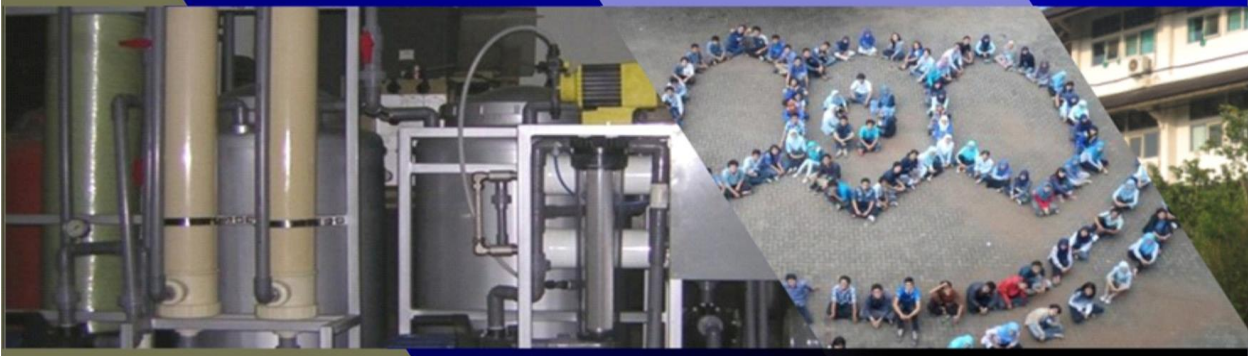
UNDERGRADUATE IN
CHEMICAL ENGINEERING
GUIDEBOOK



DEPARTMENT OF CHEMICAL ENGINEERING
FACULTY OF ENGINEERING
DIPONEGORO UNIVERSITY

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Semarang, Jawa Tengah, 50275, Indonesia

PREFACE

The guidebook provides a brief and comprehensive information about the program of the Department of Chemical Engineering, Faculty of Engineering, Universitas Diponegoro. This book used as a guide for the students, faculty, and administrator in carrying out the teaching learning process in order to achieve the best educational purposes.

Chemical Engineering Guidebook is reviewed annually in order to improve the content based on the developments and progress in the Department of Chemical Engineering Faculty of Engineering, Universitas Diponegoro.

Finally, we hope the guidebook could help the stakeholders and the student to understand various system held on the Department of Chemical Engineering, Faculty of Engineering, Universitas Diponegoro.

Semarang, August 2021
Head of Chemical Engineering Department

Prof. Dr.-Ing Suherman, S.T., M.T.

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1 DEPARTMENT PROFILE

1.1 VISION, MISION, AND OBJECTIVES

Vision Statement of the Department

To be recognized both nationally and internationally for excellence in chemical engineering education and research.

Mission Statement of the Department

To achieve its vision, the DCE has decided to perform activities based on the *Tridharma Perguruan Tinggi* (Three Pillars of Higher Education). The mission of the CESP can be stated in three statements:

1. Carrying out high-quality education to produce graduates having fundamental chemical engineering science and expertise by considering recent competitive job market.
2. Performing high-quality researches in chemical engineering field and increasing the number of patents and publications in national and international scientific journals.
3. Performing community service by providing consultation, supervision, and professional training in chemical engineering field.

Goals of the Department

Considering its vision and mission, the DCE has set its goals as:

1. To prepare students for careers in industry or government, and for further study at the graduate level,
2. To produce innovative and applied science and technology based on local resource and culture.

To achieve the goals, the Department of Chemical Engineering always:

1. Improves the quality of the management,
2. Periodically updates its curriculum inline with the requirements in chemical engineer's job markets,
3. Improves the competence of its graduates, especially in English, leadership, computer, and entrepreneurship,

4. Improves the quality of teaching and learning as well as laboratory facilities, textbooks, and scientific journals, improves the quality of human resources, including academic, laboratory, and administrative staffs.

Expected Learning Outcomes

Consistent with the mission of the chemical engineering program, the educational objectives for the program are to enable graduates during various phases of their careers to exhibit:

A. Ability to apply mathematics, natural sciences, and engineering principles to solve complex engineering problem in the process, process system, and process equipment to convert raw material into added value products through chemical reaction.
   - A-1 Ability to combine mathematical and/or scientific principles to formulate models of chemical, physical, and/or biological processes and systems relevant to chemical engineering,
   - A-2 Ability to apply concepts of integral and differential calculus and/or statistics to solve chemical engineering problems
   - A-3 Ability to apply the governing equations and underlying concepts of material balances, energy balances, thermodynamics, heat transfer, mass transfer, fluid flow, chemical reaction kinetics, reaction engineering, separations, process dynamics, and/or process control to chemical engineering problems

B. Ability to find the engineering root problem in the process, system process, and process equipment needed in the production of higher value product from raw material through process analysis, data and information interpretation, based on the engineering principle.

C. Ability to do the research, completed with identification, formulation, engineering analysis, system process, and the equipment to produce high value product from raw material.
   - C-1 Able to follow an experimental protocol with attention to safety
   - C-2 Able to operate laboratory and pilot scale equipment following a standard operating procedure
   - C-3 Able to design and conduct an experiment which will test a given hypothesis
   - C-4 Analyze and interpret experimental data

D. Ability to arrange alternative solution to solve complex engineering problem, system process, and the equipment to produce high value

product, with health, public safety, cultural, social and environmental consideration.

E. Ability to design the process, system process, and the equipment used to produce high value product from raw material, with analytical approach and considering the technical standard, performance aspect, reliability, ease of application, sustainability, economical, health and public safety, cultural, social and environmental factors.
   - E-1 Able to analyze and synthesize chemical engineering unit operations, including integrated complex systems consisting of multiple unit operations
   - E-2 Able to include constraints such as economic, health and safety, ethical, environmental, and social considerations in designing systems and processes.

F. Ability to select resources and utilize design tools and engineering analysis based on appropriate information and computing technologies to perform engineering activities in the process areas, processing systems, and equipment used in the production of value-added products from raw materials.

G. Ability to communicate effectively by verbal and non-verbal

H. Ability to plan, complete, and evaluate the assignment.

I. Capable to work in multi-discipline and multi-cultural teams
   - I-1 The ability to demonstrate and describe chemical engineering problems and solutions to people in other disciplines
   - I-2 Able to gain knowledge of technical skills, issues, and approaches germane to disciplines outside of chemical engineering
   - I-3 Able to solve problems in cooperation with a group of colleagues from other disciplines
   - I-4 Able to lead effectively by drawing out the skills of others

J. Have high social sensitivity and concern to the society and environment.
   - J-1 Understand about global economic, environmental, demographic and political issues
   - J-2 Understand about the impact of engineering decisions on the local and global environment, economy, and society
   - J-3 Understand about the multicultural knowledge

K. Have good responsibility and good ethics

L. Willingness to have long life learning

L-1 Proficient to use various informational and educational media such as textbooks, scientific and technical journals, the library system as a whole, the internet, and educational software

L-2 Have a broad understanding and exposure of professional and technical society

L-3 Aware to dynamic evolving nature of science, engineering, technology, and industry

L-4 Understand that learning does not end with a degree

1.2 AUTONOMOUS PROFESSIONAL PROFILE

The profile of autonomous professional of the Chemical Engineering Study Program Universitas Diponegoro is the reflection of the capacities of the graduates after 5 (five) years serving in any kinds of profession as chemical engineers. The details of the profile are as follows:

1. Being steadily developed in his/her profession through the application and approach of chemical engineering principles by upholding the safety, environmental sustainability and professional ethics,
2. Being an effective and strong individual with excellent leadership capacity in his/her working environment.
3. Continuously developing his/her knowledge through the concept of lifelong learning; the hunger of pursuing higher education level in engineering, sciences, business etc., including the formal certification of profession, and being actively involved in the professional development program in his/her serving field.

The graduates of Chemical Engineering Study Program - Universitas Diponegoro are mostly developing their careers in the following areas:

1. Process Engineer
   As a process engineer, mastering the knowledge and skills in process innovation is highly important. In line with the fast growing of fine chemical industries where customer satisfaction is one the keys success of a design, then the product and process designs are both inseparable.
3. Product Developer
   As a product developer, in-depth understanding of the knowledge and complete skill capacities in process and product design is strongly required. To ensure that a newly developed product gains high customer acceptance, the concept of technology push and market pull should be implemented. The chemical engineering students study the product design.
2. Education and Training

By luck, most of the graduates who have the passion in education services are usually the top 10 in their batch. Those graduates working as university lectures should have in-depth understanding of the whole chemical engineering knowledge and adequate skill capacities. While for those working as vocational education requires adequate understanding of the chemical engineering knowledge and good practical skill capacities. In order to support this academic profession, some other competencies related to teaching and learning must be regularly upgraded.

4. Researcher
   Research and development (R&D) is one of the most important part of chemical, petrochemical, agrochemical and mineral industries in facing tight global competition. The synthesis of new product and modification of the existing product require specific process and process equipment. A chemical engineer should have in-depth understanding in chemical engineering principles and applications, especially those related to chemical reaction and the separation processes. In addition, this engineer has to be discipline with time limited target project and of course the passion of doing research and properly reporting the results.
5. Leader
   To obtain successful career in the chemical industry, a chemical engineer has to explore and forge his/her leadership and communication skills. During study, the students are provided with facilities and environment that suit this need, i.e. laboratory practices, research group, extracurricular activities. As a leader he/she has to achieve the goal of the company trough effective communication and direction to his/her staffs. This leader has to continuously enrich and update his/her knowledge in the respective field to ensure that the decision made is truly the best solution.
6. Entrepreneur
   In regard to the need for extension of job market as a result of globalisation, some chemical engineers do have good entrepreneurship. In addition to adequate knowledge in chemical engineering principles, this category of chemical engineers is good in economic analysis, financial and human resources management, communication skill and willingness to learn the experience from other entrepreneurs. They can be running the business in trading of goods or providing technical or operational service.
7. Analyst
   Being a professional analyst, a chemical engineering graduate must back up him/her self with excellent analytical skill in addition to strong understanding chemical engineering principles. Good

communication skill in both oral and writing modes for intensive discussion with customer is also required. The graduates mostly work in chemical industries, petroleum industries, environmental management and governmental and private owned laboratories.

8. Sales Engineer
   To be a good sales engineer for chemical and other manufacturing products, a chemical engineer has to have adequate understanding in chemical engineering principles with strong economic analysis ability. Something important is the discipline, strong ability to communicate the product to the customer and persuade for possible optimum purchase.

1.3 HISTORY OF THE DEPARTMENT

Department of Chemical Engineering Diponegoro University was founded in 1965 as a respond of vast increase of chemical industries in Indonesia, including Semarang as the capital of Central Java Province. The idea of establishing the department came from Ir. Basit Wachid and Ir. Nisyamhuri. In August 1965 the Department of Chemical Engineering became the third department in the Faculty of Engineering after the Department of Civil Engineering and the Department of Architecture.

In its early ages, the department was supported by ten full-time academic staffs and seventeen part-time staffs from the Gadjah Mada University and industries. After more than four decades, now the department consists of forty one academic staffs. Twenty of the staffs hold doctorate degree, while the rest hold master degree.

Over the past four decades, the department has trained and produced engineering manpower of high quality. Up to Mei 2018, the department has graduated more than 5,000 graduates. Many of the graduates are now in top positions in the industry, R & D organizations, government, and academia.

1.4 DEPARTMENT PRODUCTIVITY

Academic staff of the Chemical Engineering Department is very active in research and research publications, both in national and international journals. The number of publications increases from year to year, as shown in Figure 1.

In 1990s, the academic staff realized that research publication in the journal was not easy, hence the department decided to publish a scientific journal. Journal "REAKTOR" was first published in 1997. In 2001, the journal was accredited "B" by the Directorate General of Higher Education.

REAKTOR is the first accredited scientific journals in the field of chemical engineering and the only one in Indonesia. In the latest accreditation on 2016, the journal has been accredited and classified as National Journal accreditated in Sinta2.

In 2005, and Chemical Reaction Engineering and Catalysis (CREC) group members began thinking about the concept of electronic journals. In 2007, the Bulletin of Chemical Reaction Engineering and Catalysis (BCREC) published first time online and was the first online scientific journal University of Diponegoro. The journal has been indexed and distributed by EBSCO PUBLISHING (ACADEMIC SEARCH COMPLETE) Volume 4 Number 1 since 2009 until now. Since 2001, the BCREC been indexed by SCOPUS, Compendex, ENCOMPASSLIT, and ENGINEERING VILLAGE. In addition, Chemical Engineering Undip also publish several international journal such as International Journal of Science and Engineering (IJSE) [ISSN: 20865023] **,** International Journal of Renewable Energy Development (IJRED) **[**ISSN : 2252-4940**] ;** and International Journal of Waste Resources (IJWR)[ISSN: 2252-5211]. In 2018, IJRED was indexed by SCOPUS.

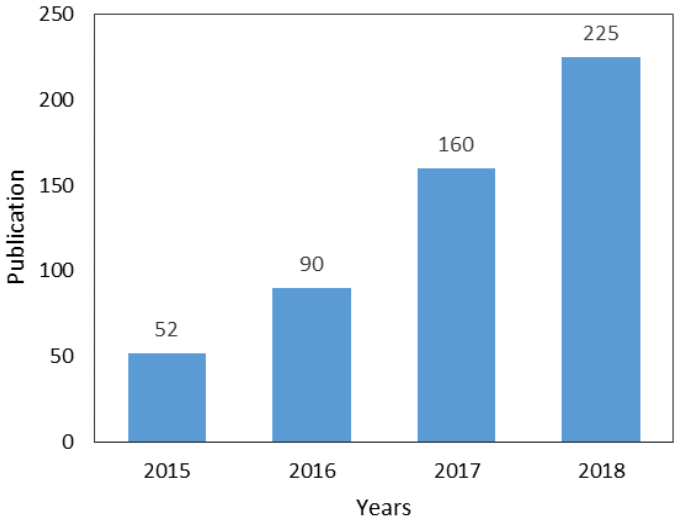


Figure 1. Number of publications

1.5 RESEARCH PROFILE

Research activities in the Department of Chemical Engineering done by establishing groups based on academic staff interests and expertise. It is intended that each group is more focused on research in their respective fields. Until 2018, Department of Chemical Engineering has 8 (eight) research groups, that is Centre of Bioprocess and Renewable Energy (C-Biore), Chemical Reaction Engineering and Catalysis Group (CREC), Thermal Process Engineering Group (Temper), Separation Process Center (SPEC), Membrane Research Center (MeR-C), Waste Treatment Center (WTC), Advanced Material Laboratory (AMAL) and Institute of Food and Remedies Bio-Materials (InFaRMa).

