Graduate Major in Materials and Information Sciences

【Doctoral Degree Program】

1. Outline

The world faces an urgent need for industrial innovation to build a more sustainable future. This innovation will be driven by "multitalented individuals" – people who can generate new ideas by combining academic expertise in materials and information science, and who embrace Japan's distinctive *monotsukuri* philosophy that embodies art, science, and craftsmanship in the pursuit of manufacturing excellence.

By integrating the analytical power of information science with the creativity and practicality of the *monotsukuri* mindset, students will develop the insights and skills to not only create new devices and manufacturing methods, but also innovate meaningful solutions with real-world impact. We anticipate that they will apply their ingenuity to drive the emergence of new industries and academic disciplines, and in doing so, help shape a more sustainable world.

This graduate major offers a seamless, integrated educational program to empower students to become "multitalented individuals." Students will learn to bridge the gap between information and materials* by studying information science, sharpening versatile cognitive skills, and gaining a multifaceted, interdisciplinary perspective. We envision them taking leadership roles in the "complex space" of a transdisciplinary framework where materials science, information science, and social services intersect.

This graduate major is designed to foster the following key abilities that ideal "multitalented individuals" should possess, building on the knowledge and perspectives from each specialized field in materials and information science acquired up through the master's degree level.

1. Creativity: the capacity to develop original ideas and methods that integrate materials science and information science
2. Broad perspective: the skills navigate vast amounts of information, identify core issues, and set meaningful goals
3. Practical skills: able to tackle the challenges to achieving sustainability and contribute to creating new industries through a multifaceted approach – encompassing and integrating diverse concepts, spiraling outward and connecting concepts from the atomic level all the way to innovative real-world applications
4. Global mindset and leadership: the ability to lead diverse teams and take the initiative in turning ideas into action on a global scale

To cultivate the capabilities of these "multitalented individuals," this graduate major will provide a practical learning experience that focuses on social services through collaboration with industry.

Applicants must pass an Eligibility Screening conducted by the department to enroll in the doctoral degree program of this graduate major.

*In this context, "materials" refers not only to substances and chemical compounds, but also to devices and processes.

2. Competencies Developed

The curriculum will enable students to develop the following competencies:

- Creativity: develop new methods and ideas that bridge the materials and information sciences.
- Broad perspective: extract essential ideas from large amounts of information, identify issues, and set goals.
- Planning and execution ability: design and manage projects that connect breakthroughs at the atomic and molecular levels to actual social services and innovative solutions.
- Global leadership: lead a diverse team and take the initiative in developing visionary ideas and putting them into practice.

3. Learning Goals

Goals of active learning set in this major to obtain competencies described in the curriculum:

A) To link materials and information and to conduct original research that integrates both fields by applying information science and considering broad, multifaceted perspectives.
B) To practically apply advanced expertise in materials and information sciences to address complex real-world issues.
C) To contribute to the creation of new industries and the development of new academic disciplines grounded in materials and information sciences expertise.
D) To demonstrate international leadership skills to understand and solve current and potential real-world problems in diverse contexts.

4. IGP Completion Requirements

Students must meet the following requirements to complete the Doctoral Degree Program of this major:

1. Attain a total of 24 credits or more from 600-level courses.
2. Among the courses specified in the Graduate Major in Materials and Information Sciences curriculum, students must acquire:
   - 12 credits from Research Seminars in Materials and Information Sciences
   - 4 credits from restricted electives
   - A minimum of 16 credits from Core Courses of the Graduate Major in Materials and Information Sciences
   - A minimum of 6 credits from Liberal Arts and Basic Science Courses
     (2 credits from Humanities and Social Science Courses, and 4 credits from Entrepreneurship 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 Materials and Information Sciences 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	B, C	
	Entrepreneurship Courses		4 credits		B, C, D	All Graduate Attributes (GA) should be acquired. (see section 7 for the definition of GA.)
	Other courses					
Core courses	**Research seminars**	Seminar in Materials and Information Sciences S3 Seminar in Materials and Information Sciences F3 Seminar in Materials and Information Sciences S4 Seminar in Materials and Information Sciences F4 Seminar in Materials and Information Sciences S5 Seminar in Materials and Information Sciences F5 2 credits each, 12 credits in total.		16 credits	A, B, C, D	
	Research-related courses					
	Major courses		Restricted electives: Practice School in Materials Informatics I, Practice School in Materials Informatics II 2 credits each, 4 credits total. Alternatively: Off-Campus Project in Materials Informatics 4 credits total		A, B, C, D	
	Major courses and Research-related courses <u>outside</u> the					

