SYLLABUS
UNDERGRADUATE PROGRAM (S1)
CURRICULUM ITS 2023 – 2028

CHEMICAL ENGINEERING DEPARTMENT
FACULTY OF INDUSTRIAL TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA
2023

COURSE	Course Name	:	**Introduction to Chemical Engineering**
	Course Code	:	TK 234101
	Credit	:	3 SKS
	Semester	:	I

DESCRIPTION of COURSE

This course studies the history and role of chemical engineering, introduction to the basics of chemical engineering, chemical engineering undergraduate profession, basics of chemical engineering design and practice, basic safety and process management, and using software used in chemical engineering.

LEARNING OUTCOME

1. Able to demonstrate attitudes and characters that reflect: devotion to God Almighty, ethics and integrity, noble character, sensitive and concerned about social and environmental problems, respect for cultural differences and pluralism, uphold law enforcement, prioritize the interests of the nation and the wider community, through creativity and innovation, excellence, strong leadership, synergy, and other potentials to achieve maximum results.
3. Able to manage self-learning and develop themself as a lifelong learner to compete at the national and international levels, to contribute significantly to solving problems by implementing information and communication technology and paying attention to the principles of sustainability and understanding technology-based entrepreneurship.
7. Mastering the principles of mathematics, physics, chemistry, and biology to be able to act as experts (sub professionals) who handle chemical engineering problems.

COURSE LEARNING OUTCOME

1. Students are able to know the history and role of chemical engineering (C1)
2. Students are able to understand and explain the basics of chemical engineering (C1, C2)
3. Students are able to understand and explain the career path of the chemical engineering profession (C1, C2)
4. Students are able to explain the basics of design and practice in chemical engineering (C2)

5. Students are able to explain about chemical process, safety, engineering and management (C2)
6. Students are able to apply and use the basics of software and software in solving chemical engineering problems (C2, C3)

MAIN SUBJECT

1. Introduction to the history and role of chemical engineering (definition of chemical engineering, history of chemical engineering, anatomy of chemical engineering plants)
2. Fundamentals of chemical engineering (mass and energy balances, process units and operating units, fluid flow, mass and heat transfer, thermodynamics, chemical reaction techniques, and separation processes)
3. Prospects and competencies needed in chemical engineering (Build Critical &; Holistic Thinking and leadhership)
4. Fundamentals of chemical engineering design and practice (Process and Technology Development, Engineering Design, Introduction to EPC stages)
5. Basic safety and process management (Process design for safety, introduction to HAZOP and safety management processes)
6. Introduction to simple software and applications (Hysis Recognition, Matlab, Autocad)

PREREQUISITES

None

REFERENCE

1. Uche, N. (2019): Introduction To Chemical Engineering. Scrivener Publishing, Wiley
2. Ghoshal, S.K., Sanjal, S.K. and Datta, S. (2017): Introduction To Chemical Engineering. Tata McGraw-Hill Publication
3. Pusphavanam, S. (2012): Introduction To Chemical Engineering. PHI Learning Private
4. Felder, R.M. dan Rosseau, R.W. (2005):"Elementary Principles of Chemical Process, ", 3rd Edition, John Wiley and Sons, New Jersey.
5. Himmelblau, D.M. (2003): Basic Principles and Calculation in Chemical Engineering, 7th Edition, Prentice Hall.

COURSE	Course Name	:	**Analytical Chemistry**
	Course Code	:	TK234102
	Credit	:	4 SKS
	Semester	:	I

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
3. Able to manage self-learning and develop themself as a lifelong learner to compete at the national and international levels, to contribute significantly to solving problems by implementing information and communication technology and paying attention to the principles of sustainability and understanding technology-based entrepreneurship. 5. Able to design and carry out laboratory and / or field experiments by utilizing methods, technical tools, and modern engineering instruments, as well as analyzing and evaluating the results in solving chemical engineering problems. 6. Mastering the principles of mathematics, physics, chemistry, and biology to be able to act as experts (sub professionals) who handle chemical engineering problems.

COURSE LEARNING OUTCOME
1. Students are able to implement and demonstrate basic calculations in chemical analysis (C3, P2) 2. Students are able to explain and use and identify equilibrium theory in chemical analysis (C2, C3, P2) 3. Students are able to carry out and demonstrate various volumetric analysis methods (C3, P2) 4. Students are able to carry out and demonstrate gravimetric analysis methods (C3, P2) 5. Students are able to compare and carry out and demonstrate potentiometric methods using titration equipment and methods (C2, C3, P2) 6. Students are able to carry out and demonstrate spectroscopic methods in quantitative analysis (C3, P2) 7. Students explain and compare several methods of analysis using instruments and their applications (C2, C3)
MAIN SUBJECT
1. Basic calculations in chemical analysis 2. Equilibrium theory in chemical analysis 3. Various Volumetric Analysis Methods 4. Gravimetric Analysis Method 5. Potentiometric Method and Potentiometric Titration 6. Spectroscopic methods in quantitative analysis 7. Analysis methods using instruments and their applications
PREREQUISITES
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REFERENCES
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	:	**Introduction to Industrial Chemistry**
	Course Code	:	TK234201
	Credit	:	2 SKS
	Semester	:	II

DESCRIPTION of COURSE
This course explains the history and characterization of industry, domestic and global chemical industry, sources of raw materials for chemical industry, organic and inorganic chemical industry, introduction to chemical industry processes, industrial energy sources, aspects that affect the chemical industry (economic, environmental and safety)
LEARNING OUTCOME
3. Able to manage self-learning, and develop themselves as lifelong learners to compete at national, and international levels, in order to contribute significantly to solving problems by implementing information and communication technology and paying attention to sustainability principles and understanding technology-based entrepreneurship 4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight. 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally

COURSE LEARNING OUTCOME
1. Understand the history and characteristics of the industry 2. Understand the domestic and global chemical industry 3. Understand the sources of raw materials for the chemical industry 4. Understand the processes of the organic chemical industry and its block diagrams and process flow diagrams 5. Understand the processes of the inorganic chemical industry and their block diagrams and process flow diagrams 6. Students are able to know and understand the energy sources of the chemical industry - Non-Renewable Energy and Renewable Energy 7. Understand economic, environmental and safety aspects in the chemical industry (C4)
MAIN SUBJECT
1. History and characterization of the industry, 2. National and international chemical industry 3. Sources of raw materials for the chemical industry 4. Organic and inorganic chemical industry 5. Introduction of chemical industry processes 6. Industrial energy sources 7. Aspects affecting the chemical industry (economic, environmental and safety)
PREREQUISITES
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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	:	**Organic Chemistry**
	Course Code	:	TK234202
	Credit	:	4 SKS
	Semester	:	II

