Graduate Major in Human Centered Science and Biomedical Engineering

In recent years, the development of engineering and technology related to human healthcare, medicine and the environment conservation in academic fields of Materials and Chemical Technology, Mechanical Engineering, Electrical and Electronic Engineering, Information Technology, Life Science and Technology has been remarkable drastically. However, in present, most of disciplinary fields train students independently, and there are few examples of educational systems crossing these fields. In a globalized society, it is indispensable to learn integrated knowledge of a wide range of academic fields such as natural sciences, bioethics, the foundation of health, medical and environmental sciences, etc. for sustainable and rich human life. In addition, by utilizing these knowledge and integrating them with expertise in each field, it can be utilized more effectively and precisely to build a living infrastructure where one can develop sustainably.

In this course, all research and development of engineering and technology regarding human healthcare, medicine and environment conservation, which has been conducted in each disciplinary field, have been taken as integrated science and technology and defined as “Human Centered Science and Biomedical Engineering”. The course provides the education and research to consider the correlation between human characteristics and artifact ones comprehensively based on the in-depth understanding of people and society. Thus, the goal of this course is to foster talents who have a deep understanding of human being and knowledge of natural sciences, bioethics, foundation of health, medical and environmental sciences and also learn several disciplinary fields such as Materials & Chemical Technology, Mechanical Engineering, Electrical & Electronic Engineering, Information Technology, and Life Science & Technology. That means to foster scientists and engineers who can contribute to the development of science and technology to protect people's health and realize a sustainable society. Moreover, by promoting the interaction among several disciplinary fields, we can expect to provide a new viewpoint to each field, as well as creating of new disciplines for the future.

【Master's Degree Program】

1. Outline

We foster scientists and engineers that have a deep understanding of human being by mastering natural sciences, bioethics, the foundation of health, medical and environmental sciences, and furthermore, by interdisciplinary learning academic fields of Materials and Chemical Technology, Mechanical Engineering, Electrical and Electronic Engineering, Information Technology, Life Science & Technology.

In the Master’s course, students learn advanced professional knowledge of Materials & Chemical Technology, Mechanical Engineering, Electric and Electronic Engineering, Information Technology, Life Science & Technology, and acquire high intelligence and liberal arts, broad perspective and deep thought ability, comprehensive decision-making ability, solid ethical and technological view, and global thinking. Based on these abilities, they study advanced research and development, and learn task assignment skills and advanced problem-solving skills in academic research.

To be specific,

1. Systematically learn professional knowledge and skills necessary for advanced research and development in Human Centered Science and Biomedical Engineering field based on professional knowledge of a disciplinary field, which student learned in the undergraduate course.
2. Learn high level advanced professional knowledge and skills by developing professional knowledge and skills that students acquired in their undergraduate.
3. Deepen one’s professional ability and creativity through lab seminar, master research planning for master thesis subjects, and master thesis research.

2. Competencies Developed

In this course, in order to achieve the above objectives, the goal of study is to acquire the following knowledge and abilities:

- Knowledge essential for Life Engineering such as Human Science, Medical & Health Science, Bioethics, and the environment in which humans are involved
- Advanced knowledge and skills of Life Engineering in each specialized field
- Basic learning ability to understand expertise in different field
- Ability to challenge the development of new areas through integration of issues and problem solving methods in each area
- Ability to set issues in relation to society and solve problems by making use of their own technology and creativity
- Leadership and communication skills that can communicate their thoughts and skills correctly and collaborate to address issues

3. Learning Goals

To acquire the skills listed in “Competencies Developed”, students in this program will have the following trainings.

A) Acquiring fundamental expertise in the field of “Human Centered Science and Biomedical Engineering”

Acquiring fundamental expertise in the research field of “Human Centered Science and Biomedical Engineering” through required courses and restricted elective courses in Major Courses.

B) Acquiring advanced expertise in the field of “Human Centered Science and Biomedical Engineering”

Acquiring advanced professional knowledge and skills through Materials & Chemical Technology, Mechanical Engineering, Electrical & Electronic Engineering, Information Technology, and Life Science & Technology courses in Major Courses of “Human Centered Science and Biomedical Engineering”.

C) Acquiring research-executing skills, problem-solving.

Acquiring research-executing skills and problem-solving skills through Research Seminars, Research-Related Courses as well as research working in lab by using obtained expertise.

D) Acquiring experience in relation to engineering ethics and society.

According to lectures by teachers working in industries, learning ethical and social values relevant to society and research and understanding engineering ethics.

E) Acquiring communication skills.

Learning advanced communication skills required as international professionals through discussion with researchers in the country and overseas.

F) Cultivating sophistication in relation to liberal arts and humanity.

Learning liberal arts and humanity required as researchers through Humanities and Social Science Courses, Career Development Courses.

4. IGP Completion Requirements

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

1. Attain a total of 30 credits or more from 400- and 500-level courses.

2. From the courses specified in the Graduate Major in Human Centered Science and Biomedical Engineering standard curriculum, you must meet the following requirements and have acquired at least 19 credits (see Table M1 below).

