SYLLABUS
UNDER GRADUATE PROGRAM (S1)
CURRICULUM ITS 2018 – 2023

CHEMICAL ENGINEERING DEPARTMENT
FACULTY OF INDUSTRIAL TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA 2018

Study Program	Chemical Engineering
Educational Level	Undergraduate Program

EXPECTED LEARNING OUTCOME		
ATTITUDE	1.1	Believing in the oneness of God and able to demonstrate religious attitude
	1.2	Upholding the value of humanity in undertaking the task based on religion, morality and ethics
	1.3	Contributing in improving the quality of community life, nation and state and the advance of civilization based on Pancasila
	1.4	Playing a role as a proud citizen who loves his/her homeland, having a nationalism and responsibility to the country and nation
	1.5	Appreciating the diversity of cultures, point of view, religion and belief as well as opinion or the original findings of others
	1.6	Working together, having social sensitivity and caring for community and environment
	1.7	Law abiding and disciplined in community and state life
	1.8	Internalizing values, norms and academic ethics
	1.9	Demonstrating attitude of responsibility on work in his/her field of expertise independently
	1.10	Internalizing spirit of independence, struggle and entrepreneurship
	1.11	Trying his/her best to achieve perfect results
	1.12	Working together to be able to make the most of his/her potential
GENERAL SKILL	1.1	Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise
	1.2	Being able to demonstrate independent performance, quality, and measurable
	1.3	Being able to examine the implications of the development or implementation of the science of technology which concerns and implements the value of humanities in accordance with its expertise based on rules, procedures and scientific ethics in order to produce solutions, ideas, designs

GENERAL SKILL		or art criticism, compile scientific descriptions of the study results in the form of thesis or final project report , and uploaded it in the college page
	1.4	Arrange the scientific description of the results of the above study in the form of a thesis or final project report, and upload it on the college page
	1.5	Being able to take decisions appropriately in the context of problem solving in the area of expertise based on the results of information and data analysis
	1.6	Being able to maintain an expanded network with mentors, colleagues, colleagues both inside and outside the institution
	1.7	Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility
	1.8	Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently
	1.9	Being able to document, store, secure and recover data to ensure validity and prevent plagiarism
	1.10	Being able to develop themselves and compete in national and international level
	1.11	Being able to implement sustainability principles and develop knowledge
	1.12	Being able to implement information and communication technology (ICT) in the context of implementation of his/her work
	1.13	Being able to apply entrepreneurship and understand technology-based entrepreneurship
KNOWLEDGE	1.1	Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes
	1.2	Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes

	1.3	Process design technique and principles, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes
	1.4	Principles and the latest issues in economy, social, general ecology
	1.5	Communication techniques and cutting-edge technologies
SPECIAL SKILL	1.1	Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes
	1.2	Able to find the engineering root cause of process, processing system, and equipment required for converting raw materials into value-added products through investigation process, analysis, interpretation of data and information according to engineering principles
	1.3	Able to do research that includes identification, formulation, and analysis on engineering problems of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes
	1.4	Able to formulate alternative solution to solve complex engineering problems of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes by considering factors such as economic, public health and safety, cultural, social and environment (environmental consideration)
	1.5	Able to design process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes by analytical approach and taking into account the following aspects, such as technical standard, performance aspect, robustness, applicability, sustainability, as well as considering factors such as economic, public health and safety, cultural, social and environment

	1.6	Able to select appropriate resources and make use of design devices and appropriate IT-based engineering analysis to assist in engineering activities of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes

COURSE LIST of BACHELOR PROGRAM

No.	Course Code	Course Name	Credit
SEMESTER I			
1	UG18490x	Religion	2
2	UG184913	Civics	2
3	UG184912	Indonesian	2
4	SF184101	Physics I	4
5	KM184101	Mathematic I	3
6	SK184101	Chemistry	3
7	TK184101	Introduction to Chemical Engineering	2
Number of Credits			18
SEMESTER II			
1	UG184911	Pancasila	2
2	KM184202	Mathematic II	3
3	SF184202	Physic II	3
4	UG184914	English	2
5	TK184201	Introduction to Industrial Chemistry	2
6	TK184202	Analytical Chemistry	4
7	TK184203	Data Processing and Analysis	2
Number of Credits			18
SEMESTER III			
1	TK184301	Chemical Engineering Thermodynamics I	3
2	TK184302	Organic Chemistry	4
3	TK184303	Chemical Engineering Principles I	3
4	TK184304	Momentum Transfer	3
5	TK184305	Physical Chemistry	4
Number of Credits			17

SEMESTER IV			
1	TK184401	Industrial Microbiology	3
2	TK184402	Chemical Engineering Mathematics	4
3	TK184403	Chemical Engineering Principles I	3
4	TK184404	Unit Operations I	3
5	TK184405	Chemical Engineering Thermodynamics II	3
6	TK184406	Mass and Heat Transfers	3
Number of Credits			19
SEMESTER V			
1	TK184501	Chemical Reaction Engineering I	3
2	TK184502	Chemical Engineering Application I	2
3	TK184503	Unit Operations II	3
4	TK184504	Construction Materials	2
5	TK184505	Chemical Equipment Design	4
6	TK184604	Chemical Engineering Numerical Computation	3
Number of Credits			17
SEMESTER VI			
1	TK184601	Chemical Reaction Engineering II	3
2	TK184602	Chemical Engineering Application II	2
3	TK184603	Unit Operations III	3
4	TK184605	Process Dynamic and Control	4
5	TK18460x	Elective I	2
6	UG184916	Concept and Application Technology	3
Number of Credits			17
SEMESTER VII			
1	TK184701*	Industrial Waste Treatment	3
2	TK184702	Synthesis and Process Simulation	3
3	TK184703	Plant Design and Economic	4
4	TK184704	Research Project	6
5	TK18470x	Elective II	4
Number of Credits			20
SEMESTER VIII			
1	TK184801*	Chemical Plant Safety	3
2	TK184802	Practical Field Work	2

3	TK184803	Plant Design Project	6
4	TK184804	Plant Utility System	2
5	xxxxxxxx	Enrichment Course	3
6	UG184915	Technopreneurship	2
Number of Credits			18
Total Credits			**144**

LIST of ELECTIVE COURSES

No.	Course Code	Course Name	Credit
Elective I			
1	TK184606	Energy Technology	2
2	TK184607	Aerosol Technology	2
3	TK184608	Lipids Technology	2
4	TK184609	Project Management	2
5	TK184610	Introduction to Combustion Engineering	2
6	TK184611	Supercritical Technology	2
7	TK184612	Air Pollution Control	2
8	TK184613	Separation Column Design	2
9	TK184614	Membrane Technology	2
Elective II			
1	TK184705	Separation Technology	4
2	TK184706	Solid and Toxic and Hazardous Waste Management	4
3	TK184707	Essential Oil Processing	4
4	TK184708	Heterogeneous Catalyst	4
5	TK184709	Polymer Technology	4
6	TK184710	Biorefinery & Bioconversion of Biomass	4
7	TK184711	Natural Gas Processing Technology & HYSYS application	4
8	TK184712	Biochemical and Food Technology	4
9	TK184713	Electrochemical and Nanomaterial Engineering	4
10	TK184714	Process Design and Integration	4
11	TK184715	Fluid Mixing Technology	4

Elective III: Enrichment Course.

*: Enrichment course opened in Chemical Engineering Department.

COURSE	Course Name	:	**Introduction to Chemical Engineering**
	Course Code	:	TK 184101
	Credit	:	2 SKS
	Semester	:	I

DESCRIPTION of COURSE
Study the history and role of chemical engineering; The professions of chemical engineers; Introduction to basics of chemical engineering.

LEARNING OUTCOME
1.1 Engineering sciences, engineering principles, and engineering designs required for the analysis and design of processes, processing systems and equipment necessary to convert raw materials into value-added products by chemical, physical and biological processes; 2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems in processes, processing systems, and equipment necessary to convert raw materials into value-added products with chemical, physical and biological processes; 3.1 Able to apply logical, critical, systematic, and innovative thinking in the context of development or implementation of science and technology that cares and implements the humanities value appropriate to their area of expertise; 4.1 Demonstrate a responsible attitude towards the work in the field of expertise independently.

COURSE LEARNING OUTCOME
Students must be able to : 1. understand the history and role of chemical engineering; 2. understand and analyze professions of chemical engineers; 3. analyze all basics of chemical engineering.

MAIN SUBJECT
1. The history and role of chemical engineering

2. The professions of chemical engineers
3. Chemical process analysis (unit processes and unit operations)
4. Chemical process analysis (mass and energy balance)
5. Fluid flow
6. Heat transfer
7. Mass transfer
8. Chemical Engineering Thermodynamics
9. Chemical Reaction Engineering
10. Separation Process

PREREQUISITES

None

REFERENCE

1. Ghoshal, S.K., Sanjal, S.K. dan Datta, S. (2017): Introduction to Chemical Engineering. Tata McGraw-Hill Publication
2. Pusphavanam, S. (2012): Introduction to Chemical Engineering. PHI Learning Private.
3. Felder, R.M. dan Rosseau, R.W. (2005): "Elementary Principles of Chemical Process, ", 3rd Edition, John Wiley and Sons, New Jersey.
4. Himmelblau, D.M. (2003): Basic Principles and Calculation in Chemical Engineering, 7th Edition, Prentice Hall.

COURSE	Course Name	:	**Introduction to Industrial Chemistry**
	Course Code	:	TK184201
	Credit	:	2 SKS
	Semester	:	II

DESCRIPTION of COURSE

Study the history and characteristics of industry; Domestic and global chemical industry, Raw material of chemical industry; Organic chemical industry, Inorganic chemical industry, Energy sources of chemical industry, Economic aspects, Environmental and safety aspects.

LEARNING OUTCOME

1.1 Engineering sciences, engineering principles, and engineering designs required for the analysis and design of processes, processing systems and equipment necessary to convert raw materials into value-added products by chemical, physical and biological processes.

2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems in processes, processing systems, and equipment necessary to convert raw materials into value-added products with chemical, physical and biological processes.

3.1 Able to apply logical, critical, systematic, and innovative thinking in the context of development or implementation of science and technology that cares and implements the humanities value appropriate to their area of expertise.

4.1 Demonstrate a responsible attitude towards the work in the field of expertise independently.

COURSE LEARNING OUTCOME

Students must be able to understand and analyze about : History and characteristics of industry; Domestic and global chemical industry, Raw material of chemical industry; Organic chemical industry, Inorganic chemical industry, Energy sources of chemical industry, Economic aspect, Environmental and safety aspects.

MAIN SUBJECT
1. History and Characteristics of Industry; 2. Domestic and Global Chemical Industry; 3. Raw Material of Chemical Industry; 4. Organic Chemical Industry; 5. Inorganic Chemical Industry; 6. Energy Sources of Chemical Industry; 7. Economic Aspects; 8. Environmental and Safety Aspects
PREREQUISITES
TK184201 Introduction to Chemical Engineering (Minimum D)
REFERENCE
1. Heaton, A. (1996): *An Introduction to Industrial Chemistry*. Springer-Science+Business Media, B.V., Ed. 3 2. Austin, G.T. (1984): *Shreve's Chemical Process Industries*. McGraw-Hill Book Company, Ed.5. 3. Wittcoff, H.A. dan Reuben, B.G. (1996): *Industrial Organic Chemical*. John Wiley & Sons, Inc, New York.

COURSE	Course Name	:	**Analytical Chemistry**
	Course Code	:	TK184203
	Credit	:	4 SKS
	Semester	:	II

DESCRIPTION of COURSE
This course learns about qualitative and quantitative analysis methods, and also analysis methods conventionally and instrumentational. The subject studied included various analytical methods, acid-base equilibrium theory, precipitation and solubility products, complex ion-forming reactions, and redox reactions, volumetric, gravimetric, potentiometric, spectroscopic, and chromatographic methods. Following this course, students are able to apply the basics of qualitative and quantitative analysis to determine the composition of raw materials and products, both using conventional means and instrumentation that can be done independently or teamwork.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes.
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes.
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes.
1.4 Communication techniques and cutting-edge technologies.
2.1 Able to select appropriate resources and make use of design devices and appropriate IT-based engineering analysis to assist in engineering activities of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes.
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise.

3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility.
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently.
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

The learning outcome of this course is to be able to apply the basics of qualitative and quantitative analysis to determine the composition of raw materials and products, both using conventional means and instrumentation that can be done independently or teamwork.
Sub-learning outcome of this course:

1. Students are able to explain the various methods of analysis.
2. Students are able to apply the acid-base equilibrium theory, solubility product, formation of complex ions, redox reactions in volumetric titration.
3. Students are able to distinguish various kinds of volumetric analysis methods.
4. Students are able to apply gravimetric analysis methods.
5. Students are able to apply potentiometric and potentiometric titration.
6. Students are able to apply the spectroscopy method in quantitative analysis.
7. Students are able to apply the chromatography analysis method.

MAIN SUBJECT

1. The types of various analytical method.
2. Equilibrium theory of acid-base, precipitation, complex ion formation, and reduction-oxidation reaction.
3. Method of volumetric analysis.
4. Method of gravimetric analysis.
5. Method of potentiometric analysis.
6. Method of spectrometric analysis.
7. Method of chromatographic analysis

PREREQUISITES

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REFERENCE

1. Harris, D. C., "Quantitative Chemical Analysis", 7th ed., W.H. Freeman and Company, New York, 2007
2. Cristian, Gary D., Dasgupta, P. K., Schug, K. A., "Analytical Chemistry", 7th ed., John Wiley & Sons., Inc., 2014
3. Harvey, D, "Modern Analytical Chemistry", MacGraw-Hill Companies, Inc., 2000
4. Svehla, G, "Vogel`s Textbook of Macro and Semi – Micro Qualitative Inorganic Analysis", 5th ed, 1982.
5. Day, RA Jr & Underwood, AL. "Quantitative Analysis", 6th ed, 1991

COURSE	Course Name	:	**Data Processing and Analysis**
	Course Code	:	TK184203
	Credit	:	2 SKS
	Semester	:	II

DESCRIPTION of COURSE
This course studies to understand descriptive statistics, probability theory, probability distribution, sampling distribution, hypothesis testing, statistical models (linear and multiple regression), and experimental design (recognition). With learning methods include lectures, discussions, case studies, problem-based learning, writing examination, (including quiz, assignments and EAS).

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes.
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes.
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes
1.4 Principles and the latest issues in economy, social, general ecology
1.5 Communication techniques and cutting-edge technologies
2.1 Able to do research that includes identification, formulation, and analysis on engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;

4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently

COURSE LEARNING OUTCOME

1. Being able to understand descriptive statistics covering the concept and way of presenting the data
2. Being able to understand probability theory, probability distribution, and sampling distribution
3. Being able to perform hypothesis testing either one sample or two samples in the population
4. Being able to build model of regression equation both linear and multiple
5. Being able to understand the experimental design.

MAIN SUBJECT

1. Descriptive statistics
2. Inference statistics
3. Statistics model
4. Design of engineering experiments.

PREREQUISITES

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REFERENCE

1. Sudjana, "Metode Statistika (Statistical Methods)", Erlangga, 1984
2. Montgomery, D.C., Runger, G.C., Hubele, N.F, "Engineering Statistics", 3rd ed, John Wiley & Sons Inc., New York, 2004
3. Ronald E. Walpole, Raymond H.Myers, *"Probability and Statistics for Engineers and Scientist"*, 4th ed., MacMilan Publishing Co., London, 1989.
4. G.E.P. Box, W.G. Hunter, J.S. Hunter, *"Statistics for Experimenters"*, John Wiley, New York, 1978.
5. Himmelblau, D.M., *"Process Analysis by Statistical Methods"*, John Wiley, New York, 1970.

COURSE	Course Name	:	**Chemical Engineering Thermodynamics I**
	Course Code	:	TK184301
	Credit	:	3 SKS
	Semester	:	III

DESCRIPTION of COURSE
This course learns about solving unit operation problems by integrating first and second law of thermodynamics; application equation of states (EoS) accurately in calculation of thermodynamic properties of pure fluids and understand the limitation of EoS used; calculation the heat effects occurred in industry associated by chemical reaction, sensible and phase transition; understanding the role of chemical engineering thermodynamic in process simulation. Teaching methods include introductory courses; Brainstorming; Examination (Quiz, etc, Final Exam) and group discussion.

LEARNING OUTCOME
1.1 Comprehend of engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Comprehend of natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Comprehend of process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Able to understand the principles and the latest issues in economy, social, general ecology;
1.5 Comprehend of communication techniques and cutting-edge technologies
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;

3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.
4.2 Trying his/her best to achieve perfect results.

