Chemical and Biomolecular Engineering

Major

※ The freshmen in all the engineering departments are required to take Seminar for Freshmen (HSS3014, 1 credits) course to be opened in the first semester of 1st grade. (applied from the class 2014)

※ CBE2006(applied biology) is not included in major credits but included in graduation credits.

※ The students before the class of 2015 are required to have the graduation assessment as of the year of graduation and the students from the class 2015 are required to have graduation assessment as of the year of admission.(the standard of graduation by years needs to be referred in the website of the department)

※ STS2010(Science Story) is excluded in core required course. In case that the students before the class of 2015 miss taking the science history, they need to take one additionally in the 'Society and Human Study' instead of science history. The students from the freshmen in 2015 need to change Choice 2 to Choice 1 in Society and Human Research'

※ From 2016 in case the students majoring in other major take multiple majors in Chemistry and Biology Engineering, they need to take additionally differential and integral calculus study.

Advanced Major for Chemistry and Biology Engineering (major credits 76 credits or more)

Major Preparatory Course : CBE2011(or MAT2410), CBE2012(or MAT2420), PHY1001, 1101,
506
Select one among CHM1001, 1002, 1051, 1052, PHY1002 or select one among CBE2006, STS2007 or 2008 (total 24 credits)

- Major preparatory course needs to be taken and is not included in the credits for completing the major.
- Students in 2015 can replace CBE2011 and CBE2012 with MAT2410 and 2420.

Required Course : CBE2002, 2003, 2004, 2005, 2007, 2008, 2009, 3001, 3003, 3004, 3005, 3007,
3015, 3016, 4001, 4013, 4017, G005 (total 53 credits)

Selective course : 23 credits or more among major course other than required course

Design course : complete 12 credits or more as a design course among a total of completion credits

Multiple Majors of Chemistry and Biology Engineering (major credits 45 credits or more)

Preparatory course : select one from CBE2011(or MAT2410), CBE2012(or MAT2420), PHY1001, PHY1002 or CBE2006 and select one from PHY1101, CHM1001, 1002, 1051, PHY1102 or CHM1052 (total 21 credits)
- Preparatory course is not included in credits for major completion.
- The students in the class of 2015 can replace CBE2011 and CBE2012 with MAT2410 and 2420.

Required course : CBE2003, 2004, 2005, 2008, 3001, 3003, 3004, 3005, 3015 (total 27 credits)

Selective course : 18 credits or more from major course other than required course

※ Major credits 45 credits or more and the completion of CBE2005 required course will be applied from the class of 2011.

Chemical & Biomolecular Engineering Curriculum
(Background/Required Courses)

Acad. Year	1st Semester		2nd Semester	
1	COR1001	2 cr.		
	HSS3014	1 cr.	STS2006	3 cr.
	COR1007	1 cr.	CHM1002	3 cr.
	STS2005	3 cr.	CHM1052	1 cr.
	PHY1101	1 cr.	COR1003	3 cr.
	PHY1001	3 cr.		
	CHM1001	3 cr.	PHY1002	3 cr.
	CHM1051	1 cr.	CBE2006 (1)	3 cr.
	STS2007 (Select 1)	3 cr.	CBE2002	3 cr.
	STS2008			
		18 cr.		15 cr.
2	ETS2001 (Select 1)	3 cr.	HFS2001 (Select 1)	3 cr.
	ETS2002		HFS2002	
	ETS2003		HFS2003	
	ETS2004			
	CBE2011 or MAT2410	3 cr.	CBE2012 or MAT2420	
	CBE2003 (3)	3 cr.	CBE2007	3 cr.
	CBE2004	3 cr.	CBE2009	3 cr.
	CBE2005	3 cr.	CBE3001	3 cr.
	CBE2008	3 cr.		3 cr.
		18 cr.		12 cr.
3	(Select 1)	3cr.	CBE3005	3 cr.
	SHS2001-2007			3 cr.
			CBE3016	
	CBE3003			
	CBE3004	3 cr.		
	CBE3007	3 cr.		
	CBE3015	3 cr.		
		3 cr.		
		15 cr.		9 cr.
4	CBE4013	2 cr.	CBE4001	3 cr.
	CBE4017	3 cr.		
	CBEG005	2 cr.		
		8 cr.		3 cr.

