Graduate Major in Engineering Sciences and Design

Graduate major in Engineering Sciences and Design includes various aspects of Mechanical Engineering, System and Control Engineering, Industrial Engineering and Economics (School of Engineering), Architecture and Building Engineering, Civil and Environmental Engineering, and Transdisciplinary Science engineering (School of Environment and Society). From a 'Design' point of view, this major fosters creative human resources who are able to generate useful solutions and products.

【Master's Degree Program】

1. Outline

The purpose of this major is the cultivation of engineering design abilities, i.e.
(1) The students will have a wide aspect without being bound to the frame of current science and technology.
(2) The students will acquire an ability to find solutions to a variety of real-life challenges.
(3) The students will contribute to the creation of new technologies, values and concepts, required to improve our society.

2. Competencies developed in the program

The students will acquire the following skills and abilities:
(1) Knowledge, comprehension and logical mind that enable their success in science and technological research fields.
(2) Fundamental skills for engineering design.
(3) Self-learning ability for research and innovation.
(4) Communication skills to progress research and innovation.
(5) Abilities for research and facilitation in engineering design.

3. Learning Goals

To acquire aforementioned competencies, the students will participate in the following classes and projects.

(A) Practical theories of design thinking

Through project-based learning, the students learn practical engineering design process.

(B) Off-campus project

Students experience the planning and practice of an engineering design project outside the classroom.

(C) Design theory

The students learn academic knowledge and skills related to engineering design.

(D) Design of artifacts

The students learn knowledge and skills in various engineering fields, as well as the fundamentals of design engineering.

(E) Design of social systems

The students learn engineering design knowledge and skills, applied to the creation of software, service and social system.

(F) Design of human environment

The students learn about the design process, with an approach centered on people.

(G) Master thesis

Through research seminars and survey of academic papers, the students complete a research project and submit a thesis for Master graduation.

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 Engineering Sciences and Design curriculum,
    - 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).
    - a minimum of 21 credits acquired from Core Courses (6 credits must be from Research Seminars, 3 credits must be acquired from “Engineering Design Challenge” and “Design Thinking Fundamentals”, minimum 6 credits from A or B subjects groups excluding the required course, minimum 6 credits selecting 2 and more subject groups from C, D, E, F
    - a minimum of 4 credits from Major Courses and Research-Related Courses outside the Graduate Major in Engineering Sciences and Design standard curriculum;
3. Pass the master's thesis review and defense.

Table M1. Graduate Major in Engineering Sciences and Design 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	C	
	Career Development Courses		2 credits		C, D	
	Other courses					
Core Courses	Research Seminars	Seminar in Engineering Design S1 Seminar in Engineering Design F1 Seminar in Engineering Design S2 Seminar in Engineering Design F2 A total of 6 credits.		21 credits	C, D, E	
	Research-Related Courses and Major Courses	Engineering Design Challenge 1credit Design Thinking Fundamentals 2 credits	•Minimum 6 credits from A or B excluding the required course in the left column •Minimum 6 credits selecting 2 and more subject groups from C, D, E, F		A, B, C, D, E	
	Major Courses and Research-Related Courses <u>outside</u> the Graduate Major in Engineering Sciences and Design standard curriculum			4 credits		
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.** • **Subject group : please refer to course numbers.** **A : Practical theories of design thinking B : Off-campus project C : Design theory** **D : Design of artifacts E : Design of social systems F : Design of human environment**				