COURSE LEARNING OUTCOME

1. Being able to solve unit operation problems by integrating first and second law of thermodynamics.
2. Being able to apply equation of states (EoS) accurately in calculation of thermodynamic properties of pure fluids and understand the limitation of EoS used.
3. Being able to calculate the heat effects occurred in industry associated by chemical reaction, sensible and phase transition.
4. Fully understands the role of chemical engineering thermodynamic in process simulation.

MAIN SUBJECT

1. The first and second laws of thermodynamics and their application in closed and open systems (steady state and unsteady state processes)
2. Concept of ideal and real gases, fluids and equation of state models
3. Thermodynamic network (combining the first and second laws)
4. Heat effects due to reaction, sensible and phase transition
5. Entropy balance and lost work
6. Carnot cycle, production of power from heat, refrigeration and liquefaction.
7. Introduction to commercial software (Aspen HYSYS 7) for process simulation (practice).

PREREQUISITES

None

REFERENCE

1. Smith, J. M., Van Ness, H.C., Abbott, M. M.,"Introduction to Chemical Engineering Thermodynamics" 6th ed., McGwaw-Hill Co-Singapore (2001).
2. Wibawa, G., Pengantar Thermodinamika untuk aplikasi pada Industri Kimia, ITS-Press, Surabaya 2017

3. Poling, B. E., Prausnitz, J. M., O'Connell, " The properties of gases and liquids fifth edition, McGraw-Hill, (2001).
4. Winnick, J., "Chemical Engineering Thermodynamics", John Wiley & Sons, Inc., USA (1997).
5. Relevance Journals

COURSE	Course Name	:	**Organic Chemistry**
	Course Code	:	TK184302
	Credit	:	4 SKS
	Semester	:	III

DESCRIPTION of COURSE
This course studies to understand the radius of atoms, chemical bonds, orbitals in covalent bonds, structural isomers, stereochemistry, substitution and elimination reactions, free radical reactions, aldehydes and ketones, carboxylic acids, carboxylic acid derivatives, enolates and carbonions, amines, aromatic heterocyclic and polycyclic, amino acids and proteins, carbohydrates and lipids. With learning methods include lectures, discussions, case studies, problem-based learning, writing examination, (including quiz, assignments and EAS)

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies.
2.1 Able to do research that includes identification, formulation, and analysis on engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;

3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently

COURSE LEARNING OUTCOME

1. Being able to understand atoms and molecules include radius of atoms, chemical bonds, orbital in covalent bonds, structural isomers
2. Being able to understand about stereochemistry, substitution and elimination reactions, and free radical reactions
3. Being able to understand the properties and reactions in the aldehyde and ketone groups, carboxylic acids, carboxylic acid derivatives, enolates and carbonions, amines, heterocyclic aromatics and polycyclic
4. Being able to understand the properties and reactions that occur in amino acids and proteins, carbohydrates and lipids

MAIN SUBJECT

1. Radius of atoms and chemical bonds
2. Orbitals in covalent bonds and structural isomers
3. Stereochemistry
4. Substitution and elimination reactions
5. Free radical reactions
6. Aldehydes and ketones
7. Carboxylic acids and carboxylic acid derivatives
8. Enolates and carbonions
9. Amines and aromatic heterocyclic and polycyclic
10. Amino acids and proteins, carbohydrates, lipids.

PREREQUISITES

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REFERENCE

1. Fessenden, Ralph and Joan. "*Organic Chemistry I & II"*, University of Montana, 6th ed, 1998
2. Pine, Stanley; Hendricson, James; Cram J, Donald; Hammond S, George. "*Organic Chemistry"*, 4th ed, International Student Ed, Mc Graw Hill Book Comp, 1986.
3. Meislich, Herbert et al. "*Theory and Problems of Organic Chemistry"*, Schaum Outline Series, Mc Graw Hill Book, New York, 1980

4. Peter Sybes, *Penuntun Mekanisme Reaksi Kimia Organik*, Edisi 6, penerbit PT Gramedia, Jakarta, 1989.

COURSE	Course Name	:	**Chemical Engineering Principle I**
	Course Code	:	TK184303
	Credit	:	3 SKS
	Semester	:	III

DESCRIPTION of COURSE
This course explains the fundamentals of strong skills and knowledge to formulate and solve material balance problems as well as physical and chemical properties of fluids. This course also introduces an efficient, meticulous and sophisticated spreadsheet-based software method for students to analyze data and solve material balance problems.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies.
2.1 Able to do research that includes identification, formulation, and analysis on engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;

4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently

COURSE LEARNING OUTCOME

1. Able to understand the basics of calculation in the field of chemical engineering.
2. Able to apply basic calculations in the field of chemical engineering for single units without chemical reactions.
3. Able to apply the basics of calculation in the field of chemical engineering for single units by chemical reactions.
4. Able to resolve the material balance problem for complex systems or for systems consisting of multiple units.
5. Able to understand the physical and chemical properties of fluids to solve the mass and energy balance and multi-phase systems.
6. Able to apply the basics of mass balance and phase equilibrium using sophisticated techniques based on spreadsheet software.

MAIN SUBJECT

1. Units and dimensions.
2. The concept of mass balance.
3. Base calculation.
4. Mass balance for single unit without chemical reaction.
5. Mass balance for single unit with chemical reaction and stoichiometry.
6. Mass balance for unit system consisting of many units.
7. Physical and chemical properties of fluid.

PREREQUISITES

1. TK184101 Introduction to Chemical Engineering (Min. D)
2. TK184201 Introduction to Industrial Chemistry (Min. D)

REFERENCE

1. Felder, R. M., & Rousseau, R. W. (2005). *Elementary Principles of Chemical Processes* (3 ed.). Wiley.
2. Himmelblau, D. M., & Riggs, J. B. (2012). *Basic Principles and Calculations in Chemical Engineering* (8 ed.). Prentice Hall.
3. Hougen, O. A., Watson, K. M., & Ragatz, R. A. (1954). *Chemical process principles. Part 1, Material and Energy Balances* (2ed.). Wiley.
4. Reklaitis, G. V. (1983). *Introduction to Material and Energy Balances.* Wiley.

COURSE	Course Name	:	**Momentum Transfer**
	Course Code	:	TK184304
	Credit	:	3 SKS
	Semester	:	III

DESCRIPTION of COURSE

Study the analogy of heat, mass and momentum tranfer; Fluids and transport properties; Fluid statics; Momenturm transfer macroscopic dan microscopis; and Dimensional analysis.

LEARNING OUTCOME

1.1 Engineering sciences, engineering principles, and engineering designs required for the analysis and design of processes, processing systems and equipment necessary to convert raw materials into value-added products by chemical, physical and biological processes.

2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems in processes, processing systems, and equipment necessary to convert raw materials into value-added products with chemical, physical and biological processes.

3.1 Able to apply logical, critical, systematic, and innovative thinking in the context of development or implementation of science and technology that cares and implements the humanities value appropriate to their area of expertise.

4.1 Demonstrate a responsible attitude towards the work in the field of expertise independently.

COURSE LEARNING OUTCOME

Students must be able to understand and analyze: analogy of heat, mass and momentum tranfer; Fluids and transport properties; Fluid statics; Momenturm transfer macroscopic dan microscopis; and Dimensional analysis.

MAIN SUBJECT

1. Analogy of Heat, Mass and Momentum Tranfer;
2. Fluids and Transport Properties;
3. Fluid Statics;
4. Momenturm Transfer Makroskopis dan Mikroskopis;

5. Dimensional Analysis

PREREQUISITES

KM184101 Mathematics I (Min. D)
KM184202 Mathematics II (Min. D)

REFERENCE

1. Altway, A., Winardi, S. and Setyawan, H. (2012): Proses Perpindahan, ITS Press, Surabaya
2. Geankoplis, C.J. (2003): Transport Processes and Unit Operations, 3rd Edition, Prentice Hall
3. Brodkey, R.S. and Hershey (1989): Transport Phenomena, A Unified Approach, Int. Edition, McGraw Hill.
4. de Nevers, N. (1991): Fluid Mechanics for Chemical Engineers, 2nd Edition, McGraw Hill International
5. Welty, J.R., Wicks, C.E., Wilson, R.E. dan Rorrer, G.L. (2007): Fundamentals of Momentum, Heat, and Mass Transfer, 5th Edition, John Wiley & Sons, Inc.

COURSE	Course Name	:	**Physical Chemistry**
	Course Code	:	TK184305
	Credit	:	4 SKS
	Semester	:	III

DESCRIPTION of COURSE
This course studies the phenomenon of physical change including the substance matter and the phase transition, theory kinetic of gases, transport processes, solution, electrochemistry, surface phenomenon and interface. After following this course, students are able to analyze the form of substances and physical changes as well as mixed system of substances related to the physical properties of the substance which can be done independently or in team.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies.
2.1 Able to do research that includes identification, formulation, and analysis on engineering problems of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;

3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

The learning outcome of this course is the students are expected to be able to analyze the form of substances and phase transition, as well as mixed system of substances related to the physical properties of the substance that can be done independently or teamwork.
Sub-learning outcome of this course:

1. Students are able to analyze the form of substances and physical properties.
2. Students are able to explain the relation of theory kinetics of gases with gas and liquid properties and their transport properties.
3. Students are able to distinguish the properties of non-electrolyte solution and electrolyte solution.
4. Students are able to identify the electrochemical systems.
5. Students are able to analyze the properties of substances based on the surfaces and interfaces, adsorption, and colloid.

MAIN SUBJECT

1. Substances of matters.
2. Theory kinetics of gases.
3. Solution.
4. Electrochemistry.
5. Surfaces and interfaces, adsorption, and colloids.

PREREQUISITES

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REFERENCE

1. Setyawan, H., “Kimia Fisika”, ITSPress, 2013
2. Levine, I., Physical Chemistry, Mc Graw Hill, 6th ed., 2008
3. Maron, S. H, and Lando, J. B., Fundamentals of Physical Chemistry, Mac Millan Publishing Co. Inc., New York., 1975
4. Bahl, B. S., Tuli, G. D., and Bahl, A., Essensial of Physical Chemistry, S Chand & Co. Ltd., 2000.

COURSE	Course Name	:	**Industrial Microbiology**
	Course Code	:	TK184401
	Credit	:	3 SKS
	Semester	:	IV

DESCRIPTION of COURSE
The subject studies the characteristic of microbe, developing and utilizing of microbes for industrial purpose, classification of microbe, media and nutrition, physical and chemical control of growth of microbes, enzyme and its metabolism, biochemical process in microorganism, microorganism in extreme condition; use of microscope to determine the characteristic of microbes, colony and yeast, media sterilization, isolation of microbes, Fermentation process. The methods consist of lecture, presentation, group discussion, written examination (quiz, assignment and final exam).

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies.
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;

3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

Students understand the basic of microbiology of industrial importance, and have skill to do basic treatment of microorganism such as isolation technique, sterilization, cell counting and simple fermentation process.

MAIN SUBJECT

1. Introduction to microbiology, morphology, characterization and classification of microorganism, media and nutrition
2. Physical and chemical control of microbial growth, Enzyme and metabolism.
3. The use of microscope to determine characteristic of microbes, colony, yeast and to identify bacteria.
4. Sterilization, Media, isolation of microbes, biochemical test, fermentation process.

PREREQUISITES

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REFERENCE

1. Tortora, Funke, Case: Microbiology. An Introduction, 9th ed., Pearson International Edition, 2007.
2. Pelezar M, Chan and Krieg, *"Microbiology",* 5th ed., Mc Graw Hill, New York, 1986.
3. Eugene W. Nester., *"Experiments in Mikrobiology",* 1978
4. 4. Casida, L.E., *"Industrial Microbiology",* John Wiley, New York, 1978.

Course	Course Name	:	**Chemical Engineering Mathematics**
	Course Code	:	TK184402
	Credit	:	4 SKS
	Semester	:	IV

DESCRIPTION OF COURSE
Chemical Engineering Mathematics is one of core courses in chemical engineering department. This course provides method to develop mathematical model or mathematical formulation for physical and chemical processes or problems and to solve the problem using known mathematical method or mathematical method to be described in this course. Basically this course will provide student with knowledge and competence to solve physical-chemical problems mathematically. Learning methods comprise lecture, tutorial and discussion, assignments, quizs and exam.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Communication techniques and cutting-edge technologies.
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;

3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

1. Student being able to formulate chemical engineering problems into mathematical problems
2. Student being able to solve ordinary first order differential equation problems derived from mathematical formulation of physical-chemical problems
3. Student being able to solve ordinary n-order differential equation and system of simultaneous ordinary first order differential equations derived from mathematical formulation of physical-chemical problems
4. Student understand the meaning of Laplace Transform, being able to determine Laplace Transform of a given function (in time) and being able to solve ordinary differential equation problem using Laplace Transform Method
5. Student understand the meaning of Fourier Series, and being able to determine Fourier series of a given periodic function
6. Student understand the meaning of power series
7. Student being able to solve second order ordinary differential equation with variable coefficient using power series
8. Student being able to solve second order ordinary differential equation with variable coefficient using Frobenius method
9. Student identify Bessel equation and being able to solve second order ordinary differential equation with variable coefficient in term of Bessel function
10. Student can identify special functions and being able to evaluate definite or improper integral in term of special function
11. Student can identify some problem types of Partial Differential Equation
12. Student being able to solve Partial Differential Equation Problems using Fourier Method, Laplace Transform Method, and Combination of Variable Method
13. Student being able to solve multiple (double and triple) integral problem
14. Student being able to apply multiple integral theory to determine volume and mass of a rigid body, area and mass of a slab, center of mass of a rigid body or a slab, area of curve surface, and moment inertia of a rigid body or a slab
15. Student being able to formulate stage wise process model

16. Student being able to solve stage wise process model problem using finite difference calculus.

MAIN SUBJECT

1. Mathematical Modelling,
2. Ordinary Differential Equation,
3. Special Function,
4. Laplace Transform,
5. Fourier Series,
6. Partial Differential Equation,
7. Multiple Integral,
8. Stage wise Process Model and Finite Difference Calculus.

PREREQUIZITES

KM184101 Mathematic I (Min. D)
KM184202 Mathematic II (Min. D)

REFERENCES

1. Ali Altway, Margono, Lindu Sunarko, Heru Seyawan, Setiyo Gunawan, Tantular Nurtono,*Matematika Teknik Kimia",*ITS Press, Surabaya, 2015
2. Rice, R.G. and Do, D.D.,*Applied Mathematics and Modeling for Chemical Engineers, John Wiley & Sons (1995).*
3. Mickley, H.S., T.S. Sherwood and C.E.Reed , *Applied Mathematics in Chemical Engineering,* Mc Graw Hill, New York, 1984
4. Jenson, V.G. and G.V.Jeffrey, *Mathematical Methods in Chemical Engineering*, Academic Press, London, 1977

COURSE	Course Name	:	**Chemical Engineering Principle II**
	Course Code	:	TK184403
	Credit	:	3 SKS
	Semester	:	IV

DESCRIPTION of COURSE
This course explains strong skills and knowledge to formulate and solve energy balance problems as well as integration between the balance of mass and energy. Students are educated to be able to apply sophisticated methods based on spreadsheets and chemical engineering process simulation software to solve complex problems as well as the balance of material and energy to be solved simultaneously.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies.
2.1 Able to do research that includes identification, formulation, and analysis on engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;

4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

1. Able to understand the concept of energy balance.
2. Able to apply energy balance concept for system without chemical reaction
3. Able to apply the concept of energy balance for the system with chemical reactions.
4. Able to apply the concept of problem solving to solve mass and energy balance simultaneously.
5. Able to apply the concept of material and energy balance problem to solve complex problems.
6. Able to apply energy balance concepts to complex systems using advanced techniques based on spreadsheet software and chemical engineering process simulator software.

MAIN SUBJECT

1. The concept of energy balance
2. Energy balance for systems without chemical reactions
3. Energy balance for the System by chemical reaction
4. Simultaneous problem solving method of material and energy balance.
5. Material and energy balance for complex system.

PREREQUISITES

1. TK184303 Chemical Engineering Principle I (Min. D)
2. TK184305 Physical Chemistry (Min. D)
3. TK184301 Chemical Engineering Thermodynamics I (Min. D)

REFERENCE

1. Felder, R. M., & Rousseau, R. W. (2005). *Elementary Principles of Chemical Processes* (3 ed.). Wiley.
2. Himmelblau, D. M., & Riggs, J. B. (2012). *Basic Principles and Calculations in Chemical Engineering* (8 ed.). Prentice Hall.
3. Hougen, O. A., Watson, K. M., & Ragatz, R. A. (1954). *Chemical process principles. Part 1, Material and Energy Balances* (2ed.). Wiley.
4. Reklaitis, G. V. (1983). *Introduction to Material and Energy Balances.* Wiley.

