

2.1 ABOUT THE DEPARTMENT

The UP Diliman Department of Chemical Engineering (DChE) offers graduate and undergraduate programs in chemical engineering and has a strong participation in the interdisciplinary graduate programs in energy engineering and environmental engineering. It has 29 full-time and 4 part-time faculty members, and produces about a hundred chemical engineers every year.

The Chemical Engineering course was planned as far back as 1949, when allied subjects were taken at the Chemistry Department. The formal curriculum in B.S. Chemical Engineering was instituted in 1952 and first appeared in the university catalogue in 1953, the year when the College started on the five-year Bachelor of Science curricula. The College turned out its first graduates in chemical engineering in April 1954. Along with other engineering courses, these classes were held in the evening at the then National Science Development Board (NSDB) premises on Pedro Gil (Herran) Street in Manila, until they were conducted in Diliman campus.

The Department is housed in a newly-constructed building located in the Engineering Complex along C.P. Garcia Avenue. The design concept of the building began in 2008 with Architect Augusto Concio (B.S. ChE, 1959) leading the project. The ChE building of about 5,000 sq. m. floor area is comprised of instructional, analytical and research laboratories, faculty rooms, lecture rooms, and administrative offices. The construction of the building was made possible through the Engineering Research and Development for Technology (ERDT) program.



The UPD Chemical Engineering Building

Chemical Engineering Education in UP

Chemical engineers devise ways to make valuable products from raw materials. They have helped develop and innovate technologies for the production of paper, dyes, drugs, plastics, fertilizers, food and beverages, petrochemicals and advanced materials. They can make processes cost effective, energy efficient and environment-friendly. The skills of

chemical engineers encompass all aspects of design, testing, scale-up, operation, control, and optimization, and require a detailed understanding of the various physical, chemical or biochemical processes.

The strength of chemical engineering education in UP lies in both the knowledge and training it imparts to the students. UP students are trained to be analytical and creative problem solvers. The Chemical Engineering curricula aim to develop and strengthen the technical, research, analytical, social and management skills of the students. It aims to prepare them to be responsible leaders in the practice of the profession.

2.2 VISION

The Department envisions to be an institution of higher education that fosters academic excellence through teaching, research, and extension service in chemical engineering, thereby contributing to national progress and global innovation.

2.3 MISSION

The department commits:

- To produce world-class chemical engineering graduates.
- To provide innovative and sustainable solutions to the technological challenges in the society, government and industry through research.
- To spearhead the development of technology with social and environmental responsibility in the interest of national progress.

2.4 UNDERGRADUATE PROGRAM

Chemical engineers worldwide have worked in a wide array of industries. Economic, health, energy and environmental considerations require new knowledge and innovations on products, product formulation, materials, processes, and systems control.

Aware of its role in providing competent chemical engineers, the department offers the Bachelor of Science in Chemical Engineering (B.S. ChE).

2.4.1. Program Educational Objectives

The University of the Philippines Diliman DChE aims to produce B.S. Chemical Engineering graduates who are able to engage in productive careers with the following expected accomplishments 3-5 years after graduation:

1. Graduates have been able to take on leadership roles in their respective fields and/or effectively work in or manage a team;
2. Graduates have applied and expanded their knowledge and skills toward successful careers and responsive citizenship;
3. Graduates have demonstrated strong research and innovative capability as they recognize and address opportunities and challenges in their respective spheres of influence and;
4. Graduates have shown a strong commitment to the ethical practice of their profession, to health, safety and environment and; service to society.

2.4.2 Program Outcomes

The UP Diliman DChE sees itself producing B.S. Chemical Engineering graduates who upon graduation:

1. Have the solid foundation of math and science needed for understanding, expressing and applying chemical engineering principles;
2. Have a very good understanding of chemical engineering principles such as the conservation of mass and energy, thermodynamics, transport, and kinetics and apply these in the analysis of chemical engineering processes and problems;
3. Possess the knowledge, understanding and skills, as well as the ability to use tools (economic analysis, statistical analysis, HAZOP analysis, etc.) for analyzing and organizing data and conceptualizing and comparing processes, materials, technology and/or equipment options;
4. Have the ability to design a system, component, or process to meet specifications according to standards of ethics and design; health, safety and environment regulations, as well as socio-cultural, political, technical, economic and sustainability constraints;
5. Are proficient in technical oral and written communications;
6. Possess the ability to identify engineering problems and opportunities, conceptualize and prepare a defensible and implementable project proposal, manage its implementation and communicate its results;
7. Possess the ability for independent research and the positive disposition for life-long learning;

8. Take to heart their role as chemical engineers in contributing innovative solutions to address society's challenges toward global sustainable development; and
9. Possess the ability to apply engineering and management principles in working in or leading a team that may be involved in multidisciplinary endeavors.

2.5. GRADUATE PROGRAMS

2.5.1 Master of Science in Chemical Engineering

The Master of Science in Chemical Engineering (M.S. ChE) program aims to educate and train competent engineers, scientists and educators in the field of chemical engineering. Courses shall be taught in a manner that shall strengthen students' creativity, analytical ability and critical thinking. The program shall prepare them for teaching and research and development in chemical engineering.

