Graduate Major in Materials Science and Engineering

【Master's Degree Program】

1. Outline

Major of Materials Science and Engineering aims at nurturing research scientists and engineers who have deep insight into materials properties and reactivity, and ability to develop innovative materials with creative and practical minds, and with excellent understanding of the social problems and requirements. Through the advanced educational system, the students are expected to learn innovative materials development and the global competence to contribute to human welfare and the sustainability.

Advanced course works and research supervision are provided in order to acquire the knowledge and skills to act as a sophisticated scientist and engineer. Through the course works and the individual supervision, students are expected to acquire the expert knowledge of materials science, the profound understanding of the relationship between technology and the environment, logical thinking and a strategical way to solve problems, and international communication skills as a global leader who is competent in the industry and in the academic.

2. Competencies Developed

The students are expected to acquire,

- Expert knowledge of materials science and engineering.
- Ability to apply the knowledge in the actual research and to develop the advanced materials.
- Ability to solve the problems with the understanding of the global issues.
- Writing and presentation skills competent to the global standard.

3. Learning Goals

The students are expected to learn,

A) Advanced expert knowledge in the field of materials science and engineering.
A wide variety of course works provide advanced knowledge of materials science and engineering.

B) Ability to apply the knowledge to practical research and development,
by using the expert knowledge to solve the individual problems, and by learning the research and development in industry to acquire the practical way of thinking.

C) English presentation skills in the field of materials science and engineering,
acquiring presentation skills through discussion with international scientists.

D) Interdisciplinary views of the academic community,
by improving communication skills through domestic and international collaboration, and by acquiring the ability to evaluate the research perspective and output from the 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. 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).
3. From the core courses specified in the Graduate Major in Materials Science and Engineering curriculum*,
    - 8 credits, acquired from "Research Seminars";
    - 10 credits or more, acquired from the Research-related courses and Major Courses;
    - 18 credits or more, acquired from the Core Courses of this major;
4. Pass the master thesis review and defense.

*Core courses of the Graduate Major in Materials Science and Engineering shown in Table M2.

Table M1 shows course categories and the number of credits required to complete the Master's 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 M1. Graduate Major in Materials 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	B, D	
	Career development courses		2 credits		A, B, C, D	All Graduate Attributes (GA) should be acquired. (Refer to Section 7 for the definition of GA.)
	Other courses					
Core courses	**Research seminars**	Seminar in Materials Science and Engineering S1 Seminar in Materials Science and Engineering F1 Seminar in Materials Science and Engineering S2 Seminar in Materials Science and Engineering F2 A total of 8 credits, 2 credits each from the above courses.		18 credits	A, B, C, D	
	Research-related courses		10 credits or more, acquired from the Research-related courses and Major Courses		A	
	Major courses				A, B, C, D	
	Major courses and Research-related courses <u>outside</u> the Graduate Major in Materials Science and 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.**

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 Materials Science and Engineering

Course category		Course number			Course title	Credits	Competencies	Learning goals	Comments
Research seminars	400 level	MAT.Y491.R	◎		Seminar in Materials Science and Engineering S1	0-2-0	1,3,5	A, B, C, D	
		MAT.Y492.R	◎		Seminar in Materials Science and Engineering F1	0-2-0	1,3,5	A, B, C, D	
	500 level	MAT.Y591.R	◎		Seminar in Materials Science and Engineering S2	0-2-0	1,3,5	A, B, C, D	
		MAT.Y592.R	◎		Seminar in Materials Science and Engineering F2	0-2-0	1,3,5	A, B, C, D	
Major courses	400 level	MAT.A410.L			Materials simulation	2-0-0	1,5	A	【Tokyo Tech Academy for Convergence of Materials and Informatics】* (TCM.A402)
		MAT.A412.L			Materials Informatics	2-0-0	1,5	A	【Tokyo Tech Academy for Convergence of Materials and Informatics】* (TCM.A404)
		MAT.A420.L			Interdisciplinary scientific principles of energy 1	1-0-0	1,4,5	A, C	【Energy Science and Engineering】（ENR.A401）
		MAT.A421.L			Interdisciplinary scientific principles of energy 2	1-0-0	1,4,5	A, C	【Energy Science and Engineering】（ENR.A402）
		MAT.A422.L			Interdisciplinary principles of energy devices 1	1-0-0	1,5	A, C	【Energy Science and Engineering】（ENR.A403）
		MAT.A423.L			Interdisciplinary principles of energy devices 2	1-0-0	1,4,5	A, C	【Energy Science and Engineering】（ENR.A404）
		MAT.A424.L			Interdisciplinary Energy Materials Science 1	1-0-0	1,4,5	A, C	【Energy Science and Engineering】（ENR.A405）

