Graduate Major in Systems and Control Engineering

【Master's Degree Program】

1. Outline

Our lives, as well as the various equipment and infrastructure that support us are made up of different elements. However, it is shown that the ability to achieve these and the values that are conceived transcend the individual elements to make an overall system. In the Master's Degree Program, all things and matters in nature and society will be objectively analyzed as systems, and students will cultivate the ability to create systems that have value based on this knowledge. Namely, by learning developmental knowledge of measurement, control, planning, and systems science, this program trains talented people who can specifically apply this knowledge to new topics, are flexibly inventive, creative, and are bold and action-oriented individuals.

2. Competencies Developed

In the Master's Degree Program, students are trained in the following abilities.

1. Expert mathematical knowledge for modelling, computerizing, and analyzing actual systems
2. Expert mathematical knowledge for creating and controlling systems that have new value
3. Practical skills to utilize the expert knowledge that is learned
4. The ability to accurately recognize societal challenges, and the ability to identify and resolve these problems
5. Communication and presentation abilities based on logical thinking

3. Learning Goals

The Master's Degree Program has a curriculum that is designed for students to learn the skills in Competencies Developed in which the following six categories are arranged in coordination.

A Courses that build expert knowledge of system mathematics
C Courses that build expert knowledge of Systems and Control Engineering
I Courses that build expert knowledge in the fields of information and sensing
M Courses that train expert abilities of system modelling
P Courses that build communication ability, as well as the abilities to identify and resolve problems
Z Courses that build expert research abilities

4. IGP Completion Requirements

The following requirements must be met to complete the Master's Degree Program of this major.

1. A total of 34 credits or more acquired from 400- and 500-level courses.
2. From the courses specified in Table M2,
   - a total of 8 credits acquired from Research Seminars;
   - a minimum of 24 credits acquired from Major Courses;
   - 3 credits acquired from Systems and Control Engineering Project;

3. 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).
4. Pass the master's thesis review and defense.

Table M1. Graduate Major in Systems and Control 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		
	Career Development Courses		2 credits			
	Other courses					
Core Courses	**Research Seminars**	Research Seminar in Systems and Control Engineering (SCE) S1 Research Seminar in SCE F1 Research Seminar in SCE S2 Research Seminar in SCE F2 A total of 8 credits, 2 credits each from the above courses.		24 credits	Z	
	Research-Related Courses					
	Major Courses	Systems and Control Engineering Project			A,C,I,M,P	
	Major Courses and Research-Related Courses <u>outside</u> the Graduate Major in Systems and Control Engineering standard curriculum			2 credits		
Total required credits		**A minimum of 34 credits in addition to meeting the above conditions**				
Note		**• Japanese Language and Culture Courses offered to International Students can be recognized as Humanities and Social Science Courses of the corresponding course level.**				

	• **As for Liberal Arts and Basic Science Courses, please refer to the relevant pages.**

5. IGP Courses

Table M2. Core Courses of the Graduate Major in Systems and Control Engineering

Course Category		Course Number	Course			Credits	Competencies	Learning goals	Comments
Research Seminars	**400 level**	SCE.Z491.R	◎		Seminar in Systems and Control Engineering S1	0-2-0	2,3,5	Z	
		SCE.Z492.R	◎		Seminar in Systems and Control Engineering F1	0-2-0	2,3,5	Z	
	500 level	SCE.Z591.R	◎		Seminar in Systems and Control Engineering S2	0-2-0	2,3,5	Z	
		SCE.Z592.R	◎		Seminar in Systems and Control Engineering F2	0-2-0	2,3,5	Z	
Major Courses	**400 level**	SCE.A401.L			Stochastic Systems	1-0-0	3	A	
		SCE.A404.L			Nonlinear Dynamics	1-0-0	3	A	
		SCE.C401.L			System Identification and Estimation	1-0-0	3,5	C	
		SCE.C402.L			Robust Control	1-0-0	3,5	C	
		SCE.I401.L			Advanced Course of Measurement and Signal Processing	1-0-0	3	I	
		SCE.I432.L			Acoustic Measurement Engineering	1-0-0	3,4,5	I	
		SCE.M401.L			Numerical Analysis of Heat Transfer and Fluid Flow	1-0-0	3,5	M	
		SCE.M402.L			Modeling of Bio-Systems I	1-0-0	3,5	M	
		SCE.S402.L			Fluid Robotics	1-0-0	3,5	S	
		SCE.Z401.A	◎		Systems and Control Engineering Project	0-3-0	2,4,5	P	Required for IGP students
		SCE.Z402.A			International Dispatch Project A	0-3-0	1,2,4,5	P	
		SCE.Z403.A			International Dispatch Project B	0-3-0	1,2,4,5	P	
	500 level	SCE.A501.L			Theory of Complex Networks	1-0-0	3	A	
		SCE.A503.L			Planning Algorithm	1-0-0	3	A	