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
2. Able to design and carry out laboratory and / or field experiments by utilizing modern methods, engineering tools and engineering instruments, as well as analyzing and evaluating the results in solving chemical engineering problems 6. Mastering the principles of mathematics, physics, chemistry, and biology to be able to act as experts (sub-professionals) who handle chemical engineering problems

COURSE LEARNING OUTCOME
1. Students are able to estimate and give examples of atoms and molecules including atomic radius, chemical bonds, orbitals in covalent bonds, isomeric structures (C2, A1) 2. Students are able to explain and answer stereochemistry, substitution and elimination reactions, and free radical reactions (C2, A1) 3. Students are able to compare, connect, and practice the properties and reactions of chemical compounds that enter the alcohol, ether, aldehyde, ketone, carboxylic acid, carboxylic acid derivatives, enolics and carbonions, amines, heterocyclic aromatics and polycyclics (C2, C3, P1, A4) 4. Students are able to compare, connect, and practice the properties and reactions that occur in amino acids and proteins, carbohydrates and lipids (fats) (C2, C3, P1, A4)

MAIN SUBJECT
1. Atomic radius, chemical bonds, orbitals in covalent bonds, isomeric structures, and stereochemistry 2. Substitution and elimination reactions 3. Free radical reactions 4. Alcohol, Ether, Aldehyde, and ketones 5. Carboxylic acids and carboxylic acid derivatives 6. Enolate and carbonion 7. Amine and aromatic heterocyclic and polycyclic 8. 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	:	**Physical Chemistry**
	Course Code	:	TK234203
	Credit	:	4 SKS
	Semester	:	II

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
3. Able to manage self-learning, and develop themselves as lifelong learners to compete at national, and international levels, in order to make a real contribution to solving problems by implementing information and communication technology and paying attention to sustainability principles and understanding technology-based entrepreneurship. 5. Able to design and carry out laboratory and / or field experiments by utilizing modern methods, engineering tools and engineering instruments, as well as analyzing and evaluating the results in solving chemical engineering problems 6. Mastering the principles of mathematics, physics, chemistry, and biology to be able to act as experts (sub-professionals) who handle chemical engineering problems
COURSE LEARNING OUTCOME
1. Students are able to identify and describe the form of substances , physical properties and phase changes as well as mixtures of substances related to the physical properties of these substances. (C1,C2) 2. Students are able to identify and describe the kinetics of gas theory, gas and liquid properties, and transport properties. (C1, C2) 3. Students are able to decipher, determine and compare non-electrolyte and electrolyte solutions. (C2, C3, C4) 4. Students are able to decipher, use, and analyze electrochemical systems (C2, C3, C4) 5. Students are able to analyze the properties of substances based on surfaces and interfaces, adsorption, and colloids. (C4)

MAIN SUBJECT
1. Substances of matters. 2. Gas kinetics theory and transport properties 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, 6^{th} 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	:	**Statistics**
	Course Code	:	TK234204
	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

3. Able to manage self-learning, and develop themselves as lifelong learners to compete at national, and international levels, in order to make a real contribution to solving problems by implementing information and communication technology and paying attention to sustainability principles and understanding technology-based entrepreneurship.
4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (changing raw materials into chemical products that have added value through physical, chemical and biological processes safely, environmentally friendly and economical) by utilizing modern engineering methods, techniques and instruments, and analyzing and evaluating the results within existing limits.
6. Mastering the principles of mathematics, physics, chemistry, and biology to be able to act as experts (sub-professionals) who handle chemical engineering problems

COURSE LEARNING OUTCOME

1. Students are able to identify and interpret Descriptive Statistics (C1, C2)
2. Students are able to identify and interpret Statistical References (C1, C2)
3. Students are able to identify and interpret Statistical Models (C1,C2)
4. Students are able to identify and interpret the Experiment Design (C1,C2)

MAIN SUBJECT
1. descriptive statistics, 2. probability theory, 3. probability distribution, 4. sampling distribution, 5. hypothesis testing, 6. statistical models (linear and multiple regression), and 7. Experiment design (introduction)
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	:	TK234301
	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
3. Able to manage self-learning, and develop themselves as lifelong learners to compete at national, and international levels, in order to make a real contribution to solving problems by implementing information and communication technology and paying attention to sustainability principles and understanding technology-based entrepreneurship. 4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight. 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub-professionals) who handle chemical engineering problems effectively and optimally.

COURSE LEARNING OUTCOME

1. Understanding the Laws I and II of Thermodynamics
2. Able to apply Laws I and II in solving in units of operations and processes in industry
3. Understand equations of state in representing fluid behavior in solid, liquid and gas phases
4. Understand the relationship between thermodynamic properties e.g. volume, temperature, pressure, enthalpy, entropy, etc.
5. Can understand the concept of ideal gas and real gas and able to accurately estimate real properties as well as ideal gas properties.
6. It can determine sensible heat effects, phase transitions and reactions and is able to estimate accurately.
7. Understand the Carnot, Rankine and Practical cycles of heat engines and refrigeration engines
8. Can calculate the thermal efficiency of the process and loss of work
9. Understand cycle processes for power generation, cooling and liquefaction applications
10. Know the role of thermodynamics in comercial process simulations.

MAIN SUBJECT

1. Understanding state and path properties
2. Law I of Thermodynamics and Energy Balance
3. Law II of Thermodynamics and Baaance Entropy
4. PVP, ideal gas concept, real gas equation such as Virial equation, Van der Waals, Redlich-Kwong, Peng Robinson, Racke Method etc.
5. Heat effects for sensible heat, phase transitions and reactions
6. Relationship between properties (Thermodybnamic network)
7. Calculation of properties of ideal gas, real gas using generalized correlation, Lee-Kesler method etc.
8. Application of Laws I and II to calculate loss of work. In the unit operation.
9. Power Generation and Refrigeration Cycles include Carnot and Rankine cycles and Practical Cycles.
10. Introduction to Hysys Simulation Process.