Master of Engineering in Chemical Engineering,
M.Eng. ChE (since 1963, currently not offered)

Master of Science in Chemical Engineering,
M.S. ChE (since 1972)

2.5.2 Doctor of Philosophy in Chemical Engineering / Doctor of Engineering in Chemical Engineering

Program Objectives and Requirements

The Doctor of Philosophy and the Doctor of Engineering in Chemical Engineering programs aim to promote advanced training for engineers, scientists and educators in the field of chemical engineering. The training given by the program enables its graduates to

1. Independently conduct research and communicate the knowledge from such study in local and international fora;
2. Collaborate in an interdisciplinary research; and
3. Express his/her technical opinion on national issues requiring his/her expertise.

The Doctor of Engineering degree is awarded to students who address an engineering problem of substance and develops a solution to it in a creative and distinguished manner. The Doctor of Philosophy degree is awarded to students whose dissertations are directed towards making an original contribution to fundamental knowledge in the field.

Doctor of Philosophy in Chemical Engineering,
Ph.D. ChE (since 1996)

Doctor of Engineering in Chemical Engineering,
D.Eng. ChE (since 1996)

2.6 ACADEMIC AND RESEARCH FACILITIES

Chemical Engineering Building

The Chemical Engineering building is located along C. P. Garcia Avenue, within the Engineering Complex. This new building provides an environment for the department's faculty, staff and students to perform to the best of their abilities as an institution committed to provide world-class education, technical research and service. It houses technologically advanced research laboratories which aim to provide solutions to challenges in sustainability, safety and security, health and quality of life.

The building is composed of five (5) sub-buildings: front building, middle building, rear building, pilot plant, and utility building. The four-storey front building houses the administration offices, conference hall, faculty lounge, two faculty rooms and lecture rooms. There are two large lecture rooms, each with a capacity of 50 students, four small classrooms for 30 students each, and two computer laboratories. The three-storey middle and rear buildings house the research and extension service laboratories and five faculty rooms.

Research Laboratories

1. Biomedical Engineering Laboratory
2. Bioprocess Engineering Laboratory
3. Catalyst Research Laboratory
4. Environmental Process Engineering Laboratory
5. Fuels, Energy, and Thermal Systems (FETS) Laboratory
6. Green Materials Laboratory
7. Laboratory of Electrochemical Engineering (LEE)
8. Polymer Research Laboratory
9. Process Systems Engineering (PSE) Laboratory
10. Separations Laboratory

The pilot plant holds the instructional laboratories and project rooms.

Chemical Engineering Analytical Laboratory (CEAL)

This laboratory caters to students, researchers and the industry. The CEAL performs testing services through its top of the line and state of the art equipment:

- Quadrupole Ion Trap Gas Chromatography Mass Spectrometer (GC-MS)
- Gas Chromatography with Flame Ionization Detector (GC-FID)
- Gas Chromatography with Thermal Conductivity Detector (GC-TCD)
- Fourier Transform Infrared Spectrophotometer (FTIR)
- Atomic Absorption Spectrometer (AAS)

- Differential Scanning Calorimeter (DSC)
- Ultraviolet-Visible Light Spectrophotometer (UV-Vis)
- High Performance Liquid Chromatography (HPLC)
- Ion Chromatograph w/ Chemical Suppression (IC)
- Scanning Electron Microscope (SEM)

Other laboratory instruments include:

- Universal Testing Machine (UTM)
- Denaturing Gradient Gel Electrophoresis (DGGE)
- Polymerase Chain Reactor (PCR)
- Gerhardt Kjeldahl Digestion and Distillation System
- Compact Volumetric Karl Fischer Titrator
- Bomb Calorimeter
- Soxhlet Apparatus
- Surface Tensiometer
- Falling Ball Viscometer

Instructional Laboratories

There are two instructional laboratories which are utilized by undergraduate students: the **Chemical Engineering Thermodynamics Laboratory** and the **Process Engineering Laboratory**.

Chemical Engineering Computer Laboratories (CECL)

There are two computer laboratories which cater to ChE 26 and ChE 182 courses: CECL 1 and CECL 2. Both laboratories are equipped with personal computers with installed Student License of MATLAB. MATLAB is a programming environment for algorithm development, data analysis, visualization, and numerical computation. In the chemical engineering courses, MATLAB is used for programming instruction, simulations in process control, data analysis, and numerical calculations.