5. IGP Courses

Table M2. Core Courses of the Graduate Major in Engineering Sciences and Design

Course category		Course Number	Course			Credits	Competencies	Learning goals	Comments
Research seminars	400 level	ESD.Z491.R	◎		Seminar in Engineering Design S1	0-1-0	3	G	Offered in English as needed
		ESD.Z492.R	◎		Seminar in Engineering Design F1	0-1-0	3	G	Offered in English as needed
	500 level	ESD.Z591.R	◎		Seminar in Engineering Design S2	0-2-0	3	G	Offered in English as needed
		ESD.Z592.R	◎		Seminar in Engineering Design F2	0-2-0	3	G	Offered in English as needed
Research-related courses	500 level	ESD.B501.L			Off-Campus Project A	0-1-1	1,2,3,5	B	Offered in English as needed
		ESD.B502.L			Off-Campus Project B	0-1-1	1,2,3,5	B	Offered in English as needed
		ESD.B503.L			Off-Campus Project C	0-1-1	1,2,3,5	B	Offered in English as needed
		ESD.B504.L			Off-Campus Project D	0-1-1	1,2,3,5	B	Offered in English as needed
Major courses	400 level	ESD.A401.R	◎	★	Engineering Design Challenge	1-0-0	1,3,4	A	
		ESD.A402.R	◎	★	Design Thinking Fundamentals	1-1-0	2,4,5	A	
		ESD.C401.L		★	Design Theories	1-1-0	1,2,3,4,5	C	
		ESD.D401.L		★	Material Selection for Engineering Design	1-1-0	3,4,5	D	
		ESD.D402.L		★	Materials Modeling and Simulation for Engineering Design	1-1-0	3,4,5	D	
		ESD.E401.L		★O	Participatory Design in Energy Business	1-1-0	1,2,4	E	
		ESD.F403.L		★	UX / Interaction Design	1-1-0	2,3,5	F	
		ESD.F404.L		★	Affective Engineering / Emotional Design	1-0-0	1,2,3,4,5	F	
		ESD.F401.L		★O	Introduction to Biomedical Instrumentation	1-0-0		F	【Human Centered Science and Biomedical Engineering】(HCB.M463)
		ESD.F402.L		★E	Introduction to Neural Engineering	1-0-0	3	F	【Human Centered Science and Biomedical Engineering】

									(HCB.M464)
		ESD.F405.L		★	Human-Centered Design	1-0-0	1,2,3,4,5	B	【Mechanical Engineering】(MEC. L432)
	500 level	ESD.B505.L			Short term Research Project M1	0-0-1	1,2,3,5	B,G	Offered in English as needed
		ESD.B506.L			Short term Research Project M2	0-0-1	1,2,3,5	B,G	Offered in English as needed
		ESD.B507.L			Short term Research Project M3	0-0-1	1,2,3,5	B,G	Offered in English as needed
		ESD.B508.L			Short term Research Project M4	0-0-1	1,2,3,5	B,G	Offered in English as needed
		ESD.D503.L		★	Civil Engineering Design Ⅰ	1-1-0	1,3	D	
		ESD.D504.L		★	Civil Engineering Design Ⅱ	1-1-0	1,3	D	
		ESD.E501.L		★	Theory of Business Architecture	1-1-0	2,3,4	E	
		ESD.E502.L		★	IT Management	1-1-0	2,3,4	E	
		ESD.F501.L		★	Practical Theories in Man Environment System Design	1-0-0	1,3,4,5	F	

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.

• 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 : Practical theories of design thinking, B : Off-campus project, C : Design theory, D : Design of artifacts, E : Design of social systems, F : Design of human environment, Z: Research seminars

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

Not applicable

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 Engineering Sciences and Design 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	ESD.E401.L		★ O	Participatory Design in Energy Business	1-1-0	C0M, C1M	E	
	ESD.B501.L			Off-Campus Project A	0-1-1	C1M	B	Offered in English as needed
	ESD.B502.L			Off-Campus Project B	0-1-1	C1M	B	Offered in English as needed
	ESD.B503.L			Off-Campus Project C	0-1-1	C1M	B	Offered in English as needed
	ESD.B504.L			Off-Campus Project D	0-1-1	C1M	B	Offered in English as needed
	ESD.B505.L			Short term Research Project M1	0-0-1	C0M	B,G	Offered in English as needed
	ESD.B506.L			Short term Research Project M2	0-0-1	C0M	B,G	Offered in English as needed
	ESD.B507.L			Short term Research Project M3	0-0-1	C0M	B,G	Offered in English as needed
	ESD.B508.L			Short term Research Project M4	0-0-1	C0M	B,G	Offered in English as needed

★: Classes in English

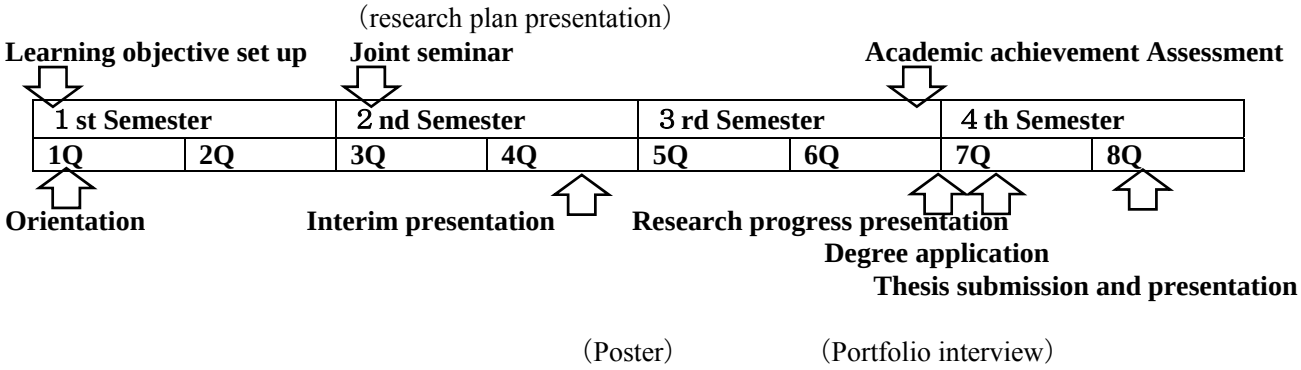
To satisfy the Career Development requirement, credits may be acquired from courses listed above as well as from those listed under Career Development Courses (see the Liberal Arts and Basic Science Courses Guide).

