Appended Form 1

Specifications for Major Program

Name of School (Program)〔School of Engineering Cluster 3 (Applied Chemistry, Biotechnology and Chemical Engineering)〕

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Program name (Japanese)	化学工学プログラム
(English)	Program of Chemical Engineering

2. Overview

Chemical engineering is the academic system of engineering that is needed in order to make chemistry useful in

newly-discovered or synthesized substances, which have highly useful functions, in real life, it is first necessary to efficiently produce the needed quantity of industrial products based on these substances at a reasonable price. Therefore, we must make effective use of limited resources and energy, and select or develop the most efficient production system that gives consideration to the environment. Essentially, we must first study which raw materials we can use to produce the intended product, by what reactions, processes, equipment, and operational conditions it can be produced, and how we can detoxify the waste products and return them to nature. Only after we have done these we can finally decide on the production system. Chemical engineering is the academic system that brings together the development of the optimal production system, the design of new plants and equipment, and the fundamentals necessary for operational management.

Chemical engineering has developed as an academic field necessary for the development of production process for chemical products. The production processes for other products, for instance those for food items, medical products, iron and steel, and those related to the energy industry, can be carried out in the same way as those used for chemical products and, therefore, engineers who have studied chemical engineering perform well in various industries. It is also possible to develop new functional materials by devising production processes based on the

mical engineering has been drawing attention to this.

Furthermore, since the development of optimal production systems and new plants is conducted in harmony with nature, chemical engineering is also helpful in creating a sustainable society.

This program aims at developing professionals who have acquired the fundamentals of, and expertise in, chemical engineering through education and research into the efficient use of substances, energy, and reaction processes. The philosophy of chemical engineering has become an indispensable tool for solving environmental issues in which it is necessary to consider resources, energy, safety, economy, and society in an integrated manner, while maintaining a global perspective. Therefore, developing professionals who can approach these environmental issues from a chemical engineering perspective is one of the objectives of this program.

Students who are enrolled in Cluster 3 (applied chemistry, biotechnology, chemical engineering) at the School of Engineering receive the common education for Cluster 3 by the end of the first semester of the second year, and are registered in this program from the second semester of the second year. From that point until graduation, under the integrated educational system, students can acquire expertise in chemical engineering to the level needed to pass the examination of Associate Professional Chemical Engineer.

Many of the graduates advance to graduate school and acquire a higher level of expertise and research capabilities. They often find employment with corporations working in areas such as chemicals, ceramics, textiles, medical products, foods, paper making, and other chemical-related industries, and they also gain employment with electricity, metals, machinery, construction, and food companies, energy and environment-related corporations, and

in various other industrial areas. They work actively inside and outside the country, using their chemical engineering knowledge as their weapon. In addition, this program was approved in 2004 by the JABEE (Japan Accreditation Board for Engineering Education) for chemistry, chemistry-related fields, and chemical engineering courses. It also received an ongoing certification review in 2009, and was accredited in terms of educational activities, educational

3. Academic Awards Policy (Goals of the Program and Policy for Awarding Degrees)

Chemical engineering is the academic system of engineering needed when making use of chemistry in real life. In -discovered or synthesized highly functional substances in real life, it is necessary to efficiently produce the needed quantity of these industrial products at a reasonable price. Therefore, we must make effective use of limited resources and energy, while minimizing the burden on the environment, and select or develop the most efficient production system. Chemical engineering is the academic system that brings together development of the optimal production system, and design and operational management of new plants and equipment.

This program develops professionals who have acquired the fundamentals of, and professional expertise in, chemical engineering, through education and research into the efficient use of substances, energy and reaction processes. It also develops professionals who are able to approach environmental problems from the perspective of chemical engineering. Therefore, the program sets the goals (A) to (E) below, and cultivates not only professional expertise in engineering in general, and chemical engineering in particular, but also the essential foundation indispensable for engineers and researchers, which includes creativity, communication skills, and the like. This

necessary to meet the standard of the course, and have achieved the following goals.