	Graduate Major in Materials and Information Sciences standard curriculum					
Total required credits		**A minimum of 24 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. ・Within about six months of advancement to doctoral-level study, students must take a qualifying examination (QE). Students enrolled in this major must take this QE in the first year of the doctoral program. ・Of the restricted electives "Practice School in Materials Informatics I and II (4 credits in total)" and "Off-Campus Project in Materials Informatics (4 credits)," students must take "Practice School in Materials Informatics I and II" unless there is a special reason for not doing so.				

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 Materials and Information Sciences

Course category		**Course number**	**Course title**			**Credits**	**Competencies**	**Learning goals**	**Comments**
Research seminars	**600 level**	MIS.Z691.R	◎	★	Seminar in Materials Informatics S3	0-2-0	1, 2, 3, 4, 5	A, B, C, D	
		MIS.Z692.R	◎	★	Seminar in Materials Informatics F3	0-2-0	1, 2, 3, 4, 5	A, B, C, D	
		MIS.Z693.R	◎	★	Seminar in Materials Informatics S4	0-2-0	1, 2, 3, 4, 5	A, B, C, D	
		MIS.Z694.R	◎	★	Seminar in Materials Informatics F4	0-2-0	1, 2, 3, 4, 5	A, B, C, D	
		MIS.Z695.R	◎	★	Seminar in Materials Informatics S5	0-2-0	1, 2, 3, 4, 5	A, B, C, D	
		MIS.Z696.R	◎	★	Seminar in Materials Informatics F5	0-2-0	1, 2, 3, 4, 5	A, B, C, D	
Major courses	**600 level**	MIS.A601.L		★	Basics of Progressive Materials Informatics	1-0-0	1,5	A, B, C, D	Only students who could not take "Basic Materials Informatics (XMC.A401.L)"

									offered by the School of Materials and Chemical Technology during their master's degree program should take this course.
		MIS.A602.L		★	Progressive Materials Simulation	2-0-0	1	A, B, C, D	Only students who could not take "Materials Simulation (XMC.A402.L)" offered by the School of Materials and Chemical Technology during their master's degree program should take this course.
		MIS.A603.L		★	Progressive Materials Informatics	2-0-0	1	A, B, C, D	Only students who could not take "Materials Informatics (XMC.A404.L)" offered by the School of Materials and Chemical Technology during their master's degree program should take this course.
		MIS.C601.L			Advanced Course of Social Service Creation	1-0-0	1,4,5	A, B, C, D	Students in this major must take this course. "TCM.C601" is the same course but for students in the Material and Information Excellence in Education Program.

