For entrants in AY 2019

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 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 program awards a "bachelor's degree in engineering" to students who have acquired the number of credits 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", "Introductory Seminar for First-Year Students", "Peace Science Courses", "Area Courses", "Health and Sports Courses", "Chemical Process and Engineering Ethics", "Green Technology" and "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-based subject "Experimental Methods and Laboratory Work in Physics", "Experimental Methods and Laboratory Work in Biology", and mathematics and physics subjects such as "Calculus", "Linear Algebra", "General Mechanics" and "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-solving abilities by completing "Applied Mathematics", "Applied Mathematics", "Mathematics for Chemical Engineers", "Probability and Statistics", "Elements of Information Literacy or Exercise in Information Literacy", "Basic Engineering Computer Programming", "Numerical Calculation Method", "Physical Chemistry", "Basic Organic Chemistry", "Basic Inorganic Chemistry", "Analytical Chemistry", "Basic Environmental Science", " Green Technology", " Introduction to Fundamental Industry", " Basic Life Science", "Biochemistry", "Materials Science" 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 completing "Chemical Stoichiometry", "Introduction to Applied Chemistry, Chemical Engineering and Biotechnology", "Chemical Engineering Fundamentals", "Physical Chemistry", "Chemical Engineering Thermodynamics", "Chemical Engineering Exercise", and "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 problems. These can be acquired by completing "Basic Organic Chemistry", "Inorganic Chemistry", "Chemical

Reaction Engineering", "Chemical Kinetics", "Synthetic Polymer Chemistry", "Electrochemistry", "Biochemistry", "Fermentation Technology", "Biotechnology", and "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 cultivation of abilities to utilize them for solving problems, by completing "Heat Transfer", "Fluids Engineering", "Mass Transfer", "Chemical Reaction Engineering", "Powder Technology", "Process Control Engineering", "Chemical Equipment Design and Practice", "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, reliability, and social impact, by completing "Chemical Process Design", " Chemical Industry Process", and "Chemical Process and Engineering Ethics".

(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", "Introductory Seminar for First-Year Students", "Chemical Process Design", and "Graduation Thesis".

(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 completing "Introductory Seminar for First-Year Students", "Elements of Information Literacy or Exercise in Information Literacy", "Communication Course", "Initial Foreign Languages", "Technical English", "Chemical Process Design", and "Graduation Thesis".

5. Program Timing and Acceptance Conditions

○ When to start the program:

The English-based Bachelor's Degree programs begin in the first semester of the first year. Enrollment in Program of Chemical Engineering occurs in the second semester of the second year.

Cluster 3 offers distinctive education that has organically integrated the fields of chemistry, biotechnology, and chemical engineering. Specifically, it aims at developing professionals that possess technical expertise in harmony with a wide range of basic knowledge about the development of new functional substances and materials; the biotechnology of plants, animals and, microbes; the design and control of chemical processes; environmental preservation and purification; and the development of resources and energy. To achieve this aim, in addition to the common, wide-ranging specialized basic education, three programs have been prepared that provide specialized education in chemistry, biotechnology, and chemical engineering. These are the Program of Applied Chemistry, the Program of Biotechnology, and the Program of Chemical Engineering.

Registration on these three programs is to be made in the second semester of the second year, so that students can choose a suitable specialized field or program while acquiring a wide range of specialized basic knowledge.

○ Credit Requirements

In order to be assigned to each program, students must acquire 16 or more credits out of a total of 18 credits in compulsory specialized basic subjects (excluding “Basic Experiments in Chemistry” and “Technical English”) and must acquire a total of 60 or more credits overall (including in Liberal Arts Education).

○ Program Quota

An upper limit is set for acceptance of students. Assignment to the Program of Applied Chemistry, the Program of Biotechnology and the Program of Chemical Engineering is decided after taking into account requests from students and their academic results.

6. Obtainable Qualifications

Type-1 High School Teaching License (Industry) (By completing “Vocational Guidance”, the prescribed “Liberal Arts Education Subjects” and “Specialized Education Subjects”, students can obtain a Type-1 High School Teaching License (Industry) upon graduation.)

Safety Supervisor (Graduates from the school of engineering, who have engaged in actual industrial safety business for over two years and finished the training for safety supervisors, are certified.)

Superintendent boiler operator (Graduates from the school of engineering, who have completed the boiler-related courses while in school and have undergone hands-on training about handling boilers for more than one or two years after graduation, are eligible to take the license examination for first-class boiler operator or the license examination for special-class boiler operator.)

