RENCANA PEMBELAJARAN SEMESTER

SEMESTER LEARNING PLAN

DEPARTMENT OF

CHEMICAL ENGINEERING

FACULTY OF INDUSTRIAL TECHNOLOGY AND SYSTEM ENGINEERING

INSTITUT TEKNOLOGI SEPULUH NOPEMBER

Study Program Name	**S2 Chemical Engineering**
Course Name	**Advanced Process Synthesis**
Course Code	**TK185102**
Semester	**1**
Credit (SKS)	**4 SKS**
The Name of Lecturer	**Renanto, Juwari, Heru Setyawan, Ali Altway, Siti Nurkhamidah, Rendra Panca A**

Study Material	1. Network theory of heat exchangers 2. Network theory of chemical industrial equipment (reactor, distillation column. Evaporator, and dryer) and their application 3. Steam management theory, cogeneration and its aoolications 4. Theory of cooling and refrigeration system and their applications 5. Theory of water management for industry and its applications 6. Solving environmental problems and work safety in the industry 7. Simulation for continuous processes in the chemical industry
PLO charged by Course	PLO – 1 Able to master engineering science theory, design engineering, the latest methods and techniques required for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into products that have added value PLO – 3 Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community PLO – 4 Able to develop themselves and compete at national and international levels PLO – 5 Able to deepen or expand knowledge in the field of processes, processing systems, and equipment needed to convert raw materials into products that have added value with chemical, physical and biological processes to make original and tested contributions through independent research. PLO – 6 Able to formulate new ideas (new research questions) from the results of research carried out for the development of science and technology in the fields of processes, processing systems, and equipment needed to convert raw materials into products that have added value through chemical, physical and biological processes. PLO – 7 Show an attitude of responsibility for work in their field of expertise independently PLO – 8 Working together to be able to make the most of their potential
Course Code	TK185102

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
1	Students understand the importance of energy efficiency and natural resources	General knowledge about the increasingly limited energy sources and the industrial advantages of more efficient use of energy	Lectures, discussions, project/problem-based learning	1x4x50”	Interaction with lecturers, discussions, and presentations	Understanding and courage in expressing opinions	
2,3	Students understand how to efficiently use energy in heat exchanger networks	Heat exchanger network (energy target, network design and cost)	Lectures, discussions, project/problem-based learning	2x4x50”	Interaction with lecturers, discussions, and presentations	Understanding and courage in expressing opinions and accuracy in answering problems	
4,5	Students understand the network theory of chemical industry tools and their applications	Various possible networks of heat exchangers between operating units (reactor, distillation etc.)	Lectures, discussions, project/problem-based learning	2x4x50”	Interaction with lecturers, discussions, and presentations	Understanding and courage in expressing opinions and accuracy in answering problems	
6,7	Students understand the management of steam usage and cogeneration	Steam is produced at various pressures with different uses. The steam balance as well as the cogeneration	Lectures, discussions, project/problem-based learning	2x4x50”	Interaction with lecturers, discussions, and presentations	Understanding and courage in expressing opinions and accuracy in answering problems	

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
		idea needs to be understood.					
8	Evaluation	Mid-semester evaluation	Questions and answers, written evaluation, online test	1x4x50”	midterm exam	Understanding and thoroughness in solving problems	
9,10,11	Students understand the theory of cooling and water circulation systems and their applications	Cooling systems, cooling water circulation, retrofitting of cooling systems and integration of compressor heat in the refrigeration process	Lectures, discussions, project/problem-based learning	3x4x50”	Interaction with lecturers, discussions, and presentations	Understanding and courage in expressing opinions and accuracy in answering problems	
12	Students understand the sources of air pollution and how to prevent them.	Source of air pollution, control of solid particles in the air, control of volatile materials, oxidation of nitrogen emissions and combustion products	Lectures, discussions, project/problem-based learning	1x4x50”	Interaction with lecturers, discussions, and presentations	Understanding and courage in expressing opinions and accuracy in answering problems	
13	Students understand the importance of	Causes fire, explosion and spread of toxic	Lectures, discussions,	1x4x50”	Interaction with lecturers, discussions,	Understanding and courage in expressing	

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
	occupational health and safety	materials. Knowledge of hazardous materials and qualitative measurements of safe equipment.	project/problem-based learning		and presentations	opinions and accuracy in answering problems	
14	Simulate continuous processes with Aspen Hysys	Simulation of chemical industrial processes with commercial software, analyze the sensitivity of the process to several changes	Project/problem based learning	1x4x50”	Simulation	Precisely simulate process	
15,16	EAS (End of Semester Evaluation)	End of semester evaluation	Questions and answers, written evaluation, online test	1x4x50”	EAS (End of Semester Evaluation)	Understanding and thoroughness in solving problems	