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	:	**Industrial Microbiology**
	Course Code	:	TK234302
	Credit	:	3 SKS
	Semester	:	III

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

5. Able to design and carry out laboratory and / or field experiments by utilizing modern methods, engineering tools and engineering instruments, as well as analyzing and evaluating the results in solving chemical engineering problems.
6. Mastering the principles of mathematics, physics, chemistry, and biology to be able to act as experts (sub-professionals) who handle chemical engineering problems

COURSE LEARNING OUTCOME

1. Students are able to understand about the classification of microorganime
2. Students are able to understand, use and apply the use of microscopes and sterilization of tools and materials
3. Students are able to calculate the number of cells
4. Students are able to isolate microrganisms, biochemical tests
5. Students are able to perform antiseptic tests and hydrolysis tests
6. Students are able to understand the growth curve of microorganisms
7. Students are able to carry out the fermentation process
8. Students are able to understand the relationship of microorganisms with enzymes

MAIN SUBJECT
1. Classification of microorganisms 2. Use of microscopes and sterilization of tools and materials 3. Calculation of the number of cells 4. Mycrorganism isolation, Biochemical test 5. Antiseptic test and Hydrolysis test 6. Growth curve of microorganisms 7. Fermentation Process 8. The relationship of microorganisms with enzymes
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 Principle I**
	Course Code	:	TK234303
	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

4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight.
5. Able to design and carry out laboratory and / or field experiments by utilizing modern methods, engineering tools and engineering instruments, as well as analyzing and evaluating the results in solving chemical engineering problems.
7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally

COURSE LEARNING OUTCOME
1. Able to understand the basics of mass balance calculation in chemical engineering. 2. Able to apply the basics of mass balance calculation in chemical engineering to a single unit without chemical reactions. 3. Able to apply the basics of mass balance calculation in chemical engineering to a single unit with chemical reactions. 4. Able to solve balance sheet problems for complex systems or for systems consisting of many units. 5. Able to understand the physical and chemical properties of fluids for solving mass and energy balances and multi-phase systems. 6. Able to apply the basics of mass balance and phase equilibrium using sophisticated settlement 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
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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	Course Name	:	**CONSTRUCTION MATERIALS**
	Course Code	:	TK234304
	Credits	:	2 SKS
	Semester	:	III

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
3. Able to manage self-learning, and develop themselves as lifelong learners to compete at national, and international levels, in order to make a real contribution to solving problems by implementing information and communication technology and paying attention to sustainability principles and understanding technology-based entrepreneurship. 4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight.
COURSE LEARNING OUTCOME
1. Students are able to explain the types of chemical plant construction materials commonly used (CPL-4) 2. Students are able to explain the relationship between the composition, structure and properties of construction materials (CPL-4) 3. Students are able to explain the properties and applications of metals, ceramics and polymers as chemical plant construction materials (CPL-4) 4. Students are able to demonstrate how to select construction materials for chemical plants (CPL-3; CPL-4)
MAIN SUBJECT

1. Material structure (chemical bond and crystal structure)
2. Engineering properties of materials (density, heat properties, mechanical properties and corrosion resistance)
3. Corrosion resistance of materials
4. Metals and Alloys (Iron and nonferrous)
5. Polymers/plastics
6. Ceramics
7. 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	:	**Momentum Transfer**
	Course Code	:	TK234305
	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
4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (changing raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally

COURSE LEARNING OUTCOME
1. Students are able to explain the analogy of momentum transfer, mass, and heat (C2) 2. Students are able to explain the characteristics of fluid and fluid flow (C2) 3. Students are able to explain the properties of static fluids and calculate the pressure on static fluids (C3) 4. Students are able to explain the principles of flow measurement and calculate fluid flow measurement (C3) 5. Students are able to explain the concepts of overall macroscopic mass, energy and momentum balances and use them in chemical engineering applications (C3) 6. Students are able to explain the concept of differential equations from fluid flow and use them in chemical engineering applications (C3) 7. Students are able to explain the concept of dimensional analysis and use it in chemical engineering applications (C3)

MAIN SUBJECT
1. Analogy of momentum, mass, and heat transfer 2. Characteristics of fluid and fluid flow 3. Fluid statics 4. Fluid flow measurement 5. Overall mass, energy, and momentum balances 6. Differential equation of fluid flow 7. Dimensional analysis
PREREQUISITES
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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	Course Name	:	**Chemical Engineering Mathematics**
	Course Code	:	TK234306
	Credit	:	4 SKS
	Semester	:	III

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

LEARNING OUTCOME
3. Able to manage self-learning, and develop themselves as lifelong learners to compete at national, and international levels, in order to make a real contribution to solving problems by implementing information and communication technology and paying attention to sustainability principles and understanding technology-based entrepreneurship. 4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight. 6. Mastering the principles of mathematics, physics, chemistry, and biology to be able to act as experts (sub-professionals) who handle chemical engineering problems. 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub-professionals) who handle chemical engineering problems effectively and optimally.

COURSE LEARNING OUTCOME
1. Able to formulate (formulate) Chemical Engineering problems into the form of mathematical problems (A4). 2. Able to solve problems of ordinary differential equations of order one, ordinary differential equations of order n and ordinary PD systems of order one simultaneously derived from the formulation of physical and chemical problems (P5). 3. Able to understand the meaning of the Laplace transform (C2), determine the Laplace transformation of a function (C2) and solve differential equations with the Laplace transform method (P5). 4. Able to understand the meaning of the power series (C2), solve the ordinary PD of order two with variable coefficients with the power series, solve ordinary PD with variable coef with the Frobenius method (P5), recognize the Bessel Equation (C4), solve the ordinary PD of order two with the variable coef in the Bessel function, recognize special function function and calculate the specified or improper integral in a special function (C3). 5. Able to understand the meaning of the Fourier series (C2), determine the Fourier series of a function (C2), recognize several types of partial PD problems (C4), solve partial PD with the Fourier method, Laplace transforms and combinations of variables (P5). 6. Able to solve the problem of two- and threefold integrals (P5) and able to apply (apply) the theory of two- and threefold integrals to determine the volume and mass of objects, area and mass of pieces, center points of objects and pieces, curved surface area and moment of inertia of objects and pieces (P2). 7. Able to formulate multilevel process models (P4) and able to solve multilevel process models with finite different calculus (P5).
MAIN SUBJECT
1. Mathematical Modelling, 2. Ordinary Differential Equation, 3. Special Function, 4. Laplace Transform, 5. Fourier Series and analytical solution of Partial Differential Equation, 6. Multiple Integral, 7. Stage wise Process Model and Finite Difference Calculus.
PREREQUIZITES
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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	:	**Plant Utility System**
	Course Code	:	TK234307
	Credit	:	2 SKS
	Semester	:	III