To support the vision of Diponegoro University, Department of Chemical Engineering have always encouraged academic staff to obtain research funds provided by the government, such as DP2M-Higher Education and IPTEKDA (from the Ministry of National Education), Ministry of Research and Technology, Research and Development (Balitbang), Central Java Province and other research funding provided by the University of Diponegoro itself. Total research funding given to the staff of Chemical Engineering increased from year to year. Figure 2 shows the total grant obtained by the Chemical Engineering Department from various sources in 2018.

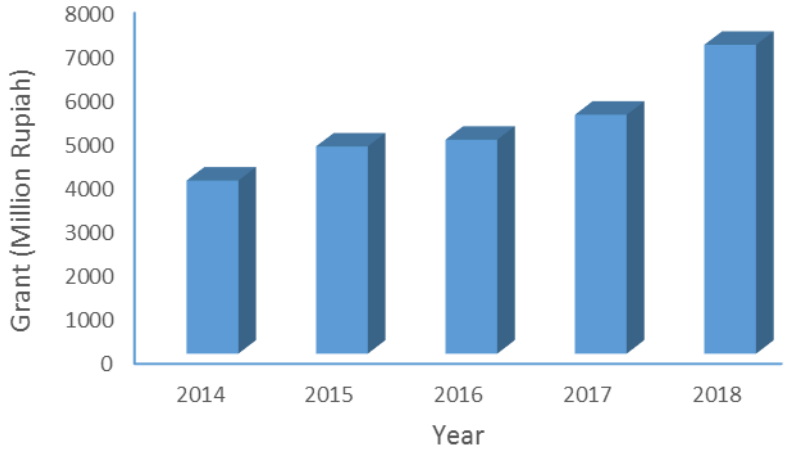


Figure 2. Total funds received Department of Chemical Engineering

2 CURRICULUM

2.1 EDUCATION SYSTEM

Undergraduate Program in Chemical Engineering has has implemented new curriculum based on "Kurikulum Merdeka" (2020 Curriculum). The curriculum was designed to make the graduates familiar with the techniques used in analyzing and solving engineering problems associated with the industries (petroleum, pharmaceutical, metallurgical, plastics, pollution control, etc.).

According to the Decree of the Rector No. 15 year of 2017 about Academic Regulation of Bachelor Degree in Diponegoro University, the education system applied in the Department of Chemical Engineering is Semester Credit System. In this system, each academic session is divided into two academic semesters, of which each consists of 14 (fourteen) teaching weeks and (2) two examination weeks. Academic program commences in August (for first Semester) and February (for second semester). A total 59 courses with 148 credit units (cu) are required to complete the chemical engineering bachelor degree program.

2.2 CURRICULUM

1st SEMESTER			
NO	**CODE**	**COURSE TITLE**	**CU**
1	PTKM6101	Physics	3
2	PTKM6102	Analytical Chemistry	3
3	PTKM6103	Inorganic Chemistry	3
4	PTKM6104	Mathematics I	3
5	PTKM6105	Introduction to Chemical Engineering	2
6	PTKM6106	Basic Chemical Engineering Lab. I	2
7	UUW000X1	Religion Education	2
8	UUW00005	Sports	1
9	UUW00007	English	2
		Total	21

2nd SEMESTER			
NO	**CODE**	**COURSE TITLE**	**CU**
1	PTKM6202	Physical Chemistry	3
2	PTKM6203	Organic Chemistry	3
3	PTKM6204	Mathematics II	2
4	PTKM6205	Thermodynamics I	3
5	PTKM6206	Basic Chemical Engineering Lab. II	2
6	UUW00003	Pancasila and Civic Education	3
7	UUW00004	Bahasa Indonesia	2
8	UUW00006	Internet of Things	2
		Total	20

3rd SEMESTER			
NO	**CODE**	**COURSE TITLE**	**CU**
1	PTKM6301	Environmental Conservation	2
2	PTKM6302	Chemical Engineering Principles I	3
3	PTKM6303	Material Engineering Science	3
4	PTKM6304	Chemical Engineering Mathematics I	3
5	PTKM6305	Chemical Industrial Process	3
6	PTKM6306	Thermodynamics II	3
7	PTKM6201	Fundamentals of Bioprocess	2
8	PTKM6307	Bioprocess Lab.	2
		Total	21

4th SEMESTER			
NO	**CODE**	**COURSE TITLE**	**CU**
1	PTKM6401	Chemical Engineering Principles II	2
2	PTKM6402	Transport Phenomena	3
3	PTKM6403	Waste Treatment Technology	2
4	PTKM6404	Heat Transfer	2
5	PTKM6405	Chemical Reaction Engineering	3
6	PTKM6406	Chemical Engineering Mathematics II	3
7	PTKM6407	Unit Operation I: Mechanical Process	2
8	PTKM6408	Chemical Process Lab.	2
		Total	19

5th SEMESTER			
NO	**CODE**	**COURSE TITLE**	**CU**
1	PTKM6501	Research Methodology	3
2	PTKM6502	Process Modeling and Computation	3
3	PTKM6503	Reactor	3
4	PTKM6504	Unit Operation II: Fluid Mechanic	3
5	PTKM6505	Unit Operation III: Heat Separation	3
6	PTKM6506	Research Proposal	1
7	PTKM6507	Utility	3
8	PTKM6508	Unit Operation Laboratory	2
		Total	21

6th SEMESTER			
NO	**CODE**	**COURSE TITLE**	**CU**
1	PTKM6601	Research	2
2	PTKM6602	Process Control	3
3	PTKM6603	Chemical Product and Process Design	3
4	PTKM6604	Unit Operation IV: Multistage Separations	3
5	LTKM6601	Process Safety	2
6	PTKM6605	Field Trip	1
7	**LTKM610X**	Elective Course I	**2**
8	**LTKM620X**	Elective Course II	**2**
		Total	18

7th SEMESTER			
NO	**CODE**	**COURSE TITLE**	**CU**
1	PTKM6701	Chemical Engineering Economics	2
2	LTKM6702	Industrial and Project Management	2
3	PTKM6703	Process Equipment Design	3
4	PTKM6704	Chemical Plant Design	3
5	**LTKM630X**	Elective Course I	**2**
6	**LTKM640X**	Elective Course II	**2**
7	UUW00008	Entrepreneurship	2
		Total	16

8th SEMESTER

NO	CODE	COURSE TITLE	CU
1	PTKM6801	Industrial Training	3
2	PTKM6802	Final Task: Preliminary Plant Design	6
3	UUW00009	Rural Internship	3
Total			12

ELECTIVE SUBJECTS 1

NO	CODE	COURSE TITLE	CU
1	LTKM6111	Functional Food Technology	2
2	LTKM6112	Petroleum Technology	2
3	LTKM6113	Catalyst Technology	2
4	LTKM6114	Clean Technology	2

ELECTIVE SUBJECTS 2

NO	KODE	MATA KULIAH	CU
1	LTKM6211	Food Processing and Preservation Technology	2
2	LTKM6212	Coal Technology	2
3	LTKM6213	Polymer Technology	2
4	LTKM6214	Pinch Technology	2

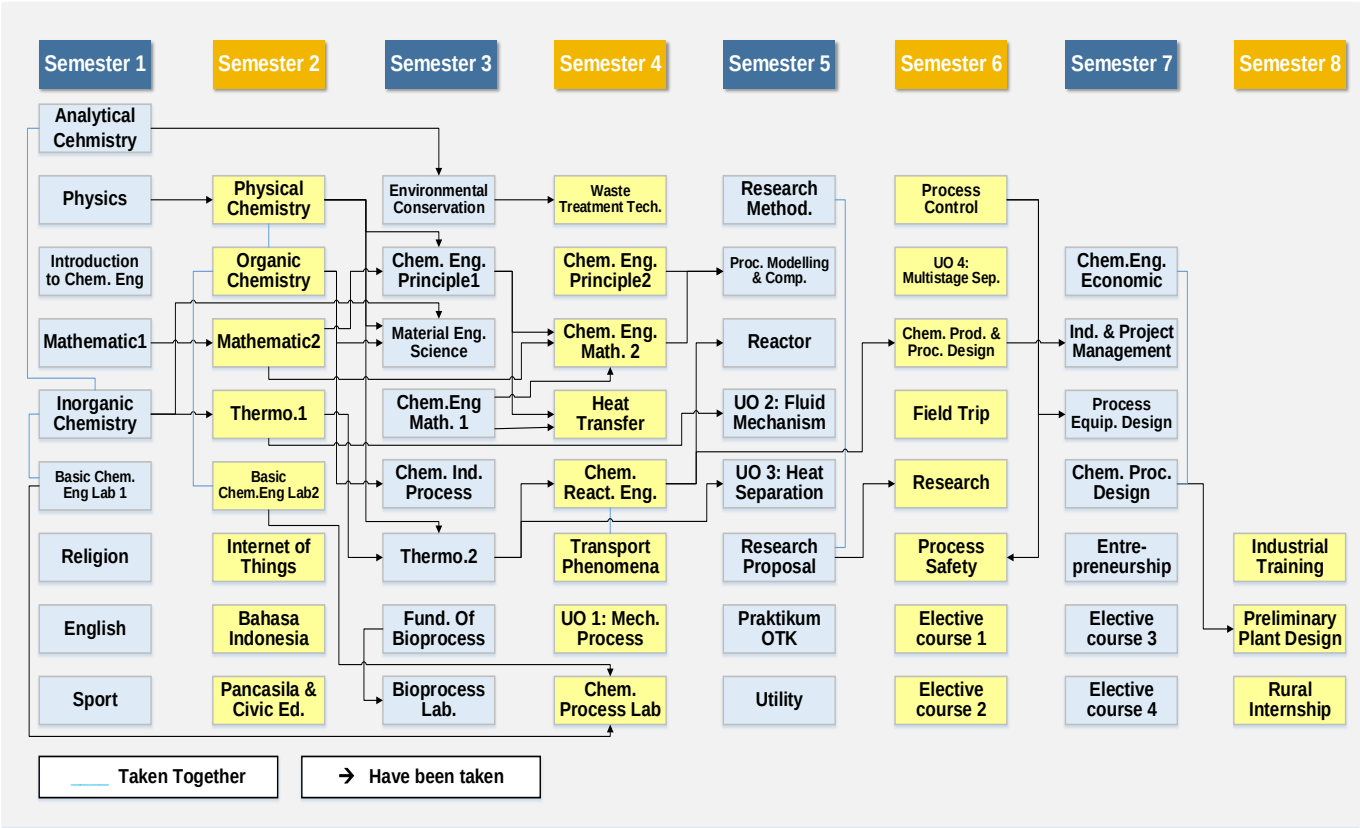
ELECTIVE SUBJECTS 3

NO	KODE	MATA KULIAH	CU
1	LTKM6311	Enzyme and Fermentation Technology	2
2	LTKM6312	Gas Processing Technology	2
3	LTKM6313	New Material Technology	2
4	LTKM6314	Emulsion and Surfactant Technology	2

ELECTIVE SUBJECTS 4

NO	KODE	MATA KULIAH	CU
1	LTKM6411	Food Packaging and Safety Tech.	2
2	LTKM6412	Renewable Energy Technology	2
3	LTKM6413	Membrane Technology	2
4	LTKM6414	Energy Management and Conservation	2

PREREQUISITE DIAGRAM



2.3 COURSE DESCRIPTION

1st SEMESTER

Course Title : Physics
Code : TKM21201
Credit unit : 3
Pre-requisite : -
Competency : A-1
Objectives : After completion of this course, the student should be able to combine the basic concepts of physics to formulate the process and systems of physics related to chemical engineering subject. Moreover, apply it to analyze a simple common events based on the chemical engineering sciences.
Syllabus :
1. Physical quantity and unit
2. Single dimension motion
3. Parabolic Motion and Rotation Motion
4. Force, work and Energy
5. Impulse, Linier Momentum, Collision
6. Fluids Statics and Mechanics (Bernouli's Law)
7. Electrics, waves and Light
8. Material thermal properties, Heat Transfer system

References :

1. Halliday, H., Resnick, R., and Walker, J. (1997). *Fundamentals of Physics. Extended*. 5ed. John Wiley & Sons, Inc., New York.
2. Alonso, M. and Finn, E.J (1992). *Dasar-Dasar Fisika Universitas. Jilid I dan II.* 2nd ed., Erlangga, Jakarta.
3. Zears, F.W. dan Zemansky, M.W., 1987, *University Physics*, Addison Wisley Publishing Company Inc.

Course Title : Analytical Chemistry
Code : TKM21202
Credit unit : 3
Pre-requisite : -
Competency : A-1
Objectives : After completion of this course, the student should be able to combine the concept of analytical chemistry to formulate the chemical analysis procedure (both quantitative and qualitative). Moreover, the student also expected to be able to determined and choose a

proper method for various samples.

Syllabus :
1. Basic principle of chemical analysis and reagent preparation procedure.
2. Qualitative Analytical Chemistry
3. Volumetric Analysis
4. Acidic-Alcalimetric
5. Argentometric and gravimetric
6. Quantitative analysis based on Redox Reaction
7. Complexometric
8. Instrumental chemical analysis techniques
9. Spectrophotometry UV-visible
10. Spectrophotometry IR, and Atomic Absorption Spektrofotometry (AAS)
11. Potentiometric and Conductometric
12. Basic of Chomatography
13. Liquid gas chromatography (LGC), and Solid Gas Chromatography (SGC)

references :

1. Ewing, 1985, "Instrumental Methods of Chemical Analysis", 5th ed., Mc. Graw Hill.
2. Vogel, A.I., 1978, "Text book of Macro and Semi Micro Qualitative Inorganics Analysis", 4th ed. Longman Green and Corp, New York.
3. Vogel, A.I., 1961, "Text book of quantitative Inorganics Analysis", 4th ed. Longman Green and Corp, New York.
4. Day, R.A. and Underwood, A.L., 1981, "Analisa Kimia Kuantitatif", edisi ke-4, Penerbit Erlangga, Jakarta.