- You have acquired 8 credits from Research Seminars;
- You have acquired 2 credits from Research-related Courses;
- Must acquire 4 credits from required Major Courses and 3 credits from restricted elective Major Courses;
- Must acquire a minimum of 5 credits 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. Pass the master's thesis review and defense.

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 Human Centered Science and Biomedical Engineering Completion Requirements

Course category		<Required courses> Required credits	<Electives> Minimum credits required	Minimum credits required	Associated learning goals	Comments
Liberal arts and basic science courses	**Humanities and social science courses**		•2 credits from 400-level •1 credit from 500-level	5 credits	D, F	
	Career development courses		2 credits		D, F	All Graduate Attributes (GA) should be acquired. (Refer to Section 7 for the definition of GA.)
	Other courses					
Core courses	**Research seminars**	HCB Seminar S1 HCB Seminar F1 HCB Seminar S2 HCB Seminar F2 A total of 8 credits, 2 credits each from the above courses.		19 credits	C, E	
	Research-related courses	Research Planning for Master Thesis I Research Planning for Master Thesis II A total of 2 credits			C, E	
	Major courses	Interdisciplinary Research Fundamentals I Interdisciplinary Research Fundamentals II Interdisciplinary Research Training A total of 4 credits	3 credits from restricted electives 2 credits from others		A, B, D, E	
	Major courses and Research-related courses <u>outside</u> the					

	Graduate Major in Human Centered Science and Biomedical 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 Human Centered Science and Biomedical Engineering

Course category		**Course number**	**Course title**			**Credits**	**Competencies**	**Learning goals**	**Comments**
Research seminars	**400 level**	HCB.Z491.R	◎	★	HCB Seminar S1	0-2-0	1,3,5	C,E	
		HCB.Z492.R	◎	★	HCB Seminar F1	0-2-0	1,3,5	C,E	
	500 level	HCB.Z591.R	◎	★	HCB Seminar S2	0-2-0	1,3,5	C,E	
		HCB.Z592.R	◎	★	HCB Seminar F2	0-2-0	1,3,5	C,E	
Research-related courses	**400 level**	HCB.C471.R	◎	★	Research Planning for Master Thesis I	0-1-0	1,3,5	C,E	
	500 level	HCB.C571.R	◎	★	Research Planning for Master Thesis II	0-1-0	1,3,5	C,E	
	400 level	HCB.C411.R	◎	★	Interdisciplinary Research Fundamentals I	1-0-0	1,5	A	
		HCB.C412.R	◎	★	Interdisciplinary Research Fundamentals II	1-0-0	1,5	A	
		HCB.C413.R	◎	★	Interdisciplinary Research Training	0-0-2	3,4,5	A,C	

		HCB.C402.A	○		Fundamentals of Creative Design	1-1-0	3,4,5	A,C	
		HCB.C421.A	○	★	Outline of Human Centered Science and Biomedical Engineering I	1-0-0	1,5	A	
		HCB.C422.A	○	★	Outline of Human Centered Science and Biomedical Engineering II	1-0-0	1,2	A	
		HCB.C431.A	○		Off Campus Training I	0-0-1	1,3,4,5	D	Offered in English as needed
		HCB.C441.A	○	★	Presentation for Science and Engineering I	1-0-0	2,3	E	
		HCB.C442.A	○	★	Presentation for Science and Engineering II	1-0-0	2,3	E	
		HCB.A425.L		★	Advanced Biofunctional Chemistry I	1-0-0	1,4,5	B	【Chemical Science and Engineering】(CAP.A425)
		HCB.A426.L		★	Advanced Biofunctional Chemistry II	1-0-0	1,4,5	B	【Chemical Science and Engineering】(CAP.A426)
		HCB.C451.L			Advanced Research Topics for Life Innovation I	1-0-0	1,2,4,5	B,D	
		HCB.C452.L		★	Advanced Research Topics for Life Innovation II	1-0-0	1,2,4,5	B,D	
		HCB.C481.L		★	International Career Development Basics	1-1-0	2,3,4,5	A,B,C,D,E	【Life Science and Technology】(LST.B404)
		HCB.C482.L		★	Bio and Environmental Industry Practice	1-0-0	1,2,5	A,B,D,E	【Life Science and Technology】(LST.A420)
		HCB.C483.L		★	Institutional Training	0-2-0	2,3	A,B,D,E	【Life Science and Technology】(LST.C401)
		HCB.C461.L			Introduction to Bioethics	1-0-0	1,2,4,5	B	【Life Science and Technology】(LST.A419)
		HCB.M461.L			Laboratory Training on Human Brain Functions and Their Measurements	0.5-0-0.5	1,3,5	B	
		HCB.M463.L		★ O	Introduction to Biomedical Instrumentation	1-0-0	1,2	B	O : Odd year in English