DESCRIPTION of COURSE
This course explains the basic knowledge of utility systems for factories related to the provision of steam, cooling water, process water and sanitation water, so that students are able to make water treatment system schemes for utility needs in industry.
LEARNING OUTCOME
3. Able to manage self-learning, and develop themselves as lifelong learners to compete at national, and international levels, in order to contribute significantly to solving problems by implementing information and communication technology and paying attention to sustainability principles and understanding technology-based entrepreneurship 4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight. 6. Mastering the principles of mathematics, physics, chemistry, and biology to be able to act as experts (sub-professionals) who handle chemical engineering problems 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally
COURSE LEARNING OUTCOME
1. Students are able to understand the quality, characteristics, and utilization of water in industry 2. Students are able to understand the basics of mechanical and chemical water treatment in the context of preparing industrial water including sanitary water, process water, cooling water and boiler feed water. 3. Students are able to understand the control of cooling water and boiler water 4. Students are able to make mechanical and chemical-physical water treatment schemes in the context of preparing industrial water including

sanitary water, process water, cooling water and boiler feed water.
MAIN SUBJECT
1. Utilities for industry, water sources and their properties. 2. Water treatment basics 3. Mechanical processing, 4. Chemical-physical processing. 5. Sanitary water 6. Process water 7. Cooling water 8. Boiler feedwater 9. Cooling water control 10. Miscellaneous boilers. 11. Boiler water control
PREREQUISITES
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REFERENCE
1. Kurita Handbook of Water Treatment", Kurita Water Industries, Ltd., Tokyo, 1999. 2. Handbook of industrial water treatment, water technologies &; solution. Veolia. 3. Betz, "Industrial Water Conditioning", 9th edition, 1991. 4. Degreemont, "Water Treatment Handbook", 5th Ed., 1979. 5. Kenn W. Lie and Priddy, *"Power Plant System Design"*, John Wiley, 1985.

COURSE			
	Course Name	:	**Unit Operations I**
	Course Code	:	TK234401
	Credit	:	4 SKS
	Semester	:	IV

DESCRIPTION of COURSE

This course studies the understanding of several operating units: fluid flow design in pipes and fluid transportation devices; motion of solid particles through the fluid; friction of fluid flow through a solid bed; stirring and mixing of fluids; mechanical-physical separation of solid-liquid; solid mixing and segregation; reduction and enlargement of solid particle size

LEARNING OUTCOME

4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (changing raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight.
7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally.

COURSE LEARNING OUTCOME

Students must be able to understand and analyze problems:

1. Pipe fluid flow: applications; velocity profile; pressure drop and friction loss; friction losses in expansion, contractions and pipe fittings; frictional losses in mechanical-energy-balance equations; selection of pipe sizes
2. Flow past immersed objects, packed bed and fluidized bed
3. Agitation and mixing of liquids: agitation of liquid; flow pattern; power consumptions; suspension of solids; dispersion operations
4. Mechanically-physically separated solid-liquids and solid-gases
5. Solid particulates: characterization, pneumatic transport and slurry
6. Mixing and segregation of solid particles
7. Comminution (size reduction) and granulation (size enlargement)

MAIN SUBJECT
1. Fluid flow in pipes: Reynolds number; flow regime; speed profile; pressure drop; friction loss and its types; pressure drop and friction loss in the mechanical energy equilibrium equation; selection of pipe sizes; fluid transportation tools: types, power supply, NPSH 2. Flow passes through a dipping object: motion of solid particles through the fluid; friction of fluid flow through stationary and fluidized solid beds 3. Stirring and mixing of liquids: application; geometry of the stirring tank; stirring liquida; flow pattern; power supply; dispersion operations; solid suspension; scale-up 4. Mechanically-physical separation of solid-liquids and solid-gases: classification of ways of separation; filtration: cake and centrifugation; settling and sedimentation; Solid-gas separation: filtration and cyclone 5. Solid particulates: characterization of solid particles, pneumatic transport and slurry 6. Mixing and segregation of solid particulates 7. Cominution (size reduction) and granulation (size enlargement)
PREREQUISITES
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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	:	TK234402
	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

3. Able to manage self-learning, and develop themselves as lifelong learners to compete at national, and international levels, in order to make a real contribution to solving problems by implementing information and communication technology and paying attention to sustainability principles and understanding technology-based entrepreneurship.
4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight.
7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub-professionals) who handle chemical engineering problems effectively and optimally.

COURSE LEARNING OUTCOMES
1. Students are able to explain/calculate chemical potential and phase equilibrium, partial properties for mixtures of ideal gases and real gases, fugasity and fugasity coefficients of pure species. 2. Students are able to explain/calculate the fugacity and fugacity coefficients of species in solution, ideal solution models and excesses properties. 3. Students are able to explain and calculate property changes and the effects of heat on the mixing process. 4. Students are able to explain/analyze the concepts of phase equilibrium (VLE), stability and equilibrium, LLE and VLLE. 5. Students are able to explain and calculate VLE with the concept of activity coefficient: gamma-phi formula, Raoult's law, modified Raoult's law and Henry's law. 6. Students are able to explain and calculate correlations for liquid phase activity coefficients and fitting activity coefficient models on VLE. 7. Students are able to explain and calculate VLE with the concept of fugasity coefficient (equation of state), and flash calculation. 8. Students are able to explain and calculate liquid-liquid equilibrium (LLE) and vapor-liquid-liquid equilibrium (VLLE).
MAIN SUBJECTS
1. Solution Thermodynamic Framework 2. Phase Equilibrium (VLE, LLE and VLLE) 3. FormulationThermodynamics for VLE
PREREQUISITE
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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	:	TK234403
	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

4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight.
5. Able to design and carry out laboratory and / or field experiments by utilizing modern methods, engineering tools and engineering instruments, as well as analyzing and evaluating the results in solving chemical engineering problems.
7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally

COURSE LEARNING OUTCOMES

1. Students understand the mechanism of heat transfer (C2) and can solve 1D and 2D conduction heat transfer problems by applying a general property balance or shell balance (C3).
2. Students can solve conduction and convection heat transfer problems for the 1D-Steady State case by simplifying the change equation (continuity equation and energy equation) that applies (C3)
3. Students understand the phenomenon of heat transfer between phases (without phase change and with phase change) (C2) and are able to solve heat transfer problems with an inter-phase approach (C3).
4. Students understand the mechanism of radiant heat transfer (C2) and can solve the problem of radiant heat transfer (C3).
5. Students understand the mechanism of mass transfer (C2) and can solve the problem of mass transfer by diffusion using shell balance (C3).
6. Students can solve the problem of diffusion period transfer and convection 1-D steady state by simplifying the component continuity equation (C3).
7. Students understand the phenomenon of interphase movement and can solve the problem of time transfer with an interphase approach (C2).