Course Title : Inorganic Chemistry

Code : TKM21203

Credit unit : 2

Pre-requisite : -

Competency : A-1

Objectives : After completion of this course, the student should be able to combine the basic concept of principle of atom, chemical bond, acid base theory, acid-base reaction equilibrium, and oxidation-reduction reaction to formulate and explain the process and system applying inorganic chemical relevant to chemical engineering subject.

Syllabus : 1. Basic concept of atom, and basic molecular aspect based on mechanical quantum models
2. Molecular ionic and covalent bond
3. Quantum theory and atomic spectrum
4. Atomic orbital based on electron properties and atomic electron configuration
5. VSEPR theory
6. Valence bond theory, orbital hybridization, sigma-pi orbital
7. Inter- and Intramolecular forces, coordination chemistry
8. Chemical equilibrium and Le-Chatelier principal
9. Theory and equilibrium of acid-base
10. Oxidation and reduction reaction

references : 1. Keenan, C.W., Kleinfelter, D.C., Wood, J.H., Pudjaatmaka, A.H., 1984, Kimia untuk Universitas, edisi keenam, Penerbit Erlangga, Jakarta.
2. Silberberg, M. S. (2015). *Chemistry: The Molecular Nature of Matter and Change*. 7th Edition, The McGraw-Hill Education, Inc., 978–0–07–351117–7.

Course Title : Mathematics I
Code : TKM21204
Credit unit : 3
Pre-requisite : -
Competency : A-1
Objectives : After completion of this course, the student should be able to combine the mathematical concept (differential and integral calculus) with science to formulate a mathematics analysis for differential and integral cases.
Syllabus : 1. Theory, and basic application of differential and partial differential
2. Integral and trigonometric integral
3. Theory and application of single and double Integral
4. Graph, relation and function
5. Limit and continuity
6. Vector and matrix
7. Probability theory

References : 1. Dajan, A., ”Pengantar Metode Statistik”, Jilid II LP3ES, Jakarta, 1986

2. Leithold, L., Kalkulus dan Ilmu Ukur Analitik", Edisi Kelima, Jilid 1, Penerbit Erlangga, Jakarta, 1988
3. Schaum,"Theory and Problems of Calculus, 2nd edition, Mc Graw Hill, 1972
4. Soemartojo, "Kalkulus", Edisi 3, Penerbit Erlangga, 1988
5. Stroud, KA, Erwin Sucipto, "Matematika Untuk Teknik", Edisi Ketiga, Penerbit Erlangga

Course Title : Introduction of Chemical Engineering

Code : TKM21205

Credit unit : 2

Pre-requisite : -

Competency : I-1, I-2, K

Objectives : To prepare the students to understand about the basic knowledge and critical way of thinking about chemical engineering tools, design and process. Moreover, the students are able to clarify and explain the role, attitude and profession responsibility of a chemical engineer in chemical engineering discipline.

Syllabus :
1. Introduction to Chemical Engineering (definition, industry and history)
2. Chemical engineer career prospect
3. Chemical engineer problem
4. Chemical engineering component (basic law, theory, and skill)
5. Chemical engineering tools, important number, graph and table
6. Introduction to process flow diagram
7. Process variable, mass and energy balance
8. Process and operational unit, process system

References :
1. Rase, H.F., 1961, " The Philosophy and Logic of Chemical Engineering", Gulf Publishing Co., Houston.
2. Andersen, L.B. and Wenzel, L.A., 1961, " Introduction to Chemical Engineering", Mc Graw Hill Book Company, International Student Edition, Tokyo.
3. Charpentier, J.C., 2005, " Four main objectives for the nature of chemical and process engineering mainly concerned by the science and technologies of new materials production", Chem. Eng.

Journal, Article in Press.
4. Perry, C., 1994, "Chemical Engineers Handbook", Mac Graw-Hill, Kogakusha, Tokyo
5. Rubin E.S., Davidson C.I.,2001, "Introduction to Engineering and the Environment", Mc Graw Hill, Boston Burr Ridge
6. Bishop P.L., 2000, "Pollution Prevention : Fundamentals and Practice", International edition, McGraw-Hill Book Co, Singapore.
7. R. M. Felder, R.W. Rousseau, L. G. Bullard, 2016, Elementary Principles of Chemical Processes, 4th ed., John Wiley & Son, Inc.

Course Title : Chemical Engineering Fundamental Laboratory I

Code : TKM21206P

Credit unit : 2

Pre-requisite : Taken together with organic and inorganic chemistry

Competency : A-1, C, G, H

Objectives : After completion of this course, the student should be able to conduct, follow, and design the basic chemical analysis (the organic and inorganic compounds) using quantitative and qualitative analytical methods.

Syllabus :
1. Anion and cation analysis
2. Acidimetric, Alkalimetric and potentiometric
3. Iodometry-Iodimetry and Permanganometry Analysis
4. Argentometric and Gravimetric Analysis
5. Complexometry Analysis
6. Thin Layer Chromatography
7. Spectrophotometric Analysis (organic and inorganic compounds)

References :
1. Underwood, A. I. And Day R. A. (1983). Analisa Kimia Kuantitatif 5th edition.
2. Perry, R.H, and Green. (1984). Perry's Chemical Engineering Hand Book, 6th edition. Mc Graw Hill Book Co: Singapore.
3. Felder, R. (2005). *Elementary Principles of Chemical Processes*. 3rd ed. Wiley.
4. Vogel, A.I., 1978, "Text book of Macro and Semi Micro Qualitative Inorganics Analysis", 4th ed. Longman Green and Corp, New York.
5. Emil, J S. (1990). Chemical Principles in the

laboratory with Qualitative Analysis. New York: Van Harstand.
6. Dick, J.G. (1973). Analytical Chemistry. McGraw-Hill Kogakusha.Ltd: Tokyo.
7. John, H. P. (1960). Chemical Engineers Handbook 5th editon. International Edition. New York: Mc Graw Hill Book Company Inc.

Course Title : English

Code : UNW00006

Credit unit : 2

Pre-requisite : Taken together with organic and inorganic chemistry

Competency : A-1, C, G, H

Objectives : After completion of this course, the student should be able to effectively communicate (verbal and written) in English, and also able to assembly an english communication on context of chemical engineering.

Syllabus :
1. The concept of English for Engineering students
2. Writing and speaking ability to explain graph and table
3. Instruction, procedure, and precaution
4. Prediction, hypothesis and comparison (experiment)
5. The concept of English for Chemical engineering students
6. Writing and speaking ability to explain basic Chem. Eng. Concept
7. Scientific writing

References :
1. Pákozdy Andrea, English for Chemistry and Chemical Engineering, 2014.
2. Nick Breiger and Alison Pohl, Technical English: Vocabulary and Grammar, Summertown Publishing.
3. Mark Ibboston, Professional English in Use , Cambridge University Press, 2009.
4. Mark Ibboston, Cambridge English for Engineering, Cambridge University Press, 2009.

2nd SEMESTER

Course Title	**:**	**Physical Chemistry**
Code	:	TKM21208
Credit unit	:	3
Pre-requisite	:	Physics
Competency	:	A-1
Objectives	:	After completion of this course, the student should be able to apply the physical chemistry principles (characteristic, changes, colloid system, interface, and electrochemistry) to interpret an engineering problem and its process system.
Syllabus	:	1. Phase distribution, equilibrium and characteristics 2. Gas and gas colloid system and ideal gas law 3. The relation of operational condition with ideal and real gas law 4. The characteristic and properties of pure substance 5. Properties diagram 6. The rules of phase equilibrium, and equilibrium constant 7. Raoult's Law, partial molar vole, ideal and non-ideal solution 8. Solution of volatile matter (Temp.-Conc. Diagram) 9. Basic principle of colloid (preparation, application) 10. Exothermic and endothermic reaction, enthalpy, and heat reaction 11. Basic of electrolyte solution and electrochemical
References	:	1. Castelan, G.W., "Physical Chemistry ", second edition, Addison-Wesley publishing Company 2. Farrington, R.A., Daniels, A., 1983 " Kimia Fisika", edisi lima, jilid 1, Erlangga, Jakarta 3. Levine, I.,N., " Physical Chemistry", 4th edition, McGraw-Hill Book Co., Singapore 4. Moore, W., J.,1972, " Physical Chemistry", 5th, Prentice- Hall, Inc., New Jersey. 5. Everet., D., H., 1988, " Basic Principles of Colloid Science", Royal Society of Chemistry Burlington House, Piccadilly, London

Course Title : Organic Chemistry

Code : TKM21209

Credit unit : 2

Pre-requisite : Inorganic Chemistry

Competency : A-1

Objectives : After completion of this course, the student should be able to describe and interpret the basic organic chemistry principle to solve and identified various organic chemistry reaction relevant to chemical engineering subject.

Syllabus :

1. Introduction to organic chemistry (characteristic, structure, functional group, and basic reaction)
2. Electronegativity, bond, and resonation in organic chemistry
3. Stereochemistry, geometric isometry, and conformation of organic substance
4. Alkyl halide compounds
5. Alkane and cycloalkane compounds
6. Alkene and alkyne compounds
7. Carbonyl, Benzene, Amine compound
8. Carbohydrate, Fat, Protein
9. Instrument to determine an organic structure

References :

1. Solomon, T. W, Fryhle, C. B., Synder, S. A. (2014). Organic Chemistry. 11ed. John Wiley and Sons., New Jersey
2. Morrison and Boyd (1992). Organic Chemistry. 6th edn. Prentice Hall, New Jersey.
3. Fesenden and Fesenden, R. (1998). Organic Chemistry, 4th edition, Cole Publishing Company, California
4. Fieser, L.F. and Fieser, M. (1959). Basic Organic Chemistry. D.C. Heath and Company., Boston.

Course Title : Environmental Conservation

Code : TKM21210

Credit unit : 2

Pre-requisite : Analytical chemistry, and taken together with organic chemistry

Competency : D, E-1

Objectives : After completion of this course, the student should be

able to understand the basic concept of environmental conservation to constructing a solution for a general environmental engineering problem.

Syllabus :
1. The basic concept of environment
2. Water and air pollution (source and consequence)
3. Water pollution conservation and management
4. Air pollution conservation and management
5. The concept of environmental system analysis
6. Prevention of environmental pollution
7. Analysis, management and instrumentation of environmental system

References :

1. Odume E.P., 1971, Fundamental of Ecology, 3rd.edition, W.B Saunders Company, Philadelphia
2. Anil Kumar De, 1987, Environmental Chemistry, Wiley Eastern Limited, New Delhi
3. Sawyer C.N., McCarty P.L., 1978, Chemistry for Environmental Engineering, 3rd rdition, Mc Graw Hill Kogakusha, Ltd, Tokyo
4. Waite T.D., 1984, Principles of Water Quality, Academic Press, Inc., London
5. Stern A.C., 1977, Air pollution : The Effect Of Air Pollution, 3rd.edition, Volume II Academic Press, New York.

Course Title : Mathematics II

Code : TKM21304

Credit unit : 2

Pre-requisite : Mathematics I

Competency : A-1

Objectives : After completion of this course, the student should be able to apply the basic concept of differential and integral, to solve problems in differential equation using various methods

Syllabus :
1. Polar complex number, and complex number equation
2. Ordinary and partial differential equation
3. Simultaneous differential equation
4. Series, and convergent analysis
5. The expansion of the infinite series (Taylor, McLaurin, Fourier, sinus-cosines Fourier series).
6. Nonlinear equation

References :

1. Ayres, F., 1985, Differential Equation, Addison-

Wiley Publishing Company, Inc.
2. Hadley, G., 1977, Linear Algebra, Addison-Wiley Publishing Company, Inc.
3. Leithold, 1980, The Calculus with Analytic Geometry, Addison-Wiley Publishing Company, Inc.

Course Title	**:**	**Thermodynamics I**
Code	:	TKM21211
Credit unit	:	3
Pre-requisite	:	Physics, Inorganic chemistry, physical chemistry
Competency	:	A-3
Objectives	:	After completion of this course, the student should be able to describe and applied the thermodynamics concept of pure fluids, application of the first law on various processes; The second law of thermodynamics.
Syllabus	:	1. Basic concept of thermodynamics 2. First law of thermodynamics 3. Pure solution properties 4. Volumetric characteristic 5. Heat effect in industry (reaction heat) 6. Second law of thermodynamic 7. Fundamental equation 8. Application of thermodynamic on various process 9. Energy production from heat 10. Refrigeration and liquefied gas
References	:	1. Smith, J. M., Van Ness, H. C., and Abbott, A. (2001). *Introduction to Chemical Engineering Thermodynamics*. 6th ed. McGraw-Hill, Boston. 2. Potter, M. C. and Somerton, C. W. (1993). *Schaum's Outline of Theory and Problems of Thermodynamics for Engineers*. McGraw-Hill, New York.

Course Title	**:**	**Chemical Engineering Fundamental Laboratory II**
Code	:	PTKM6206
Credit unit	:	2
Pre-requisite	:	Taken together with physical chemistry and organic chemistry
Competency	:	A-1, C, G, H

Objectives : After completion of this course, the student should be able to conduct, follow, and design the basic chemical analysis (the organic and inorganic compounds) using quantitative and qualitative analytical methods based on electrochemical reaction, phase equilibrium, physical properties of materials.