*** GA：Graduate Attribute**

8. Research processes for Master's thesis

Research for Master's thesis
Model diagram

In researches for master's theses, students will cultivate abilities to set issues based on previous researches from his or her own points of views and to study the issues experiencing the series of research process.



・ Research plan presentation・Research interim presentation

To leave good research findings, it is important to proceed research systematically and to check the progress of researches on a regular basis. For the sake of gaining clear conscious of his or her research backgrounds and purposes, of having an overhead view of engineering design research areas and of directing his or her researches, master students are required to present the plan of their research work at around the same time when doctor students present in third quarter. Then, students will make interim presentations in fourth quarter and will make research progress presentation which students will by going round laboratories, where professors who manage research progress have, in six quarter.

・Criteria of master's thesis assessment

Master's thesis should include either new findings in the academic area of engineering design or useful findings which contribute to develop problem solution and future value creation of related technology. Also it should be written by students themselves and should include own consideration.

・Process of master's thesis assessment

An assessment committee consists of 3 judges including supervisors. Before final assessment and evaluation, judges conduct peer in advance followed by students' oral presentation. Assessments for students who are willing to proceed to doctor's course will be judged by more than five judges including three professors who are in charge of this course.

・Assessment criteria of specific issue assignment

If students choose specific issue assignment specified by the course, it can be assessed as the work or specific issue assignment of equivalent to master's thesis. However, the work or the specific issue assignment should include own findings such as problem solutions and future value creation.

・Assessment process of specific issue research

Final assessment is conducted by more than five judges including more than three professors who are in charge of this course.

【Doctoral Degree Program】

1. Outline

The purpose of this major is the cultivation of advanced engineering design abilities, i.e.
(1) The students will have a wide aspect without being bound to the frame of science and technology.
(2) The students will acquire an ability to find solutions to a variety of real-life challenges.
(3) The students will contribute to the creation of new technologies, values and concepts, required to improve our society.

2. Competencies Developed

The students will acquire the following high skills and abilities:
(1) Mind to challenge to outstanding problems considering science, technology and morality.
(2) Collaboration ability with other researches that have different culture and philosophy.
(3) International communication and management ability to progress their research and innovation.
(4) Ability to create a new concept for technology and innovation with wide aspects.
(5) Design ability to advance their research through Doctoral thesis and practical projects.

3. Learning Goals

To acquire aforementioned competencies, the students will participate in the following classes and projects.

(A) Teaching methodology

Participating a project class and PBL for master course or undergraduates, the students will learn teaching methodology including metering and facilitation under the instruction of their supervisor.

(B) Off-campus project

Students experience the planning and practice of an engineering design project outside the classroom (recommended in foreign countries).

(C) Literate of engineering science design

The students learn academic knowledge and skills for education related to engineering sciences and design.

(D) Doctoral thesis

Through research seminars and survey of academic papers, the students complete a research project and submit a thesis for Doctoral graduation.

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 Engineering Sciences and Design curriculum,
   - a minimum of 6 credits acquired from Liberal Arts and Basic Science Courses (2 credits must be from 600-level Humanities and Social Science Courses, and 4 credits from Career Development Courses).
   - a minimum of 13 credits acquired from Core Courses (12 credits must be from Research Seminars, a minimum of 1 credit must be from Pedagogical Seminars for Graduate Students);
3. Pass the doctoral thesis review and defense.