Study Program Name	**S2 Chemical Engineering**
Course Name	**Advanced Phenomenon Transport**
Course Code	**TK185201**
Semester	**2**
Credit (SKS)	**3 SKS**
The Name of Lecturer	**Sugeng Winardi, Ali Altway, Tantular Nurtono, Heru Setyawan, Susianto, Widiyastuti, Suci Madhania**

Study Material	1. Transport Momentum 2. Transport Energy 3. Transport Massa
PLO charged by Course	PLO – 1 Able to master engineering science theory, design engineering, the latest methods and techniques required for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into products that have added value PLO – 3 Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community PLO – 4 Able to develop themselves and compete at national and international levels PLO – 5 Able to deepen or expand knowledge in the field of processes, processing systems, and equipment needed to convert raw materials into products that have added value with chemical, physical and biological processes to make original and tested contributions through independent research. PLO – 6 Able to formulate new ideas (new research questions) from the results of research carried out for the development of science and technology in the fields of processes, processing systems, and equipment needed to convert raw materials into products that have added value through chemical, physical and biological processes. PLO – 7 Show an attitude of responsibility for work in their field of expertise independently PLO – 8 Working together to be able to make the most of their potential
Course Code	TK185201

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
1	1. Students can describe differential property balances for certain properties including momentum, energy, and species mass by accurately calculating the flux property by convection and diffuse (molecular) as well as by reviewing property generation. 2. Students can write continuity equations, navier stokes, energy equations and species continuity equations and simplify them appropriately for certain transport problems	1. Basic Concept: Shell Balance Equation of Change	1. Lecture 2. Class Discussion 3. Exercises and problem-solving tasks	1x4x50”	1. Exercises and problem-solving tasks 2. Doing exercises to solve problems in class while discussing 3. Doing homework	1. Ability to describe differential property balances for certain properties including momentum, energy, and species mass by accurately calculating flux properties by convection and diffuse (molecular) as well as by reviewing property generation 2. Ability to write continuity equations, navier stokes, energy equations and species continuity equations and simplify them appropriately for certain transport problems 3. Ability to write boundary conditions that apply to a	2 %
2				1x4x50”			

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
	3. Students can write down the boundary conditions that apply to a particular transport problem 4. Students can solve and physically interpret the problem of one-dimensional viscous fluid flow in an isothermal system					particular transport problem 4. Ability to solve and physically interpret the problem of one-dimensional viscous fluid flow at steady state isothermal systems	
. .3 . 4	1. Students can perform scaling or dimensional analysis of transport problems using analysis to help simplify or improve understanding of the displacement process that occurs 2. Students can solve and physically	1. Unsteady State One Dimensional Isothermal Fluid Flow Problem 2. One Dimensional Steady State Conduction and Diffusion Problem	1. Lecture 2. Class discussion 3. Exercises and problem-solving tasks	1x4x50” 1x4x50”	1. Interaction with Lecturers and Assistants 2. Doing exercises to solve problems in class while discussing 3. Homework 4. Get Group Assignments to be presented at	1. Ability to perform scaling or dimensional analysis of transport problems using analysis to help simplify or improve understanding of the displacement process that occurs 2. Ability to solve and physically interpret one-dimensional and steady state	3 %

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
	interpret the solution of one-dimensional and steady state conduction and diffusion problems in rectangular, cylindrical, and spherical geometries with and without first-order or zero-order generation				week 11, 12, 13 and 14	conduction and diffusion problems in rectangular, cylindrical, and spherical geometries with and without first-order or zero-order generation	
5	1. Students can solve and interpret the solution to the problem of one-dimensional unsteady state flow isothermal viscous fluid using the similarity method and variable separation 2. Students can solve and interpret the problem of solving a two-	1. Unsteady State One Dimensional Fluid Flow Problem (Closed and Open Regions) 2. Two-Dimensional Steady State Fluid Flow Problems (Creeping flow)	1. Lecture 2. Class Discussion 3. Exercises and problem-solving tasks	1x4x50”	1. Interaction with Lecturers and Assistants 2. Doing exercises to solve problems in class 3. Doing Homework	1. Ability to solve and interpret the solution to the problem of one-dimensional unsteady state flow isothermal viscous fluid flow using the similarity method and variable separation 2. The ability to solve and interpret the problem of solving two-dimensional steady state steady state viscous fluid flow problems with the concept of	3 %
6				1x40x50”			

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
	dimensional steady state steady state viscous fluid flow problem with the concept of stream function (creeping flow)					stream function (creeping flow).	
7 8	1. Students can solve and interpret the solution to the two-dimensional steady state inviscid (potential flow) problem. 2. Students can solve and interpret the solution to the steady state two-dimensional fluid flow problem using boundary layer theory	1. Two-Dimensional Steady State Fluid Flow Problem (potential flow) 2. Two-dimensional steady state fluid flow problem (laminar boundary layer theory)	1. Lecture 2. Class Discussion 3. Exercises and problem-solving tasks	1x4x50”	1. Interaction with Lecturers and Assistants 2. Doing exercises to solve problems in class 3. Doing Homework 4. UTS	1. Ability to solve and interpret two-dimensional steady state inviscid (potential flow) problems. 2. Ability to solve and interpret steady state two-dimensional fluid flow problems using boundary layer theory	33 %