Syllabus :
1. Determination of heat of dissolution
2. Determination of density, viscosity and surface tension; refraction index
3. Determination of boiling point elevation and freezing point depression
4. Phase equilibrium
5. Determination of carbohydrate, protein, and fat
6. Electrochemical
7. Instrumental analysis

References :

1. A.O.A.C., Oficial Method of Analysis of the A.O.A.C., 11 ed, p.539 – 540, Washington, D.C., 1970
2. Daniel, F. (1962). Experimental Physical Chemistry. 6thedn. International Student Edition, Mc Graw Hill Book Co. Inc., Kogakusha Co, Ltd., Tokyo
3. Daniels, F.,1961, "experimental physical Chemistry",6th ed., McGraw Hill book., Kogakusha, Tokyo.
4. Perry, R. H.. 1984. Chemical Engineering Hand Book 6th ed. Mc Graw Hill Book Co. Kogakusha Co. Ltd. Tokyo.
5. Vogel, A.I., 1975, "Qualitative Organics Analysis", 2nd ed. William Clowers & Sons Limited London

Course Title : Internet of Things (IoT)

Code : UUW00006

Credit unit : 2

Pre-requisite : -

Competency : F

Objectives : After completion of this course, the student should be able to describe the utilization of engineering tools based on appropriate information and computing technologies to perform engineering activities.

Syllabus :
1. Introduction of IoT in relation to the community
2. Application of IoT on the relevant study subject

based on social, economic and political environment
3. Governance and business opportunity of IoT
4. Data collection and marketing tools
5. Artificial intelligence on IoT
6. Basic concept of cyber security
7. Architectural and organization of IoT
8. IoT for e-commerce
9. IoT based software
10. IoT of multi project study

References : 1. Buyya Rajkumar, Dastjerdi Amir Vahid, 2016, Internet of Things – Principles and Paradigms, Cambridge: Morgan Kaufmann

3rd SEMESTER

Course Title : Chemical Engineering Principles I

Code : PTKM6302

Credit unit : 3

Pre-requisite : Mathematics II, Physical Chemistry

Competency : A-1, A-2, A-3

Objectives : After completion of this course, the student should be able to apply mass and energy balances to determine unknown process/operation variables on a chemical engineering problem.

Syllabus :
1. Single and multi-system mass balance
2. Mass balance for recycle system, bypass system and purge system
3. Energy balance for close system without reaction
4. Energy balance for open system without reaction
5. Energy balance for chemical reaction system
6. Heat of solubilization and heat of mixing
7. Humidity chart

References :
1. Felder, R. (2005). *Elementary Principles of Chemical Processes*. 3rd ed., Wiley.
2. Himmelblau, D. M. (1996). *Basic Principles and Calculations in Chemical Engineering*. 6th edn. Prentice Hall, New Jersey.
3. Reklaitis, G. V. (1983). *Introduction to Material and Energy Balances*. John Wiley and Sons, New York.

Course Title : Material Engineering Science

Code : PTKM6303

Credit unit : 3

Pre-requisite : Inorganic Chemistry, Organic Chemistry, Physical Chemistry

Competency : A-1

Objectives : After completion of this course, the student should be able to explain the properties, structures of various materials and utilization of various materials in industrial equipment

Syllabus :

1. Classification of solid
2. Crystal and non-crystal structure
3. Mechanical properties of metal
4. Material failure
5. Alloy of iron-C and Metal alloy system
6. Degradation and corrosion
7. Classification of polymer
8. Polymer transition, degradation and deformation
9. Definition, structure and properties of ceramics
10. Ceramics processing
11. Mechanical properties of ceramics

References :

1. Callister, W. D, Jr. Fundamentals of Materials Science & Engineering; An Integrated approach, John Wiley & Sons, 2008
2. Donald R. Askeland, Pradeep P Fulay., Wendelin J. Wright, The sciene and engineering of materials, 2010,
3. Van Vlack, H.L., "Elements of Materials Science and Engineering" Addison – Wesley Publishing Company, 1985
4. Jacobs, J.A. and Kilduff, T.A., " Engineering Material Technology", 1994
5. Manas Chanda,"Science of Engineering Material", vol 1 – 3, 1979.
6. Smith, W.F., " Principles of Materials Science and Engineers", 1986.

Course Title : Chemical Engineering Mathematics I

Code : PTKM6304

Credit unit : 3

Pre-requisite : Mathematics II

Competency : A-1, A-2

Objectives : After completion of this course, the student should be able to solve chemical engineering problems in non-linear ordinary differential equations

Syllabus :
1. Systematical data presentation
2. Equation model (semi log and log-log coordinate, linear regression, multiple regression, least square, lagrange)
3. Preparation and completion of an empirical equation
4. Graphics methods to solve mathematics problem in chemical engineering
5. Antiderivative, Laplace transform and its application to solve differential equation
6. Series and power series to solve differential equation

References :

1. Mickley, H. S., Sherwood, T. S., and Reed, C. E. (1957). *Applied Mathematics in Chemical Engineering*. Mc Graw Hill Book, Co. New York.
2. Jenson, V. G. and Jeffreys, G. V. (1977). *Mathematical Methods in Chemical Engineering*. Academic Press, NY.
3. Andersen, L.B., Wenzel, L.A., "Introduction to Chemical Engineering", International Student Edition, 1961.
4. Creese, T.M., Haralick, R.M., "Differential Equation- For Engineers", International Student Edition, Mc. Graw Hill, Inc., 1978.
5. Stroud, K.E, "Further Engineering Mathematics (Programs and Problems", 2nd Ed., Springer Science+Business Media, LLC, 1990

Course Title : Chemical Industry Process

Code : PTKM6305

Credit unit : 3

Pre-requisite : Inorganic chemistry, Organic chemistry

Competency : B

Objectives : After completion of this course, the student should be able to describe and explain the processes in various organic and inorganic chemical industry and the basic principal of engineering of the process.

Syllabus :
1. Classification, characterization and basic concept of chemical industry

2. Process and process system of various Chemical Industry (cement, fertilizer, soda, sulfuric acids)
3. Process and process system of Food industry
4. Process and system process of inorganic chemical industry
5. Industrial process of gas (ammonia, CO_2, N_2, O_2, H_2)
6. Process and system process of various miscellaneous product (pulp, petrochemical, petroleum, ceramic, polymer)

References : 1. Shreve, N. (1984). *Chemical Process Industry*. Mc Graw-Hill, Boston.
2. Ali et al., Handbook of Industrial Chemistry – Organic Chemicals, 2005, Mc Graw Hill Book
3. Kent, Riegel's Handbook of Industrial Chemistry and Biotechnology, 2007, Springer

Course Title : Thermodynamics II
Code : PTKM6306
Credit unit : 3
Pre-requisite : Physical Chemistry, Thermodynamics I
Competency : A-3
Objectives : After completion of this course, the student should be able to describe phase equilibrium (vapor-liquid), phase rule, Duhem's theory, solution thermodynamics, equilibrium in single and multiple reaction
Syllabus : 1. Liquid-gas equilibrium (Clausius-Clapeyron equation and Antoine equation)
2. Multicomponent Gas-Liquid equilibrium (Raoult's Law, Modified Raoult's Law, Henry's Law and VER model)
3. Residual properties of pure component
4. Partial molar properties of mixed component
5. Excess property, coefficient of activity
6. Gas-Liquid equilibrium by equation of state (Mono-component and binary system)
7. Chemical reaction equilibrium constant
8. Equilibrium composition for single and double reaction

References : 1. Smith, J. M., Van Ness, H. C., and Abbott, A. (2001). *Introduction to Chemical Engineering*

Thermodynamics. 6th ed. McGraw-Hill, Boston.
2. Potter, M. C. and Somerton, C.W., (1993). *Schaum's Outline of Theory and Problems of Thermodynamics for Engineers*. McGraw-Hill, New York.
3. Sonntag, R.E., Borgnakke, C., and Van Wylen, G.J., (2003), "Fundamentals of Thermodynamics", 6th edition, John Wiley & Sons, Inc, Singapore.

Course Title	**:**	**Bioprocess Fundamental**
Code	:	PTKM6201
Credit unit	:	2
Pre-requisite	:	-
Competency	:	A-1
Objectives	:	After completion of this course, the student should be able to explain and apply the basic engineering principles of bioprocess (the role of microbe/enzyme) bioprocess system to solve engineering problem.
Syllabus	:	1. Basic concept: biochemical engineer, biological process, fermentation. 2. Microorganism and part of cell for bioprocess 3. Thermal death kinetics and sterilization 4. Cell counting and isolation process 5. Sterilization methods on bioprocessing 6. Microorganism growth in batch system 7. Basic theory of enzyme and enzyme kinetics in batch reactor 8. Competitive inhibition and non-competitive inhibition for enzymatic reaction 9. Fermenter and enzyme application in industry 10. Enzyme immobilization, analysis and isolation methods 11. Case study : bioprocess product : production concept and its application
References	:	1. Stanbury, P.F., "Principles of Fermentation Technology", 1984. 2. Duta, R. (2008). *Fundamentals of Biochemical Engineering*. Springer, Ane Books India. 3. Shuler, M. L. and Kargi, F. (2002). *Bioprocess Engineering–Basic Concepts*. 2nd ed. Prentice Hall International Series, New Jersey. 4. McNeil, B., Harvey, L., "Practical Fermentation

Technology" Wiley, 2008
5. Vogel, H C., Haber, C C. (Ed.), "Fermentation and Biochemical Engineering Handbook" William Andrew, 2007

Course Title	:	**Bioprocess Laboratory**
Code	:	PTKM6307
Credit unit	:	2
Pre-requisite	:	Bioprocess Fundamental
Competency	:	A-1, C, G, H
Objectives	:	After completion of this course, the student should be able perform, follow a procedure, and design a procedure of a process and analysis based on microbiological study or using microbe
Syllabus	:	1. Analysis and production of Alcohol, citric acids and acetic Acid 2. Enzyme isolation 3. Oil 4. Solid state fermentation : making of tempe 5. Production and quality analysis of yogurt, nata, soya milk (optional) 6. Water investigation, and aseptic transport
References	:	1. Bailey, J.F., &Ollis, D.F. (1988).Biochemical Engineering Fundamentals. Second edition. McGraw Hill Book Co., Singapore. 2. Darwis, A.Z. & Said, E.G. (1992).Teknologi Fermentasi. PAU Bioteknologi IPB, Rajawali Press, Jakarta. 3. Prescott & Dunn.(1959).Industrial Microbiology. 3rd edition. Mc Graw Hill Book Co. Inc., New York

4th SEMESTER

Course Title	:	**Chemical Engineering Principles II**
Code	:	PTKM6401
Credit unit	:	2
Pre-requisite	:	Mathematics II
Competency	:	A-3
Objectives	:	After completion of this course, the student should be able to applied the concept of dimensional analysis

and apply the theoretical model for the process scale-up tool

Syllabus :
1. Dimensional analysis
2. Units and dimensions (homogeneities)
3. Dimensionless product (concept and calculation by matrix)
4. Dimensional analysis Rayleigh
5. Dimensional analysis Buckingham
6. Dimensions matrix
7. Process study, study progress
8. Similarity
9. Regime concept
10. Concept of heat transfer
11. Variable and dimension analysis for Fluid mechanic, heat transfer, mixer and chemical reactor.

References :

1. Greenkorn, R. A., Kessles, D. P. (1972). *Transfer Operations*.
2. Johnstone, R. E., Thring, M. W. (1957). *Pilot Plants, Models, and Scale up Method in Chemical Engineering*.
3. Langhaar, H. L. (1995). *Dimensional Analysis and Theory of Models*.

Course Title : Transport Phenomena

Code : PTKM6402

Credit unit : 3

Pre-requisite : Chemical Engineering Mathematics I, Chemical Engineering Principles I

Competency : A-3

Objectives : After completion of this course, the student should be able to describe, explain and applied the concepts of mass, energy, and momentum transfer and to apply the concepts in chemical engineering problems.

Syllabus :
1. Basic law of momentum transport
2. Momentum transfer mechanism for steady state and laminar flow
3. Flux distribution of momentum and velocity for momentum transfer due to viscous transfer and flow on a cylinder and annulus
4. Continuity equation for flat sheet, cylinder, and ball

5. Momentum equation for flat sheet (x, y, and z)
6. Velocity distribution concept for unsteady state and the methods to solve velocity equation
7. Fourier's law
8. Basic law of heat transport
9. Simultaneous energy and momentum transport
10. Fick's diffusion law
11. Basic law of mass transport
12. Simultaneous mass, energy, and momentum transport

References : 1. Bird, R. B., Stewart, W. E., and Lightfoot, E. N. (2002). *Transport Phenomena*. 2nd ed. John Wiley and Sons, Inc., New York.
2. Welty, J. E., Wilson, R. E., and Wicks, C. E. (1984). *Fundamental of Momentum, Heat, and Mass Transfer*. John Wiley and Sons, Inc., New York.

Course Title : Chemical Engineering Mathematics II
Code : PTKM6406
Credit unit : 3
Pre-requisite : Chemical Engineering Principles I, Chemical Engineering Principles II, Chemical Engineering Mathematics I
Competency : A-1
Objectives : After completion of this course, the student should be able to develop mathematical model for various phenomena related to chemical engineering problems and to solve it both analytically and numerically
Syllabus :
1. Chemical engineering tools (mass balance, mathematic models, heat balance)
2. Mathematic models for heat balance, and mass balance
3. Integral function
4. Integral function with numeric methods
5. Numeric methods for ordinary differential equation (Euller methods and Runge Kutta)
6. Numeric methods for partial differential equation
7. Ordinary differential equation (Completion of single and simultaneous first order linear equations)
8. Ordinary differential equation (Completion of

single and simultaneous second order linear equations)

9. Ordinary differential equation (Completion of single and simultaneous second order non-linear equations)
10. 2nd order differential equation (undetermined coeff. Methods, inverse operator methods,)
11. Preparation, completion, and application of partial differential equation (power series, taylor series, frobenius methods, bessels equation, Eigen function, Laplace transformation)

References :

1. Mickley, H.S., T.K., Sherwood, C.E., Reed,. 1975, " Applied Mathematics in Chemical Engineering", 2th ed., MC Graw Hill Book Co. Inc.
2. Jenson, V.G., dan G.V., Jeffreys, 1977, "Mathematics for Chemical Engineering", Academic Press.
3. Raman, 1985, "Chemical Process Computation", Elsevier.
4. Rice, R.S. dan D.D. Do, 1995, "Applied Mathematics and Modelling for Chemical Engineers", John Wiley & Sons, Inc.