2.7 FACULTY AND STAFF

Department Chair

Dr. Rizalinda L. de Leon

Professors

Richard Q. Chu

Ph.D. Biomedical Engineering
Rensselaer Polytechnic Institute, 1984
Biomedical Engineering and Separations Laboratory
Biomedical Engineering, Public Health and Energy Applications of Biotechnology, Computer-aided Improvements in Manufacturing

DEPARTMENT OF CHEMICAL ENGINEERING

Angela D. Escoto

Ph.D. Chemical Engineering
University of the Philippines Diliman, 2001
Fuels, Energy, and Thermal Systems Laboratory
Thermal Management, Thermal Cooling, Phase Change Materials, Heat Transfer Phenomena, Biofuels

Jose C. Muñoz

Ph.D. Chemical Engineering
Chung Yuan Christian University, 2012
Process Systems Engineering Laboratory
Data Reconciliation, Process Modeling, Process Monitoring, Process Control, Fault Diagnosis

Analiza P. Rollon

Ph.D. Environmental Technology
Wageningen University & International Institute for Infrastructural, Hydraulic, and Environmental Engineering, Delft (joint program), 1999
Bioprocess Engineering Laboratory/Environmental Process Engineering Laboratory
Environmental Biotechnology, Environmental Process Engineering

Associate Professors

Florencio C. Ballesteros, Jr.

Ph.D. Environmental Science
New Jersey Institute of Technology and Purdue University, 2008
Environmental Process Engineering Laboratory
PPCP Treatment, Control & Management, E-waste Management, Natural and Engineered Biological Treatment Systems, Land Use/Cover Change Impact Modeling

Maria Lourdes P. Dalida

Ph.D. Chemical Engineering
University of the Philippines Diliman, 2005
Bioprocess Engineering Laboratory/Catalyst Research Laboratory
Catalysis, Environmental Engineering

Rizalinda L. de Leon

Ph.D. Chemical Engineering
University of the Philippines Diliman, 2006
Fuels, Energy, and Thermal Systems Laboratory/
Catalyst Research Laboratory/Bioprocess Engineering Laboratory
Photocatalysts for Hydrogen Production and Pollutant Degradation, Biocatalysts (enzymes) for Fuel Production

Mark Daniel G. de Luna

Ph.D. Environmental Engineering
University of the Philippines Diliman, 2011
Environmental Process Engineering Laboratory
Environmental Engineering

Bryan B. Pajarito

D. Eng. Chemical Engineering
Tokyo Institute of Technology, 2012
Polymer Research Laboratory
Plastics, Rubber, Thermosets, and Polymer Composites

Terence P. Tumolva

D. Eng. Chemical Engineering
Tokyo Institute of Technology, 2011
Green Materials Laboratory
Green Materials, Polymers

Assistant Professors

Jhud Mikhail O. Aberilla

M.S. Chemical Engineering
National University of Singapore, 2015
Process Systems Engineering Laboratory
Industrial Ecology, Sustainable Engineering

Jay R T. Adolacion

Ph.D. Chemical Engineering
University of Houston (in progress)
Bioprocess Engineering Laboratory
Biomolecular Engineering

Jonas Karl Christopher N. Agutaya

M.S. Chemical Engineering
University of the Philippines Diliman, 2015
Process Systems Engineering Laboratory
Transient Flow through Pipes

Bryan G. Alamani

Ph.D. Chemical Engineering
University of Houston (in progress)
Bioprocess Engineering Laboratory/Fuels, Energy, and Thermal Systems Laboratory
Thermal Energy Storage, Inclusion Complex Chemistry, Crystal Engineering, Biomineralization, Ion Effects in Solutions

Marjorie L. Baynosa

Ph.D. Chemical Engineering
Yeungnam University (in progress)
Bioprocess Engineering Laboratory/Environmental Process Engineering Laboratory
Water and Wastewater Treatment, Fermentation Processes

Julie Anne D. del Rosario

Ph.D. Chemical Engineering
University of the Philippines Diliman (in progress)
Laboratory of Electrochemical Engineering
Electrochemical Energy Storage and Conversion Technologies

Arthur A. Gonzales III

Ph.D. Chemical Engineering
Northeastern University (in progress)
Process Systems Engineering Laboratory
Transport, Adsorption, Pollution Control

DEPARTMENT OF CHEMICAL ENGINEERING

Charlimagne M. Montealegre

M.S. Chemical Engineering
University of the Philippines Diliman, 2015
Bioprocess Engineering Laboratory
Fermentation Processes, Particle Technology

Joey D. Ocon

Ph.D. Environmental Science & Engineering
Gwangju Institute of Science and Technology, 2015
Laboratory of Electrochemical Engineering
Batteries, Fuel Cells, Electrocatalysis, Carbon Dioxide-to-Fuels Conversion

Karl Ezra S. Pilario

M.S. Chemical Engineering
University of the Philippines Diliman, 2015
Process Systems Engineering Laboratory
Dynamic Data Reconciliation, Stochastic Optimization

Patrick D. Ramoso

M.S. Chemical Engineering
University of the Philippines Diliman, 2014
Catalyst Research Laboratory
Photocatalytic Reaction Engineering and Reactor Design, Photocatalysis for Water Treatment

Miguel Francisco M. Remolona

Ph.D. Chemical Engineering
Columbia University (in progress)
Process Systems Engineering Laboratory
Intelligent Process Systems

Ralph P. Villa

M.S. Chemical Engineering
University of the Philippines Diliman, 2014
Polymer Research Laboratory
Materials Modeling, Biopolymers

Kristian July R. Yap

M.S. Chemical Engineering
University of the Philippines Diliman, 2014
Fuels, Energy, & Thermal Systems Laboratory
Microfluidics, Photocatalytic Reaction Engineering, Computational Fluid Dynamics

Instructors

Myron T. Alcanzare

M.S. Chemical Engineering
University of the Philippines Diliman (in progress)
Laboratory of Electrochemical Engineering
Corrosion

Michael Sean P. Deang

B.S. Chemical Engineering
University of the Philippines Diliman, 2015
Bioprocess Engineering Laboratory

Marlon L. Mopon, Jr.