CBE2002 Creative Design 3 cr.
(lect.: 3hr, design 3)

The purpose of this course is to help students understand the fundamental concepts and principles of engineering, and to increase their ability in creative design. For this purpose, a basic overview of engineering will be mentioned, and student will work to creatively design engineering problems. Through this course, students further their interest in the field of engineering, while increasing their ability to use their creativity in engineering projects.

CBE2003 Material and Energy Balance 3 cr.
(lect.: 3hr, theory 3)

A survey of the general principles of calculation that are required in basic quantities, which are used for chemical processes. In other words, the calculation of major process (temperature, pressure, concentration, and flow rates), the basic concepts of balancing mass and energy in processes, and the application of process analysis. Also, methods of physical and physicochemical processes are introduced.

CBE2004 Physical Chemistry 3 cr.
(lect.: 3hr, theory 3)
This course is a survey of physical chemistry, including basic concepts of molecular motion and energy, state of matter, entropy, free energy, and the Boltzmann factor. Also, this course offers an introduction to chemical and physical phase equilibrium, which includes fundamental quantities in statistical mechanics, kinetic theory of molecules, and reaction kinetics.

CBE2005 Advanced Organic Chemistry 3 cr.
(lect.: 3hr, theory 3)
This course presents advanced topics in organic chemistry, such as the basic theory of organic compound structure and its properties, substitution, elimination, oxidation, reduction, and radical reaction with an emphasis on petroleum, raw materials, as well as intermediate and advanced organic materials.

CBE2006 Applied Biology 3 cr.
(lect.: 3hr, theory 3)
General principles on the infection of human by microbes, activities in food and agricultural production, and biotechnological process using microbes based on cell biology, biochemistry, molecular biology, and genetics. Also includes basic concepts of the mass production of pharmaceutical materials such as antibiotics, vaccines, and bio-surfactant.

CBE2007 Applied Biochemistry 3 cr.
(lect.: 3hr, theory 3)
This course deals with the molecular characteristics of major cellular components including proteins, carbohydrates, lipids, and nucleotides. Also, the molecular structure of various biochemicals, derivatives, their interactions, metabolic networks, and energy metabolism will be covered, along with a discussion of their industrial application.

CBE2008 Basic Experiment in Chemical & Biomolecular Engineering I 3 cr.
(lab.: 6hr, exp. 3)
A study of the basic tools used in experiments such as report writing, presenting, and doing statistical analysis are taught. Also includes fundamental knowledge related to physical chemistry, Thermodynamics and basic principles of biosystems are obtained through experiments. A special experiment topic is selected, which is applied to the design process by combining the basic principle with a real system.

CBE2009 Basic Experiment in Chemical & Biomolecular Engineering II 3 cr.
(lab.: 6hr, exp. 3)
To gain a fundamental knowledge, basic experiments in analytical methods, property measurement methods, and surface analysis are done, with advanced knowledge related to physical chemistry, thermodynamics, and basic principles of biosystem being obtained through advanced experiments. Later in the course, a special experiment topic is selected.

CBE2011 Mathematics for Engineers I
(Lecture 3 hours : theory 3) 3 Credits
This course covers necessary linear algebra, value of simultaneous equation, Laplace transform, value of ordinary differential equation.

CBE2012 Mathematics for Engineers II
(Lecture 3 hours : theory 3) 3 Credits
Pre-requisite subject : STS2006
Pre-requisite subject : CBE2011
This course covers vector differential and integral calculus, Fourier interpretation, value of partial differential equation, complex number analysis to get the

interpretation and value of engineering problems.

CBE3001 Chemical Engineering Thermodynamics 3 cr.

