Engineering】(MEC.H433)
		ENR.K462.L		★	Advanced Course of Actuator Engineering	1-0-0	1,5	A	【Mechanical Engineering】(MEC.H434)
		ENR.K471.L		★	Ultra-precision Measurement	1-0-0	1	A	【Mechanical Engineering】(MEC.J431)
		ENR.K472.L		★	Mechanism and Control for Ultra-precision Motion	1-0-0	1,5	A	【Mechanical Engineering】(MEC.J432)
		ENR.K492.L		★	Space Systems Analysis A	1-0-0	1	A	【Mechanical Engineering】(MEC.M433)
		ENR.K493.L			Space Systems Initiative	2-0-0	1,3,4,5	A	【Mechanical Engineering】(MEC.M435)
		Mechanical Engineering Course Track 500 Level							
		ENR.K501.L		★	Mechanics of High Temperature Materials	1-0-0	1,5	B	【Mechanical Engineering】(MEC.C531)
		ENR.K511.L		★	Experimental Modal Analysis for Structural Dynamics	1-0-0	1,5	B	【Mechanical Engineering】(MEC.D531)
		ENR.K521.L		★	Plasma Physics	1-0-0	1,5	B	【Mechanical Engineering】

									(MEC.E531)
		ENR.K532.L		★	Cryogenic Engineering	1-0-0	1,4,5	B	【Mechanical Engineering】 (MEC.E532)
		ENR.K561.L		★	Rarefied Gas Dynamics	1-0-0	1,5	B	【Mechanical Engineering】 (MEC.F532)
		ENR.K562.L		★	Precision Manufacturing Processes	1-0-0	1,5	B	【Mechanical Engineering】 (MEC.G531)
		ENR.K580.L		★	Leading edge energy technology	1-0-0	1,2	B	
		ENR.K591.L		★	Space Systems Analysis B	1-0-0	1	B	【Mechanical Engineering】 (MEC.M531)
		ENR.K592.L			Space Systems and Missions	2-0-0	1,4	B	【Mechanical Engineering】 (MEC.M532)
		Electrical and Electronic Engineering Course Track 400 Level							
		ENR.L401.L		★	Mechanical-to-electrical energy conversion	2-0-0	1,5	A	
		ENR.L402.L			Utilization of Intelligent Information Resources and Patents	1-0-0	1,5	A	【Electrical and Electronic Engineering】 (EEE.G401)
		ENR.L404.L		★	Graph Theory with Engineering Application	1-0-0	1	A	【School of Engineering】 (XEG.S404)
		ENR.L405.L		★	Topics in Digital VLSI Design	1-0-0	1	A	【School of Engineering】 (XEG.S405)
		ENR.L410.L		★	Introduction to Photovoltaics	2-0-0	1,5	A	
		ENR.L411.L		★	Fundamentals of Electronic Materials	2-0-0	1,5	A	【Electrical and Electronic Engineering】 (EEE.D401)
		ENR.L412.L		★	Semiconductor Physics	2-0-0	1,5	A	【Electrical and Electronic Engineering】 (EEE.D411)
		ENR.L413.L			Electrical Modeling and Simulation	2-0-0	1,5	A	【Electrical and Electronic Engineering】

									(EEE.G411)
		ENR.L416.L			Advanced Electric Power Engineering	2-0-0	1,3	A	【Electrical and Electronic Engineering】(EEE.P421)
		ENR.L417.L		★	Advanced Electromagnetic Waves	2-0-0	1,5	A	【Electrical and Electronic Engineering】(EEE.S401)
		ENR.L441.L			VLSI Technology I	2-0-0	1	A	【Electrical and Electronic Engineering】(EEE.C441)
		ENR.L442.L		★	VLSI Technology II	2-0-0	1,5	A	【Electrical and Electronic Engineering】(EEE.C442)
		ENR.L443.L		★	Bipolar Transistors and Compound Semiconductor Devices	2-0-0	1,5	A	【Electrical and Electronic Engineering】(EEE.D451)
		ENR.L444.L			Advanced Power Semiconductor Devices	2-0-0	1,4,5	A	【Electrical and Electronic Engineering】(EEE.D481)
		ENR.L445.L		★	Plasma Engineering	2-0-0	1	A	【Electrical and Electronic Engineering】(EEE.P451)
		ENR.L446.L		★	Pulsed Power Technology	2-0-0	1,4,5	A	【Electrical and Electronic Engineering】(EEE.P461)
		ENR.L447.L		★	Wireless Communication Engineering	2-0-0	1,5	A	【Electrical and Electronic Engineering】(EEE.S451)
		ENR.L448.L			Optical Communication Systems	2-0-0	1,5	A	【Electrical and Electronic Engineering】(EEE.S461)
		ENR.L449.L		★	Power electronics circuits and systems	1-0-0	1,5	A	【Electrical and Electronic Engineering】

									(EEE.P412)
		ENR.L450L		★	Power electronics application to power systems	1-0-0	1,5	A	【Electrical and Electronic Engineering】(EEE.P413)
		ENR.L451L		★	Power electronics control and analysis	1-0-0	1,5	A	【Electrical and Electronic Engineering】(EEE.P414)
		Electrical and Electronic Engineering Course Track 500 Level							
		ENR.L501.L		★	Dielectric Property and Organic Devices	2-0-0	1	B	【Electrical and Electronic Engineering】(EEE.D501)
		ENR.L502.L		★	Magnetic Levitation and Magnetic Suspension	2-0-0	1	B	【Electrical and Electronic Engineering】(EEE.P501)
		ENR.L511.L		★	Magnetism and Spintronics	2-0-0	1,5	B	【Electrical and Electronic Engineering】(EEE.D511)
		ENR.L530.L		★	Advanced functional electron devices	2-0-0	1,2,3,4,5	B	
		ENR.L550.L		★	Nano-Structure Devices	2-0-0	1,5	B	【Electrical and Electronic Engineering】(EEE.D551)
		Materials Science and Engineering Course Track 400 Level							
		ENR.J401.L		★	Advanced Metal Physics	2-0-0	1,3,5	B	
		ENR.J402.L		★	Physical Chemistry for High Temperature Processes -Thermodynamics-	1-0-0	1,5	A	
		ENR.J403.L		★	Physical Chemistry for High Temperature Processes -Smelting and Refining Processes-	1-0-0	1,5	B	
		ENR.J404.L		★	Physical Chemistry for High Temperature Processes -Oxidation of Metals-	1-0-0	1,5	B	
		ENR.J405.L		★ O	Microstructure Evolution and Diffusion in Metals	2-0-0	1,4,5	B	O: English, E: Japanese
		ENR.J406.L		★	Organic Electronic Materials	1-0-0	1	B	