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
9	1. Students can use the variable separation method to physically solve and interpret the solution to the two-dimensional conduction and diffusion problem 2. Students can use the similarity method and physically interpret the solution to the problem of unsteady state conduction and diffusion in an unbounded region (open region).	1. Two-dimensional conduction and diffusion problems 2. Unsteady conduction and diffusion problems (open region)	1. Lecture 2. Class Discussion 3. Exercises and problem-solving tasks	1x4x50”	1. Exercises and problem-solving tasks 2. Doing exercises to solve problems in class 3. Doing chores at home	1. Ability to use variable separation methods to physically solve and interpret the solution of two-dimensional conduction and diffusion problems 2. Ability to use the similarity method and physically interpret the solution to the problem of unsteady state conduction and diffusion in an unbounded region (open region)	3 %
10				1x4x50”			
11	1. Students can use the finite Fourier Transform	1. Unsteady state region closed	1. Lecture 2. Exercises and	2x2x50”	1. Interaction with Lecturers	1. Ability to use the finite Fourier Transform method	8 %

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
12	method to solve and interpret the solution to the problem of unsteady state conduction and diffusion in a closed region 2. Students can physically solve and interpret convection and diffusion (conduction) problems simultaneously including the interaction of thermal and concentration boundary layers by forming velocity profiles or with existing velocity profiles	conduction and diffusion problems 2. The problem of conduction and convection (also diffusion and convection) simultaneously using analytical methods and with an asymptotic approach	problem-solving tasks 3. Presentation	1x4x50”	and Assistants 2. Doing exercises to solve problems in class 3. Doing Homework	to solve and interpret unsteady state conduction and diffusion problems in a closed region 2. Ability to physically solve and interpret convection and diffusion (conduction) problems simultaneously including interaction of thermal and concentration boundary layers by forming velocity profiles or with existing velocity profiles	
13	1. Students can solve and interpret multi-component mass transfer solutions using the Stefan-Maxwell equation equation	3. Multicomponen diffusion problem 4. The problem of heat and mass transfer simultaneously	1. Lecture 2. Exercises and problem-solving tasks 3. Presentation	1x4x50”	1. Interaction with Lecturers and Assistants 2. Doing Homework	1. Ability to solve and interpret multi-component mass transfer solutions using the Stefan-Maxwell persamaan equation	8 %
14				1x4x50”			

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
	2. Students can solve and interpret the solution of mass and heat transfer problems simultaneously				3. Presentation of group assignments	2. Ability to solve and interpret the solution of mass and heat transfer problems simultaneously	
15	Students gain understanding and ability on how to obtain applicable differential conservation equations and their boundary conditions and their solutions to transport problems using analytical methods, asymptotic approaches, boundary layers and other approaches.	All material that has been taught	Frequently Asked Questions (QA)	1x4x50”	Exam	1. Accuracy in answering problems 2. Accuracy in solving problems	
16				1x4x50”			

REFERENCES

1. R. Byron Bird, Waren E. Stewart, Edwin N. Lightfoot, Transport Phenomena, second edition, Wiley (2002)
2. L. Gary Leal, Advancrd Transport Phenomena, Cambridge University Press (2010)
3. William M. Deen, Analysis of Transport Phenomena, Oxford University Press (2012).
4. Truskey, Yuan and Katz, Transport Phenomena in Biological Systems, Pearson Prentice Hall (2009).
5. Ali Altway, Sugeng Winardi, Heru Seyawan,*Proses Perpindahan,*ITS Press, Surabaya, 2012

Study Program Name	**S2 Chemical Engineering**
Course Name	**Advanced Chemical Reaction Engineering**
Course Code	**TK185202**
Semester	**2**
Credit (SKS)	**4 SKS**
The Name of Lecturer	**Achmad Roesyadi, Arief Widjaja, Mahfud, Susianto, Firman Kurniawansyah, SR Juliastuti, Lailatul Qodariyah**