COURSE	Course Name	:	**Unit Operations I**
	Course Code	:	TK184404
	Credit	:	3 SKS
	Semester	:	IV

DESCRIPTION of COURSE

Stydy Pipe fluid flow; Measurement of fluid flow: Equipment of fluid transporta-tion; Agitation and mixing of liquid; Flow past a submerged objects; Fixed and fluidized bed: Mechanical-physical separation of solid-liquid: Size reduction of particle solid: Solid-solid mixing.

LEARNING OUTCOME

1.1 Engineering sciences, engineering principles, and engineering designs required for the analysis and design of processes, processing systems and equipment necessary to convert raw materials into value-added products by chemical, physical and biological processes;

2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems in processes, processing systems, and equipment necessary to convert raw materials into value-added products with chemical, physical and biological processes;

3.1 Able to apply logical, critical, systematic, and innovative thinking in the context of development or implementation of science and technology that cares and implements the humanities value appropriate to their area of expertise;

4.1 Demonstrate a responsible attitude towards the work in the field of expertise independently.

COURSE LEARNING OUTCOME

Students must be able to understand and analyze problems : pipe fluid flow, measurement of fluid flow, equipment of fluid transportation, agitation and mixing liquid, flow past a submerged objects, fixed and fluidized bed, mechanical-physical separation of solid-liquid, size reduction of particle solid, solid-solid mixing.

MAIN SUBJECT

1. Pipe fluid flow
2. Measurement of fluid flow
3. Equipment of fluid transportation
4. Agitation and mixing of liquid
5. Flow past submerged objects
6. Fixed bed and fluidized bed
7. Mechanical-physical solid-liquid separation
8. Size reduction of particle solid and classification
9. Solid-solid mixing

PREREQUISITES

TK184304 Momentum Transfer (Min. D)

REFERENCE

1. Geankoplis, C.J.,Hersel , A.H. dan Lepek, D.H. (to be release in 2018): Transport Processes and Separation Process Principles (5th Edition). Prentice Hall International
2. Geankoplis, C.J. (1993): Trasport Processes and Unit Operations. 3rd Edition. Pearson College Div
3. Geankoplis, C.J. (2003): Transport Processes and Separation Process Principles (Includes Unit Operations). 4th Edition. Prentice Hall.
4. McCabe, W., Smith, J. and Harriot, P.(2003): Unit Operations of Chemical Engineering. McGraw-Hill Education.

COURSE	Course Name	:	**Chemical Engineering Thermodynamics II**
	Course Code	:	TK184405
	Credit	:	3 SKS
	Semester	:	IV

DESCRIPTION of COURSE
This course learns about the Introduction of Vapor-Liquid Equilibrium (VLE) and simple models for VLE such as Raoult's Law, Henry's Law and Raoult's Law application on real gas and real solutions. Calculation methods of VLE: BUBL, DEW and Flash calculations, Theory of Thermodynamics solution and its application to VLE, Approach methods in VLE calculation (activity coefficients and equations of state), Introduction to Liquid-Liquid Equilibrium (LLE) and Vapor-Liquid-Liquid Equilibrium (VLLE), Introduction to Thermodynamics for polymer-containing systems, Introduction to commercial software use (ASPEN HYSYS). The learning methods include: introductory courses; group discussion; brainstorming; exercises, writing exams, practices (including presentation and simulation software).

LEARNING OUTCOMES
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies.
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and

technology that concerns and implements the value of humanities in accordance with their area of expertise;

3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;

3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;

4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOMES

The Students are able to

1. Calculate the solution properties and the phase equilibria with appropriate thermodynamic models.
2. Correlate experimental data with thermodynamic models.
3. Understand the limitations of thermodynamic models
4. Know the application of thermodynamic models in the process simulation (ex: HYSYS).

MAIN SUBJECTS

1. Introduction to Vapor-Liquid Equilibrium (VLE) and simple models for VLE, ex Raoult's Law, Henry's Law and Raoult's Law application on real gas and real solutions.
2. Calculation methods of VLE: BUBL, DEW, and Flash
3. The basic theory of the solution and its application for the phase equilibrium
4. The approach methods in VLE calculation (activity coefficients and equations of state)
5. Introduction to Liquid-Liquid Equilibrium (LLE) and Vapor-Liquid-Liquid Equilibrium (VLLE)
6. Introduction to Thermodynamics for the systems containing polymers
7. Practice using Aspen HYSYS 7 software.

PREREQUISITE

TK184301 Chemical Engineering Thermodynamics I (Minimum D)

REFERENCES

1. Smith, J. M., Van Ness, H.C., Abbott, M. M.,"Introduction to Chemical Engineering Thermodynamics" 6th ed., McGwaw-Hill Co-Singapore (2001).

2. Poling, B. E., Prausnitz, J. M., O'Connell, "The properties of gases and liquids fifth edition, McGraw-Hill, (2001).
3. Winnick, J., "Chemical Engineering Thermodynamics", John Wiley & Sons, Inc., USA (1997).
4. Modell, M., Reid, R. C., "Thermodynamics and its Aplications", Prentice-Hall International, INC., USA (1974).

Course	Course Name	:	**Mass and Heat Transfer**
	Course Code	:	TK184406
	Credit	:	3 SKS
	Semester	:	IV

DESCRIPTION OF COURSE
Mass and Heat Transfer is one of core courses in chemical engineering department. The course will give an introductory treatment of the governing laws for heat and mass transfer to be applied in chemical industrial equipment's unit operation calculation. Learning method and activities comprises lecture, tutorial (discussion), exercises, quiz and exam.

LEARNING OUTCOMES
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Communication techniques and cutting-edge technologies.
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOMES
1. Student understand several mechanism of heat transfer 2. Student understand rate law to determine heat transfer rate with mechanism of conduction and convection 3. Student being able to solve one dimension heat transfer problem using combination of rate law and conservation law in shell balance 4. Student being able to solve two dimension conduction heat transfer problem and unsteady state one dimension conduction heat transfer problem 5. Student understand the meaning of equation of change and equation of energy 6. Student being able to simplify equation of energy to solve 1-D steady state conduction heat transfer problem 7. Student understand the definition of heat transfer coefficient 8. Student being able to determine the value of forced and natural convective heat transfer coefficient without phase change 9. Student being able to determine condensing and boiling heat transfer coefficient. 10. Student understand mechanism of radiation heat transfer and understand rate law to determine radiation heat transfer flux 11. Student understand view factor and being able to determine radiation heat transfer flux between two bodies with various geometries 12. Student understand the mechanism of mass transfer 13. Student understand rate law to determine diffusive and convective mass transfer rate 14. Student being able to solve mass transfer problem using rate law and conservation law in shell balance for 1-D system 15. Student being able to solve steady state 2-D diffusive mass transfer problem and unsteady state 1-D diffusive mass transfer problem 16. Student understand the meaning of equation of change and component continuity equation 17. Student being able to simplify component continuity equation to solve 1-D steady state diffusive-convective mass transfer problem 18. Student understand the meaning and definition of mass transfer coefficient for unicomponent and equimolar counter diffusion case 19. Student being able to determine the value of mass transfer coefficient for various geometries and being able to solve various interface mass transfer problems.
MAIN SUBJECT
1. Molecular Heat Transfer (conduction) and Shell Balance,

2. Energy Equation,
3. Interphase Heat Transfer (Heat Transfer Coefficient),
4. Radiation,
5. Molecular Mass Transfer (Diffusion) and Shell Balance,
6. Component Continuity Equation,
7. Interphase Mass Transfer (Mass Transfer Coefficient)

PREREQUIZITE

TK184304 Momentum Transfer (Minimum D)

REFERENCES

1. Ali Altway, Sugeng Winardi, Heru Seyawan,*Proses Perpindahan*,ITS Press, Surabaya, 2012
2. C.J. Geankoplis: "*Transport Processes and Unit Operations"*, Prentice Hall, 4th edition.
3. Bird, R.B., Stewart, W.E., Lightfoot, E.N., "*Transport Phenomena*", John Wiley & Sons, Singapore, edisi 1(1960) atau edisi 2 (2002).
4. Brodkey R.S. and H.C. Hershey: *Transport Phenomena :"A Unified Approach",* McGraw Hill, 1988Rice, R.G. and Do, D.D.,*Applied Mathematics and Modeling for Chemical Engineers, John Wiley & Sons (1995).*

COURSE	Course Name	:	**Chemical Reaction Engineering I**
	Course Code	:	TK184501
	Credits	:	3 SKS
	Semester	:	V

DESCRIPTION of COURSE
This course studies the understanding of kinetics of reactions and designing reactors including Kinetics of homogeneous reactions; Interpretation of batch reactor data; Single and double ideal flow reactor design; The flow reactor is ideal for single reactions and multiple reactions; Effect of temperature and pressure.

LEARNING OUTCOME
1.1 engineering sciences, engineering designs and engineering designs necessary for the analysis and design of processes, systems of furnishings, and equipment necessary to convert raw materials into value-added products by chemically processing, physics and biology
1.2 the concept of natural science and the principles of application of engineering mathematics to the analysis and design of processes, processing systems, and equipment necessary to convert raw materials into value-added products by chemical, physical and biological processes.
1.3 principles and techniques of process design, processing systems and equipment necessary to convert raw materials into value-added products by chemical, physical and biological processes
1.4 principles and issues in economics, social, ecology in general
1.5 communication techniques and latest and latest technological developments
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;

4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.
COURSE LEARNING OUTCOME
Students are able to understand the reaction kinetics and design a homogenous chemical reactor
MAIN SUBJECT
1. Homogeneous Reaction Kinetics 2. Interpretation of batch reactor data. 3. Single and double ideal flow reactor design 4. The ideal flow reactor for single reaction and double reaction 5. 5. Effect of temperature and pressure
PREREQUISITES
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MAIN REFERENCE
1. Octave Levenspiel, " *Chemical Reaction Engineering*" , 3rd Ed. McGraw-Hill, 2000Fogler," *Elements of Chemical Reaction Engineering* ", 3rd ed,Prentice-Hall, 1999. 2. Gilbert F.Froment, Kenneth B.Bischoff,"*Chemical Reactor Analysis and Design",* 2nd ed, John Wiley & Sons, 1990
SUPPORTING REFERENCE
J.M.Smith, "*Reaction Kinetics*" 3rd ed, McGraw-Hill,1982

Course	Course Name	:	**Chemical Engineering Application I**
	Course Code	:	TK184502
	Credit	:	2 SKS
	Semester	:	V

DESCRIPTION OF COURSE
The course explains fundamental of chemical engineering in the form of laboratory/experimental works. In addition to its principal engineering emphasis, the course introduces safety and environmental aspects of the applications. Learning strategy covers: introductory class, experiments/ laboratory works, written and oral reports.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Communication techniques and cutting-edge technologies.
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME
Students learns unit operation principles through experimental works to solve practical problems
MAIN SUBJECT
1. Principle of chemical engineering 2. Unit operation principles 3. Occupational of health and safety 4. Fluid dynamics and measurements 5. Fluidized bed column 6. Mixing 7. Filtration
PREREQUIZITES
TK184404 Unit Operations I (Minimum D)
REFERENCES
1. Perry's Chemical Engineering Handbook, 8th Ed, 2008 2. W Mc Cabe, J Smith, P Harrott, Unit Operation of Chemical Engineering 7th Ed, Mc Graw Hill, 2005 3. C Geankoplis, Transport Processes and Uni Operations 3rd Ed, Allyn Bacon, 1993
SUPPORTING REFERENCES
JM Coulson and JF Richardson, Coulson and Richardson's Chemical Engineering 5th Ed, Butterworth – Heinemann 2001

COURSE	Course Name	:	**Unit Operation II**
	Course Code	:	TK184503
	Credits	:	3 SKS
	Semester	:	V

DESCRIPTION of COURSE
This course learns about the understanding of the operation of process equipment based on heat and mass transfers, i.e: evaporation, humidification, drying and crystallization. This course includes the calculation of mass and energy balance in evaporator equipment, drying, continuous humidification process, and crystallization. The strategies of learning activities are an introductory course, brainstorming, written test including quizzes and final examination, and group discussion.

LEARNING OUTCOME
1.1 Comprehend the engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Comprehend the natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Comprehend the process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Able to understand the principles and the latest issues in economy, social, general ecology;
1.5 Comprehend the communication techniques and cutting-edge technologies;
2.2 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
2.3 Able to find the engineering root cause of process, processing system, and equipments required for converting raw materials into value-added products through investigation process, analysis, interpretation of data and information according to engineering principles

3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise; 3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility; 3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently; 4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.
COURSE LEARNING OUTCOME
1. Students are able to comprehend the concepts and principles of chemical engineering to handle problems related to the chemical engineering fields. 2. Students are able to comprehend the evaporation concept and design the required mass and heat transfer in evaporator to handle problems related to the chemical engineering fields. 3. Students are able to comprehend the drying concept and design the required mass and heat transfer in drying to solve the problem in chemical engineering fields. 4. Students are able to comprehend the continuous humidification concept and design the required tower to handle problems related to the chemical engineering fields. 5. Students are able to comprehend the crystallization concept and calculate the yield in the final process to solve the problem in chemical engineering fields. 6. Students are able to solve the problems in unit operation related to the chemical engineering fields.
MAIN SUBJECT
1. Evaporation 2. Drying 3. Continuous humidification process 4. Crystallization
PREREQUISITES
TK184406 Mass and Heat Transfer (Minimum D)

MAIN REFERENCE
1. C.J. Geankoplis: "Transport Processes and Separation Process Principles", Prentice Hall, 4th edition, 2003. 2. McCabe, W.L, J. C. Smith and P. Harriott, "Unit Operations of Chemical Engineering", 6th Ed., McGraw-Hill, Inc., 2001 3. Badger and Banchero, "Introduction to Chemical Engineering", McGraw Hill, 1955 4. Peters, "Elementary Chemical Engineering", 2nd ed, Mc Graw Hill, 1984
SUPPORTING REFERENCE
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Course	Course Name	:	**CONSTRUCTION MATERIALS**
	Course Code	:	TK184504
	Credits	:	2 SKS
	Semester	:	V

DESCRIPTION of COURSE
This course studies the basics of materials used in the construction of a chemical plant, which include of its types, its constituent chemical elements, its crystal structures, its engineering properties, and its method of selection as a construction material in accordance with its requirements, also its corrosion and protection phenomena during the plant's operation, by using lecture learning methods that include lectures, brainstorming; written exams (including Quiz I & II, and EAS) and discussion of group assignments.

LEARNING OUTCOME
1.1. Understanding the engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes.
1.2. Understanding the natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes.
1.3. Understanding the principles and the latest issues in economy, social, general ecology.
2.1. Able to formulate alternative solution to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes by considering factors such as economic, public health and safety, cultural, social and environment.
3.1. Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise.
3.2. Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3. Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently.

4.1. Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

The students must understand the basics of construction materials, and its properties of metal and nonmetallic structures that is purposely engineered, in order to be able to choose the construction materials according to their needs in chemical industry.

MAIN SUBJECT

1. Introduction of construction materials
2. Material Structure
3. Properties of materials engineering
4. Corrosion Resistance
5. Metals and Alloys
6. Ceramics
7. Polymers
8. Composite
9. Selection of construction materials

PREREQUISITES

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MAIN REFERENCE

1. Callister, Jr., W. D., Materials Science and Engineering, 7th Ed., John Wiley & Sons, Inc., 2007.
2. Domone, P. & Illston, J., Construction Materials: Their Nature and Behavior, 4th Ed., Spon Press, 2010.
3. Mitchell, B.S., An Introduction to Materials Engineering and Science for Chemical and Materials Engineers, John Wiley & Sons, Inc., 2004.
4. Sinnott, R. K., Coulson & Richardson's Chemical Engineering Vol. 6: Chemical Engineering Design, 4th ed., Elsevier Butterworth-Heinemann, 2005.
5. Fontana M.G., "Corrosion Engineering", 3rd ed., Mc Graw Hill Book Co., New York, 1986.

COURSE	Course Name	:	**Chemical Equipment Design**
	Course Code	:	TK184505
	Credit	:	4 SKS
	Semester	:	V

DESCRIPTION of COURSE
This course studies the introduction and understanding of how to read engineering drawings, design of chemical industry equipment related to pressurized vessels and heat exchangers in order to design and evaluate the chemical industry equipment, including the introduction and selection of materials, the introduction and understanding of engineering drawings, the design of pressure vessels dimensions (internal and external), basics of heat transfer and design of heat exchangers. With learning methods include lectures, discussions, case studies, problem-based learning, writing examination, (including quiz, assignments and EAS).