					Physics				
		ENR.J407.L		★	Soft Materials Design	1-0-0	1,5	B	
		ENR.J408.L		★	Energy Conversion Ceramics Materials	2-0-0	1	B,C	
		ENR.J409.L			Introduction to Intellectual Property System	2-0-0	1,2,4,5	B,C	
		ENR.J410.L		★ O	Applied Diffraction Crystallography in Metals and Alloys	2-0-0	1,5	B	【Materials Science and Engineering】 (MAT.M401) O: English, E: Japanese
		ENR.J411.L		★ E	Characterization of Nanomaterials	2-0-0	1	B	【Materials Science and Engineering】 (MAT.M402) a 4Q course,E,b 1 to 2 Q (class held at Tsinghua Univ.), opening English every year
		ENR.J412.L		★ O	Environmental Degradation of Materials	2-0-0	1	B	【Materials Science and Engineering】 (MAT.M403) O: English, E: Japanese
		ENR.J446.L		★ E	Transport Phenomena at High Temperature - Momentum and Heat Flow -	1-0-0	1,5	B	【Materials Science and Engineering】 (MAT.M426) O: Japanese, E: English
		ENR.J447.L		★ E	Transport Phenomena at High Temperature - Flow of charged particles in solid -	1-0-0	1,5	B	【Materials Science and Engineering】 (MAT.M427) O: Japanese, E: English
		ENR.J414.L		★ E	Advanced Microstructure Design of Ferrous Materials	2-0-0	1,2,4	B	【Materials Science and Engineering】 (MAT.M405) O: Japanese, E: English
		ENR.J416.L		★ O	Advanced Solid State Physics	2-0-0	1,5	B	Not offered in AY 2021 【Materials Science

									and Engineering】(MAT.M407) a 3Q course,O,b 1 to 2 Q (class held at Tsinghua Univ.), opening English every yeay
		ENR.J417.L			Quantum Statistical Mechanics	2-0-0	1,2,5	B	【Materials Science and Engineering】(MAT.M408)
		ENR.J418.L		★ O	Thermodynamics for Phase Equilibria	2-0-0	1	B	【Materials Science and Engineering】(MAT.M409) O: English, E: Japanese
		ENR.J419.L		★ O	Deformation and Strength of Solids	2-0-0	1	B	【Materials Science and Engineering】(MAT.M410) O: English, E: Japanese
		ENR.J448.L		★ E	Exercise in Materials Design	0-1-0	1,5	B	【Materials Science and Engineering】(MAT.M423) E: English, O: Japanese
		ENR.J449.L		★ E	Exercise in Physical Metallurgy	0-1-0	1,5	B	【Materials Science and Engineering】(MAT.M424) E: English, O: Japanese
		ENR.J450.L		★ O	Recovery, Recrystallization and Texture of Metals	1-0-0	1	B	【Materials Science and Engineering】(MAT.M425) O: English, E: Japanese
		ENR.J421.L		★	Organic Optical Materials physics	1-0-0	1,5	B	【Materials Science and Engineering】(MAT.P401)
		ENR.J422.L		★ E	Soft Materials Physical Chemistry	1-0-0	1	B	【Materials Science and Engineering】(MAT.P402) O: Japanese, E: English

		ENR.J423.L		★	Soft Materials Physics	1-0-0	1,2	B	【Materials Science and Engineering】(MAT.P403)
		ENR.J424.L		★	Soft Materials Functional Physics	1-0-0	1,3	B	【Materials Science and Engineering】(MAT.P404)
		ENR.J427.L		★ E	Soft Materials Functional Chemistry	1-0-0	1,5	B	【Materials Science and Engineering】(MAT.P413) O: Japanese, E: English
		ENR.J428.L		★	Soft Materials Function	1-0-0	1,5	B	【Materials Science and Engineering】(MAT.P414)
		ENR.J429.L		★ E	Organic Materials Functional Design	1-0-0	1,5	B	【Materials Science and Engineering】(MAT.P421) O: Japanese, E: English
		ENR.J430.L		★ E	Organic Materials Design	1-0-0	1,5	B	【Materials Science and Engineering】(MAT.P422) O: Japanese, E: English
		ENR.J431.L		★	Advanced Course in Composite Materials	1-0-0	1	B	【Materials Science and Engineering】(MAT.P423)
		ENR.J434.L			Materials Engineering and Ecology	1-0-0	3,4,5	D	【Materials Science and Engineering】(MAT.P491)
		ENR.J435.L			Advanced Course in Organic Polymer Science	1-0-0	1	B,C	【Materials Science and Engineering】(MAT.P492)
		ENR.J437.L		★	Thermal Properties of Materials	1-0-0	1,5	B	【Materials Science and Engineering】(MAT.P426)
		ENR.J438.L			Crystals Science	2-0-0	1	B	【Materials Science and Engineering】(MAT.C400)
		ENR.J439.L			Advanced Course of Dielectric and Ferroelectric Materials	2-0-0	1,5	B	【Materials Science and Engineering】(MAT.C401)
		ENR.J440.L		★	Quantum Physics in Optical Response of Materials	2-0-0	1	B	【Materials Science and Engineering】

									(MAT.C402)
		ENR.J441.L			Advanced Course of Ceramic Thin Film Technology	2-0-0	1,4,5	B	【Materials Science and Engineering】(MAT.C403)
		ENR.J442.L			Physics and Chemistry of Semiconductors	2-0-0	1,2,5	B	【Materials Science and Engineering】(MAT.C404)
		ENR.J443.L			Advanced Course of Instrumental Analysis for Materials	2-0-0	1,5	B	【Materials Science and Engineering】(MAT.C405)
		ENR.J445.L		★	Nuclear Materials and Structures	2-0-0	1	B	【Nuclear Engineering】(NCL.N403)
		ENR.J451.L		★	Advanced Course of Surface Chemistry on Inorganic Materials	2-0-0	1,5	A	【Materials Science and Engineering】(MAT.C408)
		ENR.J452.L			Advanced Course of Nano-Particles Science	2-0-0	1,3,4,5	A	【Materials Science and Engineering】(MAT.C416)
		ENR.J453.L			Soft Materials Chemistry	1-0-0	1,5	B	【Materials Science and Engineering】(MAT.P416)
		ENR.J454.L		★ E	Quantum theory of metals	2-0-0	1,5	B	【Materials Science and Engineering】(MAT.M430) E: English, O: Japanese
		ENR.J455.L		★ E	Kinematical theory of microstructure formed by diffusionless phase transformation	2-0-0	1	B	【Materials Science and Engineering】(MAT.M431) E: English, O: Japanese
		Materials Science and Engineering Course Track 500 Level							
		ENR.J501.L		★ O	Advanced Course of Materials Optics	2-0-0	1,5	B	【Materials Science and Engineering】(MAT.C500) O: English, E: Japanese
		ENR.J502.L			Advanced Course of Deformation and Fracture of Engineering Materials	2-0-0	1,3,4,5	B	【Materials Science and Engineering】(MAT.C501)
		ENR.J503.L			Advanced Course of Material Development I	2-0-0	1,5	B,C	【Materials Science and Engineering】(MAT.C502)