Study Material	1. Reaction Non-Isothermal 2. Reactor Design system Isothermal/Non-Isothermal 3. Internal Transport, Diffusion and Kinetic 4. Reactor Katalitik
PLO charged by Course	PLO – 1 Able to master engineering science theory, design engineering, the latest methods and techniques required for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into products that have added value PLO – 3 Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community PLO – 4 Able to develop themselves and compete at national and international levels PLO – 5 Able to deepen or expand knowledge in the field of processes, processing systems, and equipment needed to convert raw materials into products that have added value with chemical, physical and biological processes to make original and tested contributions through independent research. PLO – 6 Able to formulate new ideas (new research questions) from the results of research carried out for the development of science and technology in the fields of processes, processing systems, and equipment needed to convert raw materials into products that have added value through chemical, physical and biological processes. PLO – 7 Show an attitude of responsibility for work in their field of expertise independently PLO – 8 Working together to be able to make the most of their potential
Course Code	TK185202
References	1. J.M.Smith, "Reaction Kinetics" 3rd ed, McGraw-Hill,1982 2. Octave Levenspiel, " Chemical Reaction Engineering" 3rd Ed. McGraw-Hill, 2000. 3. Fogler," Elements of Chemical Reaction Engineering ", 3rd Ed, Prentice-Hall, 1999.

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
1	Students can find out in general: Non-isothermal Operation	Non-isothermal reactor	Lecture/Discussion	1x4x50’	Interaction and discussion with Lecturers	1. Retention of material 2. material application capabilities	10%
2-3	Students can design with the principle of mixed flow reactor stability	1. Principle of mixed flow reactor 2. Heat aspect in mixed flow reactor 3. Examples of industrial applications	1. Studying 2. Discussion	2x4x50’	Interaction and discussion with lecturers	1. retention of material 2. application capabilities 3. Review critically	10%
4-5	Students understand the basic techniques of isothermal and non-isothermal system reactor design	1. Design of isothermal and non-isothermal reactor 2. Optimum temperature reactor design	1. Studying 2. Discussion	2x4x50’	Interaction and discussion with lecturers	1. retention of material 2. application capabilities 3. Review critically	10%
6-7	Students understand the concept of diffusion and kinetics	1. Thiele Modulus 2. Factor efektifitas 3. External vs internal mass transfer	1. Studying 2. Discussion	2x4x50’	Interaction and discussion with lecturers	1. retention of material 2. application capabilities 3. Review critically	10%
8	QUIZ I	week material I - 7	written exam	1x4x50”	Exam	1. Exam	15%
9-11	Students can evaluate the	1. Mass Transfer Internal	1. Studying 2. Discussion	3x4x50’	Interaction and	1. retention of material	10%

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
	kinetic/mass transfer regime in solid catalysts	2. Liquid Difusion 3. Gas Difusion 4. Mass transfer and chemical reaction			discussion with lecturers	2. application capabilities 3. Review critically	
12-14	Students can do Reactor design with heat transfer evaluation	1. Packed bed catalytic reactor 2. Contact system 3. MFR and PFR	1. Studying 2. Discussion 3. Presentation	3x4x50'	Interaction and discussion with lecturers	1. retention of material 2. application capabilities 3. Review critically	15%
15	Students can apply chemical engineering concepts in catalyst engineering and heterogeneous catalytic reactions	All material that has been taught as a final evaluation material	Comprehensive written exam	1x4x50"	Exam	1. retention of material 2. application capabilities 3. accuracy in problem solving	20%
16				1x4x50"			

Study Program Name	**S2 Chemical Engineering**
Course Name	**Teknologi Partikel**
Course Code	**TK185104**
Semester	**1**
Credit (SKS)	**3 SKS**
The Name of Lecture	**Sugeng Winardi, Heru Setyawan, Widiyastuti**

Study material	1. Particle Characterization 2. Particle processing (mixing and segregation, granulation, deposition) 3. Particle formation (size reduction and enlargement, granulation) 4. Particle transport (multiphase flow, pneumatic displacement, fluidized bed) 5. Fluid-particle separation (filtration, settling, cyclone) 6. Safety (dust explosion)
PLO charge by Course	PLO – 1 Able to master engineering science theory, design engineering, the latest methods and techniques required for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into products that have added value PLO – 3 Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community PLO – 4 Able to develop themselves and compete at national and international levels PLO – 5 Able to deepen or expand knowledge in the field of processes, processing systems, and equipment needed to convert raw materials into products that have added value with chemical, physical and biological processes to make original and tested contributions through independent research. PLO – 6 Able to formulate new ideas (new research questions) from the results of research carried out for the development of science and technology in the fields of processes, processing systems, and equipment needed to convert raw materials into products that have added value through chemical, physical and biological processes. PLO – 7 Show an attitude of responsibility for work in their field of expertise independently PLO – 8 Working together to be able to make the most of their potential
Course Code	TK185104