		HCB.M464.L		★ E	Introduction to Neural Engineering	1-0-0	1	B	E: Even year in English
		HCB.T408.L		★	Soft Materials Design	1-0-0	1,5	B	【Energy Science and Engineering】(ENR.J407)
		HCB.T409.L			Introduction to Intellectual Property System	2-0-0	1,2,4,5	B,C	【Energy Science and Engineering】(ENR.J409)
		HCB.E431.L		★	Fundamentals of Light and Matter I	2-0-0	1	A	【Electrical and Electronic Engineering】(EEE.D431)
		HCB.E451.L		★	Plasma Engineering	2-0-0	1	A	【Electrical and Electronic Engineering】(EEE.P451)
		HCB.I409.L		★	Optics in Information Processing	1-0-0	1	B	【Information and Communications Engineering】(ICT.H409)
		HCB.I411.L		★	Basic Sensation Informatics	1-0-0	1,5	B	【Information and Communications Engineering】(ICT.H411)
		HCB.I421.L		★	Medical Imaging Systems	1-0-0	1	B	【Information and Communications Engineering】(ICT.H421)
		HCB.I422.L		★	Computational Brain	1-0-0	1	B	【Information and Communications Engineering】(ICT.H422)
		HCB.T401.L			Advanced Course of Dielectric and Ferroelectric Materials	2-0-0	1,5	B	【Materials Science and Engineering】(MAT.C401)
		HCB.T407.L		★ E	Advanced Course of Nano-Bionics	2-0-0	1,2,3,5	B	【Materials Science and

									Engineering】 (MAT.C407) E: Even year in English O: Odd year in Japanese
		HCB.T412.L		★	Polymeric Biomaterials	2-0-0	1,5	B	【Materials Science and Engineering】 (MAT.C412)
		HCB.T402.L		★ E	Characterization of Nanomaterials	2-0-0	1	B	【Materials Science and Engineering】 (MAT.M402) a Held in 4Q O: Odd year in Japanese E: Even year in English b Held in 1～2Q (in Tsinghua University), Every year in English
		HCB.T406.L		★ O	Advanced Microstructure Design of Non-ferrous Materials	2-0-0	1,5	B	【Materials Science and Engineering】 (MAT.M406) O: Odd year in English E: Even year in Japanese
		HCB.T414.L		★ E	Reliability and Durability of Metals and Alloys	2-0-0	1,4,5	B	【Materials Science and Engineering】 (MAT.M412) E: Even year in English O: Odd year in Japanese
		HCB.T403.L		★	Soft Materials Physics	1-0-0	1,2	B	【Materials

									Science and Engineering】(MAT.P403)
		HCB.T404.L		★	Soft Materials Functional Physics	1-0-0	1,3	B	【Materials Science and Engineering】(MAT.P404)
		HCB.T413.L		★ E	Soft Materials Functional Chemistry	1-0-0	1,5	B	【Materials Science and Engineering】(MAT.P413) E: Even year in English O: Odd year in Japanese
		HCB.T422.L		★ E	Organic Materials Design	1-0-0	1,5	B	【Materials Science and Engineering】(MAT.P422) E: Even year in English O: Odd year in Japanese
		HCB.T426.L		★	Thermal Properties of Materials	1-0-0	1,5	B	【Materials Science and Engineering】(MAT.P426)
		HCB.T491.L			Materials Engineering and Ecology	1-0-0	3,4,5	B	【Materials Science and Engineering】(MAT.P491)
		HCB.T416.L		★	Catalysis for the Environmental Issues	1-0-0	1	B	【Chemical Science and Engineering】(CAP.I416)
		HCB.L401.L		★	Molecular and Cellular Biology	2-0-0	1,4	B	【Life Science and Technology】(LST.A401)
		HCB.L405.L		★	Design of Bioactive Molecules	2-0-0	1	B	【Life Science and Technology】(LST.A405)
		HCB.L407.L		★	Science of Metabolism	2-0-0	1,4,5	B	【Life Science

									and Technology】(LST.A407)
		HCB.L410.L		★	Advanced Neuroscience	2-0-0	1,5	B	【Life Science and Technology】(LST.A410)
		HCB.L411.L		★	Biomolecular Engineering	2-0-0	1,2,5	B	【Life Science and Technology】(LST.A411)
		HCB.L412.L		★	Biomaterial Science and Engineering	2-0-0	1,2,4,5	B	【Life Science and Technology】(LST.A412)
		HCB.L413.A	○	★	Advanced Biological Science and Engineering (Tsinghua University)	2-0-0	1,2,4,5	B	【Life Science and Technology】(LST.A417) (for Tokyo Tech-Tsinghua Univ. Joint Graduate program students)
		HCB.S401.L		★	Modeling of Continuous Systems	1-1-0	1,5	B	【Artificial Intelligence】(ART.T452)
		HCB.S402.L		★	Modeling of Discrete Systems	1-1-0	1,5	B	【Artificial Intelligence】(ART.T455)
		HCB.S403.L		★	Non-linear Dynamical Systems	2-0-0	1	B	【Artificial Intelligence】(ART.T456)
		HCB>S404.L		★	Complex Networks	2-0-0	1	B	【Artificial Intelligence】(ART.T462)
	500 level	HCB.A561.L		★	Nanobio Materials and Devices	2-0-0	1,2	B	
		HCB.C521.A	○	★	Advanced Human Centered Science and Biomedical Engineering I	1-0-0	1,2,5	A	
		HCB.C522.A	○	★	Advanced Human Centered Science and Biomedical Engineering II	1-0-0	1,4,5	A	
		HCB.C531.A	○		Off Campus Training II	0-0-2	1,3,4,5	D	Offered in English as needed