		ENR.J504.L		★	Advanced Course of Material Development II	2-0-0	1	B,C	【Materials Science and Engineering】(MAT.C503)
		ENR.J505.L		★	Functional Devices	2-0-0	1,2	B	【Materials Science and Engineering】(MAT.C504)
		ENR.J520.L		★	Fundamentals of electrochemistry and the application to energy conversion materials	1-0-0	1,2,3,4,5	B,C	【Materials Science and Engineering】(MAT.P506)
		ENR.J521.L		★	Analytical and analogical methods to solve the heat transfer equation and the application to infrared image processing	1-0-0	1,2,3,4,5	B,C	【Materials Science and Engineering】(MAT.P507)
		ENR.J522.L		★	Applied Vibrational Spectroscopy	1-0-0	1,4,5	B	【Materials Science and Engineering】(MAT.P512)
		ENR.J523.L		★	Plastic Electronic Materials and Devices	1-0-0	1,4,5	B	【Materials Science and Engineering】(MAT.P513)
		ENR.J524.L		★	Photoacoustic and Photothermal Techniques (PA&PT) for material testing: Principles and Applications	1-0-0	1,4,5	B	【Materials Science and Engineering】(MAT.P514)
		Chemical Science and Engineering Course Track 400 Level							
		ENR.H403.L		★	Advanced Electrochemistry I	1-0-0	1	B	
		ENR.H404.L		★	Advanced Electrochemistry II	1-0-0	1,5	B	
		ENR.H405.L		★	Advanced Inorganic Materials Chemistry I	1-0-0	1,5	B	
		ENR.H406.L		★	Advanced Inorganic Materials Chemistry II	1-0-0	1,5	B	
		ENR.H410.L		★	Topics in Properties of Semiconductors	1-0-0	1,5	B	Not offered in AY 2022
		ENR.H411.L		★	Topics in Applied Electrochemistry	1-0-0	1,5	B	
		ENR.H415.L		★	Introduction to Organic Electrochemistry	1-0-0	1,5	B	
		ENR.H420.L		★	Introduction to Photochemistry I	1-0-0	1,5	B	
		ENR.H421.L		★	Advanced Electrochemistry I	1-0-0	1	B	【Chemical Science and Engineering】(CAP.A441)
		ENR.H422.L		★	Advanced Electrochemistry II	1-0-0	1	B	【Chemical Science and Engineering】

									(CAP.A442)
		ENR.H423.L			Advanced Instrumental Analysis	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.A481)
		ENR.H424.L			Scope of Chemical Science and Engineering IA	1-0-0	1	B	【Chemical Science and Engineering】(CAP.A401)
		ENR.H425.L			Scope of Chemical Science and Engineering IIA	1-0-0	1	B	【Chemical Science and Engineering】(CAP.A402)
		ENR.H428.L		★	Advanced Organic Synthesis I	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.A423)
		ENR.H429.L		★	Advanced Organic Synthesis II	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.A424)
		ENR.H430.L			Introduction to Photochemistry II	1-0-0	1,4,5	B	Not offered in AY 2022
		ENR.H431.L		★	Advanced Solid State Chemistry I	1-0-0	1	B	【Chemical Science and Engineering】(CAP.A461)
		ENR.H432.L		★	Advanced Solid State Chemistry II	1-0-0	1	B	【Chemical Science and Engineering】(CAP.A462)
		ENR.H433.L		★	Advanced Molecular Design of Metal Complexes I	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.A463)
		ENR.H434.L		★	Advanced Molecular Design of Metal Complexes II	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.A464)
		ENR.H435.L		★	Advanced Bioinorganic Chemistry I	1-0-0	1	B	【Chemical Science and Engineering】(CAP.A465)
		ENR.H436.L		★	Advanced Bioinorganic Chemistry II	1-0-0	1	B	【Chemical Science and Engineering】(CAP.A466)
		ENR.H439.L		★	Advanced Solid-state Physical Chemistry I	1-0-0	1	B	【Chemical Science and Engineering】(CAP.A443)
		ENR.H440.L		★	Advanced Solid-state Physical Chemistry II	1-0-0	1	B	【Chemical Science and Engineering】(CAP.A444)
		ENR.H441.L		★	Advanced Polymer Synthesis	1-0-0	1,5	B	【Chemical Science and Engineering】

									(CAP.P411)
		ENR.H443.L		★	Special Lecture on Characterization of Polymer Structures and Properties	1-0-0	1	B	【Chemical Science and Engineering】(CAP.P421)
		ENR.H444.L		★	Advanced Polymer Properties	1-0-0	1	B	【Chemical Science and Engineering】(CAP.P422)
		ENR.H445.L			Advanced Polymer Science II	1-0-0	1,3,5	B	【Chemical Science and Engineering】(CAP.P425)
		ENR.H450.L		★	Environmentally-Friendly Polymer Chemistry	1-0-0	1,5	B	
		ENR.H451.L		★	Process Systems Engineering	2-0-0	1,4,5	B	【Chemical Science and Engineering】(CAP.C412)
		ENR.H452.L		★	Advanced Energy Transfer Operation	2-0-0	1,4,5	B	【Chemical Science and Engineering】(CAP.C421)
		ENR.H453.L		★	Advanced Reaction Process Engineering	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.C424)
		ENR.H494.L		★	Advanced Bioprocess Engineering	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.C425)
		ENR.H454.L		★	Computational Fluid Dynamics	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.C423)
		ENR.H455.L		★	Physico-Chemical Property Analysis in Chemical Engineering	1-0-0	1,4	B	【Chemical Science and Engineering】(CAP.C432)
		ENR.H495.L		★	Phase Equilibrium Analysis in Chemical Engineering	1-0-0	1,4	B	【Chemical Science and Engineering】(CAP.C433)
		ENR.H456.L		★	Transport Phenomena and Operation	2-0-0	1,2,4,5	B	【Chemical Science and Engineering】(CAP.C441)
		ENR.H458.L		★	Chemical Engineering for Advanced Materials and Chemicals Processing I	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.C411)
		ENR.H459.L		★	Chemical Engineering for Advanced Materials and Chemicals Processing II	1-0-0	1	B	【Chemical Science and Engineering】(CAP.C431)
		ENR.H461.L		★	Advanced Organometallic Chemistry and Catalysis I	1-0-0	1,5	B	【Chemical Science and Engineering】