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
1-2	Students can use the concepts of particle characterization	1. Particle size 2. Particle size measurement 3. Particle shape characterization 4. Particle density 5. Particle size structure and characterization	1. Studying /response 2. Group discussion 3. Case study	Face to face (TM) = 2 x 3 x 50” Structured learning (BT) = 2 x 3 x 60” Independent Learning (BM) = 2 x 3 x 60”	1. Two-way Lecturer-Student Interaction 2. Discussion 3. Assignment assessment	Able to use particle characterization concepts	15% Total: 15%
3-4	Students can use particle processing procedures	1. Mixing 2. Segregation 3. Granulation 4. Deposit	1. Studying /response 2. Group discussion 3. Simulation	Face to face (TM) = 2 x 3 x 50” Structured learning (BT) = 2 x 3 x 60” Independent Learning (BM) = 2 x 3 x 60”	1. Two-way Lecturer-Student Interaction 2. Discussion 3. Assignment /assessment	Able to properly use particle processing procedures	15% Total: 30%
5-6	Students can use the concept of particle formation	1. Particle size reduction 2. Particle size enlargement 3. Granulasi	1. Studying /response 2. Collaborative 3. Problem based learning	Face to face (TM) = 2 x 3 x 50” Structured learning (BT) = 2 x 3 x 60” Independent Learning (BM) = 2 x 3 x 60”	1. Two-way Lecturer-Student Interaction 2. Discussion 3. Assigment / asessment	Able to properly use the concept of particle formation	15% Total: 45%
7-9	Students can demonstrate the mechanism of particle transport	1. Multiphase flow 2. Pneumatic displacement 3. Fluidized bed	1. Studying /response 2. Group Discussion 3. Case Study	Face to face (TM) = 3 x 3 x 50” Structured learning (BT) = 3 x 3 x 60” Independent Learning (BM) = 3 x 3 x 60”	1. Two-way Lecturer-Student Interaction 2. Discussion 3. Assigment / Assesment	Can pinpoint the mechanism of particle transport	15% Total: 60%

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
10-11	Students can distinguish various kinds of fluid-particle separation	1. Filtration 2. Deposition 3. Cyclone	1. Studying /response 2. Problem based learning 3. Group Discussion	Face to face (TM) = 2 x 3 x 50” Structured learning (BT) = 2 x 3 x 60” Independent Learning (BM) = 2 x 3 x 60”	1. Two-way Lecturer-Student Interaction 2. Discussion 3. Assigment /Assesment	Be able to correctly distinguish various types of fluid-particle separation	15% Total: 75%
12-14	Students can relate the concepts of particle technology to security	1. Burning 2. Explosion 3. Dust Cloud	1. Studying /responsi 2. Problem based learning 3. Group Discussion	Face to face (TM) = 3 x 3 x 50” Structured learning (BT) = 3 x 3 x 60” Independent Learning (BM) = 3 x 3 x 60”	1. Two-way Lecturer-Student Interaction 2. Discussion 3. Assigment / Assesment	Can relate well to the concepts of particle technology for safety such as fire explosions and dust clouds	15% Total: 90%
15-16	students can apply particle technology in fields / industries that require knowledge of the process and handling of particles and powders.	All material that has been taught	Question and Answer (QA)	Face to face (TM) = 2 x 4 x 50” Structured learning (BT) = 2 x 4 x 60” Independent Study (BM) = 2 x 4 x 60”	Exam	Accuracy in answering problems Accuracy in solving problems	10% Total: 100%

Program Study Name	**S2 Chemical Engineering**
Course Name	**Thermal System Analysis**
Course Code	**TK185105**
Semester	**2**
Credit (SKS)	**3 SKS**
The Name of Lecturer	**Renanto, Gede Wibawa**

Study Material	- The concept and formulation of energy and exergy - Development of the exergy method as an energy analysis tool - An example of the advantages obtained by the exergy method. - Examples of application of the exergy method to individual chemical engineering systems. - Exergy analysis block method - Exergy analysis application for complex systems kompleks - Exergy analysis for simple processes - Examples of thermal and chemical plant analysis - Thermoeconomic application
CPL charged by Course	PLO – 1 Able to master engineering science theory, design engineering, the latest methods and techniques required for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into products that have added value PLO – 3 Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community PLO – 4 Able to develop themselves and compete at national and international levels PLO – 5 Able to deepen or expand knowledge in the field of processes, processing systems, and equipment needed to convert raw materials into products that have added value with chemical, physical and biological processes to make original and tested contributions through independent research. PLO – 6 Able to formulate new ideas (new research questions) from the results of research carried out for the development of science and technology in the fields of processes, processing systems, and equipment needed to convert raw materials into products that have added value through chemical, physical and biological processes. PLO – 7 Show an attitude of responsibility for work in their field of expertise independently PLO – 8 Working together to be able to make the most of their potential.
Course Code	TK185105