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other staff in the program give guidance to students.

Research topics are set, an overview is given and research approaches are explained.

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 made public on the website of the chemical engineering course http://www.chemeng.hiroshima-u.ac.jp/ .

○ 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 (in a meeting) 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 to classes 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.

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Cluster 3　Specialized Basic Subjects

◎Required

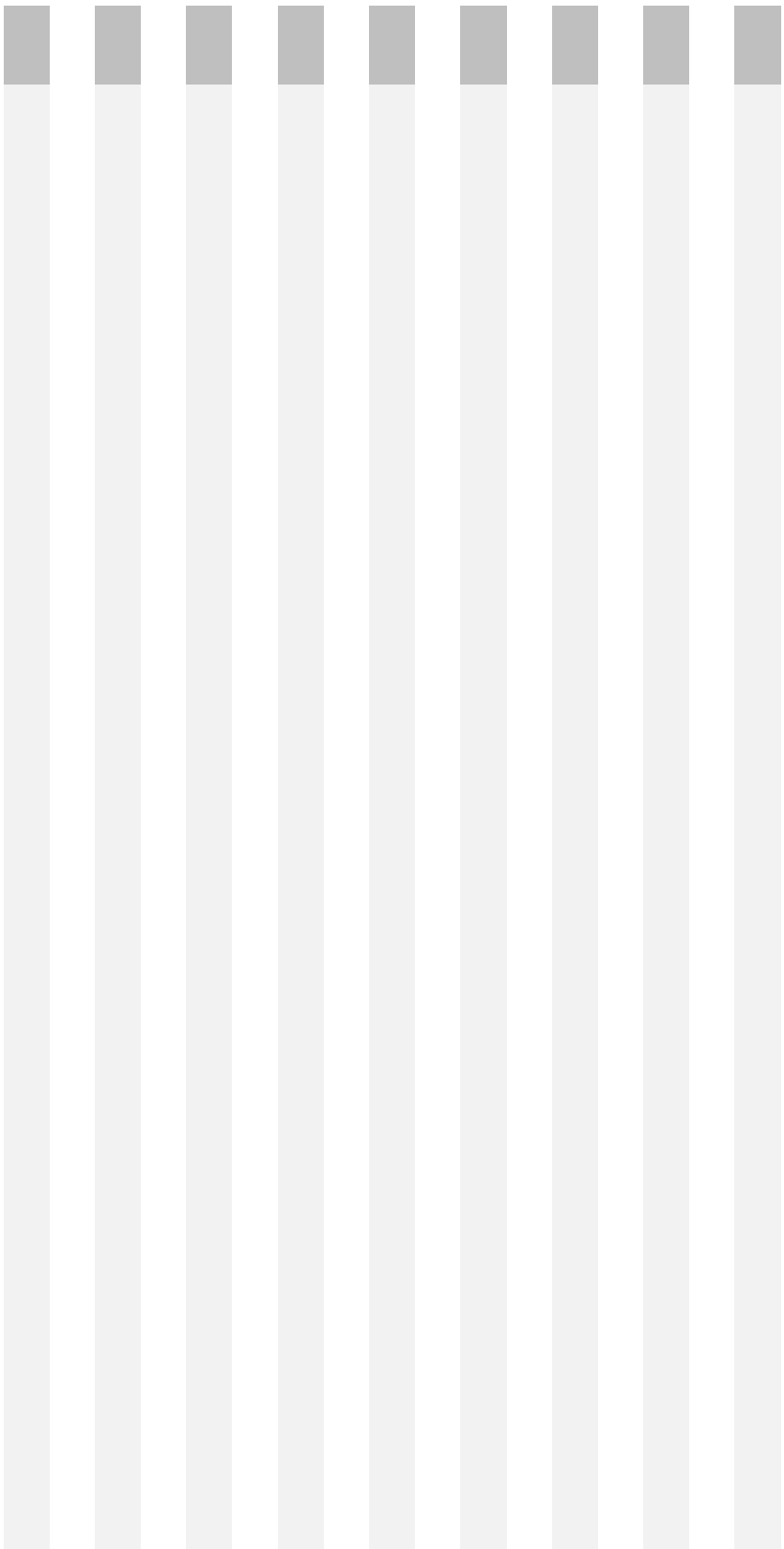
Class Subjects	Credits	Type of course registration			Class Hours/ Week																note
		Applied Chemistry	Biotechnology	Chemical enneenering	1st grade				2nd grade				3rd grade				4th grade				
					Spring		Fall		Spring		Fall		Spring		Fall		Spring		Fall		
					1T	2T	3T	4T	1T	2T	3T	4T	1T	2T	3T	4T	1T	2T	3T	4T	
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	◎	◎	◎							12	12									
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				
			Spring		Fall		Spring		Fall		Spring		Fall		Spring		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 Engineering	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	◎																	