		HCB.C532.A	○		Off Campus Training III	0-0-4	1,3,4,5	D	Offered in English as needed
		HCB.C541.A	○	★	International Writing	1-0-0	2,3,4,5	E	
		HCB.C542.A	○	★	International Presentation I	0-1-0	1,2,3,4,5	E	
		HCB.C543.A	○	★	International Presentation II	0-1-0	1,2,3,4,5	E	
		HCB.C551.L			Advanced Research Topics for Life Innovation III	1-0-0	1,2,4,5	D	
		HCB.C552.L		★	Advanced Research Topics for Life Innovation IV	1-0-0	1,2,4,5	D	
		HCB.M563.L		★	Micro and Nano Systems	2-0-0	1	B	【Mechanical Engineering】(MEC.J531)
		HCB.M561.L		★	Kinematics and mechanism of medical robotics	1-0-0	1,4	B	
		HCB.E533.L		★O	Fundamentals of Light and Matter IIc	1-0-0	1	B	【Electrical and Electronic Engineering】(EEE.D533) O: Odd year in English E: Even year in Japanese
		HCB.I504.L		★	Medical Image Processing	2-0-0	1,5	B	【Information and Communications Engineering】(ICT.H504)
		HCB.I514.L		★	Mechanisms of Visual Perception	1-0-0	1,5	B	【Information and Communications Engineering】(ICT.H514)
		HCB.T504.L		★	Functional Devices	2-0-0	1,2	B	【Materials Science and Engineering】(MAT.C504)
		HCB.A532.L		★	Advanced Catalytic Reactions	1-0-0	1	B	【Chemical Science and Engineering】(CAP.T532)
		HCB.L501.L		★	Biomolecular Analysis	2-0-0	1,5	B	【Life Science and

									Technology】(LST.A501)
		HCB.L502.L		★	Science of Biological Resources	2-0-0	1,5	B	【Life Science and Technology】(LST.A502)
		HCB.L504.L		★	Medical Biotechnology	2-0-0	1,2,5	B	【Life Science and Technology】(LST.A504)
		HCB.S501.L		★	Molecular Simulation	1-1-0	1,2	B	【Artificial Intelligence】(ART.T545)
outside the Graduate Major in Human Centered Science and Biomedical Engineering standard curriculum		HCB.C403			Field Works for Creative Design	1-1-0	3,4,5	D,E	
		HCB.C404			Industrial design	1-1-0	2,3,4,5	C,E,F	
		HCB.C501			Practical Creative Design	1-2-0	3,4,5	C,D,E	
		HCB.C502			Management for Business Creation	0.6-0-0.4	1,2,3,4,5	D,E	

Note：

• ◎：Required course, ○：Restricted elective, ★: Course given in English, O：Odd academic years, E：Even academic years

• Competencies: 1 = Specialist skills, 2 = Intercultural skills, 3 = Communication skills, 4 = Critical thinking skills, 5 = 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 ABC.D400.R): A (Applied Chemistry), C (Common Major Courses), E (Electrical and Electronic Engineering), I (Information Technology), L (Life Science and Technology), M (Material Technology), Z (Research seminars)

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 cannot be counted more than once as Major Courses or Career Development Courses towards the completion requirements for the master's degree program.

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:

C0M: You will be able to delineate your career plan clearly and recognize the skills necessary to materialize that plan, taking into account its relation to society

C1M: You will be able to understand academic integrity, utilize your own expertise for the development of academia and technology, and work with others with different expertise to contribute to problem-solving

Table M3. Courses of the Graduate Major in Human Centered Science and Biomedical 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	HCB.C402.A	○		Fundamentals of Creative Design	1-1-0	C0M C1M	A,C	
	HCB.C403			Field Works for Creative Design	1-1-0	C0M C1M	D,E	outside the Graduate Major in Human Centered Science and Biomedical Engineering standard curriculum
	HCB.C501			Practical Creative Design	1-2-0	C0M C1M	C,D,E	
	HCB.C502			Management for Business Creation	0.6-0-0.4	C0M C1M	D,E	
	HCB.C431.A	○		Off Campus Training I	0-0-1	C1M	D	Offered in English as needed
	HCB.C531.A	○		Off Campus Training II	0-0-2	C1M	D	Offered in English as needed
	HCB.C532.A	○		Off Campus Training III	0-0-4	C1M	D	Offered in English as needed
	ICT.J405			Strategic ICT Policy Planning	2-0-0	C0M C1M	C	【Information and Communications Engineering】
	CAP.E521			Scientific Ethics	1-0-0	C0M	D	【Chemical Science and Engineering】
	CAP.E422			Presentation Practice	0-1-0	C1M	E	【Chemical