		MIS.B601.A	○	★	Practice School in Materials Informatics I	0-0-2	1,3,4	A, B, C, D	Students in this major must take this course. "TCM.B601" is the same course but for students in the Material and Information Excellence in Education Program.
		MIS.B602.A	○	★	Practice School in Materials Informatics II	0-0-2	3,4,5	A, B, C, D	Students in this major must take this course. "TCM.B602" is the same course but for students in the Material and Information Excellence in Education Program.
		MIS.B603.A	○	★	Off-Campus Project in Materials Informatics	0-0-4	1,2,3,4,5	A, B, C, D	
		MIS.B604.L		★	Overseas Off-Campus Project in Materials Informatics	0-0-4	1,2,3,4,5	A, B, C, D	
		MIS.B605.L		★	Short-Term Overseas Off-Campus Project in Materials Informatics I	0-0-1	1,2,3,4,5	A, B, C, D	
		MIS.B606.L		★	Short-Term Overseas Off-Campus Project in Materials Informatics II	0-0-2	1,2,3,4,5	A, B, C, D	
		MIS.B607.L			Domestic Off-Campus Project in Materials Informatics	0-0-4	1,2,3,4,5	A, B, C, D	
		MIS.B608.L			Short-Term Domestic Off-Campus Project in Materials Informatics I	0-0-1	1,2,3,4,5	A, B, C, D	
		MIS.B609.L			Short-Term Domestic Off-Campus Project in Materials Informatics II	0-0-2	1,2,3,4,5	A, B, C, D	
		MIS.C602.L			Advanced Practice in Materials Informatics I	0-0-1	1,2,3,4,5	A, B, C, D	
		MIS.C603.L			Advanced Practice in Materials Informatics II	0-0-1	1,2,3,4,5	A, B, C, D	
		MIS.C604.L			Advanced Practice in Materials Informatics III	0-0-1	1,2,3,4,5	A, B, C, D	
		MIS.C605.L			Advanced Practice in Materials Informatics IV	0-0-1	1,2,3,4,5	A, B, C, D	
		MIS.B621.L		★	Basic Presentation Exercises in Materials Informatics I	0-0-1	1,2,3	A, B, C, D	

		MIS.B622.L		★	Basic Presentation Exercises in Materials Informatics II	0-0-1	1,2,3	A, B, C, D	
		MIS.B623.L		★	Advanced Presentation Exercises in Materials Informatics I	0-0-1	1,2,3	A, B, C, D	
		MIS.B624.L		★	Advanced Presentation Exercises in Materials Informatics II	0-0-1	1,2,3	A, B, C, D	
		MIS.C611.L			Cooperative Education through Research Internships of Materials Informatics	0-0-4	1,3,4,5	A, B, C, D	

Notes:

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

Competencies:

1 = Specialist skills

2 = Liberal arts skills

3 = Communication skills

4 = Applied skills (critical thinking and/or problem-finding skills)

5 = Applied skills (practical and/or problem-solving skills)

Course numbers: the character preceding the three digits denotes the course's subdiscipline (i.e., "D" represents the subdiscipline code in the course number ABC.D600.R).

Z: Research Seminars

A: Courses related to developing creativity

B: Courses related to developing practical skills and global mindsets

C: Courses related to developing a broad perspective and leadership skills

6. IGP Courses that can be counted as Humanities and Social Science Courses

None

7. IGP Entrepreneurship Courses and IGP Courses That Can Be Counted as Entrepreneurship Courses

In order to fulfill the completion requirements for the doctoral degree program, students must attain at least four credits in Entrepreneurship Courses, and should satisfy all of the Graduate Attributes (GAs) specified in Table D-1 of the "Entrepreneurship Courses" listed as "Liberal Arts and Basic Science Courses" in the Guide to Graduate Education and International Graduate Program, as well as shown below. Students will be evaluated in regards to GA achievements at the time of their degree completion. For courses with two GAs, both GAs stipulated for the courses are considered to be acquired if students attain the corresponding credits for those courses.

Entrepreneurship Courses and Major Courses that enable students to acquire GAs and are recognized as equivalent to Entrepreneurship Courses, offered by the Graduate Major, are listed in Table D3 below. Students can also acquire GAs and credits

by taking the Entrepreneurship Courses offered by the Center for Entrepreneurship Education (CEE) listed as “Liberal Arts and Basic Science Courses” in the Guide to Graduate Education and International Graduate Program.

As there are some Entrepreneurship Courses without GAs, please check carefully before registering for them.