Table D1. Graduate Major in Engineering Sciences and Design 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, D	
	Other courses					
Core Courses	Research Seminars	Research Seminar in Engineering Design S3 Research Seminar in Engineering Design F4 Research Seminar in Engineering Design S5 Research Seminar in Engineering Design F5 Research Seminar in Engineering Design S6 Research Seminar in Engineering Design F6 A total of 12 credits		13 credits	C, D	
	Research-Related Courses and Major Courses		1 credit from Pedagogical Seminar subject group		A, B, C, D	
	Major Courses and Research-Related Courses outside the Graduate Major in Engineering Sciences and Design 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. • Subject group : please refer to course numbers. A : Practical theories of design thinking B : Off-campus project C : Design theory D : Design of artifacts E : Design of social systems F : Design of human environment				

5. IGP Courses

Table D2. Core Courses of the Graduate Major in Engineering Sciences and Design

Course category		Course Number	Course			Credits	Competencies	Learning goals	Comments
Research seminars	600 level	ESD.Z691.R	◎		Seminar in Engineering Design S3	0-2-0	3	D	Offered in English as needed
		ESD.Z692.R	◎		Seminar in Engineering Design F3	0-2-0	3	D	Offered in English as needed
		ESD.Z693.R	◎		Seminar in Engineering Design S4	0-2-0	3	D	Offered in English as needed
		ESD.Z694.R	◎		Seminar in Engineering Design F4	0-2-0	3	D	Offered in English as needed
		ESD.Z695.R	◎		Seminar in Engineering Design S5	0-2-0	3	D	Offered in English as needed
		ESD.Z696.R	◎		Seminar in Engineering Design F5	0-2-0	3	D	Offered in English as needed
Research-related courses	600 level	ESD.B601.L			Off-Campus Project E	0-0-1	1,2,3,5	B	Offered in English as needed
		ESD.B602.L			Off-Campus Project F	0-0-1	1,2,3,5	B	Offered in English as needed
		ESD.B603.L			Off-Campus Project G	0-0-1	1,2,3,5	B	Offered in English as needed
		ESD.B604.L			Off-Campus Project H	0-0-1	1,2,3,5	B	Offered in English as needed
Major courses	600 level	ESD.A601.L			Pedagogical Seminar for Graduate Students A	0-0-1	2,5	A	Offered in English as needed
		ESD.A602.L			Pedagogical Seminar for Graduate Students B	0-0-1	2,5	A	Offered in English as needed
		ESD.A603.L			Pedagogical Seminar for Graduate Students C	0-0-1	2,5	A	Offered in English as needed
		ESD.A604.L			Pedagogical Seminar for Graduate Students D	0-0-1	2,5	A	Offered in English as needed
		ESD.B605.L			Long term Off-Campus project D1	0-1-1	1,2,3,5	B,D	Offered in English as needed
		ESD.B606.L			Long term Off-Campus project D2	0-1-1	1,2,3,5	B,D	Offered in English as needed
		ESD.B607.L			Long term Off-Campus project D3	0-1-1	1,2,3,5	B,D	Offered in English as needed
		ESD.B608.L			Long term Off-Campus project D4	0-1-1	1,2,3,5	B,D	Offered in English as needed
		ESD.S601.L			Business practice D1	0-0-1	3,4	B,C,D	Offered in English as needed
		ESD.S602.L			Business practice D2	0-0-1	3,4	B,C,D	Offered in English as needed
		ESD.S603.L			Business practice D3	0-0-1	3,4	B,C,D	Offered in English as needed
		ESD.S604.L			Business practice D4	0-0-1	3,4	B,C,D	Offered in English as needed

		ESD.S610.L			Research Dialog	0-0-1	2,3,4	B,C,D	Offered in English as needed

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.

• 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 : Practical theories of design thinking, B : Off-campus project, C : Design theory, D : Design of artifacts, E : Design of social systems, F : Design of human environment, S: Research related activities Z: Research seminars

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

Not Applicable

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 Engineering Sciences and Design that can be recognized as Career Development Courses in the Academic Leader Program (ALP)

Course Category	Course Number	Course			Credits	GA*	Learning goals	Comments
can be recognized as Career Development Courses	ESD.A601.L			Pedagogical Seminar for Graduate Students A	0-0-1	A3D	A	Offered in English as needed
	ESD.A602.L			Pedagogical Seminar for Graduate Students B	0-0-1	A3D	A	Offered in English as needed
	ESD.A603.L			Pedagogical Seminar for Graduate Students C	0-0-1	A3D	A	Offered in English as needed
	ESD.A604.L			Pedagogical Seminar for Graduate Students D	0-0-1	A3D	A	Offered in English as needed
	ESD.B601.L			Off-Campus Project E	0-0-1	A0D	B	Offered in English as needed
	ESD.B602.L			Off-Campus Project F	0-0-1	A0D	B	Offered in English as needed
	ESD.B603.L			Off-Campus Project G	0-0-1	A0D	B	Offered in English as needed
	ESD.B604.L			Off-Campus Project H	0-0-1	A0D	B	Offered in English as needed
	ESD.B605.L			Long term Off-Campus project D1	0-1-1	A1D	B,D	Offered in English as needed
	ESD.B606.L			Long term Off-Campus project D2	0-1-1	A1D	B,D	Offered in English as needed
	ESD.B607.L			Long term Off-Campus project D3	0-1-1	A1D	B,D	Offered in English as needed
	ESD.B608.L			Long term Off-Campus project D4	0-1-1	A1D	B,D	Offered in English as needed