B.S. Chemical Engineering
University of the Philippines Diliman, 2015
Laboratory of Electrochemical Engineering

Bemboy Niño F. Subosa

M.S. Chemical Engineering
University of the Philippines Diliman (in progress)
Process Systems Engineering Laboratory
Separation Processes

Louie Arelvi G. Villanueva

M.S. Biochemistry
University of the Philippines Manila (in progress)
Bioprocess Engineering Laboratory
Transgenic Plant Cell Culture Suspensions

Lecturers

Kenneth Robert C. de Guzman

B.S. Chemical Engineering
University of the Philippines Diliman, 2010
Chemical Process Development, Plant Design

Walter Michael C. Escaño

B.S. Chemical Engineering
University of the Philippines Diliman, 2004
Natural Gas Business Process, Elementary Chemical Engineering

Antonio Y. Rivera

M.S. Chemical Engineering
Catholic University of Louvain (Belgium), 1976
Industrial Gases, Chemical Plant Operation, Project Management

Carmelita J. Villanueva

B.S. Chemical Engineering
Far Eastern University, 1984
Petroleum and Petrochemicals, Health, Safety and Environment (HSE)

Research & Extension Staff

Emma A. Macapinlac
Ph.D. Environmental Engineering

Administrative Staff

Diwata I. Ronda
Cynthia P. Sikat

Laboratory Technician

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DEPARTMENT OF CHEMICAL ENGINEERING

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2.8 UNDERGRADUATE PROGRAM CURRICULUM

BACHELOR OF SCIENCE IN CHEMICAL ENGINEERING[†]