									(CAP.T431)
		ENR.H462.L		★	Advanced Organometallic Chemistry and Catalysis II	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.T432)
		ENR.H463.L		★	Introduction to Polymer Science	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.I426)
		ENR.H465.L		★	Introduction to Polymer Chemistry	2-0-0	1,4,5	B	【Chemical Science and Engineering】(CAP.I427)
		ENR.H466.L		★	Introduction to Polymer Physical Properties	1-0-0	1	B	【Chemical Science and Engineering】(CAP.I437)
		ENR.H467.L		★	Advanced Organometallic Chemistry and Catalysis	1-0-0	1	B	【Chemical Science and Engineering】(CAP.I439)
		ENR.H471.L		★	Advanced Coordination Chemistry	1-0-0	1	B	【Chemical Science and Engineering】(CAP.I403)
		ENR.H472.L		★	Environmental Chemistry	2-0-0	1,5	B	【Chemical Science and Engineering】(CAP.I405)
		ENR.H473.L		★	Introduction to Chemical Engineering (Basics)	1-0-0	1,5	A	【Chemical Science and Engineering】(CAP.I407)
		ENR.H474.L		★	Advanced Supramolecular Science	1-0-0	1	B	【Chemical Science and Engineering】(CAP.I420)
		ENR.H475.L		★	Analytical Techniques for Environmental Chemistry	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.I419)
		ENR.H476.L		★	Catalysis for the Environmental Issues	1-0-0	1	B	【Chemical Science and Engineering】(CAP.I416)
		ENR.H477.L		★	Introduction to Chemical Engineering (Unit Operation)	1-0-0	1,5	A	【Chemical Science and Engineering】(CAP.I417)
		ENR.H478.L		★	Advanced Organic Materials Chemistry	1-0-0	1	B	【Chemical Science and Engineering】(CAP.I423)
		ENR.H479.L		★	Advanced Geochemistry	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.I435)
		ENR.H480.L		★	Nano-Surface Chemistry and	1-0-0	1,2,5	B	【Chemical Science

					Advanced Devices				and Engineering】(CAP.I446)
		ENR.H481.L		★	Functionalized Nano-Materials Chemistry I	1-0-0	1	B	【Chemical Science and Engineering】(CAP.I438)
		ENR.H482.L		★	Functionalized Nano-Materials Chemistry II	1-0-0	1	B	【Chemical Science and Engineering】(CAP.I445)
		ENR.H486.L			Scope of Chemical Science and Engineering IB	1-0-0	1	A	【Chemical Science and Engineering】(CAP.I401)
		ENR.H487.L			Scope of Chemical Science and Engineering IIB	1-0-0	1	A	【Chemical Science and Engineering】(CAP.I402)
		ENR.H488.L			Introduction to the Frontiers of Environmental Chemistry I	1-0-0	1,2	B	【Chemical Science and Engineering】(CAP.I481)
		ENR.H489.L			Introduction to the Frontiers of Environmental Chemistry II	1-0-0	1,2	B	【Chemical Science and Engineering】(CAP.I482)
		ENR.H490.L			Frontiers of Chemical Science and Engineering I	1-0-0	1	B	【Chemical Science and Engineering】(CAP.T423)
		ENR.H496.L			Frontiers of Chemical Science and Engineering II	1-0-0	1	B	【Chemical Science and Engineering】(CAP.T424)
		ENR.H497.L			Frontiers of Chemical Science and Engineering III	1-0-0	1	B	【Chemical Science and Engineering】(CAP.T425)
		ENR.H491.L		★	Introduction to Polymer Physical Chemistry	1-0-0	1	B	【Chemical Science and Engineering】(CAP.P433)
		ENR.H492.L		★	Advanced Course of Step-growth Polymerization	1-0-0	1,4	B	【Chemical Science and Engineering】(CAP.P413)
		ENR.H493.L		★	Advanced Polymer Assembly	1-0-0	1,4	B	【Chemical Science and Engineering】(CAP.P414)
		Chemical Science and Engineering Course Track 500 Level							
		ENR.E521.L		★	Advanced Chemistry of Transition Metal Complexes I	1-0-0	1	B	【Chemical Science and Engineering】(CAP.A561)
		ENR.E522.L		★	Advanced Chemistry of Transition Metal Complexes II	1-0-0	1	B	【Chemical Science and Engineering】

									(CAP.A562)
		ENR.E541.L		★	Advanced Polymer Reactions	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.P511)
		ENR.E542.L			Advanced Polymer Processing	1-0-0	1,4,5	B	【Chemical Science and Engineering】(CAP.P581)
		ENR.E543.L			Advanced Polymer Science I	1-0-0	1,2,5	B	【Chemical Science and Engineering】(CAP.P582)
		ENR.E551.L		★	Chemical Engineering in Global Business	1-0-0	1,2,3,5	B	【Chemical Science and Engineering】(CAP.C521)
		ENR.E552.L		★	Advanced Chemical Equipment Design	2-0-0	1,5	B	【Chemical Science and Engineering】(CAP.C531)
		ENR.E553.L		★	Plasma Chemistry and Plasma Processing	1-0-0	1,4	B	【Chemical Science and Engineering】(CAP.C533)
		ENR.H527.L		★	Advanced Supercritical Fluid Process	1-0-0	1,4	B	【Chemical Science and Engineering】(CAP.C534)
		ENR.E554.L		★	Fine Particle Engineering	1-0-0	1,2,4,5	B	【Chemical Science and Engineering】(CAP.C542)
		ENR.H528.L		★	Tribology and Surface Engineering	1-0-0	1,2,5	B	【Chemical Science and Engineering】(CAP.C543)
		ENR.E562.L		★	Advanced Catalytic Reactions	1-0-0	1	B	【Chemical Science and Engineering】(CAP.T532)
		ENR.E571.L		★	Advanced Strategic Organic Synthesis	1-0-0	1	B	【Chemical Science and Engineering】(CAP.I533)
		ENR.E572.L		★	Advanced Material Cycle Analysis	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.I536)
		ENR.E573.L		★	Systematic Material Design Methodology	1-0-0	4,5	B	【Chemical Science and Engineering】(CAP.I537)
		ENR.H503.L		★	Advanced Polymer Design for Energy Materials	1-0-0	1,4,5	B	
		ENR.H523.L		★	Advanced Molecular Design for Organic Synthesis I	1-0-0	1,5	B	【Chemical Science and Engineering】