Course Title : Heat Transfer

Code : PTKM6404

Credit unit : 2

Pre-requisite : Chemical engineering principle I, Chemical Engineering mathematic I,

Competency : A-3

Objectives : After completion of this course, the students are expected to understand and able to governing equations from the modes, laws and rules, types and heat transfer equipment design consideration

Syllabus :

1. Review and basic concept of conductive; Convective and radiative heat transfers;
2. One dimensional Conductive heat transfer
3. Simultaneous conduction and convection;
4. Double dimension conductive transfer
5. Heat transfer on natural and synthetic convection
6. Basic concept of radiation heat transfer
7. Classification of heat exchanger
8. Heat transfer parameter

9. Temperature profile, single pass and multi-pass LMTD, correction factor
10. Design of heat exchanger (fin)
11. NTU methods for heat transfer calculation

References :

1. Kern, D. Q. (1950). *Process Heat Transfer*. McGraw-Hill Kogakusha, Ltd., Tokyo.
2. Slattery, J. C. (1972). *Momentum, Heat and Mass Transfer in Continua*. Mc Graw Hill Kogakusha, Ltd., Tokyo.
3. Holman, J. P. (1989). *Heat Transfer*. McGraw-Hill Book Company, Singapore.
4. Incropera, F. P and De Witt, D. P. (1990). *Introduction to Heat Transfer*. 2nd ed. John Wiley & Sons, New York.

Course Title : Chemical Reaction Engineering

Code : PTKM6405

Credit unit : 3

Pre-requisite : Thermodynamics II, Chemical Engineering Principles I, taken together with transport phenomena

Competency : A-3

Objectives : After completion of this course, the student should be able to describe classification, rate, and mechanism of reaction, and to analyze data of homogeneous and heterogeneous reaction. Moreover, the student should be able to describe and explain mechanism of reaction and catalytic and non-catalytic reaction kinetics.

Syllabus :

1. The basic concept of homogenous chemical kinetics-the determination of the rate of a chemical reaction, the reaction mechanism
2. Data interpretation for batch reactor (mass balance for batch and CSTR reactor, stoichiometry)
3. Interpretation of experimental data on batch reactor
4. Definition and kinetics of heterogeneous catalyst
5. Production, deactivation, regeneration of catalyst
6. Equation of catalytic reaction rate

References :

1. Fogler, H. S. (2004). *Elements of Chemical Reaction Engineering*. 3rd ed. Prentice Hall International, New Jersey.
2. Levenspiel, O. (1999). *Chemical Reaction*

Engineering. John Wiley & Sons, New York.
3. Twigg, M.V. (1989). *Catalyst Handbook*. 2nd ed. Wolfe Publishing Ltd., London.

Course Title	**:**	**Waste Treatment Technology**
Code	:	PTKM6403
Credit unit	:	2
Pre-requisite	:	Environmental conservation, Bioprocess Fundamental
Competency	:	D
Objectives	:	After completion of this course, the student should be able to describe and explain the concepts of liquid, solid, and gas waste treatment. Moreover, the students should be able to design a solution for waste treatment.
Syllabus	:	1. Physical and chemical characteristic of wastewater 2. Physical, chemical and biochemical wastewater treatment 3. Introduction to toxic and hazardous waste 4. Toxic and hazardous waste treatment 5. Introduction to waste gas 6. Principle of waste gas treatment 7. Organic and inorganic water treatment 8. Solids waste treatment
References	:	1. Tchobanoglous, G., Burton, F.L., Stensel, H.D. (2004). *Wastewater Engineering*. 4th ed. Metclaf and Eddy. Inc., New York. 2. De Nevers, N. (2000). *Air Pollution Control Engineering*. 3. Peavy, H.S., Rowe, D.R., Tchobanoglous, G. (1985). *Environmental Engineering*. McGrawHill Book Co., New York

Course Title	**:**	**Unit Operation I: Mechanical Process**
Code	:	PTKM6407
Credit unit	:	2
Pre-requisite	:	-
Competency	:	A-3, E-1
Objectives	:	After completion of this course, the student should be able to describe and explain process and equipment for transporting fluid and solid
Syllabus	:	1. Characteristic, transportation, and storage of

particulate solid
2. Mixing of solid matter
3. Fluidization and flotation
4. Separation of solid-solid mixture
5. Size reduction and enlargement (basic, concept, and equipment)
6. Size segregation

References :

1. Oldshue and James, 1983, Fluid Mixing Technology, McGraw Hill Book Co.
2. Tatterson and Gary, 1991, Fluid Mixing and Gas Dispersion in Agitated Tanks, 2nd Ed,
3. Edward L. Paul, Victor A. Atiemo-Ob, Suzanne M. Kresta, 2004, Handbook of Industrial Mixing-Science and Practice, John Wiley & Sons, Inc., New Jersey.
4. Richardson, J.F., Harker, J.H., Backhurst, J.R. (2002). *Coulson and Richardson's Chemical Engineering. Particle Technology and Separation Processes*. 5th ed., Butterworth & Heinemann, New York.

Course Title : Chemical Process Laboratory

Code : PTKM6408

Credit unit : 2

Pre-requisite : Chemical Engineering Fundamental Laboratory I & II

Competency : A-1, C, G, H

Objectives : After completion of this course, the student should be able to develop skill to design and perform experiments

Syllabus :
1. Hydrodynamics of airlift reactor (sodium thiosulfate oxidation)
2. Continuous-flow ideal reactor for saponification reaction
3. Kinetics of hydrolysis of starch and oil
4. Gas-liquid reaction (carbon dioxide absorption using caustic soda)
5. Esterification (Ethyl acetate or methyl ester)
6. Level control
7. Electroplating

References :

1. Levenspiel, Octave. 1999. Chemical Reaction Engineering 3rd Edition. John Wiley & Sons: New York

2. Fogler,H.S.2006.Element of Chemical Reaction Engineering. 4th Edition. Prentice Hall PTR
3. Fessenden, R.J, dan Fessenden, J.S. 1999. Kimia Organik jilid 2.Ed 3. Hal 83. Jakarta : Erlangga
4. Groggins, P.H.1958. Unit Processes in Organic Synthesis. Pp.669. New York: McGraw Hill.Inc
5. Kirk, R.E. and Othmer, D. F. 1953. Encyclopedia of Chemical Technology 6, pp. 231-236. New York : The Interscience Encyclopedia. Inc.,
6. Coulson. J. M., & Richardson. J. F. 1996. Chemical Engineering : Volumme I: Fluid flow. Heat transfer and mass transfer (5th ed). London : Butterworth Heinemann.

5th SEMESTER

Course Title	**:**	**Process Modeling and Computations**
Code	:	PTKM6502
Credit unit	:	3
Pre-requisite	:	Chemical Engineering Principles I & II, Chemical Engineering Mathematic II
Competency	:	F
Objectives	:	After completion of this course, the students are expected to be able to identify and develop a model of chemical engineering problems, and solve it using computation models
Syllabus	:	1. Basics of computer programming 2. Solving a linear equation system by numerical method 3. Application of numerical methods to find the suitable curve 4. Differential and integral with numerical methods 5. Find the roots of equations with numerical method 6. Solving single ordinary differential equation with numerical methods 7. Completion of single ordinary differential by numerical methods simultaneously 8. Application and Programming of Linear Equation Systems 9. Application and Programming for Curve fitting 10. Application and Programming of equation roots 11. Application and programming of a single ordinary

differential equation

12. Application and programming of ordinary simultaneous differential Equations.
13. Introduction to Ready-to-Use Programs for Non-Reaction and Steady State Systems

References :

1. Bambang Triatmodjo, "Metoda Numerik", Beta Offset, 1992.
2. Bequette, B.W, "Process Dynamics, Modeling, Analysis, and Simulation", Prentice Hall, 1998.
3. Constantinides, A and Mostoufi, N, "Numerical Methods for Chemical Engineers with MATLAB Applications", John Wiley & Sons, Inc, NY, 1999.
4. Deutsch, D. J., "Microcomputer Programs for Chemical Engineers", Vol. II, Mc Graw Hill Book Comp., 1987.
5. Koyode, C. A., "Fortran Programs for Chemical Process Design, Analysis, and Simulation", Gulf Publishing Comp., 1995.
6. Luyben, WL., "Plantwide dynamic simulators in Chemical Processing and Control", Marcel Dekker, 2002
7. Riggs, J. B., "An Introduction to Numerical Methods for Chemical Engineers", Texas Tech University Press, Lubbock, Texas, USA, 1988
8. Seider, WD., Seader, JD & Lewin DR., 1999, " Process Design Principles, Synthesis, Analysis and Evaluation", John Wiley & Sons, New York.

Course Title : Research Methodology

Code : PTKM6501

Credit unit : 3

Pre-requisite : -

Competency : C-4, G

Objectives : After completion of this course, students are expected to posses' basic principles, procedures and analyses as well as to accomplish a research project comprehensively

Syllabus :

1. Research Philosophy
2. Basic concept of research
3. Problem statement and research objectives
4. Thinking Framework
5. Hypothesis
6. Experiment Design: Determine the model/design

of the study, statistic, and factorial design
7. Writing a research proposal
8. Solving the research problem by modeling
9. Measuring (basic concept, accuracy, and precision)
10. Research report, writing procedures and preparation of scientific papers.

References :

1. Box, E.P dan Hunter, W.G. (1978), Statistics for experimenters, John Wiley & Sons, New York
2. Nazir, 1988, Metode Penelitian, Ghalia Indonesia, Jakarta.
3. Marzuki, 1989, Metodolgi Riset, Penerbit BPFE, Yogyakarta.
4. Rifai, M.A. 2001. Pegangan Gaya Penulisan, Penyuntingan dan Penerbitan Karya Ilmiah Indonesia. Gadjahmada University Press. Halaman 4-7.
5. Singarimbun, M dan S. Efendi, 1989, Metode Penelitian Survei, Penerbit LP3ES, Jakarta.
6. Suryabrata, S., 1992, Metodologi Penelitian, CV Rajawali, Jakarta,
7. Sutrisno Hadi, 1976, Metodologi Riset, Jilid 1 dan 3, Andi Offset, Yogyakarta.
8. Soetrisno dan SRD. Rita Hanafi.2007. Filsafat Ilmu dan Metodologi Penelitian. Penerbit Andi Offset, Yogyakarta
9. Wasito, H., 1992, Pengantar Metodologi Penelitian, Gramedia, Jakarta.
10. Dikti, 1994, Petunjuk Pengelolaan Penelitian di Dirjen DIKTI, Jakarta

Course Title : Reactor

Code : PTKM6503

Credit unit : 3

Pre-requisite : Chemical Reaction Engineering

Competency : A-1, A-2, A-3, E

Objectives : After completion of this course, the students are expected to be able to design catalytic and non-catalytic homogeneous and heterogeneous reactors

Syllabus :

1. Introduction (basic concept of reactor design)
2. Reactor design for steady state isothermal and non-isothermal single reaction
3. Design of reactor with recycle and autocatalysis

reaction
4. Design of reactor for double reaction
5. Effect of temperature and energy in reactor design.
6. Liquid-gas heterogeneous reactor
7. Design of catalytic reactor
8. Design of Solid-gas heterogeneous reactor
9. Bioreactor and feremento

References :

1. Fogler, H. S. (2004). *Element of Chemical Reaction Engineering*. 3rd ed. Prentice-Hall, Englewood-Cliffs, New Jersey
2. Levenspiel, O. (2003). *Chemical Reaction Engineering*. John Wiley & Sons, New York.
3. Smith, J.M., 1981, "Chemical Engineering Kinetics", 3nd ed., Mc. Graw Hill, Kogakusha, Ltd., Tokyo.

Course Title : Unit Operation II: Fluid Mechanics
Code : PTKM6504
Credit unit : 3
Pre-requisite : Thermodynamics I
Competency : A-1, A-2, E-1
Objectives : After completion of this course, the student should be able to explain the mechanism and the concept of handling equipment for handling fluids and solids mixture.
Syllabus :
1. Definition of fluid
2. The concept of fluid mechanics and fluid transport
3. The laws of conservation of mass and conservation of energy
4. Piping system
5. Gas transportation
6. Liquid fluid transport
7. Fluid flow rate measuring devices
8. Choosing Conveyor
9. Screw conveyor, Belt conveyor, Bucket elevator, Vibrating conveyor, Pneumatic conveyor
10. Fluid transport with continuous system

References : 1. Richardson, J. F., Harker, J. H., Backhurst, J. R. (2002). *Coulson and Richardson's Chemical Engineering. Particle Technology and Separation Processes*. 5th edn. Butterworth & Heinemann, New York.
2. Foust, AS, 1979, Principle of Unit Operatida, 2 ed . John Wiley, Sons, New York.
3. Geankoplis, CJ, 1997, Transport Process and Limit Operation, 3 th ed. Prentice Hall of India, New Delhi..
4. Hollan, FA and Bragg, R, 1995, Fluida Flow for Chemical Engineering, 2 nd ed. Arnold, London.
5. Krans and Milton, 1980, Pneumatic Conveging of Bulk Material, 2 nd ed, Mcgraw Hill Publising Co.
6. Mc Cabe, WL, Smith, JL, and Harriot, P, 2001, Unit Operation of Chemical Engineering , 6 th ed, Mc Graw. Hill , New York.
7. Perry, RH Green, DW and Moloney JA, 1997, Perry"s Chemical Engineers Handbook, 7 th ed, Mc Graw Hill, New York.

Course Title : Unit Operation III: Heat Separation
Code : PTKM6505
Credit unit : 3
Pre-requisite : Thermodynamics II
Competency : A-1, E-1, E-2
Objectives : After completion of this course, the student should be able to explain the mechanism and the concept of separation processes based on heat transfer is applied to the operation of evaporation, condensation, crystallization, drying and humidification.
Syllabus :
1. Separation process by evaporation, crystallization and diffusion
2. Humidification and dehumidification
3. Drying and adsorption
4. Phase equilibrium
5. Multistage operation
6. Design of tower and separator

References : 1. Badger, W.L & Banchero, J.T, 1957, Introduction to chemical engineering, Mc Graw Hill

International Editions New York.
2. McCabe, W. L., Smith, J. L., and Harriot, P., 2001, Unit Operation of Chemical Engineering, 6th ed., Mc GrawHill Book Co, New York.
3. Foust, A.S., 1979, Principles of Unit Operations, 2nd ed., John Wiley & Sons, New York.
4. Geankoplis, C.J., 1997, Transport Processes and Unit Operation, 3rd ed., Prentice Hall of India, New Delhi.
5. Treybal, R.E., 1981, Mass-Transfer Operations, 3rd. Ed., International Student Edition, Tokyo.
6. Perry, R.H., Green, D.W., and Maloney, J.O., 1997, Perry's Chemical Engineers Handbook, seven ed., Mc Graw Hill, New York.