		MAT.A425.L			Interdisciplinary Energy Materials Science 2	1-0-0	1,4,5	A, C	【Energy Science and Engineering】（ENR.A406）
		MAT.A462.L			Off-campus Project in Materials Science and Engineering B1	0-0-1	2,3,5	A, B, C, D	actual work:80～160 hours (i.e.2 week～1 month)
		MAT.A463.L			Off-campus Project in Materials Science and Engineering B2	0-0-2	2,3,5	A, B, C, D	actual work: 160 hours～ (i.e. 1 month～)
		MAT.M401.L		O	Applied Diffraction Crystallography in Metals and Alloys	2-0-0	1,5	A	
		MAT.M402.L		E	Characterization of Nanomaterials	2-0-0	1	A	a 4Q course,E, b 1 to 2 Q (class held at Tsinghua Univ.), opening English every year
		MAT.M403.L		O	Environmental Degradation of Materials	2-0-0	1	A	
		MAT.M405.L		E	Advanced Microstructure Design of Ferrous Materials	2-0-0	1,2,4	A	
		MAT.M407.L		O	Advanced Solid State Physics	2-0-0	1,5	A	a 3Q course,O, b 1 to 2 Q (class held at Tsinghua Univ.), opening English every year
		MAT.M409.L		O	Thermodynamics for Phase Equilibria	2-0-0	1	A	
		MAT.M410.L		O	Deformation and Strength of Solids	2-0-0	1	A	
		MAT.M411.L		O	Phase Transformation and Microstructure Control	2-0-0	1	A	
		MAT.M412.L		E	Reliability and Durability of Metals and Alloys	2-0-0	1,4,5	A	
		MAT.M414.L			Advanced Metal Physics	2-0-0	1,3,5	A	【Energy Science and Engineering】(ENR.J401)

		MAT.M415.L			Physical Chemistry for High Temperature Processes - Thermodynamics-	1-0-0	1,5	A	【Energy Science and Engineering】(ENR.J402)
		MAT.M416.L			Physical Chemistry for High Temperature Processes -Smelting and Refining Processes-	1-0-0	1,5	A	【Energy Science and Engineering】(ENR.J403)
		MAT.M417.L			Physical Chemistry for High Temperature Processes -Oxidation of Metals-	1-0-0	1,5	A	【Energy Science and Engineering】(ENR.J404)
		MAT.M418.L		O	Microstructure Evolution and Diffusion in Metals	2-0-0	1,4,5	A	【Energy Science and Engineering】(ENR.J405)
		MAT.M421.L			Advanced Course of Quantum Chemistry	2-0-0	1,5	A	class held at Tsinghua Univ.
		MAT.M423.L.		E	Exercise in Materials Design	0-1-0	1,3,5	A	
		MAT.M424.L.		E	Exercise in Physical Metallurgy	0-1-0	1,3,5	A	
		MAT.M425.L		O	Recovery, Recrystallization and Texture of Metals	1-0-0	1	A	
		MAT.M426.L		E	Transport Phenomena at High Temperature - Momentum and Heat Flow -	1-0-0	1,5	A	
		MAT.M427.L		E	Transport Phenomena at High Temperature - Flow of charged particles in solid -	1-0-0	1,5	A	
		MAT.M428.L		O	Properties and manufacturing process for automotive sheet steels	1-0-0	1,4	A	
		MAT.M430.L		E	Quantum theory of metals	2-0-0	1,5	A	
		MAT.M431.L		E	Kinematical theory of microstructure formed by diffusionless phase transformation	2-0-0	1	A	
		MAT.M432.L			Aerospace materials and modelling techniques	1-0-0	1	A	
		MAT.M433.L.		O	Advanced microstructure design of non-ferrous materials A	1-0-0	1,5	A	
		MAT.M434.L.		O	Advanced microstructure design of non-ferrous materials B	1-0-0	1,5	A	
		MAT.P401.L			Organic Optical Materials physics	1-0-0	1,5	A	
		MAT.P402.L		~~E~~	Soft Materials Physical Chemistry	1-0-0	1	A	