									(CAP.A521)
		ENR.H524.L		★	Advanced Molecular Design for Organic Synthesis II	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.A522)
		ENR.H525.L		★	Advanced Polymer Structures	1-0-0	1,4,5	B	【Chemical Science and Engineering】(CAP.P522)

Note：

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

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

• 【 】Course offered by another graduate major

• The character preceding the three digits in the course number denotes the course's subdiscipline (i.e., "D" represents the subdiscipline code in the course number ENR.D400.R): A (Interdisciplinary Scientific Principles of Energy Courses (electively required)), B (Interdisciplinary Scientific Principles of Energy Course (selective)), H (Chemical Science and Engineering Courses), I (Chemistry Courses), J (Materials Science and Engineering Courses), K (Mechanical EngineeringCourses), L (Electrical and Electronic Engineering Courses), Z (Research Seminars) The character “R” succeeding the course number represents that the course is electively required (A), elective (L), and required (R), respectively.

6. IGP Courses That Can Be Counted as Humanities and Social Science Courses

None

7. IGP Courses That Can Be Counted as Career Development Courses

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

Major Courses that enable students to acquire GA and that are recognized as equivalent to Career Development Courses are listed in Table M3 below.

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

For Graduate Attributes, refer to the Guide to the Career Development Courses.
The Graduate Attributes of the Master's Degree Program are listed in Table MA-1 as follows:

GA0M: You can clearly plan your own career and recognize the abilities necessary for realizing it while considering ethics and relevance to societal problems.

GA1M: You can acquire the knowledge, skills, and ethics necessary for realizing your planned career and contribute to societal problem-solving while collaborating with other experts

Table M3. Courses of the Graduate Major in Energy Science and Engineering 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	ENR.B502.L	Energy innovation co-creative project	0-0-1	GA1M	A,C,E	
	ENR.B503	Energy Engineering Internship A	0-0-1	GA1M	C,D,E	Course outside the standard curriculum
	ENR.B504	Energy Engineering Internship B	0-0-2	GA1M	C,D,E	Course outside the standard curriculum
	ENR.J409.L	Introduction to Intellectual Property System	2-0-0	GA0M/ GA1M	B,C	
	CHM.A461	Presentation Exercises in Chemistry	0-1-0	GA0M	C,E	Available only to students belonging to the Department of Chemistry
	CHM.A462	Introductory Exercises in Chemistry	0-1-0	GA1M	C,E	Available only to students belonging to the Department of Chemistry
	EEE.G401	Utilization of Intelligent Information Resources and Patents	1-0-0	GA1M	B,E	Available only to students belonging to the Department of Electrical and Electronic Engineering
	CAP.E521	Scientific Ethics	1-0-0	GA0M	D	Available only to students belonging to the Department of Chemical Science and Engineering
	CAP.E422	Presentation Practice	0-1-0	GA1M	E	Available only to students belonging to the Department of Chemical Science and Engineering
	CAP.E411	Advanced Internship in Chemical Science and Engineering I	0-0-1	GA1M	B,D	Available only to students belonging to the Department of Chemical Science and Engineering
	CAP.E412	Advanced Internship in Chemical Science and Engineering II	0-0-2	GA1M	B,D	Available only to students belonging to the Department of

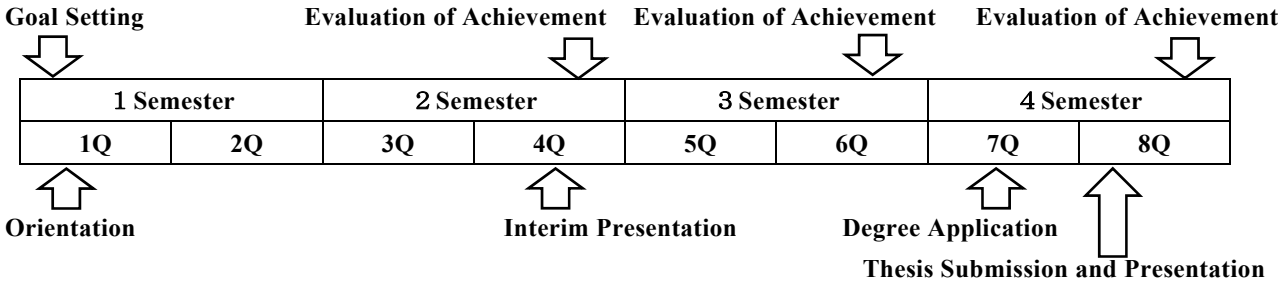
								Chemical Science and Engineering
	ENR.B511.L		★	Energy Off-Campus Project S A	0-0-1	GA1M	B,C,E	
	ENR.B512.L		★	Energy Off-Campus Project S B	0-0-1	GA1M	B,C,E	
	ENR.B513.L		★	Energy Off-Campus Project S C	0-0-1	GA1M	B,C,E	
	ENR.B514.L		★	Energy Off-Campus Project S D	0-0-1	GA1M	B,C,E	
	ENR.B515.L		★	Energy Off-Campus Project L A	0-0-2	GA1M	B,C,E	
	ENR.B516.L		★	Energy Off-Campus Project L B	0-0-2	GA1M	B,C,E	
	ENR.B517.L		★	Energy Off-Campus Project L C	0-0-2	GA1M	B,C,E	
	ENR.B518.L		★	Energy Off-Campus Project L D	0-0-2	GA1M	B,C,E	
	ENR.B519.L		★	Energy International Workshop A	0-0-1	GA1M	C,E	
	ENR.B520.L		★	Energy International Workshop B	0-0-1	GA1M	C,E	
	ENR.B521.L		★	Energy International Workshop C	0-0-1	GA1M	C,E	
	ENR.B522.L		★	Energy International Workshop D	0-0-1	GA1M	C,E	

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

Research Related to the Completion of Master Thesis

During the master's thesis research the student acquires the abilities to identify and to solve new issues as well as develope technical communication skills by communicating the research results. The typical time lineof the master's thesis research is shown below. The learning objectives and research results will be evaluated by the candidate's supervisor. The candidate will develophis or her study plan based on the goals and progress during the master's thesis research.