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies.
2.1 Able to do research that includes identification, formulation, and analysis on engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;

3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

1. Being able to understand the introduction and selection of materials used for pressurized vessels and heat transfer equipment
2. Being able to understand how to read engineering drawings
3. Being able to design and evaluate the design of pressure vessel (internal and external pressure)
4. Being able to understand the theory of heat transfer (mechanism of heat transfer, various temperatures)
5. Being able to design and evaluate the design of double pipe heat exchanger (DPHE), shell & tube heat exchanger (STHE), reboiler and condenser.

MAIN SUBJECT

1. Introduction and material selection
2. Introduction and knowledge of engineering drawings
3. Design of pressurized vessels (internal and external pressure)
4. Theory of heat transfer (mechanism of heat transfer, temperature)
5. Design of heat exchanger (DPHE, STHE, reboiler, condenser)

PREREQUISITES

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REFERENCE

1. Hewit G.E., G.L. Shires, and T.R. Bott, 1994, "Process Heat Transfer",CRC Press**.**
2. Brownell, L.E., and E.H. Young, 1979, “Process Equipment Design”, Wiley Eastern Limited
3. Kern D.Q., 1965, "Process Heat Transfer", Mc. Graw Hill Book Co.
4. Perry R.H. and D.W. Green, 1997, " Perry's Chemical Engineer's Hand Book", 7th Ed., Mc. Graw Hill
5. Ludwig, E.E., 1999, "Applied Process Design for Chemical and Petro Chemical Plants”, Vol. 3, 3rd Ed., Gulf Publishing Co.

6. Coulson, M., J.F. Richardson, and R.K. Sinnotf, 1999, "Chemical Engineering", Vol 6," An Introduction to Chemical Engineering Design", 3rd Ed., Buttworth Heineinmann

COURSE	Course Name	:	**Chemical Engineering Numerical Computation**
	Course Code	:	TK184604
	Credit	:	3 SKS
	Semester	:	V

DESCRIPTION OF COURSE
This course learns and develops students' abilities on Chemical Engineering issues that are solved using numerical calculation methods and concepts, Solutions of nonlinear equations, Solutions of linear and nonlinear simultaneous equations, Interpolation, Numerical Differentiation and Integration, Numerical solutions for ordinary differential equations, Numerical solutions for partial differential equations. The learning method used is simulation and applied computation including practice and writing exams.

LEARNING OUTCOMES
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Communication techniques and cutting-edge technologies.
1.1 Able to select appropriate resources and make use of design devices and appropriate IT-based engineering analysis to assist in engineering activities of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;

3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

The students are able to solve numerically the problems of Chemical Engineering.

MAIN SUBJECTS

1. The concept of numerical calculation
2. Sollving nonlinear equations
3. Solving sets of linear and nonlinear equations
4. Interpolation, numerical differentiation and integration
5. Numerical solutions of ordinary differential equations
6. Numerical solutions of partial differential equations

PREREQUISITES

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REFERENCES

1. Gerald, C. F. and Wheatley, P.0., Applied Numerical Analysis, 7th ed., Addison Wesley Publishing Co., Boston, 2004.
2. Constantinides, A. and Mostoufi, N., Numerical Methods for Chemical Engineers with Matlab Application, Prentice Hall, New Jersey, 1999.
3. Cutlip M.B. and Shacham, M., Problem Solving in Chemical Engineering with Numerical Methods, Prentice Hall, New Jersey, 1999.
4. Chapra, S.C., Applied Numerical Methods with Matlab for Engineers and Scientists, McGraw-Hill, New York, 2005

COURSE	Course Name	:	**Chemical Reaction Engineering II**
	Course Code	:	TK184601
	Credits	:	3 SKS
	Semester	:	VI

DESCRIPTION of COURSE
This course studies the understanding of kinetics of reactions and designing reactors including Kinetics of homogeneous reactions; Interpretation of batch reactor data; Single and double ideal flow reactor design; The flow reactor is ideal for single reactions and multiple reactions; Effect of temperature and pressure.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies.
2.1 Able to do research that includes identification, formulation, and analysis on engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;

4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.
COURSE LEARNING OUTCOME
Students are able to understand the reaction kinetics and design a homogenous chemical reactor
MAIN SUBJECT
1. Homogeneous Reaction Kinetics 2. Interpretation of batch reactor data. 3. Single and double ideal flow reactor design 4. The ideal flow reactor for single reaction and double reaction 5. Effect of temperature and pressure
PREREQUISITES
TK184501 Chemical Reaction Engineering I (Minimum D)
MAIN REFERENCE
1. Octave Levenspiel, " *Chemical Reaction Engineering*" , 3rd Ed. McGraw-Hill, 2000Fogler," *Elements of Chemical Reaction Engineering* ", 3rd ed,Prentice-Hall, 1999. 3. Gilbert F.Froment, Kenneth B.Bischoff,"*Chemical Reactor Analysis and Design",* 2nd ed, John Wiley & Sons, 1990
SUPPORTING REFERENCE
J.M.Smith, "*Reaction Kinetics*" 3rd ed, McGraw-Hill,1982

Course	Course Name	:	**Chemical Engineering Application II**
	Course Code	:	TK184602
	Credit	:	2 SKS
	Semester	:	VI

DESCRIPTION OF COURSE
The course explains fundamental of chemical engineering in the form of solving practical problems. In addition to its principal engineering emphasis, the course introduces safety and environmental aspects of the applications. Learning strategy covers: introductory class, experiments/laboratory works, written and oral reports.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Communication techniques and cutting-edge technologies.
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME
Students learns unit operation principles through experimental works to solve practical problems
MAIN SUBJECT
1. Principle of chemical engineering 2. Unit operation principles 3. Occupational of health and safety 4. Case I: Mass transfer 5. Case II: Heat transfer 6. Case III: Reaction 7. Case IV: Drying
PREREQUIZITES
TK184503 Unit Operations II (Minimum D) TK184502 Chemical Engineering Application I (Minimum C) TK184603 Unit Operations III
REFERENCES
1. Perry's Chemical Engineering Handbook, 8th Ed, 2008 2. W Mc Cabe, J Smith, P Harrott, Unit Operation of Chemical Engineering 7th Ed, Mc Graw Hill, 2005 3. C Geankoplis, Transport Processes and Uni Operations 3rd Ed, Allyn Bacon, 1993
SUPPORTING REFERENCES
JM Coulson and JF Richardson, Coulson and Richardson's Chemical Engineering 5th Ed, Butterworth – Heinemann 2001

COURSE	Course Name	:	**Unit Operations III**
	Course Code	:	TK184603
	Credit	:	3 SKS
	Semester	:	VI

DESCRIPTION of COURSE
This course learns and develops the understanding of the theory of separation operations, in particular the units of absorption, distillation, leaching, and extraction and determine the basic specifications of the separation process equipment with stage-wise and packing. The learning methods include the Introduction to separation, Absorption, Distillation, Leaching, and Extraction operations. Strategies of learning activities are: introductory courses; brainstorming; group discussion; assignments; written exams (including Quiz and EAS).

LEARNING OUTCOMES
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies.
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;

3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently; and
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOMES

The students are able to
1. understand the principles of separation operations, especially the units of absorption, distillation, leaching, and extraction.
2. determine the basic specifications of separation process equipment with stage-wise and packing types.

MAIN SUBJECTS

1. Introduction to the separation operations
2. Absorption
3. Distillation
4. Leaching
5. Extraction

PREREQUISITES

TK184406 Mass and Heat Transfer (Minimum D)

REFERENCES

2. McCabe, W.L., J.C. Smith dan P. Harriott, "*Unit Operations of Chemical Engineering*", 7th ed., McGraw-Hill, New York, 2005.
3. Geankoplis, C.J., "*Transport Processes and Separation Process Principles (Includes Unit Operations*", 4th ed., Pearson Education, Inc., New Jersey, 2003.

COURSE	Course Name	:	**Process Dynamics and Control**
	Course Code	:	TK184605
	Credit	:	4 SKS
	Semester	:	VI

DESCRIPTION of COURSE
The use of process dynamics and control in industry. Introduction to mass and energy transient balance. Review Laplace Transformation. Understanding chemical processes in industry based on process dynamics in first order, second order and higher order processes through mathematical model and empirical method. Understanding simple control process. Introduction to closed loop block diagram. Understanding response of first, second, and higher order processes. Process stability based on Routh, Bode and Nyquist criteria. Understanding advanced process control to apply for SISO system.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Communication techniques and cutting-edge technologies;
2.1 Able to select appropriate resources and make use of design devices and appropriate IT-based engineering analysis to assist in engineering activities of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;

3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

1. Students can do theoretical mathematical models and empirical methods for physical process in industries.
2. Students are able to solve problems on ordinary differential equation using Laplace Transform.
3. Students are able to give examples dynamics on all order of the process in the openloop system.
4. Students are able to do problems on closed loop block diagram.
5. Students are able to show open loop and closed loop responses for all orders of the processes.
6. Students are able to do tuning controller parameters to prevent the processes become unstable.

MAIN SUBJECT

1. The use of process dynamics and control in industry.
2. Derivation mathematical models end empirical models on physical processes in industry.
3. Review Laplace Transform with its application.
4. Transfer function of first, second and higher order and their dynamics.
5. Feedback and feedforward control systems.
6. Routh, Bode and Nyquist stabilities for first, second and higher order processes.

PREREQUISITES

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REFERENCE

1. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp, Francis J. Doyle III, “Process Dynamics and Control”, 4th ed. , John Wiley & Sons, New. York., 2016.
2. Donald R. Coughanowr, Steven E. Le Blanc,”Process Systems Analysis and Control, 3rd ed, Mc Graw Hill, New York, 2009.
3. William L Luyben, “Process Modelling, Simulation and Control for Chemical Engineers”, 2nd ed, Mc Graw Hill, New York, 1996.

COURSE	Course Name	:	**Industrial Waste Treatment***
	Course Code	:	TK184701
	Credits	:	3 SKS
	Semester	:	VII

DESCRIPTION of COURSE
Industrial Waste Treatment Course studies the design of industrial waste treatment system biologically, both aerobic and anaerobic by using batch reactor, mixed flow and plug flow reactor. Knowledge of biological kinetic parameters such as specific maximum biomass (microbial), yield, loading factor, as well as sludge age and washout residence time as the basis for calculation in design are required.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Communication techniques and cutting-edge technologies;
2.1 Able to select appropriate resources and make use of design devices and appropriate IT-based engineering analysis to assist in engineering activities of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;

4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

1. Students understand the source and understanding of pollutant parameters
2. Students understand the parameters of kinetics in biological waste treatment
3. Students are able to design industrial wastewater treatment system by using biological method in batch, mixed flow and plugflow reactor

MAIN SUBJECT

1. Waste and environmental management, water resources, Legislation, environmental quality standards
2. Liquid Waste Processing: Source and type of waste, main parameters, pretreatment. Secondary treatment (aerobics), advanced processing
3. Liquid Waste Treatment (anaerobic)

PREREQUISITES

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REFERENCE

Main Reference:

1. Wesley W Eckenfelder Jr,"*Industrial Water Pollution Control*", McGraw Hill Book International Edition, 1989
2. Donald W.Sundstrom, " *Wastewater Treatment*", Prantice Hall ind, Englewood Cliffs, New York, 1979

Supporting Reference:

1. Metcalf & Eddy. "*Wastewater Engineering*", McGraw Hill International edition, 3rd editions, 1991
2. Albert Parker , " *Industrial Air Pollution Handbook*", McGraw Hill, Maidenhead, Englnad, 1st edition, 1978

COURSE	Course Name	:	**Synthesis and Process Simulation**
	Course Code	:	TK184702
	Credit	:	3 SKS
	Semester	:	VII

DESCRIPTION of COURSE

Synthesis and Simulation Process aim to teach strategies that used in synthesis or design of chemical processes. Synthesis and process design usually starts from a statement about an opportunity to produce a new product or a new way to create an existing product. Often this initial idea is driven by the economy, ie one sees economic opportunities that involve new products or new process concepts. For new products, the synthesis process is part of the most creative design process. This is also the thing that requires the most experience from the designer. He must know the performance of many operating units so that they can be integrated into a process. There are many guides for steps in process synthesis but there is no general method that explicitly "generates" the best process. Instead, the synthesis process is a trial-and-error activity (which experienced designers try to avoid). However, modern tools such as ASPEN Hysys or ASPEN Plus software packages allow simulate the process quickly and accurately enough. With tools such as ASPEN, it is recommended that the designer construct a relatively fast of Process Flow Diagram even though it will be substantially modified later. The development of this PFD forces the designer to learn the process from feed to product, through main equipment (reactor and separator) as well as supporting equipment such as heat exchangers. The synthesis and design also learn types of reactors and separators for the homogen and heterogeneous materials, especially distillation columns as they are the most commonly used separator devices in the chemical industry. The thing that should be highlight is heat integration of heat exchangers or heat exchanger network. With the deepening of HEN, it is expected that the utility needs will be reduced, reusable energy will be higher in other words or higher energy efficiency. Scheduling of batch processes and some examples of batch processes is studied because in fact several chemical industrial process are combine between continuous and batch processes

LEARNING OUTCOME

1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;

1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes; 1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes; 1.4 Principles and the latest issues in economy, social, general ecology; 1.5 Communication techniques and cutting-edge technologies. 2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes; 2.2 Able to find the engineering root cause of of process, processing system, and equipments required for converting raw materials into value-added products through investigation process, analysis, interpretation of data and information according to engineering principles; 2.3 Able to do research that includes identification, formulation, and analysis on engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes; 3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise; 3.2 Being able to demonstrate independent performance, quality, and measurable; 3.3 Being able to examine the implications of the development or implementation of the science of technology which concerns and implements the value of humanities in accordance with its expertise based on rules, procedures and scientific ethics in order to produce solutions, ideas, designs or art criticism, compile scientific descriptions of the study results in the form of thesis or final project report, and uploaded it in the college page; 4.1 Believing in the oneness of God and able to demonstrate religious attitude; 4.2 Demonstrating attitude of responsibility on work in his/her field of expertise independently.
COURSE LEARNING OUTCOME

1. Understanding the concept of synthesis and process simulation to make the chemical process is more efficient, safe and economical.
2. Understanding appropriate selection of reactors and separators, to produce the desired product by involving physical and thermodynamic properties of a mixture.
3. Understanding heat exchangers network to be efficient in energy use.
4. Understanding the batch process and its scheduling for.

MAIN SUBJECT

1. Concept of synthesis and process simulation
2. Calculation of equipment and economic evaluation
3. Review of chemical engineering unit operations, chemical reaction and thermodynamics
4. Design of distillation and azeotropic distillation processes
5. Design of distillation squence
6. Continuous process design, application of mass and heat balance using commercial software
7. Design of batch process and its application
8. Concept of heat exchangers network

PREREQUISITES

TK184405 Chemical Engineering Thermodynamics II (Minimum D)
TK184505 Chemical Equipment Design (Minimum D)
TK184601 Chemical Reaction Engineering II (Minimum D)
TK184603 Unit Operation III (Minimum D)

REFERENCE

1. Robin Smith, “Chemical Process Design and Integration””, John Wiley and Son, 2005
2. James M Douglas, Conceptual Design of Chemical Processes”, New York McGraw-Hill - McGraw-Hill chemical engineering series , 1998
3. Warren D. Seider, J. D. Seader, Daniel R. Lewin , Widagdo ,”Process Design Principles: Synthesis, Analysis and Evaluation”, 3th edition, John Wiley & Sons, 2008
4. Lorenz T. Biegler, Ignacio E. Grossmann , Arthur W. Westerberg , “Systematic Methods of Chemical Process Design“, Prentice Hall, 1997

COURSE	Course Name	:	**Plant Design and Economic**
	Course Code	:	TK184703
	Credit	:	4 SKS
	Semester	:	VII

COURSE DESCRIPTION
This course learn about design of chemical plant based chemical engineering sciences as well as basics of designing chemical plants and Determination of the manufacturer's specifications; Selection process, manufacturing process flow diagrams, calculations and writing of mass and energy balance; Specification of process equipment, process safety and utility; The location and layout of the plant; Money-time relationship: interest, present value, future values and annuities, linear and geometric gradients, nominal and effective interest rates, continuous compounding; Structure costs: fixed capital investment, working capital investment. Principles of management in Chemical Industry, Organizational Structure in chemical companies / industries. And Economic Analysis. Evaluation of the project. The learning methods include: an introductory course; brainstorming; problem solving; Writing Exam (includes quizzes, assignments, ETS and UAS), Practice includes presentations and group discussions.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies.
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;

2.2 Able to find the engineering root cause of of process, processing system, and equipments required for converting raw materials into value-added products through investigation process, analysis, interpretation of data and information according to engineering principles;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to demonstrate independent performance, quality, and measurable;
3.3 Being able to examine the implications of the development or implementation of the science of technology which concerns and implements the value of humanities in accordance with its expertise based on rules, procedures and scientific ethics in order to produce solutions, ideas, designs or art criticism, compile scientific descriptions of the study results in the form of thesis or final project report, and uploaded it in the college page;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

1. Able to know the general definition of chemical engineering process and its implementation in industry.
2. Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes.
3. Process design technique and principles, processing system, and equipment's required for converting raw materials into value-added products through chemical, physical, and biological processes
4. Able to design specific system or process based on chemical engineering principle (mass and energy balance etc).
5. Able to perform the study of the particular system or process based on chemical engineering principle.
6. Able to utilize modern technology in designing a system or process.
7. Able to utilize modern technology to perform the study of particular system or process.
8. Able to utilize modern engineering instrument in designing a system or process.
9. Able to utilize modern engineering instrument in performing the study of system or process.