However, it must be noted that credits attained from courses that are recognized as Entrepreneurship Courses can be counted towards the completion requirements of the doctoral degree program, either for Major Courses or for Entrepreneurship Courses (not for both). Nevertheless, even in cases where credits pertaining to courses that are not considered as Entrepreneurship Courses are attained, the associated GAs may be considered by the Graduate Major to have been acquired.

For Graduate Attributes, refer to the Guide to Entrepreneurship Courses.
The Graduate Attributes of the Doctoral Degree Program are listed in Table D-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 advanced leadership skills, entrepreneurship, knowledge and expertise, and by developing social responsibility necessary for materializing your designed career.

Table D3. Courses of the Graduate Major in Materials and Information Sciences recognized as equivalent to Entrepreneurship Courses, and Entrepreneurship Courses

Course category	Course number	Course title			Credits	GA*	Learning goals	Comments
Courses that can be counted as Entrepreneurship Courses	MIS.C601.L			Advanced Course of Social Service Creation	1-0-0	GA0D	A, B, C, D	
	MIS.B604.L		★	Overseas Off-Campus Project in Materials Informatics	0-0-4	GA1D	A, B, C, D	
	MIS.B605.L		★	Short-Term Overseas Off-Campus Project in Materials Informatics I	0-0-1	GA1D	A, B, C, D	
	MIS.B606.L		★	Short-Term Overseas Off-Campus Project in Materials Informatics II	0-0-2	GA1D	A, B, C, D	
	MIS.B607.L			Domestic Off-Campus Project in Materials Informatics	0-0-4	GA1D	A, B, C, D	
	MIS.B608.L			Short-Term Domestic Off-Campus Project in Materials Informatics I	0-0-1	GA1D	A, B, C, D	
	MIS.B609.L			Short-Term Domestic Off-Campus Project in Materials Informatics II	0-0-2	GA1D	A, B, C, D	
	MIS.C602.L			Advanced Practice in Materials Informatics I	0-0-1	GA1D	A, B, C, D	
	MIS.C603.L			Advanced Practice in Materials Informatics II	0-0-1	GA1D	A, B, C, D	
	MIS.C604.L			Advanced Practice in Materials Informatics III	0-0-1	GA1D	A, B, C, D	

	MIS.C605.L			Advanced Practice in Materials Informatics IV	0-0-1	GA1D	A, B, C, D	
	MIS.C611.L			Cooperative Education through Research Internships of Materials Informatics	0-0-4	GA1D	A, B, C, D	
Entrepreneurship Courses	MIS.R601			Doctoral Recurrent Program 1 of Materials Informatics	0-0-1	GA0D GA1D		Entrepreneurship Course offered by the Graduate Major in Materials and Information Sciences. (Cannot be counted for Major Courses)
	MIS.R602			Doctoral Recurrent Program 2-1 of Materials Informatics	0-0-1	GA0D GA1D		Entrepreneurship Course offered by the Graduate Major in Materials and Information Sciences. (Cannot be counted for Major Courses)
	MIS.R603			Doctoral Recurrent Program 2-2 of Materials Informatics	0-0-2	GA0D GA1D		Entrepreneurship Course offered by the Graduate Major in Materials and Information Sciences. (Cannot be counted for Major Courses)
	MIS.R604			Doctoral Recurrent Program 3 of Materials Informatics	0-0-3	GA0D GA1D		Entrepreneurship Course offered by the Graduate Major in Materials and Information Sciences. (Cannot be counted for Major Courses)
	MIS.R605			Doctoral Recurrent Program 4 of Materials Informatics	0-0-4	GA0D GA1D		Entrepreneurship Course offered by the Graduate Major in Materials and Information Sciences. (Cannot be counted for Major Courses)