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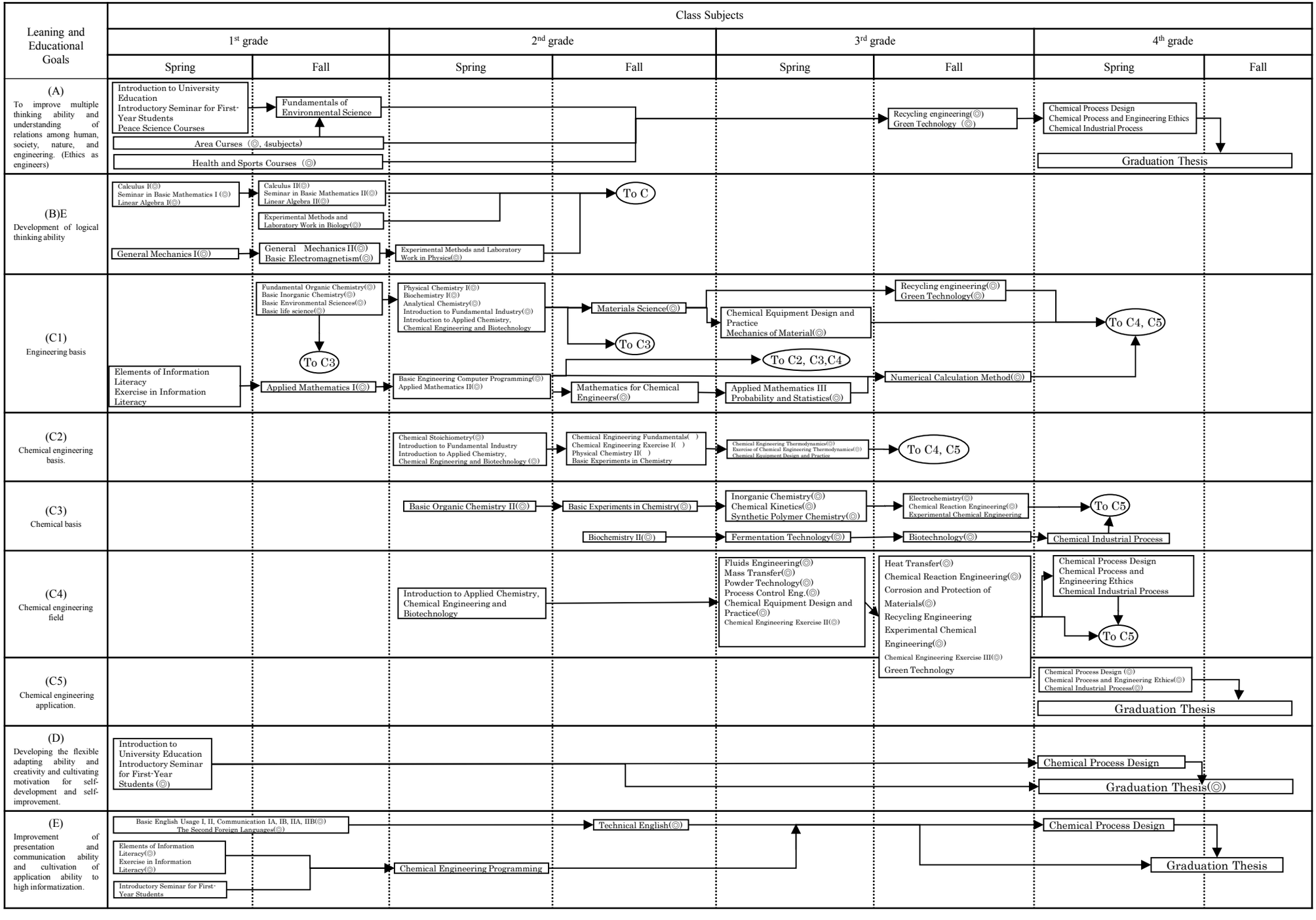
（２）Structure of Program



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