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
1	Able to define exergy	1. Develop an environmental model. 2. Understand the meaning of dead state. 3. Conduct exergy evaluation	1. Lecture 2. Discussion 3. Question Answer	1x3x50”	1. Interaction with Lecturer 2. Discusion	Correct understanding of the definition of exergy	0.8%
2 .	Able to make exergy balance in open and closed cycle systems	1. balance energy balance 2. Transfer of energy followed by heat and work	1. Lecture 2. Discussion 3. Question Answer	1x3x50”	1. Interaction with Lecturer 2. Discussion	Correct understanding of the preparation of the exergy balance. Correct understanding of exergy transfer followed by heat and work	0.8%
3	Able to calculate exergy in a process	Compare the exergy with the energy. The exergy transfer with heat. The exergy transfer with work	1. Lecture 2. Discussion 3. Question Answer	1x3x50”	1. Interaction with Lecturer 2. Discussion	Correct understanding of the difference between exergy and energy.	0.8%
4	Able to compile exergy rate balance on control volume	1. General form of exergy rate balance. 2. Exergy destruction in throttling valve	1. Lecture 2. Discussion 3. Question Answer	1x3x50”	1. Interaction with Lecturer 2. Discussion	Correct understanding of energy and exergy. Correct understanding of energy destruction in throttling valve .	0.8%
5	Able to design processes using exergy method.	Calculate exergetic efficiency	1. Lecture 2. Discussion 3. Question Answer	1x3x50”	1. Interaction with Lecturer	Correct understanding about exergetic efficiency.	0.8%

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
					2. Discussion		
6	Able to understanding design based on thermodynamics with costs to be incurred.	An example of a design for a power generation unit and a heat recovery steam generator. An example of a simple cogeneration system.	1. Lecture 2. Discussion 3. Question Answer	1x3x50"	1. Interaction with Lecturer 2. Discussion	Correct understanding of the technical calculations and the total annual cost of the selected design.	0.8%
7.	Able to understanding partfrom plant analysis.	Control mass analysis. Control region analysis. Intrinsic irrreversibility.	1. Lecture 2. Discussion 3. Question Answer	1x3x50"	1. Interaction with Lecturer 2. Discussion	Correct understanding about control mass analysis and control region analysis. Correct ubderstanding about intrinsic irreversibility.	0.8%
8	Able to understanding partfrom plant analysis	Performance criteria. Exergy chart. Thermodynamic feasibility for the new plant.	1. Lecture 2. Discussion 3. Question Answer	1x3x50"	1. Interaction with Lecturer 2. Discussion	Correct understanding about performance criteria. Correct understanding about exergy diagram and thermodynamic feasibility for the new plant	0.8%

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
9	Able to understanding exergy analysis for simple process.	Expansion and compression processes. heat transfer process.	1. Lecture 2. Discussion 4. Question answer	1x3x50”	1. Interaction witch lecturer 3. Discussion	Correct understanding expansion and compression processes. Understanding yang benar tentang proses perpindahan panas.	0.8%
10	Able to understanding exergy analysis for simple process	Mixing and separation process. Chemical reaction processes including combustion	1. Lecture 2. Discussion 5. Question answer	1x3x50”	1 Interaction witch lecturer 2 Discussion 4.	Correct understanding about mixing and separation process . Correct understanding chemical reaction processes including combustion	0.8%
11	Able to provide examples of thermal and chemical plant analysis.	Linde's air solution plant. Sulfuric acid plant. Plant Gas Turbine. Plant Cooling.	1. Lecture 2. Discussion 3. Question answer 6.	1x3x50”	1. Interaction witch lecturer 2. Discussion 5.	Correct understanding of the discovery of air plants. Correct understanding of sulfuric acid plant. Correct understanding of Gas Turbine Plant and Refrigeration.	1%

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
12 .	Able to provide examples of thermoeconomic exergy applications	Structural coefficient. Non-equivalent thermodynamics of exergy and loss of exergy	1. Lecture 2. Discussion 3. Question answer 7.	1x3x50”	1. Interaction witch lecturer 2. Discussion 6.	Correct understanding of structural coefficients. Correct understanding of non-equivalent thermodynamics of exergy and loss of exergy.	1%
13	Quizz I	The material from the first week to the sixth week	8.	1x3x50”	7.		20%
			9.		8.		

Program Study Name	**S2 Chemical Engineering**
Course Name	**Biochemical Reactor**
Course Code	**TK185203**
Semester	**2**
Credit (SKS)	**3 SKS**
The Name of Lecturer	**Arief Widjaja, Setiyo Gunawan, Tri Widjaja, Hakun Wira W.A.**

Study Material	• The basics of processes using microbial and enzyme catalysts • Cell reaction kinetics and enzymatic reactions • Immobilization of cells and enzymes • Batch, mixed flow & plug flow bioreactor design
PLO charge by Course	PLO – 1 Able to master engineering science theory, design engineering, the latest methods and techniques required for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into products that have added value PLO – 3 Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community PLO – 4 Able to develop themselves and compete at national and international levels PLO – 5 Able to deepen or expand knowledge in the field of processes, processing systems, and equipment needed to convert raw materials into products that have added value with chemical, physical and biological processes to make original and tested contributions through independent research. PLO – 6 Able to formulate new ideas (new research questions) from the results of research carried out for the development of science and technology in the fields of processes, processing systems, and equipment needed to convert raw materials into products that have added value through chemical, physical and biological processes. PLO – 7 Show an attitude of responsibility for work in their field of expertise independently PLO – 8 Working together to be able to make the most of their potential
Course Code	TK185203