★: Classes in English

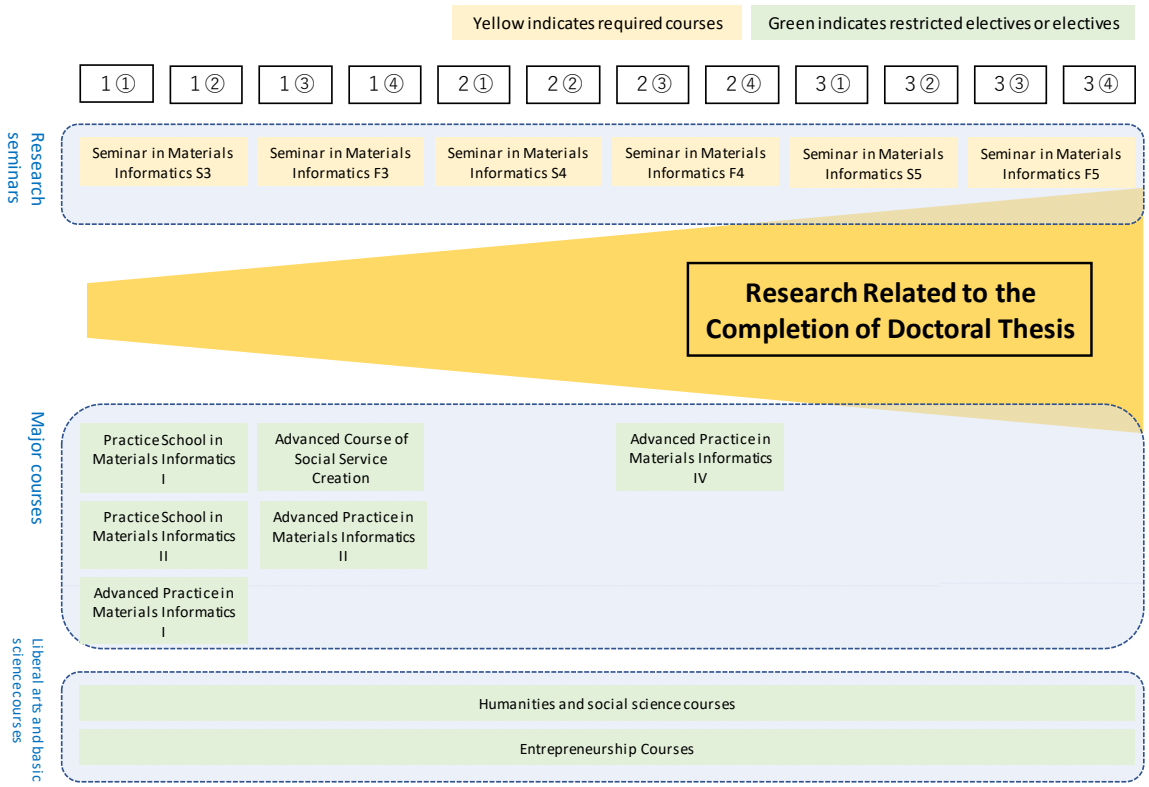
Credits in Entrepreneurship Courses must be attained from among the above-listed courses and those listed as such in the Liberal Arts and Basic Science Courses Guide.