・Interim Presentation of Master's Thesis

To understand background, purposes, and issues of his or her own master's thesis research, "Interim Presentation of Master's Thesis" is required.

・Screening Criteria for Master's Thesis

A master's thesis must include new knowledge contributing to the development in energy science and engineering and which is also original.

・Screening of Master's Thesis

Prior to the final screening, the thesis will be reviewed by examiners. Final screening and evaluation of the thesis is based on the student's oral presentation. Oral presentation must be carried out in English or Japanese.

【Doctoral Degree Program】

1. Outline

To integrate and reorganize the inter-relationships in conventional energy-related disciplines, which developed with differentiation and deepening, creation of a novel discipline, “Interdisciplinary Scientific Principles of Energy”, and development of human resources mastering this discipline have been strongly required for overlooking of energy issues and effectively utilization of energy-related disciplines.

In the Doctoral Degree Program, the Energy Science and Engineering Major aims at nurturing an independent research scientist and engineer with advanced expert knowledge in the field of energy science and engineering. Students in this major are expected to pursue the principles of energy-related phenomena by using knowledge in the field of energy science and engineering and to lead a cutting-edge research and development in consideration of societal responsibilities and ethics as well as acquire competence as a global leader who contributes to create a sustainable society.

2. Competencies Developed

The students are expected to acquire,

- Abilities to identify, to investigate, and to solve new issues by using knowledge in the field of energy science and engineering.
- Ability to conduct innovative research and development in an ethical manner.
- Management and technical communication skills by integrating energy-related findings from the viewpoint as an expert of energy-related discipline.
- Competence as a global leader in the energy-related fields.

3. Learning Goals

Students will learn,

A) Advanced expert knowledge in the field of energy science and engineering

Students will gain expert knowledge in greater depth than the master course and to have the ability to apply the knowledge to energy-related phenomena through the doctoral coursework Core Courses and Research Seminars.

B) Ability to solve problems

Students are requested to acquire the ability to find out research problems and solve them by integrating their original discipline such as in chemistry, applied chemistry, material science, mechanical engineering, energy based economics or electrical engineering with other energy-related disciplines.

C) Ability to create solutions

Students are requested to acquire the ability to create solutions by freely utilizing their original discipline and other energy-related disciplines.

D) Competency as a global leader in energy research

Students will acquire the abilities to evaluate their research perspectives and applications from the global point of view, establishing a human network, and lead frontier energy science and engineering, by integrating energy-related disciplines.

E) Communication skills

Develop technical communication skills through discussions with expert scientists in the domestic and international community and presenting their own research results.

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 Energy Science and Engineering curriculum,
   - 12 credits acquired from Research Seminars;
   - 12 credits or more, acquired from the subject in 600-level courses of this major;
   - a minimum of 6 credits acquired from Liberal Arts and Basic Science Courses
     (2 credits from Humanities and Social Sciences Courses, and 4 credits from Career Development Courses
3. Pass the doctoral thesis review and defense.

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

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

Table D1 Graduate Major in Energy Science and Engineering Completion Requirements

<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</td><td rowspan="3">6 credits</td><td>B</td><td></td></tr>
<tr><td>Career development courses</td><td></td><td>4 credits</td><td>C,D,E</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="5">Core courses</td><td>Research seminars</td><td>Seminar in Energy Science S3
Seminar in Energy Science F3
Seminar in Energy Science S4
Seminar in Energy Science F4
Seminar in Energy Science S5
Seminar in Energy Science F5
A total of 12 credits, 2 credits each from the above courses.</td><td></td><td rowspan="3">12 credits</td><td>A,B,C,D,E</td><td></td></tr>
<tr><td>Research-related courses</td><td></td><td></td><td>C,D,E</td><td></td></tr>
<tr><td>Major courses</td><td></td><td></td><td>A,B,C,D</td><td></td></tr>
<tr><td colspan="2">Major courses and Research-related courses <u>outside</u> the Graduate Major in Energy Science and Engineering 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 24 credits including those attained according to the above conditions</td></tr>
<tr><td colspan="2">Note</td><td colspan="5">・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 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 Energy Science and Engineering

Course category		Course number	Course title			Credits	Competencies	Learning goals	Comments
Research seminars	600 level	ENR.Z691.R	◎		Seminar in energy science S3	0-0-2	1,3,4,5	A,B,C	
		ENR.Z692.R	◎		Seminar in energy science F3	0-0-2	1,3,4,5	A,B,C	
		ENR.Z693.R	◎		Seminar in energy science S4	0-0-2	1,3,4,5	A,B,C	
		ENR.Z694.R	◎		Seminar in energy science F4	0-0-2	1,3,4,5	A,B,C	
		ENR.Z695.R	◎		Seminar in energy science S5	0-0-2	1,3,4,5	A,B,C	
		ENR.Z696.R	◎		Seminar in energy science F5	0-0-2	1,3,4,5	A,B,C	
Major courses	600 level	ENR.E601.L			Practical Presentation A	0-0-1	1,3	A,B,C,E	
		ENR.E602.L			Practical Presentation B	0-0-1	1,3	A,B,C,E	
		ENR.E603.L			Practical Presentation C	0-0-1	1,3	A,B,C,E	
		ENR.E618.L			Practical Presentation W1	0-0-1	1,3	A,B,C,E	
		ENR.E604.L		★	International scientific presentation A	0-0-1	1,3	A,B,C,D,E	
		ENR.E605.L		★	International scientific presentation B	0-0-1	1,3	A,B,C,D,E	
		ENR.E606.L		★	International scientific presentation C	0-0-1	1,3	A,B,C,D,E	
		ENR.E619.L		★	International scientific presentation W1	0-0-1	1,3	A,B,C,D,E	
		ENR.E607.L			Practical research in energy science A	0-0-1	1,3,4	A,B,C	
		ENR.E608.L			Practical research in energy science B	0-0-1	1,3,4	A,B,C	
		ENR.E613.L			Practical research in energy science C	0-0-1	1,3,4	A,B,C	