(lect.: 3hr, theory 3)

Engineering concepts of classic thermodynamics, interaction of energies in system-boundary-surroundings, ideal and real states, calculation of work and heat problems, calculation of thermodynamic properties of pure substances, entropy and second law, free energy and equilibrium, and the stability of matter.

CBE3002 Process Thermodynamics 3 cr.

(lect.: 3hr, theory 3; prereq.: CBE3001)

A continued discussion on thermodynamics, including chemical and physical equilibrium and their relationships in simple and reactive systems, estimation of chemical potential and thermodynamic properties for multiphase multicomponent mixtures, and bubble, dew, and flash calculations of mixtures.

CBE3003 Reaction Engineering 3 cr.

(lect.: 3hr, theory 2, design1)

A study of the kinetics of various chemical reactions, including basic principles and theories of reactor design, selection, sizing, searching operation conditions, reactor models, and an analysis of reacting systems.

CBE3004 Chemical Process Fluid Mechanics 3 cr.

(lect.: 3hr, theory 3. prereq CBE2011(MAT2410))

Basic concepts of continuum mechanics, a macroscopic and microscopic approach to momentum transfer, approximate solution of fluid mechanics, as well as their application to unit operations such as polymer processing, mixing, filtration, packed bed, and fluidized bed.

CBE3005 Heat and Mass Transfer 3 cr.

(lect.: 3hr, theory 2, design1; prereq.: CBE3004(CE 50))

Molecular diffusion of heat and mass transfer, a macroscopic approach to convective heat and mass transfer, radiation and its applications to multistage operations such as heat exchanges, distillation, absorption, and extraction.

CBE3006 Process Control 3 cr.

(lect.: 3hr, theory 2, design 1)

In this course the following topics are covered: basic concepts of chemical process control, design of control loops, elements in a feedback control system, dynamics modeling of a process, transfer function representation, stability, principles and tuning methods of PID controller, frequency domain analysis, and state space methods. Students are required to conduct a project to design and evaluate a control system for a numerical but practical process.

CBE3007 Polymer Engineering 3 cr.

(lect.: 3hr, theory 2, design 1, prereq.: CBE2002 2005)

Introduction to polymers, including their chemical structures, molecular weight (distribution), molecular interaction, transitional phenomena, and morphology. Their effects on physical properties on molecular level and their characterization methods are also discussed.

CBE3008 Physical Properties of Polymers 3 cr.

(lect.: 3hr, theory 3)

An introduction to the physical properties of polymers such as their mechanical, electrical, and optical properties, including characterization methods and the effect of testing conditions on physical properties. Also includes an introduction to current research in polymers.

CBE3010 Molecular Engineering 3 cr.

(lect.: 3hr, theory 3)

An introduction to quantum mechanics, quantum chemistry, and solid-state physics to provide a basic understanding of nanotechnology.

CBE3011 Computer-Aided Design Theory 3 Credits(Lecture 3 hours : theory 3) 3 Credits

This course helps student learn analysis of engineering data, modeling about general process in chemical engineering, numerical analysis, ordinary differential equation, and finite difference method and finite elements method regarding partial differential equation. Students also learn the method to analyze in a numeric way by applying it to chemical process phenomenon.

CBE3012 Mathematical Methods in Chemical Engineering 3 cr.

(lect.: 3hr, theory 3)

Mathematical methods for the analysis of chemical process systems are introduced and applied to various chemical processes and equipments. Analytical and approximate methods for ODE and PDE solutions, solutions of difference equation for multistage processes, calculus of variation, Green's functions, and the methods of weighted residuals are covered.

CBE3013 Applied Molecular Biology 3 cr.

(lect.: 3hr, theory 3;prereq.: CBE2007(CE 33))

This course covers the structure of macromolecules including DNA and protein, DNA replication, transcription, translation, regulation of gene activity in prokaryotes and eukaryotes, and genomics and proteomics for the basic understanding of life science. Also, this course deals with biological analytical systems such as biosensors, DNA chips, protein chips, and lab-on-a-chip.

