For entrants in AY 2021

Appended Form 1

Specifications for Major Program

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

Program name (Japanese)	
(English)	Program of Chemical Engineering

1. Academic degree to be acquired

Bachelor's degree in engineering

2. Overview

(1) Overview of "English-based Bachelor's Degree Program"

This program aims to foster and produce future members of a global society who have the knowledge to be innovative, creative, take leadership, and possess language abilities that will help them play an important role in the international world.

This program focuses specifically on producing individuals who are capable of addressing various global issues from an engineering perspective and contribute to the creation of new and valuable solutions that are significant to both the industrial and academic societies.

Students enrolled in the program will begin the curriculum from the first semester of their first year.

In the second year, students will set off on their major programs and take the designated courses which are offered at each cluster.Major program overview is as (2).

(2)Program overview of "Program of Chemical Engineering".

Chemical engineering is the academic system of engineering that is needed in order to make chemistry useful in real life. In other words, it is "the engineering of chemistry". For instance, in order for us to make use of 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 academic system of chemical engineering, and today's chemical 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 content, graduates' knowledge, and their ability to reach an adequate level.

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 other words, it is the "engineering of chemistry". For instance, in order to make use of newly-discovered or

Reaction Engineering", "Chemical Kinetics", "Synthetic Polymer Chemistry", "Electrochemistry", "Biochemistry", "Fermentation Technology", "Biotechnology", and "Basic Experiments in Chemistry".

(C5) Chemical engineering application

(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.

The specific goals are as follows.

(1) The ability to understand the social background of, and previous research outcomes in, the chosen topic of research, as found in research papers (including English papers)

(2) The ability to understand the purpose of research and to establish specific goals and research schedules, as well as the ability to conduct research voluntarily

(3) The ability to understand the social requirements of research contents, their impact on society or on nature, and the significance of this impact, as well as the ability to recognize the contribution made by researchers, and their responsibilities, from a multifaceted perspective

(4) The ability to understand the principles, structure, and operational procedures of equipment, and the ability to use it properly, as well as the ability to observe the phenomena resulting from experimental operations, and to write down the necessary information in laboratory notebooks

(5) The ability to interpret the results gained, and to express the phenomena in terms of physics models

(6) The ability to collect the necessary information when identifying a problem, and to apply acquired knowledge in creative ways in order to solve the problem

(7) The ability to express the content of the oral or written research logically and effectively

(8) The ability to discuss research with others, express one’s own opinion adequately, take others’ opinions seriously, and digest these opinions for one's own improvement

(9) The ability to overcome problems and technical issues, find pleasure in achieving objectives and goals, and demonstrate a willingness to work on further intellectual activities

(10) The ability to develop in social skills and human qualities in order to live and act as part of a group

○ When and how it is assigned

When it is assigned: At the start of the fourth year (only those who meet “the conditions for undertaking a graduation thesis” are to be assigned.)

Conditions for undertaking a graduation thesis

(1) Students must acquire 8 credits in foreign languages and all of practical subjects and laboratory subjects to be taken (including experiments practical work in the basic subjects).

(2) Students must acquire a total of 112 credits or more, excluding chemical process design, out of which students must acquire a total of 66 credits or more in specialized basic subjects and specialized subjects (excluding “Chemical Process Design”)

○ How it is assigned

The research details of each laboratory to which students can be assigned are explained during the lectures of “Introduction to Applied Chemistry, Chemical Engineering and Biotechnology” and at the explanatory meeting on assignment. After the number of students acceptable to each o Ealeao y ost inv4 (e)-12.3 (dn)-1.1 ( )tuden-12.3 (dn)-1

Students set the purpose and the goal of the research, arrange long-term and short-term research schedules, and are given guidance about the contents as needed.

A seminar is held for the entire laboratory, lectures are given about safety control, specialized experimental technics, and basic knowledge in related fields and research contents, and students are trained in presentation skills, question and answer sessions, and writing summaries.