		MAT.P403.L			Soft Materials Physics	1-0-0	1,2	A	
		MAT.P404.L			Soft Materials Functional Physics	1-0-0	1,3	A	
		MAT.P405.L			Organic Electronic Materials Physics	1-0-0	1	A	【Energy Science and Engineering】(ENR.J406)
		MAT.P406.L			Soft Materials Design	1-0-0	1,5	A	【Energy Science and Engineering】(ENR.J407)
		MAT.P413.L		E	Soft Materials Functional Chemistry	1-0-0	1,5	A	
		MAT.P414.L			Soft Materials Function	1-0-0	1,5	A	
		MAT.P416.L			Soft Materials Chemistry	1-0-0	1,5	A	
		MAT.P421.L		E	Organic Materials Functional Design	1-0-0	1,5	A	
		MAT.P422.L		E	Organic Materials Design	1-0-0	1,5	A	
		MAT.P423.L			Advanced Course in Composite Materials	1-0-0	1	A	
		MAT.P426.L			Thermal Properties of Materials	1-0-0	1,5	A	
		MAT.P471.L			Advanced Polymer Synthesis	1-0-0	1	B	【Chemical Science and Engineering】(CAP.P411)
		MAT.P473.L			Special Lecture on Characterization of Polymer Structures and Properties	1-0-0	1	B	【Chemical Science and Engineering】(CAP.P421)
		MAT.P474.L			Advanced Polymer Properties	1-0-0	1	B	【Chemical Science and Engineering】(CAP.P422)
		MAT.P477.L			Elements of Polymer Science I	1-0-0	1,3,4,5	B	【Chemical Science and Engineering】(CAP.P431)
		MAT.P478.L			Elements of Polymer Science II	1-0-0	1,5	B	【Chemical Science and

									Engineering】(CAP.P432)
		MAT.P483.L			Soft Materials	2-0-0	1,2,3,5	B	class held at Tsinghua Univ.
		MAT.P484.L			Introduction to Polymer Physical Chemistry	1-0-0	1	B	【Chemical Science and Engineering】(CAP.P433)
		MAT.P485.L			Advanced Nano Science	2-0-0	1,2,4,5	B	【Chemical Science and Engineering】(CAP.P494)
		MAT.C402.L			Quantum Physics in Optical Response of Materials	2-0-0	1	A	
		MAT.C407.L		E	Advanced Course of Nano-Bionics	2-0-0	1,2,3,5	A	
		MAT.C408.L			Advanced Course of Surface Chemistry on Inorganic Materials	2-0-0	1,5	A	
		MAT.C410.L			Energy Conversion Ceramics Materials	2-0-0	1	A	【Energy Science and Engineering】(ENR.J408)
		MAT.C412.L			Polymeric Biomaterials	2-0-0	1,5	A	
		MAT.C414.L		O	Introduction to Solid State Science	2-0-0	1,2,5	A	
		MAT.C415.L			Nuclear Materials and Structures	2-0-0	1	A	【Nuclear Engineering】(NCL.N403)
		MAT.C416.L.			Advanced Course of Nano-Particles Science	2-0-0	1,3,4,5	A	
	500 level	MAT.P501.L			Advanced Polymer Reactions	1-0-0	1,5	B	【Chemical Science and Engineering】(CAP.P511)
		MAT.P502.L			Advanced Polymer Physics	1-0-0	1	B	【Chemical Science and Engineering】(CAP.P521)
		MAT.P506.L			Fundamentals of electrochemistry and the application to energy conversion materials	1-0-0	1,2,3,4,5	B, C	
		MAT.P507.L			Analytical and analogical methods to solve the heat transfer equation	1-0-0	1,2,3,4,5	B, C	