		ENR.E614.L			Practical research in energy science D	0-0-1	1,3,4	A,B,C	
		ENR.E609.L			Academic teaching	0-1-0	1,3	D,E	
		ENR.E610.L		★	Academic Writing A	1-0-0	3,4	A,C,E	
		ENR.E611.L		★	Academic Writing B	1-0-0	1,2,3,4	A,C,E	
		ENR.E612.L		★	International energy project	0-0-2	2,3,4,5	C,D,E	
		ENR.E615.L			Special Experiment and Practice for Working Adults in Energy Science and Engineering 1	0-0-1	1,4,5	C	
		ENR. E616.L			Special Experiment and Practice for Working Adults in Energy Science and Engineering 2	0-0-1	1,4,5	C	
		ENR.E617.L			Special Experiment and Practice for Working Adults in Energy Science and Engineering 3	0-0-1	1,4,5	C	
		ENR.L601.L		★	Advanced Topics in Digital VLSI Design	1-0-0	1,4	A,B	【School of Engineering】(XEG.S605)
		ENR.P601.L		★	Energy Science and Engineering Project	0-0-2	3,4	A,E	
		ENR.R602.L		★	Energy Science and Engineering Off-Campus Project D1c	0-0-2	3,4,5	A,C,E	
		ENR.R603.L		★	Energy Science and Engineering Off-Campus Project D2c	0-0-4	3,4,5	A,C,E	
		ENR.K601.L		★	Special Lecture in Mechanical Engineering I	1-0-0	1,2	B	【Mechanical Engineering】(MEC.N631)
		ENR.K602.L		★	Special Lecture in Mechanical Engineering II	1-0-0	1,2	B	【Mechanical Engineering】(MEC.N632)
		ENR.K603.L		★	Special Lecture in Mechanical Engineering III	1-0-0	1,2	B	【Mechanical Engineering】(MEC.N633)
		ENR.K604.L		★	Special Lecture in Mechanical Engineering IV	1-0-0	1,2	B	【Mechanical Engineering】(MEC.N634)
		ENR.R604			Cooperative Education through Research Internships of Energy Science and Engineering	0-0-4	1,3,4,5	C,D,E	
Note：									

• ◎ : Required course, ★ : Classes in English

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

• 【 】Course offered by another graduate major

• The character preceding the three digits in the course number denotes the course's subdiscipline (i.e., "D" represents the subdiscipline code in the course number ENR.D600.R): E (Major Courses), Z (Research Seminars). The character “R” succeeding the course number represents that the course is elective (L) and required (R), respectively.

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 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 below.

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

For Graduate Attributes, refer to the Guide to the Career Development Courses.
The Graduate Attributes of the Doctoral Degree Program are listed in Table A-1 as follows:

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

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

Table D3 Courses of the Graduate Major in Energy Science and Engineering recognized as equivalent to Career Development Courses in the Academic Leader Program

Course category	Course number	Course title	Credits	GA*	Learning goals	Comments
Courses that	ENR.E607.L	Practical research in energy science A	0-0-1	GA1D	A,B,C	

can be counted as Career Development Courses	ENR.E608.L			Practical research in energy science B	0-0-1	GA1D	A,B,C	
	ENR.E604.L		★	International scientific presentation A	0-0-1	GA1D	A,B,C,D, E	
	ENR.E605.L		★	International scientific presentation B	0-0-1	GA1D	A,B,C,D, E	
	ENR.E606.L		★	International scientific presentation C	0-0-1	GA1D	A,B,C,D, E	
	ENR.E619.L		★	International scientific presentation W1	0-0-1	GA1D	A,B,C,D, E	
	ENR.E609.L			Academic teaching	0-1-0	GA1D	D,E	
	ENR.E612.L		★	International energy project	0-0-2	GA1D	C,D,E	
	ENR.P601.L		★	Energy Science and Engineering Project	0-0-2	GA1D	A,E	
	ENR.R602. L		★	Energy Science and Engineering Off-Campus Project D1c	0-0-2	GA1D	A,C,E	
	ENR.R603. L		★	Energy Science and Engineering Off-Campus Project D2c	0-0-4	GA1D	A,C,E	
	CHM.A661		★	Basic Exercises in Global Presentation	0-1-0	GA1D	C	Available only to students belonging to the Department of Chemistry
	CHM.A662		★	Advanced Exercises in Global Presentation	0-1-0	GA1D	C	Available only to students belonging to the Department of Chemistry
	CHM.A651			Laboratory Training of Advanced Chemistry I	0-0-1	GA1D	C	Available only to students belonging to the Department of Chemistry
	CHM.A652			Laboratory Training of Advanced Chemistry II	0-0-1	GA1D	C	Available only to students belonging to the Department of Chemistry
	CHM.A653			Laboratory Training of Advanced Chemistry III	0-0-1	GA1D	C	Available only to students belonging to the Department of Chemistry
	CHM.A654			Laboratory Training of Advanced Chemistry IV	0-0-1	GA1D	C	Available only to students belonging to the Department of Chemistry
	MEC.T631			Teaching Practice in Mechanical Engineering	0-0-2	GA1D	D	Available only to students belonging to the Department of Mechanical Engineering
	MEC.R631			Off Campus Project D1c	0-0-1	GA1D	C,D	Available only to students belonging to the Department of

								Mechanical Engineering
	MEC.R632			Off Campus Project D2c	0-0-2	GA1D	C,D	Available only to students belonging to the Department of Mechanical Engineering
	MEC.R633			Off Campus Project D3c	0-0-3	GA1D	C,D	Available only to students belonging to the Department of Mechanical Engineering
	MEC.R634			Off Campus Project D4c	0-0-4	GA1D	C,D	Available only to students belonging to the Department of Mechanical Engineering
	MEC.R635			Off Campus Project D5c	0-0-5	GA1D	C,D	Available only to students belonging to the Department of Mechanical Engineering
	MEC.R636			Off Campus Project D6c	0-0-6	GA1D	C,D	Available only to students belonging to the Department of Mechanical Engineering
	MEC.S631			Overseas Research Project D1c	0-0-1	GA1D	E	Available only to students belonging to the Department of Mechanical Engineering
	MEC.S632			Overseas Research Project D2c	0-0-2	GA1D	E	Available only to students belonging to the Department of Mechanical Engineering
	MEC.S633			Overseas Research Project D3c	0-0-3	GA1D	E	Available only to students belonging to the Department of Mechanical Engineering
	MEC.S634			Overseas Research Project D4c	0-0-4	GA1D	E	Available only to students belonging to the Department of Mechanical Engineering
	MEC.S635			Overseas Research Project D5c	0-0-5	GA1D	E	Available only to students belonging to the Department of Mechanical Engineering
	MEC.S636			Overseas Research Project D6c	0-0-6	GA1D	E	Available only to students belonging to the Department of