(A) Acquisition of a multiple thinking ability and understanding of relations among human, society, nature, and engineering. (engineering ethics)

(B) Acquisition of logical thinking ability

(C) Acquisition of basic chemistry and chemical engineering and cultivation of application ability

(D) Acquisition of flexible adapting ability and creativity and cultivating motivation for self-development and self-improvement

(E) Acquisition of presentation and communication ability and cultivation of application ability to high informatization.

4. Curriculum Policy (Policy for Preparing and Implementing the Curriculum)

To achieve the goals (A) to (E) in this program, a curriculum consisting of liberal arts education subjects and specialized basic subjects, which are common to Cluster 3, and specialized subjects, which are unique to this program, is organized as described below. Learning outcomes are evaluated based on the grade calculation for each subject, and attainment levels against the goals set by the educational program.

(A) Cultivation of multiple thinking ability and understanding of relations among human, society, nature, and engineering.

Cultivation of an understanding of the impact that technology has on society and nature, and the responsibility that engineers have towards society, as well as cultivation of the ability to think multilaterally, from a global perspective, about the relationship between engineering, people, society, and the natural environment. This is achieved through the study of liberal arts education subjects such as Introduction to University Education - Health and Sports Courses , Green Technology Recycling Engineering

(B) Cultivation of logical thinking ability.

Acquisition of basic knowledge about natural science, such as mathematics and physics, and acquisition of basic knowledge about technology, as well as the reinforcement of logical thinking skills based on the acquired basic knowledge, is achieved through the study of foundation courses in liberal arts education such as the

experiment- Experimental Methods and Laboratory Work in Biology , , Linear Algebra , Basic Electromagnetism .

(C) Cultivation of basic chemistry and chemical engineering, and cultivation of application ability.

Cultivation of basic academic ability in engineering through a systematized and carefully selected educational curriculum, and cultivation of professional expertise and applied skills. Particularly, by focusing on exercises and experiments, aiming at acquisition of specialized subjects in chemical engineering that enable students to acquire the ability to become independent engineers and to acquire the basics needed to engage in advanced research in graduate school. Furthermore, cultivation of a high level of consciousness as engineers through plant tours and practical work related to chemical plant design, and through lectures by external instructors with rich, real-life business experience. Abilities are cultivated by focusing on the following five fields in achieving Goal (C) in this program.

(C1) Engineering basis

Cultivation of knowledge about basic engineering such as applied mathematics, information processing・calculator utilization technology, basic chemistry, environmental science, material science, material mechanics, and cultivation of problem- Mathematics for Chemical Engineers Probability and Statistics Elements of Information Literacy or Exercise in Information Literacy Basic Engineering Computer Programming Numerical Calculation Method Basic Organic Chemistry Basic Inorganic Chemistry Analytical Chemistry Green Technology Introduction to Fundamental Industry Basic Life Science Biochemistry , and Mechanics of Materials

(C2) Chemical engineering basis

Cultivation of professional expertise such as chemical stoichiometry including mass and energy balance, thermodynamics including physics and chemical equilibrium, theory of transport phenomena such as heat, mass, and momentum, and cultivation of experimental technology and ability that can be used for solving a problem by Introduction to Applied Chemistry, Chemical Engineering and Biotechnology Chemical Engineering Exercise Exercise of Chemical Engineering Thermodynamics .

(C3) Chemical basis

Acquisition of basic knowledge of chemical fields such as organic chemistry, analytical chemistry, reaction engineering, polymer chemistry, electrochemistry, biochemistry, and energy chemistry, as well as basic knowledge of fields related to chemistry and experimental techniques, and the cultivation of abilities to utilize them for solving Inorganic Chemistry Chemical Reaction Engineering Chemical Kinetics Synthetic Polymer Chemistry Biochemistry Fermentation Technology Biotechnology Basic Experiments in Chemistry

(C4) Chemical engineering field

Acquisition of expertise in chemical engineering fields such as heat transfer, fluids engineering, material transfer, reaction engineering, process control engineering, powder technology, drafting and design, and experimental technology, and cultivat Chemical Reaction Engineering Process Control Engineering , Chemical Engineering Exercise , and Experimental Chemical Engineering ,

(C5) Chemical engineering application

Cultivation of management abilities and the ability to study, develop, and design the substances and energy processes that consider material circulation and environmental burdens while taking account of economy, safety,

(D) Cultivation of flexible adapting ability and creativity and cultivating motivation for self-development and self-improvement.