10. Able to identify and formulate problems of chemical engineering in daily life.
11. Able to present some alternatives solution from problems of chemical engineering in daily life.
12. Able to make decision based on consideration of chemical engineering principle combined with green technology concept.
13. Able to prepare technical report as result of process design in chemical engineering fields.
14. Able to prepare technical report as result of study of process in chemical engineering fields.
15. Comprehend the concepts or principles of mathematics, physics, biology and chemistry to handle problems of chemical engineering.
16. Comprehend the concepts or principles of energy to handle problems related to chemical engineering fields.
17. Comprehend the economic concepts or principles to handle problems related to chemical engineering fields.
18. Comprehend the ecological concepts or principles to handle problems related to chemical engineering fields.
19. Able to estimate the salary needs of employees in the management and operators in the chemical industry.
20. Able to create the financing structure: fixed capital investment, working capital investment.
21. Able to conduct an economic evaluation to determine the feasibility of establishing a factory with NPV, IRR, POT, and BEP methods.

MAIN SUBJECT

1. Fundamentals of chemical plant design and stipulation of factory specifications.
2. Selection process, making process flow diagram, Calculation and Writing mass and energy balance,
3. The location and layout of the plant,
4. Specification of process equipment, equipment price estimate, process safety and Utilities,
5. Principle of management in Chemical Industry
6. Organizational Structure in chemical company / industry
7. Evaluate the value of factory investment with respect to the Value of Money.

PREREQUISITE

TK184403 Chemical Engineering Principles II (Minumum D)
TK184503 Unit Operations II (Minimum D)

TK184603 Unit Operations III (Minimum D)

Reference

1. Peter, Max S. & Timmerhaus, *Chemical Engineering Plant Design and Economics*, 5rd Ed, Mc.Graw Hill, 2003
2. William, D.B, 1990, "Preliminary Chemical Engineering Plant Design", 2nd Ed., Van Nostrand Reinhold, New York.
3. Vilbrandt, F.C. and C.E. Dryden 1959, "Chemical Engineering Plant Design", 4th Ed., Mc Graw Hill Book Co. Lmtd., Tokyo.
4. Ulrich, G.D., 1984, "A Guide to Chemical Engineering Process Design and Economics", John Wiley & Son, New York.
5. Mondy, R.W., Arthur S., Edwin B.F., 1988, "Management Concepts and Practices", 4th Ed., Allyn and Bacon Inc.

Course	Course Name	:	**Research Project**
	Course Code	:	TK184704
	Credit	:	6 SKS
	Semester	:	VII

COURSE DESCRIPTION
This course gives assignments to students to practice doing research under faculty mentors, and provide progress on research conducted in the form of a final report containing background paper; Purpose and objectives; Literature review; methodology; Results and Discussion; The conclusion of the study. The method of learning is done the practices (including lab and simulation tool or computing), final examination in the form of presentations and discussions on the submission of the thesis report has been completed.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies.
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
2.2 Able to find the engineering root cause of of process, processing system, and equipments required for converting raw materials into value-added products through investigation process, analysis, interpretation of data and information according to engineering principles;
2.3 Able to do research that includes identification, formulation, and analysis on engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;

3.1	Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2	Being able to demonstrate independent performance, quality, and measurable;
3.3	Being able to examine the implications of the development or implementation of the science of technology which concerns and implements the value of humanities in accordance with its expertise based on rules, procedures and scientific ethics in order to produce solutions, ideas, designs or art criticism, compile scientific descriptions of the study results in the form of thesis or final project report, and uploaded it in the college page;
4.1	Believing in the oneness of God and able to demonstrate religious attitude;
4.2	Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

1.	Able to design specific system or process based on chemical engineering principle.
2.	Able to perform the study of the particular system or process based on chemical engineering principle.
3.	Able to utilize modern technology in designing a system or process.
4.	Able to utilize modern technology to perform the study of particular system or process.
5.	Able to utilize modern engineering instrument in designing a system or process.
6.	Able to utilize modern engineering instrument in performing the study of system or process.
7.	Able to identify problems of chemical engineering in daily life.
8.	Able to formulate problems of chemical engineering in daily life.
9.	Able to present some alternatives solution from problems of chemical engineering in daily life.
10.	Able to make decision based on consideration of chemical engineering principle combined with green technology concept.
11.	Able to prepare technical report as result of process design in chemical engineering fields.
12.	Able to prepare technical report as result of study of process in chemical engineering fields.

13. Comprehend the concepts or principles of mathematics to handle problems of chemical engineering.
14. Comprehend the concepts or principles of physics to handle problems of chemical engineering.
15. Comprehend the concepts or principles of chemistry to handle problems of chemical engineering.
16. Comprehend the concepts or principles of biology to handle problems of chemical engineering.
17. Comprehend the concepts or principles of chemical engineering to handle problems related to chemical engineering fields.
18. Comprehend the concepts or principles of energy to handle problems related to chemical engineering fields.
19. Comprehend the economic concepts or principles to handle problems related to chemical engineering fields.
20. Comprehend the ecological concepts or principles to handle problems related to chemical engineering fields.
21. Able to cooperate with other field expert.
22. Having good responsibility regarding their individual task.
23. Being responsible for organization's achievement.
24. Able to provide alternatives solution.
25. Having good leadership.
26. Able to propose alternatives solution creatively.
27. Able to perform both spoken and written communication.
28. Faithful and devoted based on their belief and religion.
29. Knowledgeable of professional ethic.
30. Having good moral and attitude during task.
31. Being loyal and patriotic Indonesian citizens
32. Able to work in a team
33. Having social concern and sensitivity on their community and environment.
34. Having good tolerance to other people
35. Having good law awareness to prioritise nation and country needs

Main Subjects

1. Research background
2. Goal and objective
3. Literature study
4. Methodology
5. Result and discussion
6. Conclusion.

PREREQUISITE
1. TK184602 Minimum grade of Chemical Engineering Application II is C 2. Completed 109 credits
Reference
- Regulation of final project

COURSE	Course Name	:	**Chemical Plant Safety**
	Course Code	:	TK184801
	Credit	:	3 SKS
	Semester	:	VIII

DESCRIPTION of COURSE
Chemical Plant Safety (KPK) is a final semester course in the Department of Chemical Engineering. This course examines the understanding of basic concepts of chemical process safety based on Health and Safety Act and Regulation in Indonesia and the OHS basis according to the ILO. Includes discussion; Risks of loss in the working environment of chemical plant, Occupational health (process safety management), Recognizing accident occurrence, Hazards identification and occurrence, Human error and contribution, Changes in chemical properties and hazard, Removal, Case Histories, Confined space, Log out and tag out, Fire and explosion, and HAZOP. The learning methods include: Introductory lecture; Brainstorming; The Writing Exam (covering Quiz, Duties, and Final Exam of the semester), Practice includes Presentations and group discussions. Basically, in this lecture students are able to understand the basics of process safety in a chemical plant.

LEARNING OUTCOME
1.1 The concept of science-engineering (engineering sciences), engineering principles, and engineering design required for the analysis and design of processes, processing systems, and equipment necessary to convert raw materials into value-added products by process chemistry, physics and biology;
1.2 The concept of natural science and the principles of application of engineering mathematics to the analysis and design of processes, processing systems, and equipment necessary to convert raw materials into value-added products by chemical, physical and biological processes;
1.3 Principles and techniques of process design, processing systems, and equipment necessary to convert raw materials into value-added products by chemical, physical and biological processes;
1.4 Communication techniques and latest technological developments and current;
2.1 Able to formulate alternative solutions to solve complex engineering problems in processes, processing systems, and equipment necessary to convert raw materials into value-added products by chemical, physical

and biological processes with due regard to economic, health and safety factors of the public, cultural, social and environmental considerations, capable of applying logical, critical, systematic, and innovative thinking in the context of the development or implementation of science and technology that cares and implements the humanities value appropriate to their area of expertise;

3.1 Able to apply logical, critical, systematic, and innovative thinking in the context of the development or implementation of science and technology that cares for and implements a humanitarian value appropriate to its area of expertise;

3.2 Able to take responsibility for the achievement of group work and to supervise and evaluate the completion of work assigned to the worker under his / her responsibility, able to conduct the self-evaluation process against the working group under his responsibility, and able to manage the learning independently;

3.3 Able to conduct a self-evaluation process against working groups under their responsibility, and able to manage learning independently;

4.1 shows a responsible attitude towards the work in the field of expertise independently;

COURSE LEARNING OUTCOME

1. Students are able to formulate process issues in the industry and understand their relationship to process issues with the effort to prevent loss.
2. Students are able to make initial risk and hazard analysis and resolve possible initiation, propagation and termination of possible accidents
3. Students are able to understand the hazard identification of a chemical industry that includes essential equipment such as tank, rector, distillation column and others. Analyze the possibility of accident events by analyzing the relationship between threat, top event, barrier, effects on humans, environment, assets, and reputation.
4. Discuss the practical issues in industry. Understanding the problem of human error as one contributor to the occurrence of accidents that are outside the system of industrial equipment. Strictly human error needs to be considered as an object of study to minimize
5. Understand the operation of confined space (limited space), for various types of industrial operations.
6. Establish confined space as a workspace, as a space isolated from any process flow, and energy flow.
7. Be able to isolate limited space by applying the principle of log out and tag out, so. Confined space and Log out must be applied simultaneously.

8. Recognize leakage / release of chemicals, and students recognize passive control with safety valve and procedures to safely design based on the nature of the fluid they protect.
9. Understand the principles of fire, fire, explosion and prevention.
10. Students are able to apply the principle of fire in the process of combustion in industrial equipment that applies combustion as a source of energy to produce raw materials and sources of working fluid, such as furnace boilers, glass furnaces, and kilns.
11. Students able to formulate can be operated and safe a process from flowsheet or P & ID process.
12. Working in groups that describe various background skills in solving process operations in terms of process instruments, and control
13. Study real cases in industry, with HAZOP studies (hazard and operability).

MAIN SUBJECT

Indonesia Safety Act and Regulation; OH3 Basics according to the ILO; accidents, consequences and losses; The risk of loss and prevention; Process safety management; Accident and their Effects; Hazard identification and occurrence, Human error and its contribution, Changes in chemical and hazard properties, Removal, Case Histories, Confined space, Log out and tag out, Fire and explosion, and HAZOP.

PREREQUISITES

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REFERENCE

1. Goetsch DL (2005),"Occupational Safety and Health for Technologists Engineers, and Managers, 5th ed, Prentice Hall
2. Crowl and Louvar (1999), "Chemical Process Safety", 2nd ed, Prentice Hall.
3. Ketentuan Keselamatan Kerja dan Perundang-undangan RI.
4. Keltz T(1999), "What When Wrong?", 4t ed, Gulf Publishing
5. King, Ralp & Magid,John (1982),"Industrial hazard and Safety Handbook", Butterworth Scientific, London.
6. Wong W (2002), "How did that Happen?, Professional Eng. Publ.

Course	Course Name	:	**PRACTICAL FIELD WORK**
	Course Code	:	TK184802
	Credit	:	2 SKS
	Semester	:	VIII

DESCRIPTION of COURSE
This course aims to introduce the students into the working environment in chemical plant, the history of that of plant, the plant management, the description of production process and its main equipments, the laboratory quality testing of raw material and product, the description of instrumentation and control system, the description of utility system, and the specific final task, using learning methods that include lectures, unit observation of equipment and interviews with related staff and / or supervisors, independent study in factory libraries, preparation and presentation of general reports and specific task of practical work.

LEARNING OUTCOME
1.1 Understanding the engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes
1.2 Understanding the natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes
1.3 Understanding the process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes
3.1 Being able to demonstrate independent performance, quality, and measurable
3.2 Being able to take decisions appropriately in the context of problem solving in the area of expertise based on the results of information and data analysis

3.3 Being able to maintain an expanded network with mentors, colleagues, colleagues both inside and outside the institution
3.4 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility
3.5 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently
4.1 Demonstrating attitude of responsibility on work in his/her field of expertsei independently.

COURSE LEARNING OUTCOME

The students must understand the working environment in chemical plant, the history of that of plant, the plant management, the description of production process and its main equipments, its instrumentation and control, its utility, and its the laboratory quality testing of raw material and product, and able to arrange it into general report of practical work, as well as able to complete the given specific task in practical work.

MAIN SUBJECT

1. History of company establishment and its role as an industry.
2. Introduction of enterprise management system.
3. Introduction of processing.
4. Laboratory.
5. Instrumentation and control.
6. System utility.
7. Specific tasks.

PREREQUISITES

Have taken 90 credits at the time of going to practical field work, and the score on the subject of Chemical Engineering Application II is minimum C.

MAIN REFERENCE

1. William, D.B, “Preliminary Chemical Engineering Plant Design”, 2nd Ed., Van Nostrand Reinhold, New York, 1990.
2. Peters, M.S., K.D. Timmerhaus, “Plant Design and Economics for Chemical Engineer”, 5th Ed., Mc Graw Hill Int. Book Co., 2003.
3. Geankoplis, C.J., “Transport Processes and Separation Process Principles”, Prentice Hall International Inc., 4th Ed, 2003.

4. Smith, J. M., Van Ness, H.C., Abbott, M. M.,"Introduction to Chemical Engineering Thermodynamics" 6th Ed., McGwaw-Hill Co-Singapore, 2001.
5. Himmelblau, DM., "Basic Principles and Calculation in Chemical Engineering, Prentice Hall, 7th Ed, 2003.

COURSE	Course Name	:	**Plant Design Project**
	Course Code	:	TK184803
	Credit	:	6 SKS
	Semester	:	VIII

COURSE DESCRIPTION
This course gives the task to the students about the design of chemical plants based on chemical engineering sciences including selection and process description; flow diagram of the process, Calculation of Mass Balance and Energy Balance; Specification of Equipment. The learning method that is done include making the final report and Presentation and discussion

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
2.2 Able to find the engineering root cause of of process, processing system, and equipments required for converting raw materials into value-added products through investigation process, analysis, interpretation of data and information according to engineering principles;
2.3 Able to formulate alternative solution to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes by considering factors such as economic, public health and safety, cultural, social and environment (environmental consideration);

2.4 Able to design process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes by analytical approach and taking into account the following aspects, such as technical standard, performance aspect, robustness, applicability, sustainability, as well as considering factors such as economic, public health and safety, cultural, social and environment;

3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;

3.2 Being able to demonstrate independent performance, quality, and measurable;

3.3 Being able to examine the implications of the development or implementation of the science of technology which concerns and implements the value of humanities in accordance with its expertise based on rules, procedures and scientific ethics in order to produce solutions, ideas, designs or art criticism;

3.4 Arrange the scientific description of the results of the above study in the form of a thesis or final project report, and upload it on the college page

3.5 Being able to take decisions appropriately in the context of problem solving in the area of expertise based on the results of information and data analysis;

3.6 Group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;

3.7 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;

4.1 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility.