		SCE.A504.L			Advanced Course of Computational Mechanics	1-0-0	3	A	
		SCE.A505.L			Inverse Problems and Data Assimilation	1-0-0	3,4,5	A	
		SCE.C501.L			Optimal Control	1-0-0	3	C	
		SCE.C502.L			Hybrid Systems Control	1-0-0	3	C	
		SCE.C531.L			Nonlinear and Adaptive Control	1-0-0	3	C	
		SCE.C532.L			Nonlinear Control: Geometric Approach	1-0-0	3	C	
		SCE.C533.L			Network Control Systems	1-0-0	3	C	
		SCE.I501.L			Computational Imaging	1-0-0	1,3	I	
		SCE.I531.L			Computer Vision	1-0-0	3	I	
		SCE.M502.L			Modeling of Bio-Systems II	1-0-0	35	M	

Note：

・◎：Required course, ○：Restricted elective, O：odd academic years, E：even academic years

・□：Course is recognized as an Academy for Co-creative Education of Environment and Energy Science, Leading Graduate School (ACEEES) course.

• Competencies: 1 = Intercultural skills; 2 = Communication skills; 3 = Specialist skills; 4 = Critical thinking skills; 5 = Practical and/or problem-solving skills

・【 】Course offered under another graduate major.

• The character preceding the three digits in the course number denotes the course's subdiscipline (i.e., "A" represents the subdiscipline code in the course number SCE.A400.L): A (System Mathematics), C (Systems and Control Engineering), I (Information and Sensing), M (System Modeling), P (Project), Z (Research seminars).

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

None

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

None

8. Research Related to the Completion of Master Theses

Students participating in this Program must submit an original master theses to the institute. At Tokyo Tech, there is no credit for the master thesis. Students are expected to work for their master theses throughout the master course under supervisions of academic advisors. Students are requested to conduct (i) process memo, (ii) off-lab discussions, and (iii) interim presentation. The process memo is a report of research activities. A students will be requested to submit his/her report to his/her academic advisors by an indicated deadline. As off-labo discussions, students are required to make discussions with professors except his/her supervisor. Two times of discussions will be set for a student. An interim presentation is mandatory for all students. The type of presentation (poster or oral) and the date of interim presentation will be announced by the department.

At Tokyo Tech, the master's degree will be awarded according to the rules and regulations for the master's degree diploma. The decision of pass or fail will be made by a review board, which consists of 3 or more faculty members. The review board must be formed with 5 or more members if you continue your study to the doctoral course.

【Doctoral Degree Program】

1. Outline

In the Doctoral Degree Program, we train people to be leaders equipped with both academic knowledge and practical abilities, who can hold a highly systemic point of view while independently discovering topics for conducting their own research into various practical problems. Students are trained to be able to systemize and understand the flow of research and development from a highly systemic and international point of view, as well as to have the ability to freely apply their expert knowledge of Systems and Control Engineering in new creative proposals to return the fruits of their research to society.

2. Competencies Developed

The following abilities will be trained, based on the extensive academic abilities and systematic viewpoint learned before the Doctoral Degree Program.

- The ability to interpret and systemize problems in various fields from a s viewpoint of system engineering, and the ability to conceive and create new values
- The ability to independently establish research topics
- The ability to design and execute projects as a leader
- The ability to systemize and understand the flow of research and development with an international point of view
- The ability to return the fruits of one's research to society

3. Learning Goals

The following courses for the Doctoral Degree Program have been established in order to acquire the abilities in Competencies Developed. These courses are designed to allow students a great deal of freedom when planning their studies and students can independently design and complete their own curriculum.

(A) Research-Process Courses that train research practice and management of creative proposals, as well as presentation abilities

(B) Research Seminars that train the abilities to execute research as well as systemization

(C) Career Development Courses that cultivate societal connections

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 Table D2,
    - a total of 12 credits acquired from Research Seminars;
    - a minimum of 14 credits acquired from Major Courses; and
    - a minimum of 6 credits acquired from Liberal Arts and Basic Science Courses

(2credits from Humanities and Social Science Courses, and 4 credits from Career Development Courses).