CBE3014 Genetic Engineering 3 cr.

(lect.: 3hr, theory 3)

Genetic engineering is a laboratory technique used by scientists to change the DNA of living organisms. This course will deal with basic theories in gene cloning, recombinant DNA, and techniques for genetic manipulation of higher animals and plants.

CBE3015 Core Experiment in Chemical & Biomolecular Engineering I 3 cr.

(lab.: 6hr, exp. 2, design 1) prereq. cbe2002 cbe2009

Through experiments, students are taught principles and practices of elementary systems in chemical and biomolecular engineering such as flow and pressure distribution in a piping system, mixing system, PCR, VL equilibrium tank. Students are required to perform process-design tasks using a process simulator or other tools.

CBE3016 Core Experiment in Chemical & Biomolecular Engineering II 3 cr.

(lab.: 6hr, exp. 2, design 1, prereq.: CBE2002)

Through experiments, students are taught principles and practices used in elementary systems in chemical and biomolecular engineering such as heat exchanger, absorption tower, chemical reactor, feedback control system, and mechanical properties of polymers. Students are required to perform process design tasks using a process simulator or other tool.

CBE4001 Advanced and Comprehensive Plan of Chemistry and Biology Engineering(Capstone Design) (Lecture 3 hours : design 3) 3 Credits

Pre-requisite subject : CBE2002
Pre-requisite subject : CBE3003
Pre-requisite subject : CBE3007
Pre-requisite subject : CBE3015
Pre-requisite subject : CBE3016

In this course, students conduct experimental research to improve the problem solving capacity related to Chemistry and Biology Engineering and present and discuss about the result.

CBEG005 Chemical Industry and Technological Management Theory(Lecture 2 hours : theory 2) 2 Credits

This course will be conducted in a way that professionals will be invited and

introduce the contents which failed to be covered in the existing course and write the report by selecting one from the themes introduced to understand the practice of chemical engineering and recent chemical engineering development.

CBE4003 Transport Phenomena 3 cr.

(lect.: 3hr, theory 3; prereq.: CBE3004)

This course provides an overview of transport phenomena and its role for analyzing the integrated chemical processes encountered in engineering, including momentum, heat, and mass transfers. Basic balance equations and advanced topics as well as some details of mathematics are discussed.

CBE4004 Separation and Purification Process 3 cr.

(lect.: 3hr, theory 2, design 1. prereq. CBE2002)

This course focuses on the design and operation of various separation equipments, and ion exchange and special noble separation technologies based on heat and mass transfer of chemical and biological materials. Also includes the methodology of the separation in a biological process, analysis of stage-wise operation under specific conditions, the influence of mixture and biochemical materials on the process operation, and performance enhancement of the designed equipments.

CBE4005 Catalysis Engineering 3 cr.

(lect.: 3hr, theory 3; prereq.: CBE3003)

Continuation of CBE3003(CE 101), an analysis of nonideal reactor systems, heterogeneous reacting system analysis, catalytic reactions, and catalytic reactors.

CBE4007 Process Engineering 3 cr.

(3hr, theory 2, design 1, prereq: CBE2002, CBE3006)

Conceptual approaches for the development of a process flow diagram, piping, and instrumentation diagram are covered. Special emphasis is given to the flow sheet simulation and the heat exchanger network and separation process synthesis.

CBE4008 Semiconductor Processing 3 cr.

(lect.: 3hr, theory 3)

A survey of chemical engineering techniques for semiconductor fabrication processes. Basic theories of applied solid-state physics and principles of semiconduction. Application of fluid machines and transport phenomena to semiconductor processing. Fundamental understanding of essential elements in semiconductor processing such as lithography, etching, doping, chemical vapor deposition (CVD), and ionic implantation.

CBE4009 Polymer Processing 3 cr.

(lect.: 3hr, theory 3)

Basic concepts of the rheology of polymer solutions and melt, viscometry and rheometry, mechanical properties of polymers and their measurement. Also includes the basic design of polymer processes and practices.