COURSE LEARNING OUTCOMES

Students are able to design of chemical plants based on chemical engineering sciences

MAIN SUBJECTS

1. Selection and description of process,
2. Flow diagram of the process,
3. Calculation of mass balance and energy balance
4. Specification of Equipment
5. Economic Analysis

PREREQUISITE
Minimum Grade of Chemical Engineering II is C

Reference

1. William, D.B, 1990, "*Preliminary Chemical Engineering Plant Design*", 2nd Ed., Van Nostrand Reinhold, New York.
2. Vilbrandt, F.C. and C.E. Dryden 1959, "*Chemical Engineering Plant Design*", 4th Ed., Mc Graw Hill Book Co. Lmtd., Tokyo.
3. Peters, M.S., K.D. Timmerhaus, 2003, "*Plant Design and Economics for Chemical Engineer*", 5nd Ed., Mc Graw Hill Int. Book Co.
4. Ulrich, G.D., 1984, "*A Guide to Chemical Engineering Process Design and Economics*", John Wiley & Son, New York
5. Ludwig, E.E., 1974, *"Applied Project Management for the Process Industries"*, Taiwan

COURSE	Course Name	:	**Plant Utility System**
	Course Code	:	TK184804
	Credit	:	2 SKS
	Semester	:	VIII

DESCRIPTION of COURSE
This course studies the position of the utility department in the industry, Water supply in nature, Water impurity parameters and their effect on water consumption in industry. Supply of clean / sanitation water and process water. Cooling water management. Boiler water treatment. Process water treatment and sanitation water.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Communication techniques and cutting-edge technologies;
2.1 Able to select appropriate resources and make use of design devices and appropriate IT-based engineering analysis to assist in engineering activities of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;

4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.
COURSE LEARNING OUTCOME
Students have the ability and understanding the basics of utility system related to regulation and use of steam, water, electricity.
MAIN SUBJECT
1. Utilities for industry, water sources and their properties. 2. The basics of water treatment 3. Mechanical processing, 4. Chemical-physics processing. 5. Sanitation water 6. Process water 7. Cooling water 8. Cooling water control 9. Boiler feed water 10. Type of boiler and turbine.
PREREQUISITES
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REFERENCE
1. John C. Geyer, Daniel A. Okun. Elements of Water Supply and Wastewater Disposal. John Wiley & Sons, Inc. New York and London. 1971 2. Kurita Handbook of water treatment, Kurita water industries,ltd,Tokyo,1985.

COURSE	Course Name	:	**Energy Technology**
	Course Code	:	TK184606
	Credit	:	2 SKS
	Semester	:	VI

DESCRIPTION of COURSE
This course learns about many types of energy sources and resources, energy conversions both fossil energy/fuels and renewable energy. National and world potential fossil energy and renewable energy sources and consumption trends are included in this course. The learning methods include: an introductory course; brainstorming; Cases study, Writing Exam (includes quizzes, assignments, ETS and UAS), Practice includes presentations and group discussions.

LEARNING OUTCOME
1.1 Comprehend of engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Comprehend of natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Comprehend of process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Able to understand the principles and the latest issues in economy, social, general ecology;
1.5 Comprehend of communication techniques and cutting-edge technologies
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;

3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently; 4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently. 4.2 Trying his/her best to achieve perfect results
COURSE LEARNING OUTCOME
1. Being able to understand energy sources and resources, energy conversion both fossil energy and renewable energy sources. 2. Fully understand national and world energy resources. 3. Being able to utilized energy sources optimally in making conceptual design in Plant Design.
MAIN SUBJECT
1. Energy Resources 2. Fossil energy technologies 3. Renewable energy technologies 4. Material & Energy Balance 5. Optimization of energy utilization
PREREQUISITES
TK184405 Chemical Engineering Thermodynamics II (Minimum D)
REFERENCE
1. Jerrold H. Krenz, Energy: Conversion and Utilization, , Allyn and Bacon, Inc, Boston, 1976. 2. D. Yogiswami and Frank Kreith, Energy Conversion, CRC Press, New York, 2007. 3. Other relevance information sources i. e. www.esdm.go.id

COURSE	Course Name	:	**Aerosol Technology**
	Course Code	:	TK184607
	Credits	:	2 SKS
	Semester	:	VI

DESCRIPTION of COURSE
This course learns about the properties and characteristics of aerosol, instrumentation and aerosol measurements, particle motion of aerosol, atmospheric aerosol, adhesion of aerosol particles, fabrication method of aerosols, and application of aerosol in various industries. The relevance of this course to the real world is the application of aerosol processes for fabrication in electronic devices, coating technology, pharmacy, energy and environmental. Following this course, students are able to understand the properties and characterizations of aerosol with their applications in various fields, including the deposition mechanism. The learning method involves a lecture, assignment, discussion, and presentation.

LEARNING OUTCOME
1.1 Comprehend the engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Comprehend the natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Comprehend the process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Able to understand the principles and the latest issues in economy, social, general ecology;
1.5 Comprehend the communication techniques and cutting-edge technologies
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology

that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.
4.2 Trying his/her best to achieve perfect results.

COURSE LEARNING OUTCOME

1. Students are able to understand definition of aerosol and their examples
2. Students are able to understand the characteristic of aerosols and instrumentations used for measuring the aerosol properties
3. Students are able to understand the motion of aerosol
4. Students are able to understand the spreading of aerosol in atmosphere
5. Students are able to understand adhesion of aerosol particles
6. Students are able to understand the fabrication processes of aerosol including their mechanisms and forces exerted during deposition
7. Students are able to understand applications of aerosol in various industries
8. Students are able to review the latest articles (journals) and present their work in the class.

MAIN SUBJECT

1. Definition and characteristic of aerosol
2. Instrumentation devices for measuring of aerosol
3. Particle motion
4. Atmospheric aerosol
5. Adhesion of aerosol particles
6. Fabrication methods of aerosol
7. Applications of aerosol in industries

PREREQUISITES

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MAIN REFERENCE

1. Hinds, W. C., Aerosol Technology: Properties, Behavior, and Measurement of Airborne Particles, John Wiley & Sons, 2nd ed. (1999).

SUPPORTING REFERENCE
1. The latest relevance articles (journals) published in good reputable journals

COURSE	Course Name	:	**Lipids Technology**
	Course Code	:	TK184608
	Credit	:	2 SKS
	Semester	:	VI

DESCRIPTION of COURSE
This course learns about lipid technology so as to be able to further deepen this knowledge with ease. Materials of lecture material covering the lipid learn about technology proppertis nature of raw materials, processing and handling, quality, and application lipids. With the strategy of learning activities namely: an introductory course; brainstorming; Writing Exam, Practice (covering Quiz, UAS and Duties); discussion groups.

COURSE LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies.
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;

4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.
LEARNING OUTCOME
Students are able to understand the production technology of vegetable oil.
MAIN SUBJECT
1. The nature and properties of lipids, 2. Sources of lipids, 3. Nutritional and health aspects of lipids, 4. Lipid processing, bleaching, hydrogenase, fractionation, interestifikasi, packaging, and quality of lipids 5. Lipids application
PREREQUISITES
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REFERENCE
1. R. D. O'Brien, W. E. Farr, P. J. Wan, Introduction to Fats and Oils Technology, 2nd edition, AOCS, Champaign, Illinois, 2000 2. Jason E. Maxwell, Soybean: Cultivation, Uses and Nutrition, Nova Science Publisher, New York, 2011. 3. Hong NGUYEN, Seed Oil: Production, Uses and Benefits, Nova Science Publisher, New York, 2017.

Course	Course Name	:	**PROJECT MANAGEMENT**
	Course Code	:	TK184609
	Credit	:	2 SKS
	Semester	:	VI

DESCRIPTION of COURSE
This course studies the understanding on the fundamentals of project management, its function, and the overview of its implementation in the chemical industry in particular and the business world in general, so that the alumni to be able in playing a maximum role in both managerial and professional channels, which including concepts, methodologies, terminology, and fundamentals of project management, by using lecture learning methods of lectures, brainstorming, written exams (including Quiz I & II, and EAS) and discussion of group assignments.

LEARNING OUTCOME
1.1 Understamding the engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes
1.2 Understanding the natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes.
1.3 Understanding the process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes.
1.4 Understanding the principles and the latest issues in economy, social, general ecology.
2.1 Able to formulate alternative solution to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes by considering factors such as economic, public health and safety, cultural, social and environment.
2.2 Able to design process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes by analytical approach and taking into account the following aspects, such as technical standard, performance

aspect, robustness, applicability, sustainability, as well as considering factors such as economic, public health and safety, cultural, social and environment.

3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise.

3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility

3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently.

4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

1. The students must able to understand the concept, methodology, terminology, and scope in project management.
2. The students must able to understand and conduct feasibility analysis of projects and investment decisions.
3. The students must able to analyze strategic and operational planning of projects, devices and human resources.
4. The students must able to apply a particular software of Microsoft Project in a company case study.

MAIN SUBJECT

1. Introduction
2. Organizational influence and project life cycle
3. Project management framework
4. Project integration management
5. Project scope management
6. Project time management
7. Project cost management
8. Project quality management
9. Project human resources management
10. Project communication management
11. Project risk management
12. Project procurement management

PREREQUISITES

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MAIN REFERENCE

1. Project Management Institute (PMI), A Guide to the Project Management Body of Knowledge (PMBOK Guide), 5th Ed., Project Management Institute Inc., 2013
2. Kerzner, Harold, PhD., Project Management: A Systems Approach to Planning Schedulling, and Controlling, Van Nostrand Reinhold Company, 8th Edition, 2003.
3. Meredith, Jack R., and Mantel JR., Samuel J., Project Management: Managerial Approach, 2nd Edition, John Wiley & Sons Inc., 1989.
4. Budi Santosa, Manajemen Proyek Konsep dan Implementasi, Graha Ilmu, 2011.

COURSE	Course Name	:	**Introduction to Combustion Engineering**
	Course Code	:	TK184610
	Credit	:	2 SKS
	Semester	:	VI

DESCRIPTION of COURSE

Fundamental concepts of combustion science and engineering; Descriptions of combustion processes for gas, liquid and solid fuels; Environmental impacts: and applications related to energy industries

LEARNING OUTCOME

1.1 Engineering sciences, engineering principles, and engineering designs required for the analysis and design of processes, processing systems and equipment necessary to convert raw materials into value-added products by chemical, physical and biological processes;

2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems in processes, processing systems, and equipment necessary to convert raw materials into value-added products with chemical, physical and biological processes;

3.1 Able to apply logical, critical, systematic, and innovative thinking in the context of development or implementation of science and technology that cares and implements the humanities value appropriate to their area of expertise;

4.1 Demonstrate a responsible attitude towards the work in the field of expertise independently

COURSE LEARNING OUTCOME

Students are able to understand and/or analyse : (1) fundamental concepts of combustion science and engineering; (2) descriptions of combustion processes for gas, liquid and solid fuels; (3) environmental impacts and applications related to energy industries

MAIN SUBJECT

1. Introduction (historical perspective; emissions, climate change and sustainability issues)
2. Basic concepts (fuels; thermodynamics of combustion; chemical energy and equilibrium principles; chemical kinetics; mass transfer principles)
3. Combustion processes
4. Combustion of gaseous fuels
5. Combustion of liquid fuels
6. Combustion of solid fuels
7. Pollution and impacts

PREREQUISITES

TK184304	Momentum Transfer (Minimum D)
TK184406	Mass and Heat Transfer (Minimum D)
TK184301	Chemical Engineering Thermodynamics I (Minimum D)

REFERENCE

1. Ragland, K.W and Bryden ,K.M. (2011): *Combustion Engineering*. 2nd Edition, CRC Press.
2. Turns, S. (2011): *An Introduction to Combustion: Concepts and Applications*. 3rd Edition, McGraw Hill.
3. Annamalai, K. And Puri, I. (2007): *Combustion Science & Engineering*. CRC Press, Taylor and Francis Group, Boca Raton, FL.

COURSE	Course Name	:	**Supercritical Technology**
	Course Code	:	TK184611
	Credit	:	2 SKS
	Semester	:	VI

DESCRIPTION of COURSE
Study the fundamental properties of supercritical fluids and the application of supercritical fluids for extraction, pharmaceutical materials processing, synthesis of organic chemistry, polymerization, nanomaterials synthesis, and reaction media.

LEARNING OUTCOME
1.1 Comprehend the engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Comprehend the natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Comprehend the process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Able to understand the principles and the latest issues in economy, social, general ecology;
1.5 Comprehend the communication techniques and cutting-edge technologies
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;

3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently
4.2 Trying his/her best to achieve perfect results.

COURSE LEARNING OUTCOME

Students must be able to understand the application of supercritical fluids for industrial processes.

MAIN SUBJECT

1. Fundamental properties of supercritical fluids
2. Supercritical fluids extraction
3. Pharmaceutical materials processing with supercritical fluids
4. Synthesis of organic chemistry in supercritical fluids
5. Polymerization in supercritical fluids
6. Nanomaterials synthesis in supercritical fluids
7. Supercritical fluids as reaction media

PREREQUISITES

TK184301 Chemical Engineering Thermodynamics I
TK184405 Chemical Engineering Thermodynamics II
Joining the experimental laboratory

REFERENCE

1. Mamata Mukhopadhyay, Natural Extracts using Supercritical Carbon Dioxide, CRC Press, 2000.
2. Ya-Ping Sun, Supercritical Fluid Technology in Materials Science and Engineering, Marcel Dekker, Inc., 2002.
3. Joseph M. Desimone and William Tumas, Green Chemistry using Liquid and Supercritical Carbon Dioxide, Oxford University Press, 2003.
4. Gerd H. Brunner, Supercritical Fluids as Solvents and Reaction Media, Elsevier Science & Technology Books, 2004.
5. Walter Leitner, Philip G. Jessop, Paul T. Anastas, Handbook of Green Chemistry Vol. 4: Green Solvents, Wiley-VCH, 2012.

COURSE	Course Name	:	**Air Pollution Contol**
	Course Code	:	TK184612
	Credits	:	2 SKS
	Semester	:	VI

DESCRIPTION of COURSE
This course studies about air pollution phenomenon and understanding of air pollution control system especially for industry, so students are able to study air pollution phenomenon and understanding of air pollution control system, characteristics, types, and effects of air pollutant, measurement and estimations of pollutant emission and emission factors, as well as the introduction of air pollutant dispersion software.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Communication techniques and cutting-edge technologies;
2.1 Able to select appropriate resources and make use of design devices and appropriate IT-based engineering analysis to assist in engineering activities of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;

4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

1. Able to understand the control of air pollution
2. Able to understand government regulations and programs on air pollution control.
3. Able to understand the nature, types, and effects of air pollutants.
4. Able to understand the measurements and estimates of pollutant emissions and emission factors.
5. Able to understand the effects of meteorology and the dispersion model of the pollutants of the aging and its control.
6. Able to understand the photochemical reaction of the atmosphere.
7. Able to understand the control of volatile organic compound (VOC), sulfur oxide, and nitrogen oxide as well as odor.

MAIN SUBJECT

1. Government Regulations and Programs on Air Pollution Control.
2. The characteristics, types, and effects of air pollutants.
3. Measurement and estimates of pollutant emissions and emission factors.
4. Meteorological effects and models of pollutant dispersal.
5. Pollutants of the particulate matter and its control.
6. Photochemical reaction of the atmosphere.
7. Control of volatile organic compound (VOC), sulfur oxide, nitrogen oxide, and odor.
8. Introduction of air pollutant dispersion software

PREREQUISITES

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REFERENCE

1. Government regulations (UU No 5/1982 tentang Perindustrian, UU No 23/1997 tentang Pengelolaan Lingkungan Hidup, PP No 41/1999 tentang Pencemaran Udara, SK Menteri Negara LH, SK Gubernur/Pemprov)
2. Nevers, N.D, Air Pollution Control Engineering., 2nd ed, Mc Graw Hill, 2001.
3. Parker A., “Industrial Air Pollution Handbook”, , McGraw-Hill Book Company (UK) Limited, Maidenhead, England, 1978

4. Spinner M. Pete, *Elements of Project Management: Plan, Schedule, and Control*, 2nd Edition, Prentice-Hall, 1992.

COURSE	Course Name	:	**Separation Column Design**
	Course Code	:	TK184613
	Credit	:	2 SKS
	Semester	:	VI

DESCRIPTION of COURSE
This course studies the design of column in detail and tray based on its hydraulic performance.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies.
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME
Students are able to design detailed columns and trays based on their hydraulic performance.
MAIN SUBJECT
1. Design details of packed column 2. Design details of tray column bubble cap type 3. Design details of tray column, sieve tray type
PREREQUISITES
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REFERENCE
1. Van Winkle, M., *Distillation*, Mc. Graw Hill Book Company, New York, 1976. 2. Ludwig, E.E., *Applied Process Design for Chemical and Petrochemical Plants*, vol.2, second edition, Gulf Publishing Company, Book Division, Houston, London, Paris, Tokyo, 1979. 3. Coulson, J.M.& Richardson, J.F., *Chemical Engineering*, vol.6, first edition, Pergaman Press, Oxford, New York, Toronto, Sydney, Paris, Frankfurt, 1983. 4. Treybal, R.E., *Mass Transfer Operation*, third edition, Mc Graw Hill Kogakusha, Ltd., Tokyo, 1980. 5. Backhurst, J.R. & Harker, J.H., *Process Plant Design*, Heinman Education Book, London, 1973.