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
1	Review biochemistry engineering and general microbiolgy.	- Cells, types of microorganisms	Lecture, presentation, Discussion	1x3x50”	• Interaction witch lecturer • Discussion • Practice	• Material mastery • Seriousness / seriousness of presentation • Presentation clarity • Activity	5%
2-3	Review kinetics reaction and general reactor design	- Batch reactor, CSTR, plug flow reactor, recycle, parallel series reactor.	Lecture, presentation, and Discussion	2x3x50”	• Interaction witch lecturer • Discussion	• Material mastery • Seriousness / seriousness of presentation • Presentation clarity • Activity	10%
4-6	Kinetic reaction and Enzymatic Reactor Design	a. Enzym as catalysts: Michaelis Menten and Briggs Halande Equations	Lecture, presentation, and Discussion	3x3x50”	• Interaction witch lecturer • Discussion	• Material mastery • Seriousness / seriousness of presentation • Presentation clarity • Activity	15%
7	Kinetic reaction and Reactor Design with Immobilized Enzymes	Types of immobilized enzymes	Lecture, presentation, and Discussion	1x3x50”	• Interaction witch lecturer • Discussion	• Material mastery • Seriousness / seriousness of presentation • Presentation clarity	5%

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
						• Activity	
8-10	Kinetic reaction and Reactor Design with dengan whole cell	b. Cell as catalysts: Monod Equation	Lecture, presentation, and Discussion	3x3x50”	• Interaction witch lecturer • Discussion	• Material mastery • Seriousness / seriousness of presentation • Presentation clarity • Activity	15%
11-12	Comparison Bioreactor Design with General Reactor	a. Material balance in the bioreaktor. b. Compare material balance / general kinetic reaction with material balance / reaction with cell c. Compare general reactor design and reactor in the bio process design d. Detail bioreactor design	Lecture, presentation, and Discussion Question answer	2x3x50”	• Interaction witch lecturer • Discussion	• Material mastery • Seriousness / seriousness of presentation • Presentation clarity • Activity	10%
13-15	Journals about bioreactor	a. Spesific reaction kinetic study: ethanol fermentation, lactic acid fermentation, dll	Lecture, presentation, and Discussion	3x3x50”	• Interaction witch lecturer • Discussion	• Material mastery • Seriousness / seriousness of presentation • Presentation clarity	15%

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
		b. membrane bioreactor c. Process control in the bioreactor d. Optimation biology process in the reactor e. Problems in bioreactor and how to solve it.				• Activity	
16	Review All material	All material	Question answer	1x3x50”	• Interaction witch lecturer • Discussion	• Material mastery • Seriousness / seriousness of presentation • Presentation clarity • Activity	25%
						Total	100%

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1. James M. Lee: Biochemical Engineering, Prentice Hall International series, 1992
2. Octave Levenspiel, Chemical Reaction Engineering, Edisi 3, 1997.
3. Bailey and Ollis: Fundamental of biochemical engineering, 2nd edition, Mc Graw Hill, 1986
4. Harvey W. Blanch and Douglas S. Clark: Biochemical Engineering, Marcell Dekker, Inc., 1997
5. Michael L. Shuler and Fikret Kargi: Bioprocess Engineering Basic Concept, 2nd edition, Prentice Hall International Edition, 2002
6. Jurnal-jurnal menyangkut bioreaktor (whole cell maupun enzim)

Program Study Name	**S2 Chemical Engineering**
Course Name	**ADVANCED INDUSTRIAL WASTE MANAGEMENT**
Course Code	**TK185204**
Semester	**2**
Credit (SKS)	**3 SKS**
The Name of Lecturer	**Tri Widjaja, Sri Rachmania Juliastuti, R. Darmawan**

Study material	• Industry and environment • Industrial waste management: (i) Planning: Environmental Management System (EMS), (ii) Industrial activity impact identification system, (iii) Environmental Impact Analysis (AMDAL), Environmental audit; Supervision; Technology: Waste treatment, B3 waste management, Technology approach system, social and institutional
PLO charge by Course	PLO – 1 Able to master engineering science theory, design engineering, the latest methods and techniques required for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into products that have added value PLO – 3 Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community PLO – 4 Able to develop themselves and compete at national and international levels PLO – 5 Able to deepen or expand knowledge in the field of processes, processing systems, and equipment needed to convert raw materials into products that have added value with chemical, physical and biological processes to make original and tested contributions through independent research. PLO – 6 Able to formulate new ideas (new research questions) from the results of research carried out for the development of science and technology in the fields of processes, processing systems, and equipment needed to convert raw materials into products that have added value through chemical, physical and biological processes. PLO – 7 Show an attitude of responsibility for work in their field of expertise independently PLO – 8 Working together to be able to make the most of their potential
Course Code	TK185204