***GA: Graduate Attributes**

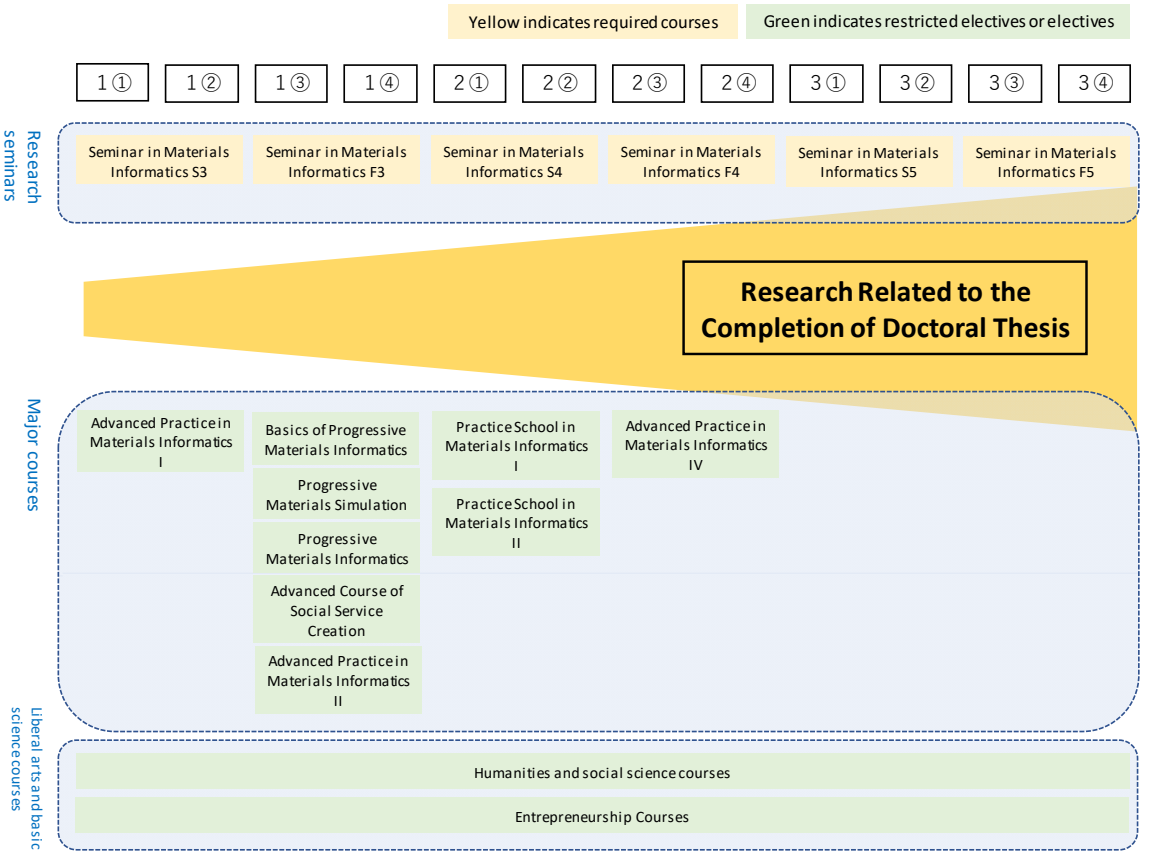
The Science Tokyo Academy for Center for Data Science and Artificial Intelligence Education may offer courses that are recognized as equivalent to Entrepreneurship Courses in addition to those listed as such under “Liberal Arts and Basic Science Courses” in the Guide to Graduate Education and International Graduate Program. For details about available courses or completion requirements, please refer to the study guide of the academy.

8. Overview of Curriculum System

Curriculum System 1: Students enrolled in Science Tokyo starting from the master's program



Curriculum System 2: Students enrolling at Science Tokyo from other universities when entering the doctoral program



9. Example of a Standard Curriculum

Example 1: Students enrolled in Science Tokyo starting from the master's program

Year in school		1								2								3							
Course category		1Q		2Q		3Q		4Q		1Q		2Q		3Q		4Q		1Q		2Q		3Q		4Q	
Liberal Arts and Basic Science Courses	Humanities and Social Science Courses			Collaboration across STEM and Liberal Arts	2																				
	Entrepreneurship Courses																								
	Other Courses																								
Core Courses	Major Courses	Practice School in Materials Informatics I (※3)	2	Practice School in Materials Informatics II (※3)	2			Advanced Course of Social Service Creation (※4)	1																
				Advanced Practice in Materials Informatics I (※4)	1			Advanced Practice in Materials Informatics II (※4)	1							Advanced Practice in Materials Informatics IV (※4)	1								
	Research-Related Courses																								
	Research Seminars	Seminar in Materials Informatics S3	2			Seminar in Materials Informatics F3	2			Seminar in Materials Informatics S4	2			Seminar in Materials Informatics F4	2			Seminar in Materials Informatics S5	2			Seminar in Materials Informatics F5	2	
	Other Courses			Advanced Presentation Exercises in Materials Informatics I	1											Advanced Presentation Exercises in Materials Informatics II	1								