								Science and Engineering】
	LST.B404		★	International Career Development Basics	1-1-0	C0M C1M	A,B,C,D,E	【Life Science and Technology】
	LST.A413			Career Development Seminars	2-0-0	C0M C1M	B,D,E	【Life Science and Technology】
	LST.A419			Introduction to Bioethics	1-0-0	C0M C1M	B,E	【Life Science and Technology】
	LST.C501			MS Internship 1	0-1-0	C1M	D,E	【Life Science and Technology】 Offered in English as needed
	LST.C502			MS Internship 2	0-2-0	C1M	D,E	【Life Science and Technology】 Offered in English as needed
	LST.C503			MS Internship 3	0-4-0	C1M	C,D,E	【Life Science and Technology】 Offered in English as needed
	LST.C504			MS Internship 4	0-6-0	C1M	C,D,E	【Life Science and Technology】 Offered in English as needed
	LST.C506		★	Overseas Research Training 1 (Tsinghua University)	0-1-0	C1M		【Life Science and Technology】 (for Tokyo Tech-Tsinghua Univ. Joint Graduate program students)
	LST.C507		★	Overseas Research Training 1I (Tsinghua University)	0-1-0	C1M		【Life Science and Technology】 (for Tokyo Tech-Tsinghua Univ. Joint Graduate

								program students)
	LST.C401		★	Institutional Training	0-2-0	C0M C1M		【Life Science and Technology】
	ACE.D543			Policy Making	1-0-0	C1M		【Academy for Co-creative Education of Environment and Energy Science】
	ACE.D541	○	★	Global Business Strategy and Standardization & Intellectual Property I	1-0-0	C0M		【Academy for Co-creative Education of Environment and Energy Science】
	ACE.C531		★	Leadership for Energy Specialists	1-0-0	C0M C1M		【Academy for Co-creative Education of Environment and Energy Science】

○: course from this major, ★: course given in English

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's Theses

In the Master's thesis research, students experience a series of the research process and aim to improve problem-setting ability, problem-solving ability and communication skills. An example of the flow of the Master's thesis research for this is shown below. The evaluation of the academic outcome is carried out as appropriate. Students also consider the course plan as related to direction of their thesis research.

・Presentation of Research Plan and Interim presentation

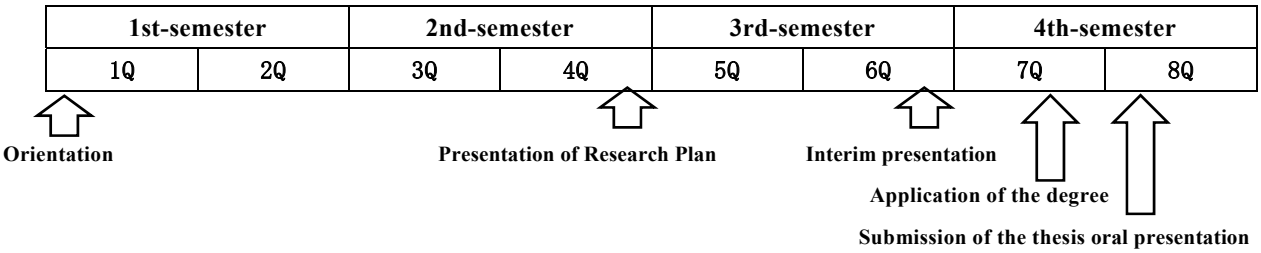
It is important to conduct research systematically and check the progress to produce research results. Students conduct "Presentation of Research Plan" (Research Planning for Master Thesis I) in 4Q and "Interim presentation" (Research Planning for Master Thesis II) in 6Q to understand their research background and purpose clearly.

・Judgement criterion of the final defense of Master's Thesis

The Master's thesis and its overview must be written in Japanese or English by the student. The thesis must include the student's original consideration, and also include new findings in Human Centered Science and Biomedical Engineering field or useful research that contributes to the development of Human Centered Science and Biomedical Engineering field.

・Implementation manner of the final defense of Master's Thesis

After the preliminary review by the advisors, the final examination and evaluation will be carried out in the oral presentation of the thesis. The oral presentation must be done in Japanese or English.



9. Seamless Transition between Degree Programs

In the graduate major of Human Centered Science and Biomedical Engineering, we foster basic academic knowledge to understand human and society deeply, expertise in science and engineering, a wide perspective, deep thought ability, comprehensive decision-making skill, ethical and technological views, internationality, and cutting-edge technological development and problem setting and solving abilities in advanced academic research and development of technology. The learning goals of this course is to acquire the following abilities.

- Knowledge about natural sciences, bioethics, the foundation of health, medical and environmental sciences necessary for research and development in Human Centered Science and Biomedical Engineering field.
- Ability that can set tasks in the society and solve these tasks by using one's skills and creativity.
- Communication skills that enables one to accurately communicate his or her ideas and skills to others.
- Leadership that enables one to collaborate on tasks.

In the curriculum at the doctoral course, as the 600 series, Research Planning for Doctoral Thesis I, Research Planning for Doctoral Thesis II, HCB Seminar S1~F5, Teaching methods for Human Centered Science and Biomedical Engineering, HCB International Internship, International Presentation III & IV, Research Working in Company, HCB off-campus advanced training I & II have been established, not only improvement of expertise by cutting-edge research based on curriculum from 400 series, It is an organic curriculum that can effectively improve communication skills and leadership skills.