3. Pass the doctoral thesis review and defense.

Table D1. Graduate Major in Systems and Control Engineering Completion Requirements

Course category		**<Required courses>** **Required credits**	**<Electives>** **Minimum credits required**	**Minimum credits required**	**Associated learning goals**	**Comments**
Liberal Arts and Basic Science Courses	**Humanities and Social Science Courses**		2 credits	6 credits	C	
	Career Development Courses		4 credits		C	
	Other courses					
Core Courses	**Research Seminars**	Research Seminar in Systems and Control Engineering S3 Research Seminar in Systems and Control Engineering F3 Research Seminar in Systems and Control Engineering S4 Research Seminar in Systems and Control Engineering F4 Research Seminar in Systems and Control Engineering S5 Research Seminar in Systems and Control Engineering F5 A total of 12 credits, 2 credits each from the above courses.		14 credits	B	
	Research-Related Courses				A	
	Major Courses					
	Major Courses and Research-Related Courses <u>outside</u> the Graduate Major in Systems and Control Engineering standard curriculum					
Total required credits		**A minimum of 24 credits in addition to meeting the above conditions**				

Note	・**Japanese Language and Culture Courses offered to International Students can be recognized as Humanities and Social Science Courses of the corresponding course level.** ・**As for Liberal Arts and Basic Science Courses, please refer to the relevant pages.**

5. IGP Courses

Table D2. Core Courses of the Graduate Major in Systems and Control Engineering

Course Category		Course Number	Course			Credits	Competencies	Learning goals	Comments
Research Seminars	600 level	SCE.Z691.R	◎		Seminar in Systems and Control Engineering S3	0-2-0	1,2,3,4,5	B	
		SCE.Z692.R	◎		Seminar in Systems and Control Engineering F3	0-2-0	1,2,3,4,5	B	
		SCE.Z693.R	◎		Seminar in Systems and Control Engineering S4	0-2-0	1,2,3,4,5	B	
		SCE.Z694.R	◎		Seminar in Systems and Control Engineering F4	0-2-0	1,2,3,4,5	B	
		SCE.Z695.R	◎		Seminar in Systems and Control Engineering S5	0-2-0	1,2,3,4,5	B	
		SCE.Z696.R	◎		Seminar in Systems and Control Engineering F5	0-2-0	1,2,3,4,5	B	
Research-related courses	600 level	SCE.Z681.B	○		Research Process A1	0-2-0	2,3,4,5	A	
		SCE.Z682.B	○		Research Process A2	0-2-0	2,3,4,5	A	
		SCE.Z683.B	○		Research Process A3	0-2-0	2,3,4,5	A	
		SCE.Z684.B	○		Research Process B1	0-1-0	2,3,4,5	A	
		SCE.Z685.B	○		Research Process B2	0-1-0	2,3,4,5	A	
		SCE.Z686.B	○		Research Process B3	0-1-0	2,3,4,5	A	
		SCE.Z687.B	○		Research Process B4	0-1-0	2,3,4,5	A	
		SCE.Z688.B	○		Research Process B5	0-1-0	2,3,4,5	A	
		SCE.Z689.B	○		Research Process B6	0-1-0	2,3,4,5	A	

Note：

・◎：Required course, ○：Restricted elective, O：odd academic years, E：even academic years

・□：Course is recognized as an Academy for Co-creative Education of Environment and Energy Science, Leading Graduate School (ACEEES) course.

• Competencies: 1 = Intercultural skills; 2 = Communication skills; 3 = Specialist skills; 4 = Critical thinking skills; 5 = Practical and/or problem-solving skills

• 【 】Course offered under another graduate major.

• The character preceding the three digits in the course number denotes the course's subdiscipline (i.e., "Z" represents the subdiscipline code in the course number SCE.Z500.R): Z (Research seminars).

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

None

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

None

8. Research Related to the Completion of Doctoral Theses

Students participating in this Program must submit an original doctoral thesis to the institute. The thesis must include qualified contents equivalent to academic journal articles. Main contributions of the doctoral thesis are expected to be published in international-level journals.

The decision of pass or fail will be made by a review board, which consists of 5 or more faculty members. The thesis must pass interim inspection and pre-defense prior to the submission to the institute. The procedure of examination for Ph.D. contains reviews of a doctoral thesis by members of a review board, interview, and final defense.