Cultivation of creativity, problem-solving abilities, and motivation for self-development and study, by actually engaging in engineering while coming into contact with people who have different ideas during experimentation, chemical process design, graduation work. This is achieved by completing Introduction to University Education

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(E) Improvement of presentation and communication ability and cultivation of application ability to high informatization.

Reinforcement of the ability to write, present, and engage in discussion logically through liberal arts seminars, experiment subjects, chemical process design, and graduation work, as well as cultivation of the ability to collect and transmit information in the fields of engineering from an international perspective through promotion of technical English. In addition, cultivation of the ability to utilize information through thorough information literacy education by

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(D) Cultivation of flexible adapting ability and creativity and cultivating motivation for self-development and self-improvement

(E) Improvement of presentation and communication ability and cultivation of application ability to high informatization.

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10. Responsibility System

(1) PDCA Responsibility

To work on the evaluation of the program, this program organizes three committees (the Educational Evaluation Committee, the Student Evaluation Committee, and the Educational Improvement Committee), the Managing Committee, which oversees these three committees, and the Program Evaluation Committee, which is an external evaluation committee consisting mainly of business people. The following are the major roles of each committee.

The Educational Evaluation Committee conducts questionnaires to evaluate attainment levels against the goals (class improvement questionnaires directed at students and staff), questionnaires to evaluate the validity of the uestionnaires targeting graduates and their superiors). The committee checks, evaluates, and improves the educational systems such as curricula, educational environments, and support systems. Based on the results of the questionnaires, the committee checks and evaluates the validity of the current educational system.

educational status. The committee evaluates the attainment levels of each subject against the use of the class improvement questionnaires and grade summary sheets, and, for the purpose of increasing

recommendations for improvement as necessary.

The Educational Improvement Committee reviews the curricula in terms of achievement of the goals, based on the recommendations for improvement and the results of the various of questionnaires submitted by the Student Evaluation Committee and the Educational Evaluation Committee, and devises new goals as needed. Furthermore, the committee makes recommendations about improvement of the educational environments and support systems. The task of each committee overlaps partially, and this system enables the committees to check each other while working in collaboration with each other. All of the staff in charge of the program belong to one of the committees.

The Managing Committee, which oversees the Educational Evaluation Committee, the Student Evaluation Committee, and the Educational Improvement Committee, has the program supervisor as its chairperson. To move

and the educational systems (educational tools, educational environments, etc.) (CHECK), suggests educational improvements (ACT) and sets the goals to be achieved, including the level or achievement necessary to meet these goals (PLAN). In this way, the Managing Committee gives guidance to each other committee for the smooth running of the PDCA system. As such, this program has in place a system under which all the staff in charge cooperate and move ahead together, with the program supervisor taking overall responsibility.

(2) Program assessment

This program evaluates and improves the program in PDCA cycles from the following evaluation perspectives.

(1) Whether goals being set are appropriate
(2) Whether the amount of learning (learning hours) is sufficient
(3) Whether curricula being set are appropriate
(4) Whether classes are conducted in accordance with the syllabus
(5) Whether equipment and facilities are sufficient
(6) Whether the student support system is sufficient
(7) Whether the goal attainment levels are sufficient
(8) Whether educational improvement is undertaken
(9) Whether continuous improvement is undertaken

(10) Whether the records of activities are publicized or disclosed

The Educational Evaluation Committee, the Student Evaluation Committee, the Educational Improvement Committee, and the Managing Committee evaluate this program on a daily and continuous basis, in a planned manner, from the above

asking of the staff in charge of subjects at a class for comments about the questionnaire, based on the results of the class improvement questionnaires completed by students, or on the class check and evaluation results given by the students, we make improvements of the lecture th

comments on the questionnaire are made public to students, so that students are able to understand how the questionnaires are utilized for class improvement.