Course Title	**:**	**Research proposal**
Code	:	PTKM6506
Credit unit	:	1
Pre-requisite	:	Taken together Research Methodology
Competency	:	C, G, L
Objectives	:	After completion of this course, the student should be able to prepare a research proposal, and ready to conduct the research procedure

Course Title	**:**	**Utility**
Code	:	PTKM6507
Credit unit	:	3
Pre-requisite	:	-
Competency	:	E-1, E-2
Objectives	:	After completion of this course, the student should be able to explain the importance of utility, how to provide utility, and the utility system in industry. Including, heating medium supply system, cooling media, and electricity to support the plant production process.
Syllabus	:	1. Introduction: importance, definition, basic concept of utility 2. Water supply in industry (resource, analysis, unit operation, intake system, various procedure for water treatment) 3. Cooling supply (type of cooling system, cooling

water requirement, cooling tower, cooling water balance, air conditioner, refrigerator, and problem solving)
4. Steam generation
5. fuel supply;
6. Electricity supply;
7. Refrigeration system in chemical industry
8. Compressed air and inert gas supply
9. Vacuum system

References :

1. Droste, R. I. (1997). *Theory and Practice of Water and Wastewater Treatment*. John Wiley and Sons, Inc., Canada.
2. Kemmer, F. N. (1988). *The Nalco Water Handbook*. 2nd edn. McGraw-Hill Book Company, New York.
3. Linsley, R.K., and J.B. Fransini, 1979, "Water Resources Engineering, 3 rd. ed., Mc Graw Hill, New York.
4. Reynolds, T.D., 1982, "Unit Operation and Processes in Environmental Engineering, Brooks / Cole Engineering Division, Monterey, California
5. Severn, N. H & Howard, E. D. (1981). *Steam, Air, and Gas Power*. Asia Publishing Co. Inc., Kolkata
6. Wallace, A. G. (1981). *Principles and Practice of Electrical Engineering.* Mc Graw-Hill Book Co.,New York.

Course Title : Unit Operation Laboratory

Code : PTKM6508

Credit unit : 2

Pre-requisite : -

Competency : A-1, C, G, H

Objectives : After completion of this course, the student should be able to develop a procedure of the experiment, select and assemble experimental apparatus, measure, analyze and discussion of the data in the operations of chemical engineering as well as reporting

Syllabus :
1. Batch Distillation,
2. Filtration (Plate and Frame Filter Press; Cross-flow filtration),
3. Heat transfer (Shell and Tube HE),
4. Size Reduction (Hammer Mill),

5. Drying (Tray drier),
6. Fluid Flow,
7. Fluidization (solid-gas),
8. Continuous crystallization,
9. Wetted Wall Column

References :

1. Brown, G.G. 1979. Unit Operation. Modern Asia Edition. Hal. 20-22; 26. Mc Graw Hill Book. Co.Ltd.Tokyo. Japan.
2. Coulson. J.M, et al. 2002. Chemical Engineering Particle Technology and Separation Process 5th edition. hal 105-106 Butterworth and Heinemann Oxford. England.
3. Foust, A. 1960. Principles of Unit Operation. 2nd ed. New York: John Wiley and Sons Inc.
4. Kern, D. G. 1980. Process Heat Transfer. McGraw Hill Book Co. Ltd. Kogakusha, Tokyo.
5. Mc Cabe, W. S. 2001. Unit Operations of Chemical Engineering. 6th ed. New York: Mc GrawHill Book. Co.

6th SEMESTER

Course Title : Research
Code : PTKM6601
Credit unit : 3
Pre-requisite : Research Proposal
Competency : C, G, L
Objectives : After completion of this course, the student should be able to carry out the steps of the scientific research in accordance with the proposals that have been presented at a seminar.

Course Title : Process Control
Code : PTKM6602
Credit unit : 3
Pre-requisite : -
Competency : A-2, A-3, E-1, F
Objectives : After completion of this course, the student should be able to explain and applied the system of process

control, stability analysis and conditioning controllers, as well as the design of control systems in chemical engineering.

Syllabus :

1. Introduction to Process Control: the importance of process control in industry
2. Analysis and response of chemical process first and second order
3. Laplace Transforms: Fundamentals of transformation, the method of partial fractions
4. The theory of choosing the proper process control for various system
5. Modeling in process control: Static and Dynamics, Linear and non-linear, Linearization Model
6. Dynamic Respond: Respond model of order 1 and order 2, the determination of the time constant and the gain constant, over damping, system delay, overshoot, frequency response and Bode analysis
7. Signals and instrumentation
8. System design of feed-back, feed forward, and cascade process control
9. PID control design: system tuning, performance of Proportional, Integral and Dynamic Control
10. Process Control Design by Precitive control model, and multiunit control for chemical engineering problem

References :

1. Marlin, T. (2000). *Process Control*. Mc Graw Hill Book Co., Boston.
2. Stephanopolous, G. (1984). *Chemical Process Control*. Prentice Hall Inc, New York.
3. Luyben, W. L. and Luyben, M. L. (1997). *Essential of Process Control*. McGraw-Hill, New York.
4. Doyle III, Francis J.2000. Process Control Moduls a Software Laboratory for Control Design. Prentice Hall Int. Series.

Course Title : Chemical Product and Process Design

Code : PTKM6603

Credit unit : 3

Pre-requisite : Chemical reaction engineering

Competency : D, E-1, E-2, F

Objectives : After attending this course, students are expected to

develop an innovative chemical product design as the integration between the ability of chemical engineering knowledge with managerial skills.

Syllabus :
1. The basic concept of chemical product design
2. Structure and synthesis of process on PFD
3. Heuristic / rule of thumb synthesis process
4. Selection of separator system;
5. The selection of the reactor system;
6. Reactor-separator network design;
7. Simulator / software for synthesis and simulation process
8. Simulator and software to design and analyze the reactor networks, recycle, heater
9. Fundamentals of heater network synthesis
10. The concept of the integration process

References :

1. Ulrich, K. T. and Eppinger, S. D. (2011). *Product Design and Development*. 5rd edn. Mc Graw Hill, Boston.
2. Seider, W. D., Seider, J. D., & Lewin, D. R. (2004). *Product & Process Design Principles: Synthesis, Analysis and Evaluation*. John Wiley & Sons, Inc., New York.
3. Turton, R., Bailie, R.C., Whiting, W.B., Shaeiwitz, J.A., 2003, Analysis, Synthesis and Design of Chemical Process, Prentice Hall PTR, New Jersey

Course Title : Unit Operation IV: Multistage Separations

Code : PTKM6604

Credit unit : 3

Pre-requisite : -

Competency : A, E-1

Objectives : After completion of this course, the student should be able to explain the mechanism and the concept of separation based on mass transfer processes that apply to the operation of adsorption, absorption, distillation, and extraction.

Syllabus :
1. Diffusion (basic concept, tower, phase equilibrium, phase equilibrium diagram)
2. Operation of multistage separation for efficiency
3. Distillation (The basic concept, Distillation 2 components, Multi-component distillation, Plate tower design, Packed tower design)

4. Extraction (basic concept, calculation of the theoretical stage)
5. Ideal stage calculation on molal flow for mixed solution

References : 1. Foust, A.S., and Associates ,1980, "Principles of Unit Operation"
2. Treybal, R.E., 1980,"Mass Transfer Operation"
3. Brown, G.G., et al, 1978, "Unit Operation"

Course Title : Process Safety
Code : LTKM6601
Credit unit : 2
Pre-requisite : Process Control
Competency : F, J-1, J-2, J-3
Objectives : After completion of this course, the student should be able to explain the philosophy of safety process and related regulations, safety process support aspects particularly associated with the use of high pressure equipment and high temperature, the concept of danger and risk, and hazards control system due to exposure to B3, equipment operation and emergency control

Syllabus :
1. Process safety philosophy, basic concept, factor standard
2. Management of health and safety environment
3. Fire in industry
4. Hazard and risk analysis (liquid chemical, gas)
5. Emergency response planning
6. Management and regulation for chemical controlling
7. Safety procedure for closed indoor
8. Safety procedure for offshore exploration and operation production
9. Inspection standard, observation and safety supervision
10. Hazardous waste and toxic materials and hazardous materials management

References :
1. Smith, J.M., Van Ness, H.C., and Abbott, A., (2001), "Introduction to Chemical Engineering Thermo-dynamics", 6th edition, McGraw-Hill, Boston
2. Walas, S. M. (19..), "Phase Equilibria In Chemical

Engineering", 1st edition, Butterworth-Heinemann.
3. Prausnitz, J. M., Lichtenthaler, R. N., de Azevedo, E. G., (1986), "Molecular Thermodynamics of Fluid-Phase Equilibria", 2nd edition, Prentice-Hall Inc., Englewood Cliffs, N. J.

7th SEMESTER

Course Title	**:**	**Chemical Engineering Economics**
Code	:	PTKM6701
Credit unit	:	2
Pre-requisite	:	Taken together with Design of Chemical Plant
Competency	:	E
Objectives	:	After completion of this course, the student should be able to explain and calculate the economic aspects of a system or a process of chemical plant equipment.
Syllabus	:	1. Cost and capital efficiency 2. Total Capital Investment and Working Capital 3. Time value of money (Present, future, and annual worth) 4. Cash flow, cumulative cash flow 5. Analysis of time value of money 6. Concept of fixed capital, working capital 7. Physical plant cost and manufacturing cost 8. General expense 9. Optimasi forcasting interest 10. Depreciation, taxes organization 11. Profitability analysis (ROI, DCF, ROR, POT)
References	:	1. Peters, M. S. (1991). *Plant Design and Economics for Chemical Engineers*. McGraw-Hill Book Co., Singapore. 2. Coupers, J. R. (2003). *Process Engineering Economics*. Marcel Dekker, Inc., New York. 3. Aries RS, Newton RD, 1955, "Chemical Eng. Cost Estimation," Mc Graw Hill Book Company, New York. 4. Hani Handoko T, 1985," Man personalia dan SDM," BPFE, Yogyakarta. 5. Mardiasmo,1997, " Perpajakan" Penerbit ANDI Yokyakarta.

Course Title	**:**	**Industrial and Project Management**
Code	:	LTKM6702
Credit unit	:	2
Pre-requisite	:	Chem. Product and Process Design
Competency	:	D, G, I-1, K
Objectives	:	After completion of this course, the student should be able to explain the principles of project management and industry as well as how to obtain economic efficiency in the production process
Syllabus	:	1. Project (definition, characteristic, classification, limitation) 2. Project management (definition, cycle, study area) 3. Project funding (Cash flow and interest) and funding management 4. Project organization 5. Industrial management 6. Interest equation in industrial process 7. The procedure to take a decision 8. Rate of return on investation 9. Inventory and supply management
References	:	1. Tonchia, S. (2008). *Industrial Project Management*. Springer-Verlag, Berlin. 2. Imam Soeharto. (1999). *Manajemen Proyek*. Jilid 1, Penerbit Airlangga. 3. Newman, D. G. (2006). *Engineering Economic Analysis*. 9nd edn. Engineering Press Inc., California

Course Title	**:**	**Process Equipment Design**
Code	:	PTKM6703
Credit unit	:	3
Pre-requisite	:	Process Control
Competency	:	D, E-1, E-2
Objectives	:	After completion of this course, the student should be able to specify the basic design information, pressure vessels design, liquid storage tanks design, heat exchangers design, and assessing the feasibility of the equipment design.
Syllabus	:	1. Introduction and the purpose of equipment design

2. Liquid storage tanks (definition, design, and various operation condition)
3. Selecting Colom type, and design of tray tower
4. Calculation of effective operation condition, and plat ideal
5. Design of packed tower
6. Selecting heat exchanger and fluid route
7. Design of heat exchanger

References :

1. Sinnot, R. K. (2005). *Chemical Engineering Design*. *Coulson & Richardson's Chemical Engineering Series*. Vol. 6. 4th ed. Elsevier, Amsterdam.
2. ASME Boiler and Pressure Vessel Code (2204), American Society of Mechanical Engineers, New York.
3. API 620 (2002) Design and construction of large, welded, low pressure storage tanks, 10th edn, American Petroleum Institute, Washington DC.
4. Bronwnell, L.E. & Young, E.H. (1959). Process Equipment Design: Vessel design, 1st ed., John Wiley & Son, Inc., New York
5. Kern, D.Q. (1965), Process Heat Transfer, 1st ed., McGraw-Hill Book Co., Inc., Tokyo

Course Title : Chemical Plant Design

Code : PTKM6704

Credit unit : 3

Pre-requisite : Unit Operation I, Unit Operation II, Unit Operation III, Unit Operation IV, Chemical Industry Process, Reactor, Utillity, Process Computations

Competency : B, D, E-1, E-2, F

Objectives : The student should be able to design a pre-designed chemical plant by considering technical, environmental, social, ethical, health and safety, and sustainability. And able to use the techniques, skills, and modern infrastructure in the chemical engineering applications.

Syllabus :

1. The role of chemical engineer in chemical plant design
2. The basic concept of chemical plant design
3. Determination of plant location
4. Raw material and product specification

5. Description of process and control philosophy
6. The use of Chemical Engineering software as a tool of plant design and Flowsheeting
7. Mass and heat balance in chemical plant design
8. Equipment design (construction material, sizing)
9. The Selection and integration of utility and storage unit
10. Equipment lay-out and plant lay-out determination
11. Organization management
12. Economic feasibility

References :

1. Baasel, W. D. (1990). *Preliminary Chemical Engineering Plant Design*. 2nd ed., McGraw Hill, Kogakusha.
2. Coulson, J. M. & Richardson, J.F. (1988). *Chemical Process Equipment*. McGraw-Hill Chemical Engineering Series, NY.
3. Seider, W. D., Lewin, D. R. (1999). *Process Design Principles*. John Wiley & Sons, New York.
4. Ulrich, G. D. (1984). *Chemical Process Design and Economic*. John Wiley & Sons, New York.
5. Perry, R. H. (ed). (1997). *Perry's Chemical Engineers' Handbook*. 7th ed. McGraw-Hill, New York.