*1: Three courses ("Basic Materials Informatics (XMC.A401)", "Materials Simulation (XMC.A402)", and "Materials Informatics (XMC.A404)" (Courses offered by the School of Materials and Chemical Technology, 400 level)) are prerequisites to take "Practice School in Materials Informatics I and II (MIS.B601 and MIS.B602)", which are restricted electives in this course. Therefore, students who have passed the Eligibility Screening in this course must take these three courses before entering the doctoral course.

*2: "Fundamentals of Data Science (XCO.T487)" and "Exercises in Fundamentals of Data Science (XCO.T488)" of the " Data Science and Artificial Intelligence program at Science Tokyo have the same lecture content as that of "Materials Informatics (XMC.A404)" offered by the School of Materials and Chemical Technology, so one may be substituted for the other, and both may fulfill some requirements listed in *1.

*3: Students are required to take either "Practice School in Materials Informatics I and II (4 credits in total) (MIS.B601 and MIS.B602)" or "Off-Campus Project in Materials Informatics (4 credits) (MIS.B603)" as elective required courses. Unless there is a special reason, students must take "Practice School in Materials Informatics I and II (MIS.B601 and MIS.B602)".

Students must take "Practice School in Materials Informatics I and II (MIS.B601 and MIS.B602)" in the same semester of the same academic year, so they must be registered at the same time.

*4: "Advanced Course of Social Service Creation (MIS.C601)", "Overseas Off-Campus Project in Materials Informatics (MIS.B604)", "Short-Term Overseas Off-Campus Project in Materials Informatics I and II (MIS.B605 and MIS.B606)", "Domestic Off-Campus Project in Materials Informatics (MIS.B607)", "Short-Term Domestic Off-Campus Project in Materials Informatics I and II (MIS.B608 and MIS.B609)", "Advanced Practice in Materials Informatics I~IV (MIS.C602~ MIS.C605)" and "Cooperative Education through Research Internships of Materials Informatics (MIS.C611)" can be regarded as Entrepreneurship Courses. Students must take at least 4 credits of Entrepreneurship Courses to complete the doctoral program.

Example 2: Students enrolling at Science Tokyo from other universities at the time of entering the doctoral program

Year in school		1								2								3							
Course category		1Q		2Q		3Q		4Q		1Q		2Q		3Q		4Q		1Q		2Q		3Q		4Q	
Liberal Arts and Basic Science Courses	Humanities and Social Science Courses			Collaboration across STEM and Liberal Arts	2																				
	Entrepreneurship Courses																								
	Other Courses																								
Core Courses	Major Courses					Basics of Progressive Materials Informatics (※5)	1	Advanced Course of Social Service Creation (※7)	1	Practice School in Materials Informatics I (※6)	2	Practice School in Materials Informatics II (※6)	2												
						Progressive Materials Simulation (※5)	2	Progressive Materials Informatics (※5)	2																
				Advanced Practice in Materials Informatics I (※7)	1			Advanced Practice in Materials Informatics II (※7)	1							Advanced Practice in Materials Informatics IV (※7)	1								
	Research-Related Courses																								
	Research Seminars	Seminar in Materials Informatics S3	2			Seminar in Materials Informatics F3	2			Seminar in Materials Informatics S4	2			Seminar in Materials Informatics F4	2			Seminar in Materials Informatics S5	2			Seminar in Materials Informatics F5	2		
	Other Courses			Advanced Presentation Exercises in Materials Informatics I	1											Advanced Presentation Exercises in Materials Informatics II	1								