MAIN SUBJECT

1. Molecular heat transfer (conduction) and shell balance
2. Energy equation
3. Heat transfer between phases (heat transfer coefficient)
4. Radiation
5. Molecular mass transfer (Diffusion) and shell balance
6. Component continuity equation
7. Mass transfer antas phase (mass transfer coefficient)

PREREQUIZITE

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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 Engineering Principle II**
	Course Code	:	TK234404
	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
3. Able to manage self-learning, and develop themselves as lifelong learners to compete at national, and international levels, in order to contribute significantly to solving problems by implementing information and communication technology and paying attention to sustainability principles and understanding technology-based entrepreneurship 4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight. 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally

COURSE LEARNING OUTCOME
1. Stundents can explain the Energy Balance Concept (C2) 2. Students can apply Energy Balance for Systems Without Chemical Reactions (C3) 3. Students can apply energy balance to systems with chemical reactions (C3) 4. Students can complete simultaneous completion of mass and energy balances (C4)

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
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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	:	**Chemical Reaction Engineering I**
	Course Code	:	TK234405
	Credits	:	3 SKS
	Semester	:	IV

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
4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight. 5. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally
COURSE LEARNING OUTCOME
1. Students can explain the Kinetics of Homogeneous Reactions (C2) 2. Students can explain the interpretation of batch reactor data. (C2) 3. Students can calculate the design of single and double ideal flow reactors (C3) 4. Students can solve ideal flow reactor calculations for single reaction and double reaction (C4) 5. Students can explain the effects of Temperature and Pressure (C2)
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
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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 Numerical Computation**
	Course Code	:	TK234406
	Credit	:	4 SKS
	Semester	:	IV

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

4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight.
7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub-professionals) who handle chemical engineering problems effectively and optimally.

COURSE LEARNING OUTCOME

1. Students are able to perform numerical (C3) calculations for linear and non-linear equations for some cases in Chemical Engineering,
2. Students are able to perform numerical (C3) calculations in a system of equations for several cases in Chemical Engineering
3. Students are able to implement (C3) polynomial approach in case solving in Chemical Engineering
4. Students are able to perform numerical (C3) calculations for ordinary and partial differentials in case solving in Chemical Engineering.
5. Students are able to develop and demonstrate (C3) computer programs in MATLAB to solve chemical engineering problems

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 Equipment Design**
	Course Code	:	TK234501
	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

3. Able to manage self-learning, and develop themselves as lifelong learners to compete at national, and international levels, in order to make a real contribution to solving problems by implementing information and communication technology and paying attention to sustainability principles and understanding technology-based entrepreneurship.
4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight.
7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally

COURSE LEARNING OUTCOME
1. Estimating material selection for chemical industry equipment (C2) 2. Describes how to read technical drawings (C2) 3. Design inner and outer pressure vessels (C3) 4. Explain the basics of heat transfer (heat transfer mechanism, temperature, and heat exchanger selection) (C2) 5. Design on Double Pipe Type (DPHE) and Shell &Tube (STHE) (C3) 6. Design heat exchangers in Liquid Evaporators, Evaporations in Shell and in Tubes (reboilers) (C3)
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
-
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	:	**Unit Operation II**
	Course Code	:	TK234502
	Credits	:	4 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
4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (changing raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight 5. Able to design and carry out laboratory and / or field experiments by utilizing modern methods, engineering tools and engineering instruments, as well as analyzing and evaluating the results in solving chemical engineering problems 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally

COURSE LEARNING OUTCOME
1. Students are able to explain the concept of evaporation and calculate the transfer of time and heat in the evaporator and are able to implement it in dealing with chemical engineering problems (C3) 2. Students are able to explain the concept of continuous humidification and calculate the needs of cooling towers in handling chemical engineering problems (C3) 3. Students are able to explain the concept of drying and calculate the transfer of mass and heat in the dryer and are able to implement it in dealing with chemical engineering problems (C3) 4. Students are able to explain the concept of crystallization, calculate the yield formed and be able to implement it in dealing with chemical engineering problems (C3)
MAIN SUBJECT
1. Evaporation 2. Drying 3. Continuous humidification process 4. Crystallization
PREREQUISITES
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MAIN REFERENCES
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 REFERENCES
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COURSE	Course Name	:	**Unit Operations III**
	Course Code	:	TK234503
	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
4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight. 5. Able to design and carry out laboratory and / or field experiments by utilizing modern methods, engineering tools and engineering instruments, as well as analyzing and evaluating the results in solving chemical engineering problems. 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub-professionals) who handle chemical engineering problems effectively and optimally.
COURSE LEARNING OUTCOMES
1. Students are able to do basic design of the absorption and stripping process. 2. Students are able to calculate the basic design of the distillation process. 3. Students are able to calculate the basic design of the extraction process. 4. Students are able to calculate the basic design of the Leaching process.

MAIN SUBJECTS
1. Introduction to the separation operations 2. Absorption 3. Distillation 4. Leaching 5. Extraction
PREREQUISITES
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REFERENCES
1. McCabe, W.L., J.C. Smith dan P. Harriott, "*Unit Operations of Chemical Engineering*", 7th ed., McGraw-Hill, New York, 2005. 2. Geankoplis, C.J., "*Transport Processes and Separation Process Principles (Includes Unit Operations*", 4th ed., Pearson Education, Inc., New Jersey, 2003.

COURSE	Course Name	:	**Chemical Plant Safety**
	Course Code	:	TK234504
	Credit	:	3 SKS
	Semester	:	VIII

DESCRIPTION of COURSE
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
4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight. 5. Able to design and carry out laboratory and / or field experiments by utilizing modern methods, engineering tools and engineering instruments, as well as analyzing and evaluating the results in solving chemical engineering problems. 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally

COURSE LEARNING OUTCOME
1. Students are able to describe process problems in industry and understand their relationship with process problems in an effort to prevent loss. (C2) 2. Students are able to demonstrate hazard identification and risk analysis of a chemical industry which includes important equipment such as tanks, rectors, distillation columns and others to analyze the possibility of accidents by analyzing the relationship between threats, top events, barriers, effects on humans, the environment, assets, and reputation (C3) 3. Students are able to describe the problem of human error as one of the contributors to accidents that are outside the industrial equipment system (C2) 4. Able to explain the principle of process flow isolation, energy flow isolation, log out principle, tag out in confined space for various types of industrial operations (C2) 5. Describe cases of leakage / release of chemicals, and students get to know passive control with safety valves and procedures for designing safely based on the properties of the fluid they protect. (C2) 6. Students are able to implement the principles of fire and fire / explosion prevention in the combustion process in industrial equipment that applies combustion as an energy source to produce raw materials and sources of working fluids, such as boiler furnaces, glass furnaces, and kilns. (C3) 7. Students are able to implement the principles of hazard identification and risk analysis so that the flowseet or P&ID process.can be operated and safely carried out (C3) 8. Students are able to explain real cases in industry, with HAZOP (hazard and operatability) studies. (C2)
MAIN SUBJECT
1. Risk of loss in the working environment of chemical plants, 2. Basic K3 according to ILO and Indonesian Regulations, 3. Industrial occupational health (process safety management), 4. Recognize the occurrence of accidents, Identify hazards and their occurrences, Human error and its contribution, 5. Changes in chemical properties and hazards, Release, Confined space, Log out and tag out, Fire and explosion, and HAZOP
PREREQUISITES
-
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	:	**Industrial Waste Treatment***
	Course Code	:	TK234505
	Credits	:	3 SKS
	Semester	:	V