Course Title : Entrepreneurship

Code : UUW00008

Credit unit : 3

Pre-requisite : -

Competency : I-1, J-1, J-2, J-3

Objectives : After completion of this course, the student should be able to explain the concepts of entrepreneurship and business in the field of chemical engineering in small and large scale industries.

Syllabus :

1. Definition and concept of entrepreneurship
2. Entrepreneurial profile and identification of entrepreneurs
3. Entrepreneurship factors and definition of intra-preneurship
4. Professionalism in chemical engineering
5. The concept of self-employment and entrepreneurship

6. Creative process (Herbert G. Hicks and Robert D. Hisrich)
7. The basics of business plan and strategy
8. Business organizations
9. Risk management and Techno-preneurship

References :
1. Smith, J.M., Van Ness, H.C., and Abbott, A., (2001), "Introduction to Chemical Engineering Thermo-dynamics", 6th edition, McGraw-Hill, Boston
2. Walas, S. M. (19..), "Phase Equilibria In Chemical Engineering", 1st edition, Butterworth-Heinemann.
3. Prausnitz, J. M., Lichtenthaler, R. N., de Azevedo, E. G., (1986), "Molecular Thermodynamics of Fluid-Phase Equilibria", 2nd edition, Prentice-Hall Inc., Englewood Cliffs, N. J.

ELECTIVE COURSES 1

Course Title : Functional Food Technology
Code : LTKM6111
Credit unit : 2
Pre-requisite : -
Competency : B
Objectives : After completion of this course, the student are able to describe the source, benefits, and how to manufacture various kinds of functional food ingredients
Syllabus :
1. The introduction of functional foods and food nutriceutical
2. Peptide, polyphenol, carotenoid
3. Bioactive compound on various drinks, meats, seafood, egg
4. Bioactive compound on fruit, vegetable, grain and nut
5. Antioxidants
6. Bioactive carbohydrate, and dietary fiber
7. Bioactive lipid
8. Prebiotics, probiotics and symbiotic

References :
1. Wildman, REC, 2000, Handbook of Nutraceuticals and Functional Foods, CRC Press Book
2. Aluko, RE, 2012, Functional Foods and

Nutraceuticals, Springer
3. William, CE, 2000, Functional Foods: Concept to Product, Woodhead
4. Pometto, A, 2007, Functional Foods and Biotechnology, CRC Press Book

Course Title : Petroleum Technology

Code : LTKM6112

Credit unit : 2

Pre-requisite : -

Competency : B

Objectives : After completion of this course, the students are able to explain the history, classification, composition, analysis, products, and petroleum refining processes, and treating processes to improve the quality of petroleum products

Syllabus :
1. Introduction (petroleum resource and its importance)
2. Petroleum clasification
3. The composition of hydrocarbons and non-hydrocarbon contents, classification and types of petroleum
4. Petroleum and its products testing/analysis
5. Petroleum evaluation
6. Preliminary refining processes: atmospheric distillation, vacuum distillation
7. Advanced refining process: thermal, catalytic and hydro cracking; catalytic and hydro reforming
8. The products can be produced from petroleum for fuel, petrochemicals and other materials
9. Lubricating oil technology

References :
1. Spleight, J. G. (2006). *The Chemistry and Technology of Petroleum*, 4th edition, Taylor and Francis Group, Boca Raton.
2. Riazi, R. M. (2005). *Characterization and Properties of Petroleum Fractions*, 1st edition, ASTM, West Conshohocken.
3. Spleight, JG 2002, *Handbook of Petroleum Product Analysis*, 4th edition, John Wiley & Sons, Inc., Hoboken.

Course Title : Catalyst Technology

Code : LTKM6113

Credit unit : 2

Pre-requisite : -

Competency : B

Objectives : After completion of this course, the student should be able to explain the synthesis, characterization, and catalysts testing principles.

Syllabus :

1. The catalyst function and mechanism in chemical reaction
2. Homogeneous catalysts
3. Heterogeneous Catalysts;
4. The basic principle of the catalyst selection
5. Catalyst properties (catalyst structure, catalyst morphology, properties of acids and bases)
6. Catalyst characterization (XRD and FTIR, NA and AAS, TPD and NMR)
7. Catalysts production, testing, deactivation, regeneration
8. Bio-and Nano-catalysts

References :

1. Richardson, J. T. (1989). *Principles of Catalyst Development*. Plenum Press, New York.
2. Centi, G., Cavani, F., and Trifirò, F. (2001). *Selective Oxidation by Heterogeneous Catalysis*. Kluwer Academic/Plenum Publishers, New York.
3. Twigg, M. V. (1996). *Catalyst Handbook*. Manson Publishing
4. Boker, M. (2004). *The Basic and Application of Heterogeneous Catalysis*. Oxford University Press, New York.

Course Title : Clean Technology

Code : LTKM6114

Credit unit : 2

Pre-requisite : -

Competency : B

Objectives : After completion of this course, the student should be to explain the definitions, basic concepts of clean production technologies, and be able to assess the implementation of cleaner production technology in the chemical industry.

Syllabus :
1. Definition and basic concepts of clean production technologies (Good House Keeping, Raw material Substitution, Technology Changes, Product changes, Onsite reuse)
2. Waste minimization (Source Reduction, Reuse-Recycle-Recovery, Waste Treatment, Disposal),
3. Pollution prevention (end of pipe treatment: hard recycle, waste treatment, disposal),
4. The concept of industrial ecology (Reject Concept of wastes),
5. Application of clean production technologies in the chemical industry

References :

1. Higgins, T.E. (1995). *Pollution Prevention Handbook: Resource Conservation and Recovery Act (RCRA)*. Lewis Publisher.
2. Bischof, P. L. (2000). *Pollution Prevention*. Mc. Graw-Hill.
3. Graedel, T. E. & Allenby, B. R. (1995). *Industrial Ecology*. Pretice Hall, Engelwood Cliffs, New Jersey.

ELECTIVE COURSES 2

Course Title : Food Processing and Preservation Technology
Code : LTKM6211
Credit unit : 2
Pre-requisite : -
Competency : B
Objectives : After completion of this course, the student should be able to explain the various ways of processing, the causes and mechanisms of damage, and various ways to preserve food.

Syllabus :
1. Damage to food (damage due to microbes, enzymes, the influence of environmental conditions)
2. Food shelf life
3. Food processing for milk
4. Food processing for meat
5. Food processing for fruit and vegetable
6. Food processing for vegetable oil and its derivatives
7. Food processing for sugar and its derivatives
8. Food preservation (principles and technologies using heat, low temperature, drying, irradiation, fermentation, chemical addition).

References : 1. Robertson, G. L. (1993). Food Packaging: Principles and Practice. Marcel Dekker, New York , USA
2. Hanlon, J. F. , Forcinio, H. E. & Kelsey, R. J. (1998). Handbook of Packaging Engineering. CRC Press, Boca Raton, FL , USA
3. Brody, A. L. & Marsh, K. S. (eds.) (1997). The Wiley Encyclopedia of Packag-ing Technology . Wiley – International, New York, USA

Course Title : Coal Technology
Code : LTKM6212
Credit unit : 2
Pre-requisite : -
Competency : B
Objectives : After completion of this course, students are able to explain and apply the principles of coal conversion into energy
Syllabus :
1. Coal formation and composition of coal
2. Classification, properties, and analysis of coal
3. Preparation and cleaning of coal
4. Coal combustion process (direct, fixed bed, pulverized, bubbling, circulating fluidized bed)
5. Pollution control and treatment in coal combustion
6. Coal gasification process
7. Coal liquefaction process
8. Air emissions from coal conversion and particulate control
9. Flue gas desulfurization

References :
1. Miller, B.G., 2005. Coal energy systems. Academic Press.
2. Kavalov, B. and Peteves, S.D., 2007. The future of coal. Luxembourg: Europäische.
3. Gavalas, G.R., 1982. Coal pyrolysis (Vol. 4). Elsevier.
4. Bell, D. A., Towler, B. F. & Fan, M. (2011). Coal Gasification and It's Applications. Elsevier, London.Bruce G. Miller, (2005), "Coal Energy Systems", Elsevier Academic Press, New York.
5. Smith, Lee K., and L., Douglas Smoot, (1990), "Characteristic of Commonly-used US Ccoals Towards a Set of Standart Research Coals", Prog. Energy Cobm. Science.

6. Elliot, A., Martin, (1981), "Chemistry of Coal Utilization",John Wiley & Sons.Inc, New York.

Course Title : Polymer Technology

Code : LTKM6213

Credit unit : 2

Pre-requisite : -

Competency : B

Objectives : After completion of this course, the student should be able to explain the types of polymer reactions, methods of polymerization process and polymer processing

Syllabus :
1. Introduction to polimer (definition, structure, functional group, isomer, MW, morphology)
2. Crystalline morphology of polymer
3. Characterization of polymer
4. Vinyl and non-vinyl polymer
5. Polymer processing into finished products (injection molding, blow molding, calendaring, blow forming and thermo forming films)
6. Elastomer, natural fiber, application of polymer
7. Polymer industry
8. Polymer additives
9. Polymer types and reaction (Polymerization condensation)
10. Polymerization reaction kinetics
11. Homogenous and heterogeneous polymerization
12. Unit operation in polymer processing

References :
1. Stephen L. Rosen, Fundamental principles of polymeric materials, john wiley & sons, 1982.
2. Mukhtar Ahmed, Coloring of plastic, theory and practice, Van Nostrand Reinhold Company International Office, 1979.
3. F. N. Cogswell, Polymer Melt Rheology, A guide for Industrial Practice, John Wiley & sons, New York, 1981.

Course Title : Pinch technology
Code : LTKM6214
Credit unit : 2
Pre-requisite : Thermodynamics I, Heat Transfer
Competency : B
Objectives : After completion of this course, the student should be able to design feasible heat exchanger networks (HEN) in an effort to improve the efficiency of heat recovery in a pinch with the principles of the system based on the first and second laws of thermodynamics.
Syllabus :
1. Law of thermodynamics in the design process
2. Data extraction from flow sheet diagram
3. Composite diagram, and grand composite
4. Problem table and minimum energy requirement
5. Heat exchanger network and grid diagrams
6. Pinch technology in design of efficient heat exchanger networks
7. Applications in plant / case studies (modification of system process on Crude oil fractionation preheat train, Aromatic plant, and evaporator/dryer) to obtain maximum energy recovery

References :

1. Kemp, IC 2007, Pinch Analysis and Process Integration. A User Guide on Process Integration for the Efficient Use of Energy, 2nd edition, Butterworth-Heinemann, Boston.
2. Linnhoff, B 1998, Introduction to Pinch Technology, Linnhoff March, Northwich, England.
3. Linnhoff, B & Hindmarsh, E 1983, The pinch design method of heat exchanger networks, Chem Eng Sci. Vol. 38(5), pp 745–763.
4. Linnhoff, B, Mason, DR & Wardle, I 1979, Understanding heat exchanger networks, Comp Chem Eng, pp 3: 295.

ELECTIVE COURSES 3

Course Title : Enzyme and Fermentation Technology
Code : LTKM6311
Credit unit : 2
Pre-requisite : Fundamental of Bioprocess
Competency : B

Objectives : After completion of this course, the student should be able to explain the functions and how to make the enzyme, the basics of fermentation operations and fermenters design calculations

Syllabus :
1. Definition, classification and mechanism of enzyme (Enzymes as catalysts)
2. The kinetics of enzymatic reactions
3. Modern enzyme technology
4. The sources of enzyme
5. Biosynthesis of enzyme (factors, mechanism, manipulation, and kinetics)
6. Production of enzyme from plant
7. Production of enzyme by microbiology
8. Enzyme recovery process and cell division method
9. Enzyme recovery by aggregation and flotation
10. Enzyme recovery by centrifugation and filtration
11. Ion-exchange, affinity, gel filtration, high performance liquid Chromatography
12. Bioreactor and Design of bioreactor

References :

1. Stanbury, PF 1984, *Principles of Fermentation Technology*, Pergamon Press. Oxford New York.
2. Atkinson, B & Mavituna F 1991, *Biochemical Engineering and Biotechnology Hand Book,* 2nd. Edition, Stockton Press, New York.
3. Blanch, HW and Clark, DS 1997, *Biochemical Engineering*, New York, Marcel Dekker, Inc.
4. Sragg, AH 1988, *Biotechnology for Engineers: Biological Systems in Technological*, John Wiley & Sons, New York.

Course Title : Gas Processing Technology

Code : LTKM6312

Credit unit : 2

Pre-requisite : -

Competency : B

Objectives : After completion of this course, the students are able to explain the principles of the Fischer-Tropsch process and the conversion processes of natural gas into liquid fuels, gas, water and other chemicals.

Syllabus :
1. Gas industry and the process flow of gas production
2. Upstream process of gas industry
3. System overview on natural gas processing

4. Chemical and physical treatment of acid gas
5. Gas dehydration plant
6. LNG production process
7. Biogas production
8. Natural gas conversion to MTG and hydrocarbon
9. LPG production process, Fischer-Tropsch process, Steam reforming process
10. Oxidative coupling process, Partial oxidation process, Reform processes

References :

1. A. J. Kidnay, W.R. Parrish, (2006), Fundamentals of Natural Gas Processsing, Taylor & Francis Group, Boca Raton
2. S. Mokhatab, W.A. Poe, J.Y. Mak. (2015). Handbook of Natural Gas Transmission and Processing Principles and Practices, Third Edition, Gulf Professional Publishing imprint of Elsevier. [download this book].
3. H.K. Abdel-Aal, M. Aggour, and M.A. Fahim, (2003). Petroleum and Gas Field Processing. Marcel Dekker, Inc., New York.

Course Title : New Material Technology

Code : LTKM6313

Credit unit : 2

Pre-requisite : -

Competency : B

Objectives : After completion of this course, the students are able to explain a wide range of new materials, including manufacturing technology, benefits, and its economic aspects.