					and the application to infrared image processing				
		MAT.P508.L			Nano-Materials Electronics	2-0-0	1,4	B	【Electrical and Electronic Engineering】(EEE.D571)
		MAT.P509.L			Advanced Polymer Design for Energy Materials	1-0-0	1,4,5	B	【Energy Science and Engineering】(ENR.H503)
		MAT.P510.L			Advanced Polymer Structures	1-0-0	1,4,5	B	【Chemical Science and Engineering】(CAP.P522)
		MAT.P512.L			Applied Vibrational Spectroscopy	1-0-0	1,2,4,5	B, C	
		MAT.P513.L			Plastic Electronic Materials and Devices	1-0-0	1,2,5	B	Not offered in AY 2022
		MAT.P514.L			Photoacoustic and Photothermal Techniques (PA&PT) for material testing: Principles and Applications	1-0-0	1,4,5	B	
		MAT.C500.L		O	Advanced Course of Materials Optics	2-0-0	1,5	A	
		MAT.C503.L			Advanced Course of Material Development II	2-0-0	1	A	
		MAT.C504.L			Functional Devices	2-0-0	1,2	A	
		MAT.C505.L			Computational Materials Science	2-0-0	1,5	A	
		MAT.C506.L		E	Advanced Course in Wettability Control of Solid Surface	2-0-0	1,3,4,5	A	
		MAT.C508.L			Nanobio Materials and Devices	2-0-0	1,2	B	【Human Centered Science and Biomedical Engineering】（HCB.A561）

Note：

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

• 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 Tokyo Tech Academy for Convergence of Materials and Informatics (TAC-MI) courses are not exclusive to students enrolled in TAC-MI. However, as the courses involve the use of TSUBAME, capacity is limited. Registration by non-TAC-MI students may not always be accepted.

• 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 MAT.D400.R): R (required), L (Elective), M: metals group, P: organic materials group, C: ceramics group, A: common

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 Materials 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	MAT.A462.L			Off-campus Project in Materials Science and Engineering B1	0-0-1	GA1M	A, B, C, D	actual work:80～160 hours (i.e.2week～1 month)

Development Courses	MAT.A463.L			Off-campus Project in Materials Science and Engineering B2	0-0-2	GA1M	A, B, C, D	actual work: 160 hours～ (i.e. 1month～)
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**								

8. Research Related to the Completion of Master Thesis

In the master's thesis research, students can learn how to set research proposal, and problem solving ability, and communication skills thorough a series of research process. Research progress is properly evaluated based on dissertation interim presentation.

Master thesis standards:

Master's thesis includes a useful knowledge to contribute to the materials development. It contains the new findings in the academic field of materials science, engineering or technology. Thesis must be an original paper written in English, containing its own consideration.

Review of Master thesis:

Review committee is organized by three or more evaluators. After the pre-review by professors, final examination is conducted by an oral presentation. In case that the student is an applicant for Doctoral Degree Program, his/her examination must been carried out by more than five reviewers in English.

【Doctoral Degree Program】

1. Outline

Doctoral degree program aims at nurturing an independent research scientist and engineer with advanced expert knowledge in the field of materials science and engineering. Students in this major are expected to acquire an innovative and challenging way of research and development as well as the competence as a global leader who contributes to the human welfare and the sustainability.

2. Competencies Developed

The students are expected to acquire,

- Independent ability to conduct innovative research and development by using advanced expert knowledge in the field of materials science and engineering.
- Ability to create innovative materials by using advanced expert knowledge in the field of materials science and engineering.
- Ability to solve the individual problems through the essential understanding of the global social issues and requirements.
- Competence as a global leader who can work as a principal investigator of a research group.

3. Learning Goals

The students are expected to learn,

A) Advanced expert knowledge in the field of materials science and engineering.
Students are requested to have expert knowledge deeper than the master course and to have the ability to apply the knowledge to innovative research and development.