Students conduct research, experiments, calculations, and analysis, and consider their achievement of the purpose and goal of the research.

Meetings will be held as needed about the status of the research; guidance will be given about the research results, their interpretation, considerations that should be made, etc., and training will be given in communication and logical thinking skills.

The interim graduation thesis presentation (December) and the final presentation (February) will be held, and students will receive training in presentation of results, summary writing, and question and answer sessions, and all the staff check and evaluate educational effects of the graduation thesis.

Guidance is given about how to compose reports and how to think logically through the writing of the graduation thesis.

10. Responsibility System

(1) PDCA Responsibility System ("Plan," "Do," "Check," and "Act")

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 goals (questionnaires at the time of students' graduation, and questionnaires 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.

The Student Evaluation Committee mainly evaluates and improves the system that assesses the students' educational status. The committee evaluates the attainment levels of each subject against the students' goals by the use of the class improvement questionnaires and grade summary sheets, and, for the purpose of increasing consciousness of learning and educational effects, it surveys the students' learning situation and makes 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 ahead with the educational program (DO), the committee checks and evaluates the students' goal attainment levels 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

○ Criteria for 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-mentioned evaluation perspectives. Therefore, the committees prepare unique questionnaires, grade summary sheets, and the survey on attainment levels, and put them into action. (Major evaluation perspectives and when to implement evaluation are described.)

Class questionnaires to evaluate the amount of learning (learning hours), class accordance with the syllabus, attainment levels against the goals (class improvement questionnaires targeting students and staff)

Teachers' comments on students' class improvement questionnaires for educational improvement, improvement reports by teacher in charge of subjects (implemented at the end of each semester)

Questionnaires to evaluate the validity of the goals and suitability of the established curriculum, the questionnaires at the time of students' graduation (targeted at fourth year students, implemented immediately after presenting graduation theses), the questionnaires targeting graduates and their superiors (conducted once every three years, for graduates who graduated 3, 4, or 5 years ago)

The amount of learning (learning hours), class accordance with the syllabus, grade summary sheet for each class subject to evaluate the attainment levels against the goals, attendance record (conducted at the end of each semester)

Drawing up of program syllabus (once a year)

Preparing the survey on attainment levels of students' academic results in order to understand the academic results of individual students and of the entire grade (conducted at the end of each semester)

FD activities, such as class observations of all staff (conducted on a regular basis)

○ How to assess the program

The Educational Evaluation Committee, the Student Evaluation Committee, and the Educational Improvement Committee gather the above data according to each task, and compile the results of various questionnaires, academic results of class subjects and comprehensive evaluations, and attainment levels against the goals. The committees then submit recommendations for improvement with reference to the students' requests, and improvement reports by the teacher in charge of each subject. The Managing Committee that oversees the three committees discusses these ideas in comprehensive way and draws up the final evaluation and ideas for improvement. Evaluation and improvement plans, and items decided here, are discussed at the meeting of staff in charge, to disseminate to all staff in charge of the programs and to gain their approval. Furthermore, the committee has a consultation with the tutors or the staff in charge of each subject directly, or through three committees, as needed about evaluation and improvement of classes.

As for the issues extend across the other programs, the committee has a consultation with the Self-check and Evaluation Committee of the Graduate School of Engineering, and the Cluster 3 Curriculum Exploratory Committee, and proceeds with evaluation and improvement while working together with them.

As for the suitability of the evaluation methods of attainment levels, and of the evaluation criteria from the point of view of society, the Program Evaluation Committee, which is an external evaluation committee held once a year, gives its evaluation.

These activities are conducted on a daily and continuous basis in a planned manner. The outcome and the activity records of each committee are shared by all faculty members of this program.