First Year								
First Semester			Second Semester					
	Lect (hrs/wk)	Lab (hrs/wk)	Units		Lect (hrs/wk)	Lab (hrs/wk)	Units	
GE (MST 1) Free Choice ³	3	0	3	GE (AH 2) Comm 3 (Pract Speech Fund)	3	0	3	
GE (AH 1) Eng 10 (College English)	3	0	3	Math 53 (Elementary Analysis I)	5	0	5	
GE (SSP 1) Philo 1 (Philo Analysis)	3	0	3	Chem 17 (General Chemistry II)	3	6	5	
Math 17 (Algebra & Trigonometry)	5	0	5	Physics 71 (Elementary Physics I)	4	0	4	
Chem 16 (General Chemistry I)	3	6	5	Physics 71.1 (Elem Physics I Lab)	0	2	1	
PE ⁴ (Physical Education)			(2)	ChE 100 (Intro to the ChE Profession)	1	0	1	
				PE ⁴ (Physical Education)			(2)	
	17	6	19		16	8	19	
Second Year								
First Semester			Second Semester					
	Lect (hrs/wk)	Lab (hrs/wk)	Units		Lect (hrs/wk)	Lab (hrs/wk)	Units	
Math 54 (Elementary Analysis II)	5	0	5	Math 55 (Elementary Analysis III)	3	0	3	
Chem 28 (Quantitative Inorg Analysis)	3	0	3	Chem 31 (Elem Organic Chemistry)	3	0	3	
Chem 28.1 (Quant Inorg Analysis Lab)	0	6	2	Chem 31.1 (Elem Org Chem Lab)	0	6	2	
Physics 72 (Elementary Physics II)	4	0	4	Physics 73 (Elementary Physics III)	4	0	4	
Physics 72.1 (Elem Physics II Lab)	0	2	1	Physics 73.1 (Elem Physics III Lab)	0	2	1	
ChE 26 (Fund of Programming for ChE)	2	3	3	ChE 101 (Fundamentals of ChE)	3	3	4	
PE ⁴ (Physical Education)			(2)	PE ⁴ (Physical Education)			(2)	
NSTP ⁵ (National Service Training Program)			(3)	NSTP ⁵ (National Service Training Program)			(3)	
	14	11	18		13	11	17	
Third Year								
First Semester			Second Semester					
	Lect (hrs/wk)	Lab (hrs/wk)	Units		Lect (hrs/wk)	Lab (hrs/wk)	Units	
ES 1 (Engineering Drawing)	0	6	2	GE (SSP 2) Kas 1 ¹ (Kasaysayan ng Pil)	3	0	3	
ES 11 (Statics of Rigid Bodies)	2	3	3	ES 12 (Dynamics of Rigid Bodies)	2	3	3	
IE 3 (Intro to Industrial Engineering)	3	0	3	EEE 1 (Essentials of Elec Engg)	3	3	4	
MatE 10 (Engineering Materials)	3	0	3	ChE 123 (Chem Engg Thermo II)	3	0	3	
ChE 106 (Math Methods in Chem Engg)	2	3	3	ChE 125 (Chem Reaction Engg I)	3	0	3	
ChE 122 (Chem Engg Thermo I)	3	0	3	ChE 131 (Transport Processes)	3	0	3	
	13	12	17		17	6	19	
Fourth Year								
First Semester			Second Semester					
	Lect (hrs/wk)	Lab (hrs/wk)	Units		Lect (hrs/wk)	Lab (hrs/wk)	Units	
GE (AH 3) Fil 40 ¹ (Wika, Kultura, at Lip)	3	0	3	GE (AH 4) Free Choice ²	3	0	3	
Chem 154 (Physical Chemistry II)	3	0	3	GE (MST 2) Free Choice ³	3	0	3	
ES 13 (Mech. of Deformable Bodies I)	3	0	3	ChE 124 (Chem Engg Thermo Lab)	0	6	2	
ChE 132 (Stagewise Operations)	3	0	3	ChE 126 (Chem Reaction Engg II)	3	0	3	
ChE 133 (Heat & Mass Transfer Eqpt Design)	2	3	3	ChE 135 (Process Engineering Lab)	0	6	2	
ChE 134 (Momentum Transfer & Materials Handling Eqpt Design)	2	3	3	ChE 140 (Chem Process Industries)	2	3	3	
	16	6	18	ChE 150 (Environmental Process Engg)	3	0	3	
					14	15	19	
Fifth Year								
First Semester			Second Semester					
	Lect (hrs/wk)	Lab (hrs/wk)	Units		Lect (hrs/wk)	Lab (hrs/wk)	Units	
GE (SSP 3) Free Choice	3	0	3	GE (AH 5) Free Choice ²	3	0	3	
PI 100 (The Life & Works of Jose Rizal)	3	0	3	GE (SSP 4) Free Choice	3	0	3	
ChE 141 (Chem Process Dev & Plant Econ)	2	3	3	GE (SSP 5) Free Choice	3	0	3	
ChE 143 (Chem Engg Research I)	1	3	2	GE (MST 3) STS (Science, Tech & Society)	3	0	3	
ChE 182 (Chem Process Dyn & Control)	2	3	3	ChE 142 (Chem Engg Plant Design)	1	6	3	
ChE 190 (Plant Inspection & Seminar)	0	3	1	ChE 144 (Chem Engg Research II)	0	6	2	
Qualified Elective ⁶	3	0	3	Qualified Elective ⁶	3	0	3	
	14	12	18		16	12	20	
Total Number of Units = 184								

Notes:

[†] Effective AY 2014-2015. Total number of units = 184

¹ Kas 1 and Fil 40 satisfy the 6-unit Philippine Studies requirement

² Nine (9) units of GE (AH) courses must be in Communication in English

³ GE courses in the MST domain must NOT be Physics 10, Chemistry 1 or Mathematics 2

⁴ For physical education (PE), the student is required to complete any 4 physical education (PE) courses

⁵ As a requirement for graduation, all students must take six (6) units in one of the National Service Training Program (NSTP) components:

Civic Welfare Training Service (CWTS), Literacy Training Service (LTS), and Reserved Officer's Training Corps Military Science (ROTC Mil Sci)

⁶ Qualified Electives: ChE 153 (Industrial Pollution Control), ChE 171 (Introduction to Biochemical Engineering), ChE 174 (Biochemical Engineering Laboratory), ChE 197 (Special Topics), ChE 198 (Special Problems), EgeE 101 (Introduction to Energy Engineering)

2.9 GRADUATE PROGRAMS CURRICULA

Master of Science in Chemical Engineering (M.S. ChE)

Program Checklist

Requirements	Number of Units (thesis)	Number of Units (non-thesis)
Applied Math / Statistics	6	6
Core Courses	9	9
Major Courses	6	12
Elective	3	9
ChE 296.1	1 ²	1 ²
ChE 296.2	1	
Thesis ¹	6	none
Comprehensive Exam		required
Minimum Total	32	37

Notes:

¹ Must be successfully defended in public

² Requires attendance and participation in lectures, seminars, symposia, colloquia and conferences

Grade requirement: Cumulative Weighted Average (CWAG) of 2.00 or better

Doctor of Philosophy in Chemical Engineering (Ph.D. ChE)
Doctor of Engineering in Chemical Engineering (D.Eng. ChE)

Program Checklist

Requirements	Number of Units (Minimum)	
	With B.S. ChE	With M.S. ChE
Core Courses	12	3
Specialization Courses	12	12
Applied Math	9	3
Electives	12	6
Total courses	45	24
Dissertation ¹	12	12
Minimum Total	57	36

Notes:

¹ Must be successfully defended in public (prior to dissertation, student must pass the Ph.D. qualifying exam and the Ph.D. candidacy exam)

Grade requirement: Cumulative Weighted Average (CWAG) of 1.75 or better

2.9.1 GRADUATE COURSES

2.9.1.1 *Applied Mathematics/Statistics*

For M.S. ChE:

Any graduate applied mathematics and/or statistics course, subject to the recommendation of the adviser and the approval of the Graduate Program Committee of the Department.