B) Ability to solve the problems.
Students are requested to acquire the ability to find out the problems and the way to solve the problems by innovative thinking through discussion with expert scientists in the domestic and international community.

C) Competency as a global leader as well as the ability to systematize knowledge from experiments and research through paper writing and literature survey.

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 Materials Science and Engineering curriculum,
    - 12 credits acquired from Research Seminars; and
    - a minimum of 4 credits acquired from Major Courses;
    - 16 credits or more, acquired from the subject in 600-level Core Courses of this major;
    - a minimum of 6 credits acquired from Liberal Arts and Basic Science Courses

      (2 credits must be from Humanities and Social Science 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 Materials 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	6 credits	C	
	Career development courses		4 credits		B, C	All Graduate Attributes (GA) should be acquired. (Refer to Section 7 for the definition of GA.)
	Other courses					
Core courses	Research seminars	Seminar in Materials Science and Engineering S3 Seminar in Materials Science and Engineering F3 Seminar in Materials Science and Engineering S4 Seminar in Materials Science and Engineering F4 Seminar in Materials Science and Engineering S5 Seminar in Materials Science and Engineering F5 A total of 12 credits, 2 credits each from the above courses.		16 credits	A, B, C	
	Research-related courses					
	Major courses		4 credits		A, B, C	
	Major courses and Research-related courses <u>outside</u> the Graduate Major in Materials Science					

	and Engineering 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.**				

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 Science and Engineering

Course category		**Course number**			**Course title**	**Credits**	**Competencies**	**Learning goals**	**Comments**
Research seminars	**600 level**	MAT.Y691.R	◎		Seminar in Materials Science and Engineering S3	0-2-0	1,2,3,4,5	A, B, C	
		MAT.Y692.R	◎		Seminar in Materials Science and Engineering F3	0-2-0	1,2,3,4,5	A, B, C	
		MAT.Y693.R	◎		Seminar in Materials Science and Engineering S4	0-2-0	1,2,3,4,5	A, B, C	
		MAT.Y694.R	◎		Seminar in Materials Science and Engineering F4	0-2-0	1,2,3,4,5	A, B, C	
		MAT.Y695.R	◎		Seminar in Materials Science and Engineering S5	0-2-0	1,2,3,4,5	A, B, C	
		MAT.Y696.R	◎		Seminar in Materials Science and Engineering F5	0-2-0	1,2,3,4,5	A, B, C	
Major courses	**600 level**	MAT.A600.L			Materials Science and Engineering Special Seminar I	0-1-0	1,3,4,5	A, B, C	
		MAT.A601.L			Materials Science and Engineering Special Seminar II	0-1-0	1,3,4,5	A, B, C	
		MAT.A602.L			Materials Science and Engineering Special Seminar III	0-1-0	1,3,4,5	A, B, C	
		MAT.A603.L			Materials Science and Engineering Special Seminar IV	0-1-0	1,3,4,5	A, B, C	
		MAT.A604.L			Practice Program of Topics Setup and Solution I	0-1-0	1,2,3,4,5	A, B, C	
		MAT.A605.L			Practice Program of Topics Setup and Solution II	0-1-0	1,2,3,4,5	A, B, C	

		MAT.A606.L			Practice Program of Topics Setup and Solution III	0-1-0	1,2,3,4,5	A, B, C	
		MAT.A607.L			Practice Program of Topics Setup and Solution IV	0-1-0	1,2,3,4,5	A, B, C	
		MAT.A610.L			Off-campus Project in Materials Informatics	0-0-4	1,2,3,4,5	A, B, C, D	【Tokyo Tech Academy for Convergence of Materials and Informatics】* (TCM.B603)
		MAT.A611.L			Short-term Off-campus Project in Materials Informatics I	0-0-1	1,2,3,4,5	A, B, C, D	【Tokyo Tech Academy for Convergence of Materials and Informatics】* (TCM.B604)
		MAT.A612.L			Short-term Off-campus Project in Materials Informatics II	0-0-2	1,2,3,4,5	A, B, C, D	【Tokyo Tech Academy for Convergence of Materials and Informatics】* (TCM.B605)
		MAT.A661.L			Materials Off-campus Project 1	0-0-1	2,3,5	B	actual work:80～160 hours (i.e.2 week～1 month)
		MAT.A662.L			Materials Off-campus Project 2	0-0-2	2,3,5	B	actual work:160～240 hours (i.e.1～2 months)
		MAT.A663.L			Materials Off-campus Project 3	0-0-4	2,3,5	B	actual work: 320～400 hours (i.e.2～3 months)
		MAT.A664.L			Materials Off-campus Project 4	0-0-6	2,3,5	B	actual work: 480 hours～ (i.e. 3 months ～)
		MAT.P601.L			Analytical and analogical methods to solve the heat transfer equation and the application to infrared image processing (Advanced)	1-0-0	1,2,3,4,5	B	
		MAT.P602.L			Fundamentals of electrochemistry and the application to energy conversion	1-0-0	1,2,4,5	B	