○ Feedback to students

To improve student education, this program has introduced a new system for tutors and various questionnaires. In other words, by use of the attainment table, the tutors in each grade understand not only individual student's academic results and attainment level, but also the entire grade's academic results and attainment levels, and are in a position to identify improvements. Based on this, by conducting interviews with individual students, this program promotes improvement of student education in close consultation with the Managing Committee. By asking of the staff in charge of subjects at a lass 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 that correspond to the students' requests. Furthermore, the comments on the questionnaire are made public to students, so that students are able to understand how the questionnaires are utilized for class improvement.

Cluster 3 (Applied Chemistry, Biotechnology and Chemical Engineering)

Required subject (period of registration specified)
○ Compulsory elective subject (any of these subjects shall be registered
Free elective subject (any of these subjects shall be registered)

Subject Type				Required No. of credits	Class subjects	No. of credits	Type of course registration	Year in which the subject is taken(The lower figure means semester) Note 1															
								1st grade				2nd grade				3rd grade				4th grade			
								Spring		Fall		Spring		Fall		Spring		Fall		Spring		Fall	
								1T	2T	3T	4T	1T	2T	3T	4T	1T	2T	3T	4T	1T	2T	3T	4T
Liberal Arts Education Subjects	Peace Science Courses			2		2	Compulsory elective		○														
	Basic Courses in University Education	Introduction to University Education		2	Introduction to University Education	2	Required																
		Introductory Seminar for First-Year Students		2	Introductory Seminar for First-Year Students	2	Required																
	Common Subjects	Area Courses		4	Courses in Arts and Humanities/Social Sc	2	Compulsory elective	○		○													
				4	Courses in Natural Sciences	2			○		○												
		Foreign Languages	English (Note2 3)	Basic English Usage	2	Basic English Usage I	1	Required															
						Basic English Usage II	1																
				Communication I	2	Communication IA	1	Required															
						Communication IB	1																
				Communication	2	Communication IIA	1	Required															
						Communication IIB	1																
			Initial Foreign Languages (Select one language from German, French, Spanish, Russian, Chinese, Korean and Arabic)	2	1 subjects from Basic language I	1	Compulsory elective	○															
					1 subjects from Basic language II	1			○														
		Information and Data Science Courses		2	Note 4 Elements of Information Literacy or Exercise in Information Literacy	2	Compulsory elective		○														
		Health and Sports Courses		2		1or2	Compulsory elective	○	○	○	○												
	Basic Subjects			15	Calculus I	2	Required																
					Calculus II	2																	
					Linear Algebra I	2																	
					Linear Algebra II	2																	
					General Mechanics I	2																	
					General Mechanics II	2																	
					Experimental Methods and Laboratory Work in Physics I	1																	
					Experimental Methods and Laboratory Work in Physics II	1																	
					Seminar in Basic Mathematics I	1																	
				1	Seminar in Basic Mathematics II	1	Compulsory elective				○												
					Experimental Methods and Laboratory Work in Biology I Note 5	1				○													
					Experimental Methods and Laboratory Work in Biology II	1					○												
					Basic Electromagnetism	2					○												
	Free elective subjects			2	From all Subject Type		Free elective																
	No. of credits required for graduation			44																			

Note 1 When students fail to acquire the credit during the term or semester marked with ○ in the boxes for the year in which the course is taken, they can take the course in subsequent terms or semesters. Depending on class subject, courses may be offered in semesters or terms different from those scheduled. Please be sure to check the time schedule for Liberal Arts Education subjects to be issued every school year.

Note 2 The credit obtained by mastery of "English-speaking Countries Field Research" or self-directed study of "Online Seminar in English A B" cannot be counted towards the credit necessary for graduation. The credit obtained by Overseas Language Training can be recognized as Communication or if application is made in advance. For more details, please refer to the article on English in Liberal Arts Education in

Note 3 We have a recognition of credit system for foreign language proficiency tests. For more details, please refer to the article on English in Liberal Arts Education in the student handbook.