For Ph.D. / D.Eng. ChE:

ES 201	Advanced Mathematical Methods in Engineering I
ES 202	Advanced Mathematical Methods in Engineering II
ES 204	Numerical Methods in Engineering

2.9.1.2 *Core Courses*

ChE 211	Optimization Methods in Chemical Engineering
ChE 220	Advanced Chemical Engineering Thermodynamics*
ChE 229	Advanced Chemical Reaction Engineering I*
ChE 231	Advanced Chemical Reaction Engineering II*
ChE 241	Transport Phenomena*
ChE 242	Advanced Heat Transmission
ChE 247	Advanced Mass Transfer
ChE 248	Stagewise Operations

*Required core courses for M.S. ChE are ChE 220, 229 or 231, and 241. An additional core course is taken to complete the 12 units required for Ph.D. / D.Eng.

2.9.1.3 *Specialization Courses*

ChE 202	Biotechnology for Engineers
ChE 205	Advanced Chemical Engineering Laboratory
ChE 221	Advanced Chemical Engineering II
ChE 224	Electrochemical Engineering
ChE 233	Biochemical Reactor Design
ChE 237	Properties of Biological Materials
ChE 242	Advanced Heat Transmission
ChE 244	High Temperature Process
ChE 245	Heat Transmission Laboratory
ChE 246	Cryogenic Engineering
ChE 247	Advanced Mass Transfer
ChE 248	Stagewise Operations
ChE 250	Computer-Aided Process Equipment Design
ChE 251	Advanced Chemical Process Dynamics and Control
ChE 261	Advanced Industrial Pollution Control
ChE 266	Waste Utilization
ChE 291	Corrosion Engineering
ChE 292	Biochemical Engineering
ChE 293	Enzyme Engineering
ChE 294	Biochemical Engineering Practice
ChE 297	Special Topics
ChE 298	Special Problems

2.9.1.4 *Electives*

For M.S. ChE, any 3-unit ChE specialization course(s) or 3-unit graduate course(s) outside the Department as recommended by the program/thesis adviser and approved by the Graduate Program Committee of the Department.

For Ph.D. / D.Eng. ChE, a maximum of 6 units of graduate courses other than graduate ChE courses may be taken with departmental approval.

2.10 UNDERGRADUATE PROGRAM COURSE DESCRIPTIONS

Chemical Engineering (ChE)

ChE 2 Elementary Chemical Engineering. Elementary mass and energy balances for some unit operations and unit processes. (For non-chemical engineering students). Prereq: Chem 16, Math 17. 3 u.

ChE 26 Fundamentals of Programming for Chemical Engineers. Concepts and methods of programming as a computational tool; computer solutions to mathematical problems in chemical engineering. Prereq: Math 53. 5 h (2 lec, 3 lab) 3 u.

ChE 100 Introduction to the Chemical Engineering Profession. Introduction to chemical engineering: history and emerging trends in various fields. The role of chemical engineers in the development of society. The chemical engineering profession. Overview of unit operations, mass and energy balances, and chemical reaction engineering. Prereq: Chem 16. 1 u.

ChE 101 Fundamentals of Chemical Engineering. Problem-solving techniques in solving chemical engineering problems; Mass and energy balances in unit operations and unit processes; Principles of phase equilibrium as applied to unit operations. Prereq: Chem 17, Math 53, ChE 100. 6 h (3 lec, 3 lab) 4 u.

ChE 106 Mathematical Methods in Chemical Engineering. Mathematical solutions of problems in chemical engineering. Analytical and numerical solutions to ordinary and partial differential equations. Vector analysis. Prereq: Math 55, ChE 26, ChE 101. 5 h (2 lec, 3 lab) 3 u.

ChE 122 Chemical Engineering Thermodynamics I. Applications of the first and second laws of thermodynamics. Thermodynamic properties of fluids. Thermodynamics of flow processes. Power cycles, refrigeration and liquefaction processes. Prereq: Math 55, ChE 101. 3 u.

ChE 123 Chemical Engineering Thermodynamics II. Thermodynamic properties of homogeneous mixtures. Phase and chemical reaction equilibria. Calculations involving models on homogenous mixtures, phase and chemical reaction equilibria. Prereq: ChE 106, ChE 122. 3 u.

ChE 124 Chemical Engineering Thermodynamics Laboratory. Experiments on the PVT behavior, phase and chemical reaction equilibria and thermodynamic properties of homogeneous mixtures. Prereq: Chem 154, Chem 28, Chem 28.1, Chem 31.1. 6 h (6 lab) 2 u.