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Cluster 3　Specialized Basic Subjects

◎Required

Class Subjects	Credits	Type of course registration: Applied Chemistry	Biotechnology	Chemical enneering	Class Hours/ Week: 1st grade Spring 1T	1st grade Spring 2T	1st grade Fall 3T	1st grade Fall 4T	2nd grade Spring 1T	2nd grade Spring 2	2nd grade Fall 3T	2nd grade Fall 4T	3rd grade Spring 1	3rd grade Spring 2	3rd grade Fall 3	3rd grade Fall 4	4th grade Spring 1	4th grade Spring 2	4th grade Fall 3	4th grade Fall 4	note
Applied Mathematics I	2	◎	◎	◎			4														
Applied Mathematics II	2	◎	◎	◎					4												
Applied Mathematics III	2													4							
Basic Engineering Computer Programming	2	◎	◎	◎					4												
Probability and Statistics	2												4								
Technical English	1	◎	◎	◎								4									
Basic Environmental Sciences	2						4														
Chemical Stoichiometry	2	◎	◎	◎						4											
Basic Organic Chemistry I	2	◎	◎	◎			4														
Basic Organic Chemistry II	2								4												
Physical Chemistry I	2	◎	◎	◎						4											
Biochemistry I	2	◎	◎	◎						4											
Basic Experiments in Chemistry	4	◎	◎	◎							#	#									
Basic Inorganic Chemistry	2	◎	◎	◎				4													
Analytical Chemistry	2	◎	◎	◎					4												
Basic life science	2						4														
Introduction to Applied Chemistry, Chemical Engineering and Biotechnology	2									4											
Introduction to Fundamental Industry	2									4											

Cluster 3 Specialized Subjects
(Program of Chemical Engineering)

◎Required subjects
○Compulsory Elective subjects

Class Subjects	Credits	Type of course registration	Class Hours/ Week																Note
			1st grade				2nd grade				3rd grade				4th grade				
			Sprin		Fall		Sprin		Fall		Sprin		Fall		Sprin		Fall		
			1T	2T	3T	4T	1T	2T	3T	4T	1T	2T	3T	4T	1T	2T	3T	4T	
Experimental Chemical Engineering	3	◎											9	9					
Chemical Equipment Design and Practice	2	◎									4	4							
Fluids Engineering	2	◎									4								
Heat Transfer	2	◎											4						
Mass Transfer	2	◎									2	2							
Chemical Engineering Thermodynamics	2	◎									2	2							
Chemical Reaction Engineering	2	◎											4						
Powder Technology	2	◎									4								
Chemical Process Design	3	◎													6	6			
Chemical Engineering Fundamentals	2	◎							2	2									
Mechanics of Materials	2	○										4							
Chemical Engineering Exercise I	2	○							4	4									
Chemical Engineering Exercise II	2	○									4	4							
Chemical Engineering Exercise III	2	○											4	4					
Exercise of Chemical Engineering Thermodynamics	1	○									2	2							
Mathematics for Chemical Engineers	2	○							4										
Materials Science	2	○								4									
Process Control Eng.	2	○										4							
Numerical Calculation Method	2										4								
Chemical Process and Engineering Ethics	2	◎													6				
Chemical Industrial Process	2														6				
Corrosion and Protection of Materials	2												4						
Green Technology	2													4					
Recycling engineering	2	◎												4					
Inorganic Chemistry	2										4								
Physical Chemistry II	2	◎							4										
Chemical Kinetics	2											4							
Synthetic Polymer Chemistry	2										4								
Electrochemistry	2												4						
Biochemistry II	2								4										
Fermentation Technology	2										4								
Biotechnology	2												4						
Graduation Thesis	5	◎																	