【Doctoral Degree Program】

1. Outline

In the Doctoral course, we foster superior talents who will contribute to human beings' happiness and the development of science and technology by (1) having the highest degree of professional knowledge in Materials and Chemical Technology, Mechanical Engineering, Electrical and Electronic Engineering, Information Technology, and Life Science and Technology, (2) obtaining the professional knowledge in natural sciences, bioethics, the foundation of health, medical and environmental sciences, (3) having the ability to promote advanced research and development ingenious and challenging by the above professional knowledge, and (4) exhibiting creativity and international leadership capable of exploiting new fields.
To be specific,

1. Acquire advanced professional knowledge in own research field through lab seminar and research planning for doctoral thesis subjects, and cultivate a wide range of outstanding expertise and ethics in the field of Human Centered Science and Biomedical Engineering.
2. Foster leadership skills, internationality and communication skills in teaching method and international presentation subjects, and obtain career experience by conducting international internship and research working in company subjects.
3. Foster outstanding creativity, task setting ability and problem-solving skills that can lead the international community through conducting the world's highest level of research in doctoral thesis research.

2. Competencies Developed

The learning objective of this Doctoral course is to acquire the following abilities and knowledge with a higher standard than the Master's course to achieve the goals above.

- Knowledge about natural sciences, bioethics, the foundation of health, medical and environmental sciences necessary for research and development in Human Centered Science and Biomedical Engineering field.
- Advanced professional knowledge and skills related with Human Centered Science and Biomedical Engineering in each disciplinary field.
- Fundamental expertise that can understand different disciplinary knowledge.
- Ability to challenge to explore new research & development areas.
- The ability that can set tasks in the society and solve these tasks by using one's skills and creativity.
- Communication skills that enables one to accurately communicate his or her ideas and skills to others.
- Leadership that enables one to collaborate on tasks.

3. Learning Goals

To acquire the skills listed in "Competencies Developed", students in this program will have the following trainings.

A) Acquiring fundamental expertise in the field of "Human Centered Science and Biomedical Engineering"

Acquiring fundamental expertise in the research field of "Human Centered Science and Biomedical Engineering" through required courses and restricted elective courses in Major Courses.

B) Acquiring advanced expertise in the field of "Human Centered Science and Biomedical Engineering"

Acquiring advanced professional knowledge and skills through Materials & Chemical Technology, Mechanical

Engineering, Electrical & Electronic Engineering, Information Technology, and Life Science & Technology courses in Major Courses of “Human Centered Science and Biomedical Engineering”.

C) Acquiring research-executing skills, problem-solving.

Acquiring research-executing skills and problem-solving skills through Research Seminars, Research-Related Courses as well as research working in lab by using obtained expertise.

D) Acquiring experience in relation to engineering ethics and society.

According to lectures by teachers working in industries, learning ethical and social values relevant to society and research and understanding engineering ethics.

E) Acquiring communication skills.

Learning advanced communication skills required as international professionals through discussion with researchers in the country and overseas.

F) Cultivating sophistication in relation to liberal arts and humanity.

Learning liberal arts and humanity required as researchers through Humanities and Social Science Courses, Career Development Courses.

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 Human Centered Science and Biomedical Engineering standard curriculum, you must meet the following requirements (see Table D1 below):

- You have acquired 12 credits from Research Seminars;
- You have acquired 4 credits from Research-related Courses;
- Must acquire a minimum of 2 credits from restricted elective Major Courses;
- Must acquire a minimum of 6 credits from Liberal Arts and Basic Science Courses (2 credits from Humanities and Social Science Courses, and 4 credits from Career Development Courses).

3. Pass the doctoral dissertation 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 Human Centered Science and Biomedical 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	D, F	
	Career development courses		4 credits		D, F	All Graduate Attributes (GA) should be acquired. (Refer to Section 7 for the definition of GA.)
	Other courses					
Core courses	Research seminars	HCB Seminar S3 HCB Seminar F3 HCB Seminar S4 HCB Seminar F4 HCB Seminar S5 HCB Seminar F5 A total of 12 credits, 2 credits each from the above courses.		18 credits	C, E	
	Research-related courses	Research Planning for Doctoral Thesis I Research Planning for Doctoral Thesis II A total of 4 credits			C, E	
	Major courses		2 credits		A, B, D, E	
	Major Courses and Research-related courses <u>outside</u> the Graduate Major in Human Centered Science and Biomedical 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 Human Centered Science and Biomedical Engineering