COURSE	Course Name	:	**Membrane Technology**
	Course Code	:	TK184614
	Credit	:	2 SKS
	Semester	:	VI

DESCRIPTION of COURSE
This course studies to understand the introduction of membrane technology, selection and understanding about membrane material properties, massa transport phenomena in membranes and membrane applications in industry. With learning methods include lectures, discussions, case studies, problem-based learning, writing examination, (including quiz, assignments and EAS)

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies.
2.1 Able to do research that includes identification, formulation, and analysis on engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;

4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

1. Being able to introduction of membrane technology
2. Being able to selection of material membrane properties
3. Being able to understand mass transport phenomena in membranes
4. Being able to understand membranes applications in industry

MAIN SUBJECT

1. Introduction of membrane technology
2. Introduction and membrane material properties selection
3. Massa transport phenomena in membranes
4. Membrane applications

PREREQUISITES

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REFERENCE

1. Mulder, M., “Basic Principles of Membrane Technology”, 2nd edition, Kluwer Academic Publishers, 1996
2. Geankoplis, S.J , "Transport Process and Unit Operation", 3nd edition. 1993.
3. Drioli, E. and Giorno, L., “Membrane Operations: Innovative Separations and Transformations”, Wiley VCH, 2009
4. Kucera, J., “Reverse Osmosis: Industrial Applications and Processes”, Wiley VCH, 2010
5. M.C. Porter (ed), “Handbook of Industrial Membrane Technology”, Noyes Publication, New York, 1990.

Course	Course Name	:	**Separation Technology**
	Course Code	:	TK184705
	Credit	:	4 SKS
	Semester	:	VII

DESCRIPTION OF COURSE
Separation Tecnology is LBE course of Heat and Mass Transfer Laboratory in chemical engineering department. This course consists of two study materials: Multicomponent Separation and Mass Transfer with Chemical Reaction or Reactive Absorption. This course provide separation concept and principles of separation calculation comprising multi component flash calculation, design (sizing) and performance analysis of absorber column, distillation column and extractor, and also principles of mass transfer with chemical reaction for design (sizing) calculation and performance analysis of reactive absorber. Learning method and activities comprises lecture, tutorial (discussion), exercises, quiz, presentation, and exam.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Communication techniques and cutting-edge technologies.
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;

3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility; 3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently; 4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.
LEARNING OUTCOME OF COURSE
1. Student understand principles of multicomponent separation 2. Student understand degree of freedom analysis of a certain process and being able to determine degree of freedom or number of design variables for a process element and a process unit consisting of several elements 3. Student being able to do mass and energy balance calculation for isothermal and adiabatic flash distillation. 4. Student being able to do performance analysis and sizing of multicomponent ditillation column using short cut equilibrium based. 5. Student being able to do performance analysis and sizing of distillation column using regorous equilibrium and rate based method. 6. Student being able to do performance analysis and sizing of multi component absorption column using short cut equilibrium based method 7. Tudent being able to do performance analysis and sizing of multicomponent absorption column using rigorous equilibrium and rate based method 8. Student being able to do performance analysis and sizing of multicomponent multistage extraction using short cut equilibrium based method 9. Student being able to do performance analysis and sizing of multicomponent multi stage extraction using rigorous equilibrium and rate based 10. Student understand the aplication of mass transfer with chemical reaction in industry 11. Student being able to determine solubility of gases in electrolyte solution 12. Student being able to determine diffusion coefficient in liquid and gas phase. 13. Student understand the mechanism and reaction kinetic for several reactive absorption system 14. Student understand the meaning of diffusion equation and can derive the diffusion equation,

15. Student being able to determine bsorption flux and number of moles of gas absorbed per unit interphase surface area in contact time t for reactive absorption system for phenomena of absorption in quesient liquid.
16. Student understand several interphase mass transfer model for absorption into agitated liquid
17. Student being able to determine absorption flux into agitated liquid for reactive absorption system using film model, Higbie model, and Danckwertz model
18. Student being able to design and analyze performance of agitated tank absorber operated continuously for reactive absorption
19. Student being able to design and analyze performance of agitated tank absorber operated batch wise for reactive absorption
20. Student being able to design and analyze performance of packed column for reactive absorption
21. Student being able to design and analyze the performance of plate column for reactive absorption
22. Student have competence in reviewing journal and present the review result orally.

MAIN SUBJECT

1. Design variable
2. Multicomponent Flash Distillation
3. Multicomponent Fractionation Distillation (multi stages)
4. Multicomponent Absorption
5. Multicomponent Extraction
6. Fundamentals of absorption with chemical reaction
7. Gas Absorption into quiescent liquid (Diffusion with reaction equation)
8. Gas Absorption into agitated liquid (Interphase mass transfer models)
9. Reactive Absorption into Agitated Tank
10. Reactive Absorption in packed and plate column

PREREQUIZITES

TK184601 Chemical Reaction Engineering II
TK184405 Chemical Engineering Thermodynamic II

REFERENCES

1. J.D. Seader, Eenest J. Henley, D.Keith Roper, *Separation Process Principles*, *Chemical and Biochemical Operation*, 3rd ed, John Wiley, 2011
2. R.E. Treyball, *Mass Transfer operations*, Mc Graw Hill, New York. 1981

3. Danckwertz, P.V.F.R.S., *Gas Liquid Reactions*, Mc.Graw Hill, New York, 1970.

4. Astarita, Giovanni, *Mass Transfer with Chemical Reaction*, Elsevier Publishing Company, Amsterdam, 1967.

5. Astarita, Giovanni, *Gas Treating with Chemical Solvents*, Wiley, New York, 1983

COURSE	Course Name	:	**Solid, Toxic and Hazardous Waste Management**
	Course Code	:	TK184706
	Credit	:	4 SKS
	Semester	:	VII

DESCRIPTION of COURSE
This course studies solid waste management by following the issues and challenges of the world in its processing, the risks and impacts of the resulting solid waste, the sources and types and categories of solid waste, how the key steps and components in solid waste management, thermal, biological treatment), off-site disposal option (landfilling, incineration, composting, recycling), 5R concept (Reduce, Reuse, Recycle, Recovery, Residual Management), and examples of technology applications in solid waste utilization. The course of Solid, Toxic and Hazardous Waste Management studies waste management/residual activities containing hazardous and/or toxic substances, which due to the nature and / or concentration and / or amount either directly or indirectly contaminate and / or damage the living environment of funds tau can endanger the environment, health, human survival, and other living things. This course studies Hazardous and Toxic Industrial waste sources, legislation, dispersion and prevention of contaminant, toxicological, chemical, physical, biological and B3 waste disposal.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes; 1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes; 1.3 Process design technique and principles, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes; 1.4 Communication techniques and cutting-edge technologies. 2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and

equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;

3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;

3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;

3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;

4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

Students are able to understand and apply the concept, technology in the management / utilization of solid waste. On the other hand, the students are able to understand the source and characteristics of Hazardous and Toxic Industrial waste and apply proper handling of Hazardous and Toxic Industrial waste management. The details course learning outcome are described in following.

The students are:

1. Able to understand the issues and challenges of waste management
2. Able to understand the risks and impacts of waste
3. Able to understand the source and type and category of solid waste
4. Able to understand key steps and components in solid waste management
5. Able to utilize modern technology in designing a solid waste management system
6. Mastering the concept of thermal and biological solid waste processing

a. Mastering the concept or principles of solid waste management, especially off-site disposal

7. Master the 5R concept (Reduce, Reuse, Recycle, Recovery, Residual Management)
8. Mastering technology in utilizing solid waste...
9. Students are able to understand the source and influence of hazardous and toxic industrial waste (B3) on the environment.
10. Students are able to perform waste management properly....

MAIN SUBJECT

1. Waste management issues and challenges
2. Risks and impacts of waste

3. Sources and types and categories of solid waste
4. Key steps and components in solid waste management
5. Solid waste treatment (thermal, biological treatment)
6. Choice of off-site disposal (landfilling, incineration, composting, recycling)
7. 5R (Reduce, Reuse, Recycle, Recovery, Residual Management)
8. Examples of solid waste utilization and technology...
9. Introduction to Hazardous and Toxic Industrial waste, Regulation
10. Fundamentals of the process
11. Spread of contaminants, prevention of contamination, toxicology
12. Hazardous and Toxic Industrial waste treatment methods are chemical, physical, biological, stabilization and solidification, thermal
13. Disposal of Hazardous and Toxic Industrial waste...

PREREQUISITES

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REFERENCE

1. Robert E. Landreth dan Paul A. Rebers, Municipal Solid Waste, Lewis Publishers, New York, 1997.
2. Ministry of Environment – British Columbia, A Guide to Solid Waste Management Planning, 2016.
3. LaGrega, M.D., Buckingham, P.L., and Evans, J.C., Hazardous waste Management, McGraw-Hill International Edition, 2nd edition, 2001
4. William Tender, D., Frederick G.Pohland,Emerging Technologies in Hazardous Waste Management, American Chemical Society, Washington DC, 1990
5. Harry M.Freeman, Hazardous Waste Minimization, Mc Graw Hill Publishing Company, 1990
6. Charles A.Wantz, Hazardous Waste Management, Mc Graw Hill International Editions, 1989
7. George Tchobanolous, et al, Solid Waste, Mc Graw Hill International Editions, 1987

COURSE	Course Name	:	**Essential Oil Processing**
	Course Code	:	TK184707
	Credit	:	4 SKS
	Semester	:	VII

DESCRIPTION of COURSE
This course study about Essential Oil, Market Potency & Essential Oil Marketing, Essential Oil Chemistry, Essential Oil Extraction Technique, Essential Oil Distillation in Indonesia, Essential Oil Usage: Perfume & Aromatheraphy The teaching methods include: introductory lecture; Brainstroming; The Writing Exam (including Quiz, Duties, EAS), Practice includes Presentations and group discussions.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to demonstrate independent performance, quality, and measurable;
3.3 Being able to examine the implications of the development or implementation of the science of technology which concerns and implements the value of humanities in accordance with its expertise based

on rules, procedures and scientific ethics in order to produce solutions, ideas, designs or art criticism,

3.4 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;

3.5 Being able to examine the implications of the development or implementation of the science of technology which concerns and implements the value of humanities in accordance with its expertise based on rules, procedures and scientific ethics in order to produce solutions, ideas, designs or art criticism,

3.6 Being able to apply entrepreneurship and understand technology-based entrepreneurship

4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

Students are able to understand about the extraction of essential oil and the market potential of essential oils

MAIN SUBJECT

1. Introduction of Essential Oils
2. Potential Market & marketing of Essential oils
3. Chemical essential oils
4. Essential oil extraction techniques
5. Essential oil distillation in Indonesia
6. Use of Essential Oils: Perfume & Aromatherapy

PREREQUISITES

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REFERENCE

1. Guenther, E., Minyak Atsiri Jilid 1,2,3,4,5 Penerjemah Ketaren S., Universitas Indonesia Press, Jakarta, 1987.
2. Hardjono Sastrohamidjojo, "Kimia Minyak Atsiri", ISBN: 978-979-420-551-8, UGM Press, 2004
3. Handbook of Essential Oil by K Husnu Can Baser & Gerhard Buchbauer

COURSE	Course Name	:	**Heterogeneous Catalyst**
	Course Code	:	TK184708
	Credit	:	4 SKS
	Semester	:	VII

DESCRIPTION of COURSE
The subject covers fundamental of heterogeneous catalysis including: preparation, characterization, finishing, experimental reactor, and practical scale application. Learning activities comprised of introductory course, group discussion, written and oral examination.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to demonstrate independent performance, quality, and measurable;
3.3 Being able to examine the implications of the development or implementation of the science of technology which concerns and implements the value of humanities in accordance with its expertise based on rules, procedures and scientific ethics in order to produce solutions, ideas, designs or art criticism,

3.4 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
3.5 Being able to examine the implications of the development or implementation of the science of technology which concerns and implements the value of humanities in accordance with its expertise based on rules, procedures and scientific ethics in order to produce solutions, ideas, designs or art criticism,
3.6 Being able to apply entrepreneurship and understand technology-based entrepreneurship
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

Students are able to understand fundamental of heterogeneous catalysis and their applications.

MAIN SUBJECT

1. Heterogeneous catalyst introduction
2. Preparation of catalyst
3. Catalyst characterization
4. Catalytic reaction
5. Experimental reaction
6. Catalyst deactivation
7. Industrial catalyst application

PREREQUISITES

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REFERENCE

1. M Albert Vannice, "Kinetics of Catalytic Reactor", Springer Science and Business Media, 2005
2. J.M.Smith, "Reaction Kinetics" 3rd ed, McGraw-Hill,1982
3. C Bartholomew, R Farrauto, "Fundamental of Industrial Catalytic Processes", 2nd Ed, Abe Books, 1997

SUPPORTING REFERENCE

1. Octave Levenspiel, "*Chemical Reaction Engineering*" 3rd Ed. McGraw-Hill, 2000.
2. Fogler," *Elements of Chemical Reaction Engineering*", 3rd ed, Prentice-Hall, 1999

COURSE	Course Name	:	**Polymer Technology**
	Course Code	:	TK184709
	Credit	:	4 SKS
	Semester	:	VII

DESCRIPTION of COURSE
Polymer technology is the elective course from Laboratory of Materials Technology. This course discusses all about polymers include; understanding of polymers, synthesis, classification and properties of polymer. Concept, classification, structure, and processing of polymer; basics and polymerization kinetics. Copolymerization and polymerization techniques; examples and discussion of the commercial polymer industry; thermal properties (such as: Cp, k, ρ) and their predictions; Concepts, estimates and data of PVT, polymer solubility, polymer processing and the types of polymer processing; the concept of Tg, Tm and its characterizations. Polymer characterization; molecular weight, DSC, SEM, TEM, FTIR and others.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies;
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipment required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;

3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
3.4 Able to do research that includes identification, formulation, and analysis on engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

1. Being able to recognize and understand the concept of polymer materials, their classification and the origin of their formation.
2. Being able to understand about monomer, polymer, polymerization and polymer structure, and the concept of the polymerization process.
3. Being able to learn and understand about polymerization reactions such as additions and condensation. And being able to analyze addition polymerization reaction processes (ionic, anionic and cationic).
4. Being able to understand the manufacture of polymers with condensation reactions. The principle of condensation based on the reaction of the functional group
5. Being able to understand the process of copolymerization reaction. The copolymerization rule is used to obtain the mixed properties of the forming polymer. Copolymerization rules as a means of polymer modification, both structure and properties.
6. Being able to understand about molding processing of polymers, especially plastics and fibers that will lead to the formation of final or frozen products. The change from liquid or melting to solids follows a change in the properties of the polymer especially at the critical point.
7. Being able to understand the problem of glass temperature (Tg) and melting temperature (Tm) for various types of polymer, amorphous and crystalline.
8. Being able to understand the polymer properties such as pressure (P), volume (V) and temperature (T), especially plastic.
9. Being able to understand the polymer solubility in solvent and how to predict it.
10. Being able to understand the mechanical properties of solid polymers, especially plastic.

11. Being able to understand the viscoelastic properties of polymers, especially plastics.
12. Being able understand the importance of plastic packaging in the modern food and beverage business today.
13. Being able to understand about the problem of recycle polymer especially plastic.
14. Being able to understand about polymer characterization.

MAIN SUBJECT

Synthesis, classification, and properties of polymer. Concept, classification, structure, and processing of polymer; basics and polymerization kinetics. Copolymerization and polymerization techniques; examples and discussion of the commercial polymer industry; thermal properties (Cp, k,ρ) and their predictions, Concepts, estimates and data of PVT, polymer solubility, polymer processing and the types of polymer processing; the concept of Tg, Tm and its characterizations. Polymer characterization; molecular weight, DSC, SEM, TEM, FTIR and others.

PREREQUISITES

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REFERENCE

1. Billmeyer, F.W. Jr., “Textbook of Polymer Science”, Wiley, New York, 1971
2. Griskey, R.G. “Polymer Process Engineering”, Chapman & Hall, New York, 1995
3. Fried, J.R., “Polymer Science and Technology”, Prentice Hall, New Jersey, 1995.
4. Stevens, M.P., “translate to Indonesia by Dr.Ir. Iis Sofyan, M.Eng., “Kimia Polimer”, PT. Pradnya Paramita, Jakarta, 2001.