Academic Achievements in Chemical Engineering

The Relationship between Evaluation Items and Evaluation Criteria

Academic Achievements			Evaluation Criteria		
Evaluation Items			Excellent	Very Good	Good
Knowledge and Understanding	(A)	To improve multiple thinking ability and understanding of relations among human, society, nature, and engineering.	Sufficient understanding of relations among human, society, nature, and engineering. Acquiring sufficient thinking ability with multiple perspectives.	Good understanding relations among human, society, nature, and engineering deeply. Acquiring thinking ability with multiple perspectives.	Understanding relations among human, society, nature, and engineering.
	(B)	Development of logical thinking ability	Acquiring an excellent logical thinking ability.	Acquiring a good logical thinking ability .	Acquiring a logical thinking ability.
Abilities and Skills	(C1)	Definite learning of basic chemistry and chemical engineering and cultivation of engineering basis.	Sufficiently learned basic chemistry and chemical engineering and the applied skills.	Learned basic chemistry and chemical engineering.	Well learned basic chemistry and chemical engineering and the applied skills.
	(C2)	chemical engineering basis			
	(C3)	chemical basis.			
	(C4)	chemical engineering field			
	(C5)	chemical engineering application			
Overall Abilities	(D)	Developing the flexible adapting ability and creativity and cultivating motivation for self-development and self-improvement	Acquiring excellent flexibility and creativity; also to have a willingness for self-improvement and self-enlightenment.	Acquiring good flexibility and creativity; also to have a willingness for self-improvement and self-enlightenment.	Acquiring flexibility and creativity; also to have a willingness for self-improvement and self-enlightenment.
	(E)	Improvement of presentation and communication ability and cultivation of application ability to high informatization.	Developed presentation and communication ability very well. Acquired application ability to high informatization very well.	Developed presentation and communication ability well. Acquired application ability to high informatization well.	Developed presentation and communication ability. Acquired application ability to high informatization.

Placement of the Liberal Arts Education in the Major Program

Liberal Arts Education in this program assumes the role of establishing the academic foundation on which the specialized educ ation will be built. It respects a voluntary, self-reliant attitude and cultivates scientific thinking based on information gathering abilities, analytical abilities, and criti cal thinking abilities. It establishes perspectives that make it possible to provide insight on the inner nature of things and their background from a wide broad viewpoint, and enhances l inguistic abilities to the level appropriate for living as a global citizen. It also strengthens interest in peace, and integrates a broad range of knowledge into a body of knowledge tha t will be truly useful in solving problems. It cultivates the ability to explore and promote cross-disciplinary /comprehensive research that goes beyond the established frameworks.

			区分																				
				1semsester-1T	40	4													40	4	20	2	
				1semsester-1T																			
				1semsester-2T																			
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				1semsester-1T																	100	10	
				1semsester-2T																	100	10	
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				2semsester-3T																			
				3semsester-2T					30	3	40	4			30	3							100
				3semsester-2T					70	7	30	3											100
				6semsester																			
				5semsester																			
				5semsester-1T																			
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				4semsester-3T																			
				5semsester-1T																			
				6semsester-3T																			
				7semsester，8semsester																			

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Leaning and Educational Goals	Class Subjects							
	1st grade		2nd grade		3rd grade		4th grade	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
(A) To improve multiple thinking ability and understanding of relations among human, society, nature, and engineering. (Ethics as engineers)						Recycling engineering(◎) Green Technology (◎)	Chemical Process Design Chemical Process and Engineering Ethics Chemical Industrial Process	Graduation Thesis
(B)E Development of logical thinking ability								
(C1) Engineering basis								
(C2) Chemical engineering basis.								
(C3) Chemical basis				Basic Experiments in Chemistry(◎) Biochemistry II(◎)				
(C4) Chemical engineering field								
(C5) Chemical engineering application.								
(D) Developing the flexible adapting ability and creativity and cultivating motivation for self-development and self-improvement.								
(E) Improvement of presentation and communication ability and cultivation of application ability to high informatization.								

Note : Subjects with (◎) symbol have direct relation with next subject, and the subjects without symbol are incidentally influence.