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
3. Able to manage self-learning, and develop themselves as lifelong learners to compete at national, and international levels, in order to make a real contribution to solving problems by implementing information and communication technology and paying attention to sustainability principles and understanding technology-based entrepreneurship. 4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight. 6. Mastering the principles of mathematics, physics, chemistry, and biology to be able to act as experts (sub-professionals) who handle chemical engineering problems 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally

COURSE LEARNING OUTCOME
1. Able to understand the source and understanding of pollutant parameters. 2. Able to understand kinetic parameters in biological waste treatment. 3. Able to design industrial liquid waste treatment systems using biological processing methods in batches, mixed flow and plugflow reactors. 4. Able to design industrial liquid waste treatment systems using physical processing methods for batches, mixed flow and plugflow reactors.
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	:	**Chemical Reaction Engineering II**
	Course Code	:	TK234506
	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
4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight. 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally
COURSE LEARNING OUTCOME
1. Students can explain reactions with non-ideal flow (C3) 2. Students can explain the Reaction of Solid Gas (C3) 3. Students can calculate Liquefied Gas Reactions (C3) 4. Students can solve the calculation of the Catalytic Reaction reactor (C4) 5. Biochemical Reactor Student (C2)
MAIN SUBJECT
1. Reactions with non-ideal flow 2. Solid-gas reaction 3. Liquid-gas reaction 4. Catalytic Reaction
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.
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	:	**Process Dynamics and Control**
	Course Code	:	TK234601
	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
4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight. 5. Able to design and carry out laboratory and / or field experiments by utilizing modern methods, engineering tools and engineering instruments, as well as analyzing and evaluating the results in solving chemical engineering problems. 6. Mastering the principles of mathematics, physics, chemistry, and biology to be able to act as experts (sub-professionals) who handle chemical engineering problems. 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub-professionals) who handle chemical engineering problems effectively and optimally.

COURSE LEARNING OUTCOME
1. Able to understand / model the dynamics of physical / chemical processes in the industry mathematically and empirically. 2. Able to determine transfer functions from dynamic models of physical / chemical processes 3. Able to understand dynamic responses to first-order, 2nd-order and complex order processes and their simplification. 4. Know the instrumentation of the control system (sensors, control valves, control devices) 5. Able to understand the concept of Feedback Close-Loop Control System, dynamic response and stability of the Feedback Close-Loop Control System. 6. Able to perform tuning on feedback controller (PID) based on function transfer model 7. Able to determine stability and tuning feedback controller based on frequency response 8. Able to understand Feedforward Control and Advanced Control System Concepts
MAIN SUBJECT
1. Purpose and benefits of using control processes in industry 2. Create mathematical and empirical dynamic models for physical and chemical processes with the concept of lump and distribution 3. Determining the transfer of functions from dynamic models to physical and chemical processes 4. Know the dynamic response to physical and chemical processes 5. The concept of feedback control and feedforward 6. Introduction to instrumentation tools (sensors, controllers, and regulating taps) 7. Closed loupe block diagram and closed loupe transfer function 8. The concept of stability based on Routh, Bode and Nyquist 9. Tuning methods for various controllers 10. Advanced process control concepts (cascade, ratio control, IMC and MPC) 11. Simulation with MATLAB and SIMULINK
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	:	**Engineering Economic**
	Course Code	:	TK234602
	Credit	:	2 SKS
	Semester	:	VI

COURSE DESCRIPTION
This course teaches about technical economics starting from organization and management, time value of money, depreciation, investment and production costs. Then how to determine the feasibility study of a company based on free cash flow, NPV and IRR. In addition, it also teaches about how to read financial statements and ratios, conduct risk analysis and financing of projects, and conduct cost-volume profit analysis &; evaluation of alternatives.
LEARNING OUTCOME
4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight. 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally
COURSE LEARNING OUTCOME
1. Students are able to explain the organization and management of the company and calculate the time value of money, depreciation, investment costs, and production costs (C1 & C2) 2. Students are able to create free cash flow, determine NPV and IRR (C3) 3. Students are able to analyze financial statements and ratios, risk analysis, financing projects, and Cost-volume profit analysis &; evaluation of alternatives (C4)
MAIN SUBJECT

1. Organisation and management
2. Time value of money
3. Depreciation
4. Investment and capital costs
5. Production cost
6. Free cash flow, NPV, IRR
7. Financial statements and ratio
8. Risk analysis
9. Financing of projects

PREREQUISITE

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Reference

1. R. Sinnott &; G. Towler, Chemical Engineering Design, 6th Edition, Elsevier, 2020.
2. M.S. Peters and K.D. Timmerhaus, Plant Design and Economics for Chemical Engineers, 5th ed. (2003).

Course			
Course	Course Name	:	**Practical Field Work**
	Course Code	:	TK234701
	Credit	:	2 SKS
	Semester	:	VII

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
5. Able to design and carry out laboratory and / or field experiments by utilizing modern methods, engineering tools and engineering instruments, as well as analyzing and evaluating the results in solving chemical engineering problems. 6. Mastering the principles of mathematics, physics, chemistry, and biology to be able to act as experts (sub-professionals) who handle chemical engineering problems 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally
COURSE LEARNING OUTCOME
1. Understand the concepts of engineering sciences, engineering principles, principles of application of engineering mathematics and engineering design needed for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into value-added products with chemical, physical, and biological processes (C2) 2. Apply mathematics, physics, chemistry, and biology concepts and engineering principles to solve complex engineering problems in processes, processing systems, and equipment needed to convert raw materials into value-added products with chemical, physical and biological processes (C3) 3. Analyze information and field data to solve problems in the field of

chemical engineering independently, quality and measurable (C4)

4. Evaluate the completion of work in the field of chemical engineering as experts (sub-professionals) effectively and optimally (C5)
5. Able to carry out the process of self-evaluation of work groups under their responsibility, and able to manage learning independently (C5)

MAIN SUBJECT

1. The history of the establishment of the company and its role as an industry.
2. Introduction of the enterprise management system.
3. Introduction to the processing process, including:
4. Laboratory: Test specification/quality on raw materials and products.
5. Instrumentation and control: Performance and how it works.
6. System Utilities
7. Specific tasks: Not limited to aspects of tool design of a main equipment, assessment of performance of main equipment, etc.