Course category		**Course number**			**Course title**	**Credits**	**Competencies**	**Learning goals**	**Comments**
Research seminars	**600 level**	HCB.Z691.R	◎	★	HCB Seminar S3	0-2-0	1,3,5	C,E	
		HCB.Z692.R	◎	★	HCB Seminar F3	0-2-0	1,3,5	C,E	
		HCB.Z693.R	◎	★	HCB Seminar S4	0-2-0	1,3,5	C,E	
		HCB.Z694.R	◎	★	HCB Seminar F4	0-2-0	1,3,5	C,E	
		HCB.Z695.R	◎	★	HCB Seminar S5	0-2-0	1,3,5	C,E	
		HCB.Z696.R	◎	★	HCB Seminar F5	0-2-0	1,3,5	C,E	
Research-related courses	**600 level**	HCB.C671.R	◎	★	Research Planning for Doctoral Thesis I	0-2-0	1,2,3,4,5	C,E	
		HCB.C672.R	◎	★	Research Planning for Doctoral Thesis II	0-2-0	1,2,3,4,5	C,E	
Major courses	**600 level**	HCB.C601.A	○		Teaching methods for Human Centered Science and Biomedical Engineering	1-0-1	1,3,4,5	C,E	Offered in English as needed
		HCB.C631.A	○	★	HCB International Internship	0-0-4	1,2,3,4,5	B,C,D	
		HCB.C632.A	○		Research Working in Company	0-2-2	1,5	B,C,D	

		HCB.C633.A	○		HCB off-Campus advanced training 1	0-0-1	1,2,3,4,5	B,C,D	Offered in English as needed
		HCB.C634.A	○		HCB off-Campus advanced training 2	0-0-2	1,2,3,4,5	B,C,D	Offered in English as needed
		HCB.C641.A	○	★	International Presentation III	0-1-0	1,2,3,4,5	E	
		HCB.C642.A	○	★	International Presentation IV	0-1-0	1,2,3,4,5	E	
		HCB.C681.A	○	★	International Career Development Advanced	1-1-0	1,2,3,4,5	A,B,C,D,E	【Life Science and Technology】 (LST.B605)

Note：

• ◎：Required course, ○：Restricted elective, ★：Course given in English

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

• 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.D600.R): C (Common Major Course), Z (Research seminars)

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 or A-2 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 D3-1 and D3-2 below.

However, it must be noted that credits attained from these courses cannot be counted more than once as Major Courses or Career Development Courses towards the completion requirements for the doctoral degree program.

For Graduate Attributes, refer to the Guide to the Career Development Courses.
The Graduate Attributes of the Academic Leader Program (ALP) are listed in Table A-1 as follows:

A0D: You will be able to precisely define your own career plan and train yourself to acquire the skills required for attaining your goals in academia

A1D: You will be able to ascertain the true nature of phenomena, master the secret of learning, and lead the vanguard of a new academic discipline or research area

A2D: You will be able to understand the position of academia in society as well as the notion of responsible conduct of

research, and adequately explain academic progress to members of society, who are our stakeholders

A3D: With the understanding of the social roles and responsibilities of researchers, you will be able to nurture next-generation experts in educational institutions, instilling in them an interest in academia and enabling them to later join in the pioneering of new academic disciplines or research areas

The Graduate Attributes of the Productive Leader Program (PLP) are listed in Table A-2 as follows:

P0D: You will be able to precisely plot your own career plan and train yourself to acquire the skills required for attaining your goals in industry, etc.

P1D: You will be able to precisely grasp the needs of society and detect its problems, comprehend relevant laws, regulations, or guidelines for responsible conduct of research, and lead future developments in science and technology

P2D: While leading teams consisting of members with varied specialties and value systems, you will be able to create products and enterprises that bring forth new values in society

P3D: With the understanding of the social roles and responsibilities of engineers, you will be able to nurture next-generation experts through the project, enabling them to help drive future development of society and industry

Table D3-1. Courses of the Graduate Major in Human Centered Science and Biomedical Engineering recognized as equivalent to Career Development Courses in the Academic Leader Program (ALP)

Course category	Course number	Course title			Credits	GA*	Learning goals	Comments
Courses that can be counted as Career Development Courses	HCB.C631.A	○	★	HCB International Internship	0-0-4	A2D A3D	B,C,D	
	HCB.C632.A	○		Research Working in Company	0-2-2	A2D A3D	B,C,D	for Graduate Program for Working Adults students
	HCB.C633.A	○		HCB off-Campus advanced training 1	0-0-1	A1D A2D A3D	B,C,D	Offered in English as needed
	HCB.C634.A	○		HCB off-Campus advanced training 2	0-0-2	A1D A2D A3D	B,C,D	Offered in English as needed
	LST.B605		★	International Career Development Advanced	1-1-0	A0D A1D A2D A3D	A,B,C,D,E	【Life Science and Technology】
	LST.C601			PhD Internship 1	0-1-0	A1D A2D A3D	A,C,E	【Life Science and Technology】 Offered in English as needed
	LST.C602			PhD Internship 2	0-2-0	A1D A2D A3D	A,C,E	【Life Science and Technology】 Offered in English as needed
	LST.C603			PhD Internship 3	0-4-0	A1D A2D	A,B,C,E	【Life Science and Technology】