ChE 125 Chemical Reaction Engineering I. Kinetics of homogeneous reactions. Analysis of various chemical reactors. Prereq: Chem 31, ChE 106, ChE 122. 3 u.

ChE 126 Chemical Reaction Engineering II. Catalysis. Heterogeneous reactors. Application of kinetics and thermodynamics to selected unit processes. Prereq: ChE 125, ChE 131. 3 u.

ChE 131 Transport Processes. Fundamentals of heat, mass and momentum transport. Differential balances; equations of change. Molecular and turbulent transport systems. Applications to interphase transfer. Prereq: ChE 106. 3 u.

ChE 132 Stagewise Operations. Unified treatment of Stagewise operations. Numerical and graphical solution techniques. Design of multistage equipment. Prereq: ChE 106, ChE 123. 3 u.

ChE 133 Heat and Mass Transfer Equipment Design. Applications of the principles of separation and rate processes to the design of heat and mass transfer equipment. Prereq: ChE 131. 5 h (2 lec, 3 lab) 3 u.

ChE 134 Momentum Transfer and Materials Handling Equipment Design. Application of the principles of momentum transfer to process equipment design. The energy balance in flow systems. Materials handling. Prereq: ChE 131. 5 h (2 lec, 3 lab) 3 u.

ChE 135 Process Engineering Laboratory. Experimental study of certain unit operations and processes. Prereq: ChE 125, ChE 133, ChE 134. 6 h (6 lab) 2 u.

ChE 140 Chemical Process Industries. Survey of the different industrial chemical processes. Unit processes and operations in chemical industries. Mass and energy balances in industrial processes. Prereq: ChE 125, ChE 132, ChE 133, ChE 134. 5 h (2 lec, 3 lab) 3 u.

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ChE 141 Chemical Process Development and Plant Economics. Application of engineering economics to process flow synthesis and industrial plant design. General chemical process design considerations; Optimization of plant processes. Economic feasibility study. Prereq: ChE 140. 5 h (2 lec, 3 lab) 3 u.

ChE 142 Chemical Engineering Plant Design. Chemical engineering components of the design of a chemical process industrial plant. Design of waste treatment and pollution management facilities. Prereq: ChE 141, ChE 150. 7 h (1 lec, 6 lab) 3 u.

ChE 143 Chemical Engineering Research I. Design of Experiments. Conceptualization and proposal writing for a chemical engineering research project. Technical paper writing and presentation. Prereq: ChE 124, ChE 135. 4 h (1 lec, 3 lab) 2 u.

ChE 144 Chemical Engineering Research II. Continuation of ChE 143. Research project implementation. Prereq: ChE 143. 6 h (6 lab) 2 u.

ChE 150 Environmental Process Engineering. Introduction on environmental systems and impacts of land use and industrial processes. Environmental processes. Nature, transport and reactions of environmental contaminants. Environmental quality management. Chemical engineering principles in gaseous, liquid and solid waste treatment. Sanitation and public health. Waste management. Sustainability. Prereq: Chem 31, ChE 125, ChE 134. 3 u.

ChE 153 Industrial Pollution Control. Types, source and harmful effects of industrial pollutants. Measurement of pollution parameters. Industrial pollution prevention and control. Prereq: Chem 31, ChE 125, ChE 134. 3 u.

ChE 171 Introduction to Biochemical Engineering. Basic microbiology and biochemistry. Enzyme and fermentation kinetics. Continuous culture. Mass transfer in biological system. Prereq: Chem 31, Nat Sci 2. 3 u.

ChE 174 Biochemical Engineering Laboratory. Elementary experiments in biochemical engineering. Coreq: ChE 171. 3 h (3 lab) 1 u.

ChE 182 Chemical Process Dynamics and Control. Introduction to process dynamics of simple chemical systems. Objectives and performance criteria of control systems. Prereq: ChE 125, ChE 133, ChE 134. 5 h (2 lec, 3 lab) 3 u.

ChE 190 Plant Inspection and Seminar. Visits to factories, chemical plants. Reports on such visits. Reports on assigned readings from technical literature. Prereq: ChE 140. 3 h (3 lab) 1 u.

ChE 197 Special Topics. 3 u.; may be taken twice.

ChE 198 Special Problems. 3 u.; may be taken twice.

2.11 GRADUATE PROGRAMS COURSE DESCRIPTIONS

Chemical Engineering (ChE)

ChE 202 Biotechnology for Engineers. Fundamentals and applications of biotechnology in engineering and industry; large-scale processes; products. Prereq: Chem 40, 40.1; Bio 120/equiv. 5 h (2 lec, 3 lab) 3 u.

ChE 205 Advanced Chemical Engineering Laboratory. Study of research methods. Design of chemical engineering experiments and laboratories; equipment in unit operations; and chemical reactors. Computer-aided design. Prereq: ChE 136/equiv. 7 h (1 lec, 6 lab) 3 u.