								Mechanical Engineering
	EEE.G601		★	Teaching Skills in English for Doctoral Course Students	0-1-0	GA1D	D,E	Available only to students belonging to the Department of Electrical and Electronic Engineering
	EEE.R611		★	Doctor Course Colloquium	0-1-0	GA1D	C,D,E	Available only to students belonging to the Department of Electrical and Electronic Engineering
	EEE.R601			Training on Teaching Technique	0-1-0	GA1D	C,D,E	Available only to students belonging to the Department of Electrical and Electronic Engineering
	EEE.R651		★	Study Abroad (Doctor Course) A	0-0-1	GA1D	B,D,E	Available only to students belonging to the Department of Electrical and Electronic Engineering
	EEE.R652		★	Study Abroad (Doctor Course) B	0-0-2	GA1D	B,D,E	Available only to students belonging to the Department of Electrical and Electronic Engineering
	EEE.R653		★	Study Abroad (Doctor Course) C	0-0-4	GA1D	B,D,E	Available only to students belonging to the Department of Electrical and Electronic Engineering
	EEE.R654		★	Study Abroad (Doctor Course) D	0-0-6	GA1D	B,D,E	Available only to students belonging to the Department of Electrical and Electronic Engineering
	EEE.R661			Internship (Doctor Course) A	0-0-1	GA1D	B,C,D,E	Available only to students belonging to the Department of Electrical and Electronic Engineering
	EEE.R662			Internship (Doctor Course) B	0-0-2	GA1D	B,C,D,E	Available only to students belonging to the Department of Electrical

								and Electronic Engineering
	EEE.R663			Internship (Doctor Course) C	0-0-4	GA1D	B,C,D,E	Available only to students belonging to the Department of Electrical and Electronic Engineering
	EEE.R664			Internship (Doctor Course) D	0-0-6	GA1D	B,C,D,E	Available only to students belonging to the Department of Electrical and Electronic Engineering
	MAT.A661			Materials Off-campus Project 1	0-0-1	GA1D	D	Available only to students belonging to the Department of Materials Science and Engineering
	MAT.A662			Materials Off-campus Project 2	0-0-2	GA1D	D	Available only to students belonging to the Department of Materials Science and Engineering
	MAT.A663			Materials Off-campus Project 3	0-0-4	GA1D	D	Available only to students belonging to the Department of Materials Science and Engineering
	MAT.A664			Materials Off-campus Project 4	0-0-6	GA1D	D	Available only to students belonging to the Department of Materials Science and Engineering
	CAP.E631			Chemical Science and Engineering Off-Campus Project 1	0-0-1	GA1D	B,D	Available only to students belonging to the Department of Chemical Science and Engineering
	CAP.E632			Chemical Science and Engineering Off-Campus Project 2	0-0-2	GA1D	B,D	Available only to students belonging to the Department of Chemical Science and Engineering
	CAP.E633			Chemical Science and Engineering Off-Campus Project 3	0-0-4	GA1D	B,D	Available only to students belonging to the Department of Chemical Science and Engineering
	CAP.E634			Chemical Science and Engineering Off-Campus Project 4	0-0-6	GA1D	B,D	Available only to students belonging to the Department of Chemical Science and Engineering

	ENR.R604			Cooperative Education through Research Internships of Energy Science and Engineering	0-0-4	GA1D	C,D,E	

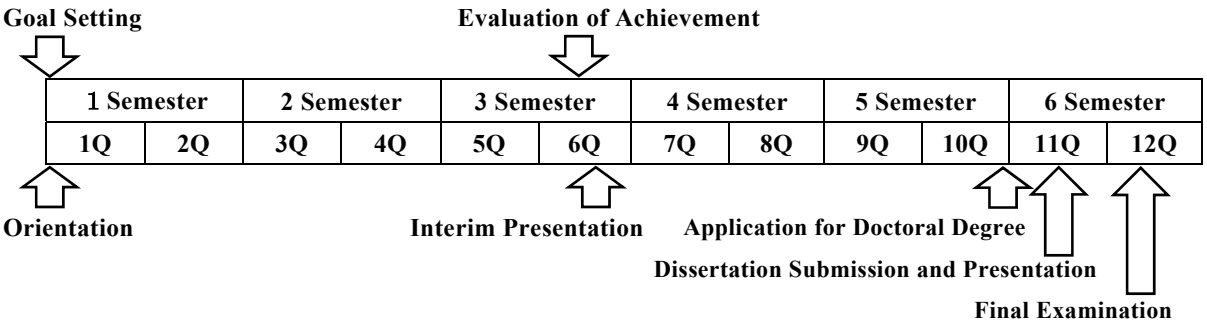
Credits in Career Development Courses must be attained from among the above-listed courses and those listed as such in the Liberal Arts and Basic Science Courses Guide.

＊GA: Graduate Attributes

Students enrolled in the educational program for leading graduate schools, the Tokyo Tech Academy for Leadership (ToTAL), the Tokyo Tech Academy of Energy and Informatics (ISE), the Tokyo Tech Academy for Convergence of Materials and Informatics (TAC-MI), or the Tokyo Tech Academy for Super Smart Society (SSS) 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.

Research Related to the Completion of Doctoral Thesis

The doctoral dissertation research aims to acquire the abilities to identify, to investigate, and to solve new issues by using organized knowledge in the field of energy science and engineering. In addition, improvement in English communication skill is strongly required. These abilities will be acquired through the process of goal setting,coursework,research activities,presentations and evaluation of the achievement. The typical time lineof the doctoral dissertation research is shown as follows.



・ Criteria for Doctoral Dissertation

A doctoral dissertation must be prepared that has sufficient novelty, originality, and academic value in the field of energy science and engineering. The dissertation must be written in English or Japanese.

・Doctoral Dissertation Examination

The examinationcommittee shall consist of multiple examiners who can evaluate the dissertation from an academic and a research advancement point of view. The committee can also include external examiners who belong to other universities, institutions, and companies. After the submission of doctoral dissertation, the final screening and evaluation will be carried out via oral presentation and reviewed by the dissertation examiners. Oral presentation must be carried out in English or Japanese.