	ESD.S601.L			Business practice D1	0-0-1	A2D	B,C,D	Offered in English as needed
	ESD.S602.L			Business practice D2	0-0-1	A2D	B,C,D	Offered in English as needed
	ESD.S603.L			Business practice D3	0-0-1	A2D	B,C,D	Offered in English as needed
	ESD.S604.L			Business practice D4	0-0-1	A2D	B,C,D	Offered in English as needed
	ESD.S610.L			Research Dialog	0-0-1	A2D	B,C,D	Offered in English as needed

★: Classes in English

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 Engineering Sciences and Design that can be recognized as Career Development Courses in the Productive Leader Program (PLP)

Course Category	Course Number	Course			Credits	GA*	Learning goals	Comments
can be recognized as Career Development Courses	ESD.B601.L			Off-Campus Project E	0-0-1	P0D	B	Offered in English as needed
	ESD.B602.L			Off-Campus Project F	0-0-1	P0D	B	Offered in English as needed
	ESD.B603.L			Off-Campus Project G	0-0-1	P0D	B	Offered in English as needed
	ESD.B604.L			Off-Campus Project H	0-0-1	P0D	B	Offered in English as needed
	ESD.B605.L			Long term Off-Campus project D1	0-1-1	P1D	B,D	Offered in English as needed
	ESD.B606.L			Long term Off-Campus project D2	0-1-1	P1D	B,D	Offered in English as needed
	ESD.B607.L			Long term Off-Campus project D3	0-1-1	P1D	B,D	Offered in English as needed
	ESD.B608.L			Long term Off-Campus project D4	0-1-1	P1D	B,D	Offered in English as needed
	ESD.S601.L			Business practice D1	0-0-1	P2D	B,C,D	Offered in English as needed
	ESD.S602.L			Business practice D2	0-0-1	P2D	B,C,D	Offered in English as needed
	ESD.S603.L			Business practice D3	0-0-1	P2D	B,C,D	Offered in English as needed
	ESD.S604.L			Business practice D4	0-0-1	P2D	B,C,D	Offered in English as needed
	ESD.S610.L			Research Dialog	0-0-1	P2D	B,C,D	Offered in English as needed

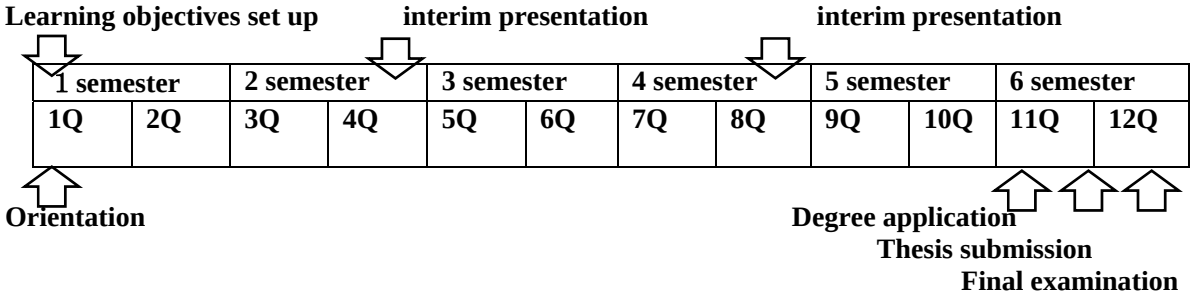
★: Classes in English

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 for doctoral thesis
Model diagram

In a research for doctoral thesis, students will cultivate abilities to set issues based on previous researches from his or her own points of views and to construct original findings for problem solving. The master's thesis research flow to achieve the goals is described below.



Note） above is a model diagram, the details of Doctoral thesis assessment will be decided separately

・Criteria of doctoral thesis assessment

Doctoral thesis should include findings newly and originally enough in the academic area of engineering design. Also the main part of the thesis should either be published in international journal or have a quality equivalent to that.

・Process of doctoral thesis assessment

An assessment committee consists of five and more judges. It is strongly recommended that the committee includes several external judges from other universities and research institutes. Students are allowed to submit papers after they pass interim assessment and preparatory assessment. Final assessments and evaluations are conducted after students' oral presentations and peer reviews by judges in advance.