PREREQUISITES

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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.

COURSE	Course Name	:	**Chemical Plant Design**
	Course Code	:	TK234702
	Credit	:	3 SKS
	Semester	:	VII

COURSE DESCRIPTION

This course teaches about chemical plant design and includes an explanation of design methods, including safety, environmental and material selection considerations. The study of the fundamentals of chemical engineering such as mass balance, heat balance and energy utilization will be reviewed and linked to its role in chemical plant design. The preparation and preparation of process flowsheets including the use of process simulation software to calculate mass and heat balances will be discussed in detail. Safety considerations in plant design and how to conduct HAZOP studies will be given to design a plant that can operate safely.

LEARNING OUTCOME

3. Able to manage self-learning, and develop themselves as lifelong learners to compete at national, and international levels, in order to make a real contribution to solving problems by implementing information and communication technology and paying attention to sustainability principles and understanding technology-based entrepreneurship
4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight.

COURSE LEARNING OUTCOME

1. Students are able to explain the anatomy of a chemical plant and the organization of a chemical engineering project (CPL-4)
2. Students are able to calculate mass and energy balances using process simulation software (example: Aspen Hysys) (CPL-4)
3. Students are able to compile chemical process flowsheets by being given raw materials and products (CPL-4)
4. Students are able to read piping diagrams and instruments drawn using standard symbols for chemical plants (CPL-3; CPL-4)
5. Students are able to choose tools for a given chemical process and determine the technical specifications.

MAIN SUBJECT
1. Introduction to design (chemical plant process anatomy, chemical plant project organization, project documentation, codes and standards, design factors and optimization) 2. Review of mass and energy balance 3. Preparation of process flowsheets (flowsheet presentation, process simulation program, dynamic simulation) 4. Piping and Instrumentation 5. Security and HAZOP studies 6. Selection of tools and specifications
PREREQUISITE
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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	:	**Synthesis and Process Simulation**
	Course Code	:	TK184703
	Credit	:	3 SKS
	Semester	:	VII

DESCRIPTION of COURSE

This course teaches modern strategies for the design and synthesis of chemical processes with an emphasis on a systematic approach. The topics covered in this lecture are introduction to process design, process synthesis, process simulation, and factory predesign. This course is designed to challenge chemical engineering students to combine fundamental knowledge from other subjects. The principles and tools for process design and synthesis will be applied with practical elements of safety, environmental, social issues to design integrated chemical processes.

LEARNING OUTCOME

4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight.
6. Mastering the principles of mathematics, physics, chemistry, and biology to be able to act as experts (sub-professionals) who handle chemical engineering problems
7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally

COURSE LEARNING OUTCOME

1. Students are able to synthesize processes for desired products.
2. Students are able to develop various alternative processes for the desired product.
3. Students are able to simulate the process using a software package.
4. Students can demonstrate an awareness of ethics and contemporary issues related to the design and operation of chemical processes.

MAIN SUBJECT

1. Introduction to process design and synthesis
2. Process preparation
3. Process simulation to assist in process preparation
4. Heuristic methods for process synthesis
5. Synthesis of tissues containing reactors
6. Synthesis of separation circuits
7. Second legal analysis
8. Heat integration
9. Batch process design and scheduling

PREREQUISITES

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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	Course Name	:	**Research Project**
	Course Code	:	TK234704
	Credit	:	4 SKS
	Semester	:	VII

COURSE DESCRIPTION
This course assigns assignments to students to be able to practice conducting research under the supervisor, as well as providing progress on the research carried out in the form of a final report containing background; formulation of problems and goals; literature review; methodology; results and discussion; Research conclusions and bibliography. The learning methods carried out are Practice (including practicum and simulation of tools or computing), final exams in the form of presentations and discussions on the submission of the final report.
LEARNING OUTCOME
2. Able to study and utilize science and technology in order to apply it to the field of chemical engineering, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking. 3. Able to manage self-learning, and develop themselves as lifelong learners to compete at national, and international levels, in order to make a real contribution to solving problems by implementing information and communication technology and paying attention to sustainability principles and understanding technology-based entrepreneurship. 4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight. 5. Able to design and carry out laboratory and / or field experiments by utilizing modern methods, engineering tools and engineering instruments, as well as analyzing and evaluating the results in solving chemical engineering problems.

COURSE LEARNING OUTCOME
1. Students are able to make a research background (C3) 2. Students are able to make problem formulations and research objectives (C3) 3. Students are able to make a research literature review (C3) 4. Students are able to make research methodology (C3) 5. Students are able to analyze research results (C4) and compile discussions according to research rules (C6) 6. Students are able to conclude research (C5) 7. Students are able to compile a research bibliography (C6)
Main Subjects
1. Research background 2. Goal and objective 3. Literature study 4. Methodology 5. Result and discussion 6. Conclusion. 7. Bibliography
PREREQUISITE
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Reference
- Regulation of final project

COURSE	Course Name	:	**Plant Design Project**
	Course Code	:	TK234801
	Credit	:	5 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
2. Able to study and utilize science and technology in order to apply it to the field of chemical engineering, and able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the final project through logical, critical, systematic and innovative thinking. 3. Able to manage self-learning, and develop themselves as lifelong learners to compete at national, and international levels, in order to make a real contribution to solving problems by implementing information and communication technology and paying attention to sustainability principles and understanding technology-based entrepreneurship. 4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight.Able to design and carry out laboratory and / or field experiments by utilizing modern methods, engineering tools and engineering instruments, as well as analyzing and evaluating the results in solving chemical engineering problems. 5. Able to design and carry out laboratory and / or field experiments by utilizing modern methods, engineering tools and engineering instruments, as well as analyzing and evaluating the results in solving chemical engineering problems 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally

COURSE LEARNING OUTCOMES
1. Students are able to choose basic data as background in chemical plant design (C4) 2. Students are able to select the process used in the design of chemical plants (C4) 3. Students are able to calculate the mass balance, energy balance for each current in the chemical plant design process (C3) 4. Students are able to calculate specifications for each equipment in the chemical plant design process 5. Students are able to conduct economic analysis in the design of chemical plants 6. Students are able to design chemical plants by utilizing chemical engineering sciences 7. Students are able to compile chemical plant design assignment reports in accordance with scientific principles. 8. Students are able to present and explain the results of chemical plant design assignments in chemical plant design assignment hearings
MAIN SUBJECTS
1. Background to the establishment of chemical plants 2. Selection and process description 3. Process flow diagram 4. Calculation of mass and energy balance 5. Equipment specifications 6. Economic Analysis
PREREQUISITE
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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	:	**Membrane Technology**
	Course Code	:	TK234603
	Credits	:	3 SKS
	Semester	:	VI