COURSE	Course Nama	:	**Biorefinery and Bioconversion of Biomass**
	Course Code	:	TK184710
	Credit	:	4 SKS
	Semester	:	VII

COURSE DESCRIPTION
This course explains in theory the definition, classification, and system process (by literary studies) of bio refinery; including bio refinery process for producing liquid fuels, energy (via gasification process) and biomass especially related to value-added chemicals from biomass and lignocellulose materials. The current status of bio refinery including its future trend development, classification and its various examples according to: IEA bioenergy task 42; Bioenergy Euro view; The US Department of Energy's report on integrated are also given in this lecture.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies.
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
2.2 Able to find the engineering root cause of process, processing system, and equipments required for converting raw materials into value-added products through investigation process, analysis, interpretation of data and information according to engineering principles;
2.3 Able to do research that includes identification, formulation, and analysis on engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
2.4 Able to formulate alternative solution to solve complex engineering problems of process, processing system, and equipments required for

converting raw materials into value-added products through chemical, physical, and biological processes by considering factors such as economic, public health and safety, cultural, social and environment (environmental consideration);

2.5 Able to design process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes by analytical approach and taking into account the following aspects, such as technical standard, performance aspect, robustness, applicability, sustainability, as well as considering factors such as economic, public health and safety, cultural, social and environment;

2.6 Able to select appropriate resources and make use of design devices and appropriate IT-based engineering analysis to assist in engineering activities of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes.

3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;

3.2 Being able to take decisions appropriately in the context of problem solving in the area of expertise based on the results of information and data analysis;

4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

1. Able to define and classify biorefinery; including the definition of value-added chemicals from biomass; and do simple classification of natural products (NPs)
2. Able to understand various classifications of the current trend of biorefinery covering various examples of biorefinery and its classification according to: IEA bioenergy task 42; Bioenergy Euroview; The US Department of Energy's report on integrated biorefinery.
3. Knowing and understanding the current position / status of biorefinery and it future trend developments
4. Knowing and understanding gasification process both in principle and its difference / modification when different raw material is used

5. able to classify NPs in simple way and know their utilization and application for life including able to explain basic processes of natural products (NPs)
6. Able to conduct literature research on material including identification and processes engineering, processing systems for biorefinery producing fuels (liquid fuels); gasification process; value-added chemicals either from plants or lignocellulosic materials.

MAIN SUBJECT

1. Definition and classification of biorefinery;
2. Borefinery current position, status and future trend development;
3. Biorefinery for producing fuels (liquid fuels);
4. Biorefinery for producing energy (Pyrolysis, gasification included coal and lignocellulosic materials);
5. Biorefinery for producing value-added chemicals from biomass

PREREQUISITES

REFERENCES

1. Xuan, T.D., Nakagoshi, N., Sakanishi, K., Minowa, T. 2012. Biorefinery: Concepts, current status, and development trends. International Journal of Biomass & Renewables.
2. Rastagno, Mauricio, and Juliana Prado. 2003. *Natural Product Extraction*. RSC Publishing.

COURSE	Course Name	:	**Natural Gas Processing Technology & HYSYS application**
	Course Code	:	TK184710
	Credit	:	4 SKS
	Semester	:	VII

DESCRIPTION of COURSE
This course learns about definition and understanding natural gas technologies include: Exploration, Drilling, Production Process and Process Refinery, so ready to work orientation in the Natural Gas Industry. Learning materials delivered include: Stages exploration included reservoir PVT, Production Engineering, Testing and measurements, Natural gas products i.e. Sales gas, LNG, CNG, LPG etc. Transportation of Gas, piping, shipping, trucking. Learning application of HYSYS or Process Simulation Tools in natural gas processing. The learning methods include: an introductory course; brainstorming; Cases study, Writing Exam (includes quizzes, assignments, ETS and UAS), Practice includes presentations and group discussions.

LEARNING OUTCOME
1.1 Comprehend of engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Comprehend of natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Comprehend of process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Able to understand the principles and the latest issues in economy, social, general ecology;
1.5 Comprehend of communication techniques and cutting-edge technologies
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and

technology that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.
4.2 Trying his/her best to achieve perfect results

COURSE LEARNING OUTCOME

1. Being able to apply PVT to analyzed well performance.
2. Being able to apply typical gas processing technology to produce sales gas, LPG, LNG and other natural gas products.
3. Having knowledge in making selection of technology in gas processing, transportation and storages economically.
4. Being able to apply HYSYS simulation to make conceptual design and process analysis.
5. Have potential motivation in developing self-knowledge become professional engineer in natural gas processing field.

MAIN SUBJECT

1. Well & Exploration
2. Gas Processing Technologies
3. Products and Specifications
4. Transportation and Storages
5. Material & Energy Balance
6. Unit Operation
7. PVT and Phase equilibria

PREREQUISITES

TK184301 Chemical Engineering Thermodynamics I
TK184405 Chemical Engineering Thermodynamics II

REFERENCE

1. A. J. Kidnay and W. R. Parish, “Fundamentals of Natural Gas Processing”, CRC Press, Boca Raton, 2006
2. A. H. Younger, “Natural Gas Processing Principles and Technology”, Univ. of Calgary, 2004.

3. Other relevance literatures, Journals

COURSE	Course Name	: **Biochemical and Food Technology**
	Course Code	: TK184712
	Credit	: 4 SKS
	Semester	: VII

DESCRIPTION of COURSE
The course studies the basic of biochemical engineering and concept of process technology and food processing operations. Basic of biochemical engineering includes: enzyme kinetics and reactor design, enzyme immobilization, application of enzyme in industry, whole cell kinetics and reactor design, genetic engineering, sterilization, agitation and down-stream biological process. Concept of process technology and food processing operations consists of subjects in order to troubleshoot processes and operations in the food processing industry, include: Nutrition, food composition and avail; Preservation technology; Process and operation of food processing industry. The learning method consists of lecture, presentation and group discussion, presentation, case study, problem based learning, written test (quiz, assignment, final exam).

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes; 1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes; 1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes; 1.4 Principles and the latest issues in economy, social, general ecology; 1.5 Communication techniques and cutting-edge technologies 2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes; 3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology

that concerns and implements the value of humanities in accordance with their area of expertise;
3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

Students are able to understand the basic of biochemical technology in order to solve the general problems in biochemical technology, and the process technology and food processing operation in order to solve the problem in process and operation in food industry.

MAIN SUBJECT

1. Introduction: Development of chemical engineering and biochemical engineering
2. Enzyme reaction kinetics
3. Enzyme reactor design
4. Enzyme Immobilization
5. Application of enzyme in industry
6. Cell cultivation
7. Whole cell kinetics
8. Whole cell reactor design
9. Genetic engineering
10. Sterilization, Agitation, and down-stream process
11. The Nutrient, Composition of food and its usage,
12. Food Analysis
13. Food processing and operation in industry.
14. Preserving technology
15. Food Engineering

PREREQUISITES

TK184501 Chemical Reaction Engineering I (Minimum D)

REFERENCE

1. James M. Lee: Biochemical Engineering, Prentice Hall International series, 1992

2. Bailey & Ollis : “Biochemical Engineering Fundamentals”, 2nd ed, Mc Graw Hill, 1986.
3. Shuler & Kargi : “Bioprocess Engineering” Prentice Hall, 1991.
4. Geoffrey Campbell-Platt, Food Science and Technology, Willey-Blackwell, Jhon Wiley, 2009.
5. Zacharias B. Maroulis & George D. Saravacos, Food Process Design, Marcel Dekker, 2003.
6. Jason E. Maxwell, Soybean: Cultivation, Uses and Nutrition, Nova Science Publisher, New York, 2011.

COURSE	Course Name	:	**Electrochemical and Nanomaterial Engineering**
	Course Code	:	TK184713
	Credit	:	4 SKS
	Semester	:	VII

DESCRIPTION of COURSE
This course learns about the electrochemical reaction and the characterization of electrochemical method. In addition, this course provides a comprehensive overview of synthesis and characterization of nanomaterials including their utilization. After completing the course, the student should be able to apply the electrochemical principles in the specific application such as nanomaterial synthesis and corrosion prevention. Students should be able to explain the synthesis methods, characterization and the utilization of nanomaterials. The conventional assignment is coupled with students' reading and presentation of advanced literature in the field which the students work independently and in a teamwork.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Being able to apply logical, critical, systematic and innovative thinking in the context of development or implementation of science and technology that concerns and implements the value of humanities in accordance with their area of expertise;

3.2 Being able to take responsibility for the achievement of group work and supervise and evaluate the work completion assigned to the worker under his/her responsibility;
3.3 Being able to conduct self-evaluation process to work group under his/her responsibility, and able to manage learning independently;
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently.

COURSE LEARNING OUTCOME

The learning outcome of this course is student should be able to apply the electrochemical principles in the specific application such as nanomaterial synthesis and corrosion prevention. Students should be able to describe the synthesis, characterization and the utilization of nanomaterials.
Sub-learning outcome of this course:

1. Students are able to apply Nernst equation to electrochemical and the overpotential concept.
2. Students are able to describe the difference between kinetically and mass transport controlled electrochemical processes.
3. Students are able to applying the electrochemical methods such as chronoamperometry, cyclic voltammetry, chronopotentiometry, and ac impedance.
4. Students are able to describe the nanomaterial synthesis and the principles controlling assembly of nanostructured material.
5. Students are able to describe the nanomaterials utilization in advances engineering application such as catalyst for biomass conversion, drug delivery carrier, inorganic membrane separation, and catalysts for fuel cell and solar cell.

MAIN SUBJECT

1. Nernst equation and overpotential concept
2. Electrochemical kinetics
3. Electrochemical methods
4. Nanomaterial synthesis
5. Nanomaterial application

PREREQUISITES

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REFERENCE

1. Bard, A. J. and Faulkner, L. R., “Electrochemical Methods, Fundamentals and Applications”, 2nd edition, John Wiley & Sons, Inc., 2001

2. Perez, N., “Electrochemistry and Corrosion Science”, Kluwer Academic Publishers, 2004
3. Rao, C. N. R., Muller, A., and Cheetham, A. K., “The Chemistry of Nanomaterials: Synthesis, Properties and Applications”, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2004
4. Chauhan, B. P. S., “Hybrid Nanomaterials: Synthesis, Characterization, and Applications”, A John Wiley & Sons, Hoboken, New Jersey, Inc., 2011

COURSE	Course Name	:	**Design and Integration Process**
	Course Code	:	TK184714
	Credit	:	4 SKS
	Semester	:	VII

DESCRIPTION of COURSE
Review heat exchanger. Designing heat exchanger networks based on energy target. Designing heat exchanger networks based on cost target. Understanding Pinch Design Method. Selection stream data from process flow diagram. Understanding heat integration in reactor and distillation column. Understanding heat integration in evaporator and dryer. Review control system design. Review feedback control system. Review Closed loop stability. Introduction to multivariable control system. Use of Relative Gain Array and Relative Dynamic Array. Application of RGA and RDA on MIMO system. Tuning Multiloop PID Control Systems. Decoupling and Multivariable Control Strategies. Model Predictive Control for MIMO System.

LEARNING OUTCOME
1.1 Engineering science concepts, engineering principles, and design engineering required for process design and analysis, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.2 Natural science concepts and mathematical engineering application principles on the design and analysis of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.3 Process design technique and principles, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
1.4 Principles and the latest issues in economy, social, general ecology;
1.5 Communication techniques and cutting-edge technologies.
2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems of process, processing system, and equipments required for converting raw materials into value-added products through chemical, physical, and biological processes;
3.1 Able to find the engineering root cause of of process, processing system, and equipments required for converting raw materials into value-added products through investigation process, analysis, interpretation of data and information according to engineering principles;

3.2 Being able to demonstrate independent performance, quality, and measurable
4.1 Demonstrating attitude of responsibility on work in his/her field of expertise independently

COURSE LEARNING OUTCOME

1. Students understand the use of composite curve.
2. Students understand the use of problem table algorithm
3. Students understand the Pinch Design Method to reduce the required utilities and to maximize the use of heat from the process.
4. Students can make a mathematical model theoretically and empirically for physical processes in industry MIMO system.
5. Students are able to solve ordinary differential equations and partial differential equations for MIMO system.
6. Students understand basic concepts of RGA and RDA.
7. Students are able to use PID controller to make processes closed loops stable.
8. Students are able to use MPC to make processes closed loop stable.

MAIN SUBJECT

1. Review heat exchange networks.
2. Basic principles on heat savings in industry.
3. The use of composite curve.
4. The use of problem table algorithm
5. The application of Pinch Design Method on heat integration based on energy target.
6. Basic principles on finding the pairing of hot and cold streams based on energy target. The use of split to get the energy target.
7. Basic principles on finding the pairing of hot and cold streams based on cost target. Reducing number of heat exchangers by looking at the loop and path.
8. The calculation on total annual cost. Finding the minimum total annual cost.
9. Heat integration on distillation column, reactor and other equipments using heat.
10. Process interaction and control loop interaction.
11. Basic concepts of RGA and RDA
12. Singular Value Decomposition Analysis
13. Tuning on PID controller multiloop control system.
14. Strategies on reduction of control loop interaction.

15. Prediction on MIMO model and building Model Predictive Control (MPC).
16. Selection and Tuning on MPC parameters.

PREREQUISITES

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REFERENCE

1. Robin Smith, "Chemical Process Design and Integration, 2nd edition, John Wiley & Sons, New York, 2005.
2. Mahmoud M. El-Hawalgi," Process Integration", 1st edition, Academic Press, Amsterdam, 2006.
3. Ian C. Kemp,"Pinch Analysis and Process Integration, 2nd edition, Butterworth-Heinemann, Amsterdam, 2007.
4. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp, Francis J. Doyle III, "Process Dynamics and Control", 4th ed., John Wiley & Sons, New. York., 2016.
5. Sigurd Skogestad, Ian Postlethwaite," Multivariable Feedback Control", 2nd edition, John Wiley & Sons, New York, 2005.

COURSE	Course Name	:	**Fluid Mixing Technology**
	Course Code	:	TK184715
	Credit	:	4 SKS
	Semester	:	VII

DESCRIPTION of COURSE
Study Power correlation; Miscible liquid blending; Suspension of solid-liquid; Emulsification of liquid-liquid; Dispersion gas-liquid; Scale-up; and Application of fluid mixing in industry; and Computational Fluid Dynamics (CFD)
LEARNING OUTCOME
1.1 Engineering sciences, engineering principles, and engineering designs required for the analysis and design of processes, processing systems and equipment necessary to convert raw materials into value-added products by chemical, physical and biological processes; 2.1 Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems in processes, processing systems, and equipment necessary to convert raw materials into value-added products with chemical, physical and biological processes; 3.1 Able to apply logical, critical, systematic, and innovative thinking in the context of development or implementation of science and technology that cares and implements the humanities value appropriate to their area of expertise; 4.1 Demonstrate a responsible attitude towards the work in the field of expertise independently.
COURSE LEARNING OUTCOME
Students must be able to understand and analyze : Power correlation; Miscible Liquid Blending; Suspension of Solid-Liquid; Emulsification of Liquid-Liquid; Dispersion Gas-Liquid; Scale-up; Application Fluid Mixing in Industry; and Computational Fluid Dynamics (CFD)
MAIN SUBJECT

1. Introduction;
2. Power correlation;
3. Miscible Liquid Blending;
4. Suspension of Solid-Liquid;
5. Emulsification of Liquid-Liquid;
6. Dispersion Gas-Liquid;
7. Scale-up;
8. Application Fluid Mixing in Industry;
9. Computational Fluid Dynamics (CFD):
   - Introduction to Computational Fluid Dynamics (CFD) modern
   - Steps of CFD simulation
   - Governing equations of fluid flow and heat transfer
   - Turbulensi and modeling
   - Solution methode
   - Solution algorithm
   - Boundary conditions
   - Meshing/grid generation
   - Validation dan verification
   - Application of CFD

PREREQUISITES

TK184304	Momentum Transfer
TK184404	Unit Operations I
TK184406	Mass and Heat Transfer
TK184604	Chemical Engineering Numerical Computation

REFERENCE

1. Paul, E.L., Atiemo-Obeng, V.A., Kresta, S.M.(2004): Handbook of Industrial Mixing-Science and Practice. A. John Wiley & Sons, Inc., Publication.
2. Harnby, N., M. F. Edwards, and A. W. Nienow (Eds.) (1992): Mixing in the Process Industries. Butterworth-Heinemann, Wolburn, MA
3. Oldshue, J.Y. (1983): Fluid mixing technology. McGraw-Hill, New York.
4. Tatterson, G. B. (1994): Scaleup and Design of Industrial Mixing Processes. McGraw-Hill Professional Publishing.
5. Tatterson, G. B. (1981): Fluid Mixing and Gas Dispersion in Agitated Tanks. McGraw-Hill School Education Group

6. Versteeg, H.K. and W Malalasekera, W. (2007): An Introduction to Computational Fluid Dynamics. Pearson Prentice Hall, London
7. Patankar, S. V. (1980). Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, Taylor & Francis Group, New York.
8. ANSYS Fluent User Guide.