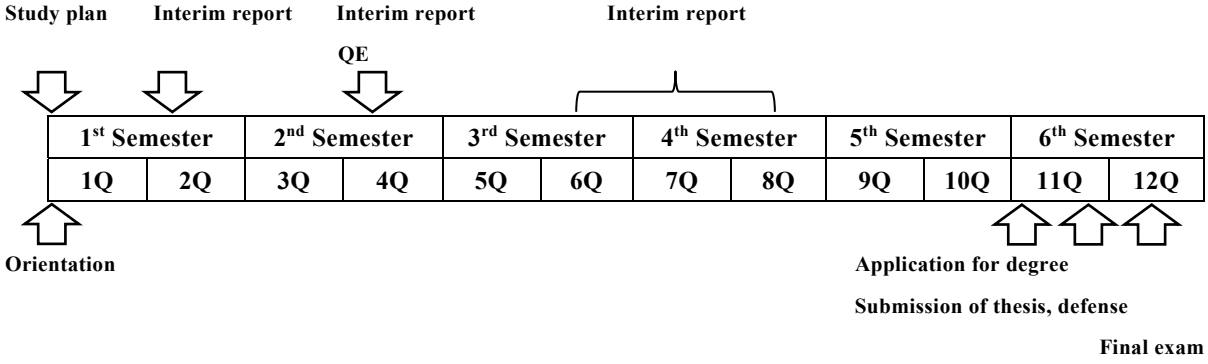
*5: Three courses (“Basics of Progressive Materials Informatics (MIS.A601)”, “Progressive Materials Simulation (MIS.A602)”, and “Progressive Materials Informatics (MIS.A603)” (600 level)) are prerequisites to take “Practice School in Materials Informatics I and II (MIS.B601 and MIS.B602)”, which are restricted electives in this course. Therefore, students who have passed the Eligibility Screening to enter the doctoral course at Science Tokyo from other universities must take these three courses in the first year of the doctoral course.
Students who were admitted in September and passed the Eligibility Screening in the second year of the master's course must also complete these three courses in the first year of the doctoral course.

*6: Students are required to take either “Practice School in Materials Informatics I and II (4 credits in total) (MIS.B601 and MIS.B602)” or “Off-Campus Project in Materials Informatics (4 credits) (MIS.B603)” as elective required courses. Unless there is a special reason, students must take “Practice School in Materials Informatics I and II (MIS.B601 and MIS.B602)”.
Students must take “Practice School in Materials Informatics I and II (MIS.B601 and MIS.B602)” in the same semester of the same academic year, so they must be registered at the same time.

*7: “Advanced Course of Social Service Creation (MIS.C601)”, “Overseas Off-Campus Project in Materials Informatics (MIS.B604)”, “Short-Term Overseas Off-Campus Project in Materials Informatics I and II (MIS.B605 and MIS.B606)”, “Domestic Off-Campus Project in Materials Informatics (MIS.B607)”, “Short-Term Domestic Off-Campus Project in Materials Informatics I and II (MIS.B608 and MIS.B609)”, “Advanced Practice in Materials Informatics I~IV (MIS.C602~ MIS.C605)” and “Cooperative Education through Research Internships of Materials Informatics (MIS.C611)” can be regarded as Entrepreneurship Courses. Students must take at least 4 credits of Entrepreneurship Courses to complete the doctoral program.

10. Research Related to the Completion of Doctoral Theses

Doctoral thesis research will enhance students' problem-solving abilities, provide profound scientific and engineering insights, and hone their communication skills to act as global leaders.



Interim report:

Research must be conducted systematically and progress checked periodically to produce meaningful research results. For this reason, interim reports will be held three times in total.

Qualifying Examination:

Within about six months of advancement to doctoral-level study, students must take a qualifying examination (QE). Students enrolled in this graduate major must take this QE in their first year of the doctoral program.

Examination criteria:

A doctoral dissertation must be prepared that has sufficient novelty, originality, and academic value in the field of Materials and Information Sciences. The dissertation may be written in English or Japanese.