					materials (Advanced)				
		MAT.P603.L			Applied Vibrational Spectroscopy (Advanced)	1-0-0	1,2,5	B	
		MAT.P604.L			Plastic Electronic Materials and Devices (Advanced)	1-0-0	1,2,5	B	
		MAT.P605.L			Photoacoustic and Photothermal Techniques (PA&PT) for material testing: Principles and Applications (Advanced)	1-0-0	1,4,5	B	
		MAT.A665.L			Cooperative Education through Research Internships of Graduate Major in Materials Science and Engineering I	0-0-4	1,3,4,5	A, B, C, D	
		MAT.A666.L			Cooperative Education through Research Internships of Graduate Major in Materials Science and Engineering II	0-0-6	1,3,4,5	A, B, C, D	

Note：

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

• 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 MAT.D600.R): R (required), L (Elective), M: metals group, P: organic materials group, C: ceramics group, A: common

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 Materials 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	MAT.A610.L	Off-campus Project in Materials Informatics	0-0-4	GA1D	A, B, C, D	【Tokyo Tech Academy for Convergence of Materials and Informatics】* (TCM.B603)
	MAT.A611.L	Short-term Off-campus Project in Materials Informatics I	0-0-1	GA1D	A, B, C, D	【Tokyo Tech Academy for Convergence of Materials and Informatics】* (TCM.B604)
	MAT.A612.L	Short-term Off-campus Project in Materials Informatics II	0-0-2	GA1D	A, B, C, D	【Tokyo Tech Academy for Convergence of Materials and Informatics】* (TCM.B605)
	MAT.A661.L	Materials Off-campus Project 1	0-0-1	GA1D	B	actual work:80～160 hours (i.e.2 week～1 month)
	MAT.A662.L	Materials Off-campus Project 2	0-0-2	GA1D	B	actual work:160～240 hours (i.e.1～2 months)
	MAT.A663.L	Materials Off-campus Project 3	0-0-4	GA1D	B	actual work: 320～400 hours (i.e.2

								～3 months)
	MAT.A664.L			Materials Off-campus Project 4	0-0-6	GA1D	B	actual work: 480 hours～ (i.e. 3 months～)
	MAT.A665.L			Cooperative Education through Research Internships of Graduate Major in Materials Science and Engineering I	0-0-4	GA1D	A, B, C, D	
	MAT.A666.L			Cooperative Education through Research Internships of Graduate Major in Materials Science and Engineering II	0-0-6	GA1D	A, B, C, D	
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) or WISE Programs 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.

8. Research Related to the Completion of Doctoral Thesis

In the doctoral thesis research, students can learn the problem solving ability by deep scientific or engineering insight and communication skills as a global leader.

Doctoral thesis standards:

Doctoral thesis includes a novelty, sufficient academic value, and originality. Main chapters of thesis are published in an international journal or are at a level to be published. Thesis must be written in English.

Review of Doctoral thesis:

Review committee is organized by more than 5 evaluators. Evaluators from other universities or institute can be included in the committee. Examination is conducted through thesis submission, oral presentation, pre-review by evaluators, and final review and evaluation. In the final review, students' knowledge in the relevant field and English language skill are evaluated.