						A3D		Offered in English as needed
	LST.C604			PhD Internship 4	0-6-0	A1D A2D A3D	A,B,C,E	【Life Science and Technology】 Offered in English as needed
	ACE.D644			Career Planning	1-0-0	A0D		【Academy for Co-creative Education of Environment and Energy Science】
	ACE.E651			Co-creative Education Off-Campus Project A (Overseas)	0-0-4	A0D A1D A2D		【Academy for Co-creative Education of Environment and Energy Science】
	ACE.E652			Co-creative Education Off-Campus Project B (Overseas)	0-0-4	A0D A1D A2D		【Academy for Co-creative Education of Environment and Energy Science】
	ACE.E653			Co-creative Education Off-Campus Project C (in Japan)	0-0-4	A0D A1D A2D		【Academy for Co-creative Education of Environment and Energy Science】
	ACE.E654			Co-creative Education Off-Campus Project D (in Japan)	0-0-4	A0D A1D A2D		【Academy for Co-creative Education of Environment and Energy Science】
	ACE.E659			Policy Internship A	0-0-4	A0D A1D A2D		【Academy for Co-creative Education of Environment and Energy Science】
	ACE.E660			Policy Internship B	0-0-4	A0D A1D A2D		【Academy for Co-creative Education of Environment and Energy Science】

○: course from this major, ★: course given in English

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

Table D3-2. Courses of the Graduate Major in Human Centered Science and Biomedical Engineering recognized as equivalent to Career Development Courses in the Productive Leader Program (PLP)

Course category	Course number	Course title			Credits	GA*	Learning goals	Comments
Courses that can be counted as Career Development Courses	HCB.C631.A	○	★	HCB International Internship	0-0-4	P2D P3D	B,C,D	
	HCB.C632.A	○		Research Working in Company	0-2-2	P2D P3D	B,C,D	for Graduate Program for Working Adults students
	HCB.C633.A	○		HCB off-Campus advanced training 1	0-0-1	P1D P2D P3D	B,C,D	Offered in English as needed
	HCB.C634.A	○		HCB off-Campus advanced training 2	0-0-2	P1D P2D P3D	B,C,D	Offered in English as needed
	LST.B605		★	International Career Development Advanced	1-1-0	P0D P1D	A,B,C,D,E	【Life Science and Technology】
	LST.C601			PhD Internship 1	0-1-0	P1D P2D P3D	A,C,E	【Life Science and Technology】 Offered in English as needed
	LST.C602			PhD Internship 2	0-2-0	P1D P2D P3D	A,C,E	【Life Science and Technology】 Offered in English as needed
	LST.C603			PhD Internship 3	0-4-0	P1D P2D P3D	A,B,C,E	【Life Science and Technology】 Offered in English as needed
	LST.C604			PhD Internship 4	0-6-0	P1D P2D P3D	A,B,C,E	【Life Science and Technology】 Offered in English as needed
	ACE.D644			Career Planning	1-0-0	P0D		【Academy for Co-creative Education of Environment and Energy Science】
	ACE.E651			Co-creative Education Off-Campus Project A (Overseas)	0-0-4	P0D P1D P2D		【Academy for Co-creative Education of

								Environment and Energy Science】
	ACE.E652			Co-creative Education Off-Campus Project B (Overseas)	0-0-4	P0D P1D P2D		【Academy for Co-creative Education of Environment and Energy Science】
	ACE.E653			Co-creative Education Off-Campus Project C (in Japan)	0-0-4	P0D P1D P2D		【Academy for Co-creative Education of Environment and Energy Science】
	ACE.E654			Co-creative Education Off-Campus Project D (in Japan)	0-0-4	P0D P1D P2D		【Academy for Co-creative Education of Environment and Energy Science】
	ACE.E659			Policy Internship A	0-0-4	P0D P1D P2D		【Academy for Co-creative Education of Environment and Energy Science】
	ACE.E660			Policy Internship B	0-0-4	P0D P1D P2D		【Academy for Co-creative Education of Environment and Energy Science】

○: course from this major, ★: course given in English

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 the Tokyo Tech Academy for Convergence of Materials and Informatics (TAC-MI) 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 Theses

In the doctoral thesis research, in addition to problem-solving skills, we foster problem setting ability and improvement of communication skills in English. These are acquired in the process of setting and evaluating the results of the studies. An example of the flow of the doctoral thesis is shown below.

・Interim presentation

It is important to conduct research systematically and check the progress to produce research results. Thus, student conduct Research Planning for Doctoral Thesis I in 4Q, and Research Planning for Doctoral Thesis II in 9Q-11Q.

・Judgement criterion of the final defense of doctoral thesis

Those who wish to make the final defense of their doctoral thesis must undergo prior examination at Research Planning for Doctoral Thesis II and obtain the approval to apply for it.

The doctoral thesis must be written in Japanese or English by the student. The content of the thesis must have novelty, creativity, and sufficient academic value in the field of Human Centered Science and Biomedical Engineering, and also major parts of the content must be published in international academic journals or the same level as the contents in international journals.

・Implementation manner of the final defense of doctoral thesis

After students pass the interim interview, they will submit their thesis and then perform the oral presentation. A final examination and evaluation will be carried out via a preliminary review by the advisors. In the final examination, their understanding abilities (including English ability) of the relevant research field will be confirmed. The oral presentation must be done in Japanese or English.