Syllabus :

1. Advance study on materials technology (advance material and conventional material)
2. Composite, nanomaterials
3. Semiconductors
4. Superconductors
5. Polymers and Elastomers;

References :

1. Callister, W. D., Jr. (2007). *Material Science and Engineering*. 7th edn. John Wiley & Sons, Inc., New York.
2. Kakani, S. L. & Kakani, A. (2004). *Material Science*. New Age International (P) Limited Publisher, New Dehli.

Course Title	**:**	**Emulsions and Surfactants Technology**
Code	:	LTKM6314
Credit unit	:	2
Pre-requisite	:	-
Competency	:	B
Objectives	:	After completion of this course, the students are able to explain the ways of stabilizing the system and solving the homogeneous mixture of immiscible liquid-liquid and its application in the food industry, cosmetics, and petroleum.
Syllabus	:	1. Emulsion definition, characteristic, classification, and emulsion identification; 2. Emulsification process; 3. Overview of emulsion system thermodynamics; 4. Emulsion characterization, analysis and factors that affect the stability of the emulsion 5. Application of emulsion 6. Destabilization of the emulsion; 7. The mechanism of stabilization and destabilization; 8. Surfactant definition; 9. The types and properties of surfactants (anionic, cationic, nonionic, and amphoterik surfactant); 10. Hydrophilic lipophilic balance (HLB); 11. Criticle Micelle Concentration, Cloud Point. 12. Emulsifiers for food (application, case study)
References	:	1. Sjoblom, J. (2001). Encyclopedic Handbook of Emulsion Technology. Marcel Dekker Inc., New York. 2. Jonsson, B., Lindman, B., Holmberg, K. & Kronberg, B. (2003). Surfactants and Polymers in Aqueous Solution. 2nd edn. John Wiley & Sons Ltd., Toronto. 3. Porter, M. R. (1994). Handbook of Surfactants. 2nd edn. Blachie Academic & Professional, Madras. 4. Hasenhuettl, Gerard L., Hartel, Richard W (2008), Food Emulsifiers and Their Applications, Springer-Verlag, New York

ELECTIVE COURSES 4

Course Title	**:**	**Food Packaging and Safety Technology**
Code	:	LTKM6411
Credit unit	:	2
Pre-requisite	:	-
Competency	:	B
Objectives	:	After completion of this course, the students are able to explain the type and process of packaging materials, packaging requirements, food packaging techniques, and recycling of packaging
Syllabus	:	1. Food damage, and food shelf life 2. Basic of food packaging (Packaging requirements, Food packaging techniques, Food packaging materials recycling) 3. Modified atmosphere packaging 4. Edible and biodegradable food packaging 5. Food safety and Food safety hazard 6. HACCP, ISO 22000 7. Food safety on food processing
References	:	1. Kadoya, T. (Ed.), "Food Packaging", Academic Press Inc., San Diego, 1990. 2. Lawley, R., Curtis, L., Davis, J., "The Food Safety Hazard Guidebook", RSC Publishing, Cambridge, 2008 3. Ortega-Rivas, E. (Ed), "Processing Effects on Safety and Quality of Foods", Taylor & Francis Group, Boca Raton, 2010.

Course title	**:**	**Renewable Energy Technology**
Code	:	LTKM6412
Credit unit	:	2
Pre-requisite	:	-
Competency	:	B
Objectives	:	Students are able to explain and describe the resources and renewable energy technologies and interpreted the data to solve engineering problem
Syllabus	:	1. Introduction (basic scope of renewable energy material) 2. Water energy 3. Wind energy

4. Solar energy
5. Biomass energy
6. Geothermal energy
7. Biogas, biodiesel, bioethanol production
8. Biofuel technology and application

References :

1. Burnham, L., Johansson, T. B., Kelly, H., Reedy, A. K. N., and Williams, R. H. (1993). *Renewable Energy. Source for Fuel and Electricity*. Island Press, Washington, DC.
2. Sorensen, B. (2011). *Renewable Energy. Its Physics, Engineering, Environmental Impacts, Economic & Planning*. 4th edn. Elsevier Ltd. Oxford.
3. Hoogers, G. (ed.) (2003). *Fuel Cell Technology Handbook*. CRC Press LLC, Boca Raton

Course Title : Membrane Technology

Code : LTKM6413

Credit unit : 2

Pre-requisite : -

Competency : B

Objectives : After completion of this course, the student should be able to explain and design processes in membrane-based separation applications for various industries.

Syllabus :

1. Introduction to membrane technology
2. Membrane material classification
3. Membrane preparation
4. Membrane composite, membrane integral
5. Membrane characterization
6. The design process and the membrane module
7. Mase transfer in membrane (pore flow models, and solution diffusion models)
8. Fouling and concentration polarization in the membrane and regeneration membrane technique
9. Separation process by membrane (MF, UF, NF, RO)
10. Membrane dialysis, membrane pervaporation, membrane reverse electro dialysis, membrane distillation
11. Membranes in industrial applications (water treatment, wastewater treatment, chemical industry, Pharmaceutical / Medical, Agricultural and food)
12. Case studies, process design, problem solving

References : 1. Mulder, M. (1996). *Basic Principles of Membrane Technology*. 2nd edn. Kluwer Academic Publishers, Dodrecht.
2. Cheryan, M. (1998). *Ultrafiltration and Microfiltration Handbook*. Technomic Publishing Company, Inc., Lancaster.
3. Baker, R. (2004). Membrane Technology and Applications, 2nd edition, jon Willey and Sons, California

Course Title : Energy Management and Conservation
Code : LTKM6414
Credit unit : 2
Pre-requisite : -
Competency : B
Objectives : After completion of this course, the student should be able to explain and analysis the energy audit system and socio-economy aspect of energy management.
Syllabus : 1. Management and conservation of energy (concept, law, basic principles)
2. Efficiency of energy
3. Life cycle costing
4. Energy audits management systems
5. The concept of energy audits
6. Energy audit procedures and techniques
7. Energy supply management system
8. Socio-economic aspects of the energy supply system

References : 1. Sorensen, B. (2004). *Renewable Energy*. 3rd ed., Academic Press, London.
2. Culp, Jr. & Archie, W. (1985). *Prinsip-prinsip Konversi Energi*. Penerbit Erlangga, Jakarta.
3. Kadir, A. (1995). *Energi Sumber Daya, Inovasi, Tenaga Listrik & Potensi Ekonomi*. UI Press, Jakarta.

3 STAFFS AND FACILITIES

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3.2. FACILITIES

3.2.1 Campus Buildings

a. **Building A,** having **total area of 1.579 m^2** is used for 3 educational laboratories (Unit Operation Laboratory, Unit Process Laboratory, Microbiology Laboratory), 5 specialized laboratories (Instrumentation Laboratory, Energy and Process Engineering Laboratory, Bioprocess Laboratory, Separation Technology Laboratory, and Food Process Engineering Laboratory), 3 class rooms having capacities of 50 students, respectively, and 14 rooms for faculty members.

b. **Building B,** having **total area of 741 m^2** is used for Process Computation Laboratory, Meeting Room, 2 Administration Room, 12 rooms for faculty members, 3 meeting room and Library.

c. **Building C,** having **total area of 758 m^2** is used for 5 class rooms with capacities of 60 students each, and a room for Student Union.

d. **Building D,** having **total area of 360 m^2** is used for Workshop and Waste Treatment Laboratory.

e. **Building E,** having **total area of 225 m^2** is used for Chemical Engineering Fundamental Laboratory I and II.

3.2.2 Laboratories

a. **Educational Laboratories**:
   - Chemical Engineering Fundamental Laboratory I
   - Chemical Engineering Fundamental Laboratory II
   - Bioprocess Laboratory
   - Process Computation Laboratory
   - Chemical Process Laboratory
   - Unit Operation Laboratory

b. **Research Laboratories**:
   - Waste Treatment Laboratory
   - Energy and Process Engineering Laboratory
   - Instrumentation Laboratory
   - Bioprocess Laboratory
   - Separation Technology Laboratory
   - Food Process Engineering Laboratory

3.2.3 Libraries

The students of the Chemical Engineering Department are able to access Diponegoro University Central Library, Engineering Faculty Library, and Departmental Library. The Departmental Library is provided with more than five hundreds textbooks, journals to support all students and faculty members' activities. The libraries are linked to Sciencedirect and Springerlink.

3.2.4 LAN/Internet

The Engineering Faculty provides LAN/internet facilities to support the transfer of information, science, and technology, as well as academic information system. The Department provides hotspot facility for students and faculty members to access LAN/internet. The facility is available 24 hours per day, 7 days per week for free.

Universitas diponegoro has a high-speed internet bandwidth access until 2255 Mbps with 18 Wi-Fi hotspot point. The internet is free accessed by SSO login for all of the students with internet bandwidth quota of 48,58 Kbps for each student.

3.2.5 Workshop

The student, researcher and lecturer are often need to self-fabricate their own equipment for laboratories work, researches, and community service. The work conducted on workshop unit and helped by the technician. The equipment fabricated on the workshop unit, such as, membrane filtration unit, dryer, fluidizer, mini reactor, etc.

4 ACADEMIC REGULATIONS

All the academic regulations applied in the Department of Chemical Engineering is based on Rector Decree No. 15 Year of 2017. Several points that are important in the academic activities in the department are as follow.

4.1 Study load and Course Plan

1. Study load per semester
   a. In the first semester, the freshmen are allowed to take courses with maximum of 22 credit units.
   b. In the following semesters, the maximum load is determined by the GPA achieved in the previous semester:
      1) GPA $\geq$ 3.00 : maximum study load = 24 credit units;
      2) 2.50 $\leq$ GPA $\leq$ 2.99 : maximum study load = 22 credit units;
      3) 2.00 $\leq$ GPA $\leq$ 2.49 : maximum study load = 20 credit units;
      4) GPA $<$ 2.00 : maximum study load = 18 credit units.
2. Course plan:
   a. Prior to every semester, the students should plan the courses to be taken online and approved by the academic counselor.
   b. The courses that have been planned are allowed to be replaced or canceled.
   c. The replacement of any course is done by the student with the approval of the academic counselor by the end of the second week after the course begins.
   d. The cancelation of any course is done by the student with the approval of the academic counselor by the end of the sixth week after the course begins.

4.2 Maximum Study Period

The maximum study period for the undergraduate program is 7 (seven) years or 14 (fourteen) semesters.

4.3 Student Assessment

1. To assess the progress of the study of the students the following forms of examination can be conducted:
   a. Written examination:
      - Quiz/test

- Mid examination of a semester
- Final examination of a semester

b. Practical examination;
c. Oral examination, such as for comprehensive examination and thesis defense;
d. Based on reasonable arguments, other forms of examination can be conducted.

2. Examination prerequisite:
   a. Mid/Final examination:
      - The student should be registered in the List of Course Attendant (LCA)
      - The student should have attended at least 75% of every course.
   b. Final examination of the program:
      The student should have passed all the courses.
3. Assessment System
   a. Type of assessment and how to do it adjusted to the characteristics of courses.
   b. The grades are designated by alphabets with the following scores:
      A = 4 D = 1
      B = 3 E = 2
      C = 2
   c. The students obtaining the grade of D and E for any course have to improve their grade by attending the course and the examination.
   d. The students obtaining the grade of B and C are allowed to improve their grades. At the end of the program, the best grades are used as the final grades
   e. The grades of the examination are announced.
   f. The students are allowed to improve their grades in other semesters.
   g. For any reason that the grades are not defined at the end of a semester, they should be graded as IC (incomplete) with the score of zero (0).
   h. Achievement
      - The achievement of the students is designated by GPA.
      - In the calculation of final GPA, every course is used once with its best grade.
      - The GPA calculation is done by using the following formula:

$$IP = \frac{\sum KN}{\sum K}$$

      with K and N are the credit unit and the score for each course, respectively.
4. The prerequisite, the validation of the attendant, and the regulation of the examination are defined by the Faculty.

4.4 Evaluation of Study Progress of the Student

Evaluation is performed to determine the progress of students in the study period.

1. The stages of criteria for evaluations is explained in following:
   a. The first three semester
      - The students must have accumulated at least 35 credit units with the GPA ≥ 2.50.
      - Should the students have passed < 35 credit units with the GPA< 2.50, the calculation of the GPA is obtained for the best 35 credit units.
   b. The second three semester (seventh semester)
      - The students have to have passed at least 85 credit units with the GPA ≥ 2.75.
      - Should the students have passed < 85 credit units with the GPA< 2.75, the calculation of the GPA is done for the best 85 credit units.
   c. End of the program
      By the end of the fourteenth semester, the student should have passed all the courses with the GPA ≥ 2.00.
2. Should the students not able to fulfill the above criteria, they are categorized as unable to attend the academic process. To these students, the Rector will issue a letter to terminate the academic process for the students.
3. Successful completion of undergraduate study
   The students are declared to have finished the undergraduate program whenever:
   a. They have passed all the courses,
   b. They have hold TOEFL certificate with the minimum score of 400 of which is obtained during the study.
   c. the GPA is≥ 2.00
4. In the final transcript, the grade D is not allowed.
5. The transcript of the undergraduate originated from the DIII program includes all the converted courses and all the courses taken in the undergraduate program.
6. The date of the graduation is the date of the defining the final GPA.

4.5 Yudicium

1. The predicate of the undergraduates are:

GPA	PREDICATE
2.76 – 3.00	satisfactorily
3.01 – 3.50	very satisfactorily
3.51 – 4.00	cumlaude

2. The cumlaude predicate is determined by considering the length of the study as well, i.e. five years.

4.6 Student Sabbatical

1. The Rector may grant a sabbatical provided:
   a. The students have received 45 credit units with the GPA ≥ 2,25,
   b. The students must submit a petition letter to the Rector.
2. The Rector may also grant a leave for:
   a. Medical reasons provided the petition is recommended by a hospital or other responsible institutions.
   b. Students as members of delegations representing the Diponegoro University in events extend for one month or more.
3. During the study period, the students are admitted to get sabbatical for maximum of twice or two semesters.
4. Sabbatical is not allowed for previous semester.
5. The sabbatical is not included in the calculation of the study period.