ChE 211 Optimization Methods in Chemical Engineering. Application of linear, non-linear programming and other optimization methods to chemical engineering problems. Prereq: ES 204 or COI. 3 u.

ChE 220 Advanced Chemical Engineering Thermodynamics I. Thermodynamics of solutions. Multicomponent phase and chemical reaction equilibria. Prereq: ChE 123/equiv. 3 u.

ChE 221 Advanced Chemical Engineering Thermodynamics II. Application of thermodynamic principles to complex systems. Statistical thermodynamics. Introduction to non-equilibrium thermodynamics. Prereq: ChE 220 or COI. 3 u.

ChE 224 Electrochemical Engineering. Applications of the basic concepts of electrochemistry to industrial processes. Design of continuous feed galvanic cells. Prereq: ChE 123/equiv. 3 u.

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ChE 229 Advanced Chemical Reaction Engineering I. Reactor design for homogeneous reactions. Prereq: ChE 125/equiv. 3 u.

ChE 231 Advanced Chemical Reaction Engineering II. Reactor design for heterogeneous reactions. Prereq: ChE 125, ES 201/equiv. 3 u.

ChE 233 Biochemical Reactor Design. Design of various types of fermenters and biological reactors. Prereq: ChE 231, 241. 3 u.

ChE 237 Properties of Biological Materials. Rheological, elastic, thermal, diffusive and chemical properties of biological materials in relation to biochemical reactor design. Property measurements. Prereq: COI. 3 u.

ChE 241 Transport Phenomena. Momentum, heat, and mass transport in solid, fluid and multi-phase systems. Laminar and turbulent flow of Newtonian and non-Newtonian fluids. Solution of the equations of continuity, motion, energy and mass transfer. Prereq: ChE 133/equiv. 3 u.

ChE 242 Advanced Heat Transmission. Conductive and convective heat transfer in single and multiphase systems. Energy Transport in macroscopic flow systems. Radiant heat transfer. Prereq: ES 201, ChE 133/equiv. 3 u.

ChE 244 High Temperature Processes. Solidification, homogeneous and heterogeneous nucleation, dendritic growth, topochemical gas-solid reactions and other high temperature processes. Prereq: ChE 242 or COI. 3 u.

ChE 245 Heat Transmission Laboratory. Experiments illustrating the principles of heat transmission. Prereq: ChE 242. 3 u.

ChE 246 Cryogenic Engineering. Principles and applications of low temperature processes. Prereq: ChE 242 or COI. 3 u.

ChE 247 Advanced Mass Transfer. Diffusion in binary and multi-component systems. Simultaneous mass and heat transfer. Applications to chemical engineering operations. Prereq: ChE 133/equiv. 3 u.

ChE 248 Stagewise Operations. Phase equilibria; distillation and other multistage separation processes. Stage efficiencies. Prereq: ChE 133/equiv. 3 u.

ChE 250 Computer-Aided Process Equipment Design. Mathematical modeling, simulation and design of chemical process equipment. Use of available software for design. Prereq: ES 201, ES 204. 3 u.

ChE 251 Advanced Chemical Process Dynamics and Control. Application of regulation control theory to different chemical engineering operations and processes. Introduction to model analysis. Prereq: ChE 172/equiv. 3 u.

ChE 261 Advanced Industrial Pollution Control. Colloid stability. Kinetics of coagulation and flocculation. Design of industrial pollution equipment. Prereq: ChE 173/equiv. 3 u.

ChE 266 Waste Utilization. Utilization of agricultural and industrial wastes. Prereq: ChE 141/equiv. 3 u.

ChE 291 Corrosion Engineering. Corrosion theories. Thermodynamics and kinetics of corrosion. Measurement and control. Prereq: ChE 123, ChE 125/ equivs. 3 u.

ChE 292 Biochemical Engineering. Integration of the principles of chemical engineering, biochemistry and microbiology with application to the analysis of biochemical reaction sequences and related transport phenomena in fermentation operations. Prereq: ChE 202. 3 u.

ChE 293 Enzyme Engineering. Application of biochemical engineering principles to enzyme technology. Prereq: ChE 202. 3 u.

ChE 294 Biochemical Engineering Practice. Biochemical engineering experiments. Enzyme and whole cell immobilization. Pilot plant fermentation experiments. Prereq: ChE 202. 7 h (1 lec, 6 lab) 3 u.

ChE 296 Seminar. 1 u. Maximum of 4 u.

ChE 296.1 Seminar in Chemical Engineering. Readings and public presentation on current research, issues and topics in chemical engineering. 1 h (seminar) 1 u.

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ChE 296.2 Research Seminar in Chemical Engineering. Conceptualization, conduct of research, and preparation of scientific manuscripts on a research problem in chemical engineering. Prereq: ChE 296.1. 1 h (seminar) 1 u.

ChE 297 Special Topics. 3 u. May be taken twice.

ChE 298 Special problems. 3 u. May be taken twice; topics to be indicated for record purposes.

ChE 300 Thesis. 3 to 6 u.

ChE 400 Dissertation. 12 u.