DESCRIPTION of COURSE
This course studies the introduction of membrane technology, the selection and understanding of membrane material properties, the phenomenon of displacement, especially mass in membranes and membrane applications in industry. With learning methods including lectures, discussions, case studies, problem-based learning, Written exams, (including quizzes, assignments and EAS)
LEARNING OUTCOME
4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight. 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally
COURSE LEARNING OUTCOME
1. Students are able to explain and identify the use of membrane technology (C2, P2) 2. Students are able to identify and explain theories in choosing membrane material properties, how to make membranes and their characterization (A2, C3, P2) 3. Students are able to explain the phenomenon of mass transfer in the membrane (C2) 4. Students are able to explain, identify and sort out membrane technology applications in industry (A2, C3, P2)
MAIN SUBJECT
1. Introduction to the use of membrane technology 2. Properties of membrane material 3. The phenomenon of mass transfer on membranes 4. Membrane applications in industry

PREREQUISITES
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MAIN REFERENCE
1. Mulder, M., "Basic Principles of Membrane Technology", 2nd edition, Kluwer Academic Publishers, 1996 2. Geankoplis, S.J , "Transport Process and Separation Process Principles", 5th edition. 2018 3. Baker, R.W., "Membrane Technology and Applications", 2nd edition, John Wiley & Sons.Ltd, 2004

COURSE	Course Name	:	**Management of Solid Waste, Industrial Waste and B3**
	Course Code	:	TK234706
	Credit	:	3 SKS
	Semester	:	VI

DESCRIPTION of COURSE

The Solid waste, industrial waste and B3 waste management course studies the design of solid waste management systems, industrial waste and B3 waste physically, chemically and biologically. Knowledge about B3 waste disposal is also required.

COURSE LEARNING OUTCOME

4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight.
7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally

LEARNING OUTCOME

1. Able to understand the source and understanding of pollutant parameters.
2. Able to understand kinetic parameters in waste treatment physically, chemically, biologically.
3. Able to design solid waste treatment systems, industrial liquid waste, B3 waste using physical, chemical and biological processing methods.
4. Able to design solid waste management systems, industrial liquid waste, B3 waste using physical, chemical and biological processing methods

MAIN SUBJECT

1. Waste management issues and challenges
2. Risk and impact 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. Off-site disposal options (landfilling, incineration, composting, recycling)
7. 5R (Reduce, Reuse, Recycle, Recovery, Residual Management)
8. Examples of solid waste utilization and technology
9. Introduction to B3 waste, B3 waste laws and regulations

10. Analysis methods of conventional methods and instrumentation
11. Basics of contaminant dispersal process, prevention of B3 waste pollution, Toxicology
12. B3 waste treatment method chemically, physically, biologically, stabilization and solidification, thermal
13. B3 waste disposal

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	Course Name	:	**Polymer Technology**
	Course Code	:	TK234709
	Credit	:	3 SKS
	Semester	:	VII

DESCRIPTION of COURSE
This subject discusses the introduction and selection of materials / materials used for pressure vessels and heat transfer devices, able to design and evaluate the design of heat transfer devices.

LEARNING OUTCOME

4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight.
7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally

COURSE LEARNING OUTCOME

1. Understand the various types of polymers, both natural polymers and natural polymers and their application (C2)
2. Explain the relationship between the composition, structure of materials and their properties, as well as the latest polymer developments (C2)
3. Study polymerization/copolymerization reactions, polymerization techniques, and purification of polymerization products (C3)
4. Learn physical, mechanical, thermal properties, and how to determine and estimate them. (C3)
5. Understand synthetic and natural polymer processing technology (C3)
6. Understand the concept of nature-based polymer application, engineering and its effects on polymers (C4
7. Understand high-energy intensity processing, sonication, supercritical fluids, and high shear mixers

MAIN SUBJECT
1. Pengenalan, understanding, and selection of polymer materials 2. Introduction and understanding of the composition and structure of materials AGAINST POLYMER PROPERTIES 3. Understand the selection and application of different types of materials in industrial tools. 4. Understand and choose Types and systems of processing according to applied purpose. 5. evaluate the need for engineering to answer applied objectives
PREREQUISITES
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MAIN REFERENCE
1. Billmeyer. F.W. Jr., "Textbook of Polymer Science". Wilcy, 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.

COURSE	Course Name	:	**Natural Gas Treatment Technology & Hysis Software Applications**
	Course Code	:	TK234711
	Credit	:	3 SKS
	Semester	:	VII

DESCRIPTION of COURSE
This course provides the students with knowledge of natural gas potential, exploration and production processes including pipeline storage and transportation, flow assurance, natural gas process design concepts into gas sales, LPG, Condensate, LNG, CNG and being able to use HYSYS simulation devices.
LEARNING OUTCOME
4. Able to identify and formulate engineering problems, conduct studies to design a system or process to solve problems based on chemical engineering principles (change of raw materials into products that have added value through physical, chemical and biological processes safely in terms of law, economy, environment, social, politics, health and safety, sustainability) and to recognize and / or utilize the potential of local and national resources with global insight. 7. Mastering the principles and methods of chemical engineering, energy, economic principles and ecological processes to be able to act as experts (sub professionals) who handle chemical engineering problems effectively and optimally
COURSE LEARNING OUTCOME
1. Understanding PVP wells, dynamic model Well & Exploration 2. Understand Natural Gas Terminology, Products and Specifications 3. Can carry out the design concept of Upstream Processing Technology 4. Can carry out the design concept of Upstream Processing TechnologyNatural Gas Processing &; Downstream. 5. Able to choose economical Transportation and Storage 6. Project Task 1 Piping Gathering System HYSYS 7. Project 2 Task Natural Gas Processing using HYSYS (Upstream and Downstream) 8. Flow Assurance for Two/Three Phase Flow in Piping System

MAIN SUBJECT

1. PVT well, dynamic model Well &; Exploration
2. Upstream Processing Technology
3. Natural Gas Terminology, Products and Specifications
4. Natural Gas Processing &; Downstream
5. Transportation and Storage
6. Project Task 1 Piping Gathering System HYSYS
7. Project 2 Task Natural Gas Processing using HYSYS (Upstream and Downstream)
8. Flow Assurance for Two/Three Phase Flow in Piping System

PREREQUISITES

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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. Gede Wibawa, Rizky Tetrisyanda and Annas Wiguno "NATURAL GAS PROCESSING TECHNOLOGY: RECEIVING TERMINAL: STORAGE &; LNG REGASIFICATION UNIT, ITS Press (2021)
4. Journals and other related articles.