Note 4 Students must take "Elements of Information Literacy" provided in the first semester. You can take the "Exercise in Information Literacy" provided in the second semester only if you fail to obtain credit for "Information Utilization Basics."

Note 5 Students must take both Experimental Methods and Laboratory Work 1credit and Experimental Methods and Laboratory Work

		1T	2T	3T	4T	1T	2	3T	4T	1	2	3	4	1	2	3	4
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																

Required subjects
○ Compulsory Elective subjects

			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						

Academic Achievements in Chemical Engineering

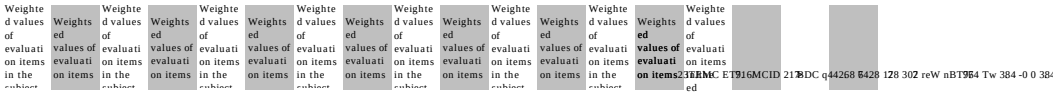
The Relationship between Evaluation Items and Evaluation Criteria

			Excellent	Very Good	Good	
	(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			
	(C1) (C2) (C3) (C4) (C5)	Definite learning of basic chemistry and chemical engineering and cultivation of engineering basis. chemical engineering basis chemical basis. chemical engineering field chemical engineering application				
	(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 engineering.	Well learned basic chemistry and chemica engineering and the applied skills.

Liberal Arts Education in this program assumes the role of establishing the academic foundation on which the specialized education will be built. It respects a voluntary, self-reliant attitude and cultivates scientific thinking based on information gathering abilities, analytical abilities, and critical 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 linguistic 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 that 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.

Relationships between the evaluation items and class subjects

					Weighted values of evaluation items in the subject	Weighted values of evaluation items	Weighted values of evaluation items in the subject	Weighted values of evaluation items	Weighted values of evaluation items in the subject	Weighted values of evaluation items	Weighted values of evaluation items in the subject	Weighted values of evaluation items	Weighted values of evaluation items in the subject	Weighted values of evaluation items	Weighted values of evaluation items in the subject	Weighted values of evaluation items	Weighted values of evaluation items in the subject	Weighted values of evaluation items	Weighted values of evaluation items in the subject	Weighted values of evaluation items	
Liberal Arts Education	Introduction to University Education	2	Required	1semsester-1T	40	4													40	4	20	2	100
Liberal Arts Education	Introductory Seminar for First-Year Students	2	Required	1semsester-1T	40	4													40	4	20	2	100
Liberal Arts Education	Peace Science Courses	2	Elective	1semsester- T	100	10																	100
Liberal Arts Education	Area Courses	8	Elective	1semsester	100	10																	100
Liberal Arts Education	Basic English Usage I	1	Required	1semsester-1T																	100	10	100
Liberal Arts Education	Basic English Usage II	1	Required	1semsester- T																	100	10	100
Liberal Arts Education	Communication IA	1	Required	1semsester																	100	10	100
Liberal Arts Education	Communication IB	1	Required	1semsester																	100	10	100
Liberal Arts Education	Communication IIA	1	Required	2semsester																	100	10	100
Liberal Arts Education	Communication IIB	1	Required	2semsester																	100	10	100
Liberal Arts Education	Basic language I	1	Elective	1semsester-1T																	100	10	100
Liberal Arts Education	Basic language II	1	Elective	1semsester-2T																	100	10	100
Liberal Arts Education	Information Courses	2	Elective	1semsester- T					40	4											60	6	


Weighted values of evaluation items in the subject
Weighted values of evaluation items
Weighted values of evaluation items in the subject
Weighted values of evaluation items
Weighted values of evaluation items in the subject
Weighted values of evaluation items

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)								
(B)E Development of logical thinking ability								
(C1) Engineering basis								
(C2) Chemical engineering basis.								
(C3) Chemical basis								
(C4) Chemical engineering field								
(C5) Chemical engineering application.								
(D) Developing the flexible adapting ability and creativity and cultivating motivation for self-development and								