CBE4010 Introduction to Materials Science for Chemical Engineers 3 cr.

(lect.: 3hr, theory 3)

The basic theories of materials and their structures, phase transformation and reaction rates, microstructure of materials and their electrical, magnetic, stereochemical properties, characteristics of materials and their optimal selection for fabrication of materials, equipment design, and construction of structural materials are covered.

CBE4011 Electrochemistry 3 cr.

(lect.: 3hr, theory 3)

The basic theory of electrochemistry is introduced and recent applications of electrochemistry in nanotechnology, biotechnology, and the energy industry are discused. Thermodynamics, electrode kinetics, and transport phenomena relevant to electrochemical processes are explained and applications to primary and secondary batteries, fuel cells, labchips, and biological systems are introduced.

CBE4012 Environmental Engineering 3 cr.

(lect.: 3hr, theory 3)

A survey of environmental problems based on environmental process technology in natural science. Basic theories of prevention and depollution of environmental problems. Also includes water pollution, solid wastes, bacterial decomposition of waste water, chemical separation of depollution processes, and biodegradation of polymeric wastes.

CBE4013 Biochemical Engineering 3 cr.

(lect.: 3hr, theory 2, design 13, prereq. CBE2002)

Basic principles of biochemical and microbiological processes and their applications to chemical, pharmaceutical, and food industries. Fundamental concepts of biochemistry, microbiology, enzyme-catalyzed reaction and kinetics, industrial application of immobilized enzyme, analysis of biological metabolism, and manufacturing process through gene manipulation.

CBE4014 Biochemical Process Engineering 3 cr.

(lect.: 3hr, theory 3)

An analysis of the biological process with an emphasis on transport phenomena and industrial applications such as growth kinetics, transport phenomena in and control of bioreactor, optimization of biological process, and separation and purification of biochemical products.

CBE4016 Petrochemical Engineering 3 cr.

(lect.: 3hr, theory 3)

A study of refinery and base chemicals from coal, crude oil and natural gases, reaction routes to chemicals, reforming methods, with an introduction to petrochemical industries, processes, and products.

CBE4017 Process Experiment in Chemical & Biomolecular Engineering 3 cr.

(lab.: 6hr, exp. 1, design 2)

This advanced laboratory course covers a wide range of topics in chemical and biomolecular engineering, including column operation of distillation and extraction, crystallization, analysis of transfer process, industrial polymerization of nanoparticles, and fuel cells. Students are required to perform process design tasks using a process simulator or other tool.

CBE4018 Industrial Microbiology 3 cr.

(lect.: 3hr, theory 3)

Idustrial microbiology encompasses the use of microorganisms in the manufacture of food and industrial products. This course covers the understanding and application of industrial microorganisms including the biochemical process.

CBE4019 Functional Polymer Chemistry

(lect.: 3hr, theory 3)

The chemistry and technology of functional polymers with regard to procedures, synthesis, and applicability. Introduction of recent advancements in high-performance polymer materials, functional polymer materials, and their application to optical, electronic, and information devices.

CBE4020 Energy Engineering 3 cr.

(lect.: 3hr, theory 3)

A overview of traditional energy resources (coal, oil, natural gas), alternative and synthetic energy resources (nuclear, reusable energy) and their production, refining, and conversion methods. Also includes an introduction to electrochemistry and energy devices (lithium battery, fuel cell, solar cell).

CBE4021 Introduction to Nanotechnology 3 cr.

(lect.: 3hr, theory 3)

Nanoscale science and nanotechnology are broad, interdisciplinary areas, encompassing not just materials science but everything from biochemistry to electrical engineering and more. This course is a survey introducing some of the fundamental principles behind nanotechnology and nanomaterials, as well as applications of nanotechnology. The role of solid state physics and chemistry in nanotech will be emphasized. Nanoscale tools such as

surface probes and atomic force microscopy, nanolithography, and special topics such as molecular electronics are also covered.