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
1	Understanding the impact of industrial activities	1. Understand the types of industrial waste 2. Knowing the impact of industrial activities	1. Lecture 2. Discussion 3. Question answer	1x3x50”	1. Interaction witch lecturer 2. Discussion	Understanding the various types of industrial waste and the impact of industrial activities	-
2	Understanding about environmental management and B3 waste management	1. Knowing the meaning of environmental management 2. Knowing the rights, obligations, and roles of the community 3. Knowing the authority of environmental management 4. Knowing the government's obligations in environmental management 5. Knowing the preservation of environmental functions 6. Knowing B3 waste management	1. Lecture 2. Discussion 3. Question answer 4.Paper and presentation	1x3x50”	1. Interaction witch lecturer 2. Discussion	Understanding the meaning of environmental management and B3 waste management	5 %

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
3. .	Understand the laws and regulations	1.RI Law PP No. 23 1997 2. RI Law No. 32 2009 concerning Environmental Protection and Management	1. Lecture 2. Discussion 3. Question answer	1x3x50”	1. Interaction witch lecturer 2. Discussion	Understanding of laws and regulations	-
4-5	Understanding environmental protection and management	1. Know the protection and management of the environment 2. Prevention and pollution of industrial waste	1. Lecture 2. Discussion 3. Question answer 4.Paper and presentation	1x3x50” 1x3x50”	1. Interaction witch lecturer 2. Discussion	Understanding of environmental protection and management, as well as prevention and pollution of industrial waste	5 %
6	Understanding love, production, blue sky program	knowing prokasih (love), production, and blue sky program	1. Lecture 2. Discussion 3. Question answer 4. Calculation tasks	1x3x50”	1. Interaction witch lecturer 2. Discussion	Understanding prokasih (love), production, and blue-sky program	-
7	Evaluation of environmental management, impact of industrial waste	Evaluation like quiz and Question answer about environmental management, industrial waste impact	1. Lecture 2. Discussion 3. Question answer 4. Pengerjaan tugas-tugas	1x3x50”	1. Interaction witch lecturer 2. Answer the written question and lisan	Understanding about environmental management, the impact of industrial waste	**Quiz I: 20 %**

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
8	Understanding environmental impact analysis (Amdal)	Knowing about Amdal Document	1. Lecture 2. Discussion 3. Question answer	1 x3x50”	1. Interaction witch lecturer 2. Discussion	Understanding about environmental impact analysis in terms of Amdal Document	**-**
9-10	Understanding Amdal about screening	Knowing the purpose of screening, step-by-step screening method and one-step screening	1. Lecture 2. Discussion 3. Question answer 4. Calculation tasks	2x3x50”	1. Interaction witch lecturer 2. Discussion	Understand about filtering and stepwise screening and one-step screening	-
11- 12	Understanding Amdal about scope and terms of reference	1. Knowing the identification of important things in the scope of the field, space and time 2. Preparation of the frame of reference	1. Lecture 2. Discussion 3. Question answer 4. Calculation tasks	2x3x50”	1. Interaction witch lecturer 2. Discussion	Understanding about scope and terms of reference	-
13	Evaluation about screening, scope, and terms of reference	Evaluation like quiz and Question answer about assessment, scoping and terms of reference	1. Calculation tasks 2. Question answer	1x3x50”	1. Interaction witch lecturer 2. Answer the written question	Understanding about screening, scope, and terms of reference	**Quiz II: 20%**
14-15	Understanding impact forecasting, environmental risk analysis and Evaluation	1. Knowing the impact forecast 2. Environmental risk analysis 3. Evaluation of impacts and risks	1. Lecture 2. Discussion 3. Question answer 4. Calculation tasks	2x3x50”	1. Interaction witch lecturer 2. Discussion	Understanding about impact forecasting environmental risk analysis and evaluation of impacts and risks	**-**

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
	of impacts and risks						
16	Final evaluation of advanced industrial waste management	The evaluation is in the form of a written test on the overall understanding of advanced industrial waste management	1. Calculation tasks 2. Question answer	1x3x50”	1. Interaction witch lecturer 2. Answer the written question	1. Accuracy in answeringproblem 2. Ketelitian dalam menyelesaikan masalah 3. Understanding	50%

Program Study Name	**S2 Chemical Engineering**
Course Name	**Computational Fluid Dynamics (CFD)**
Course Code	**TK185205**
Semester	**3**
Credit (SKS)	**3 SKS**
The Name of Lecturer	**Suci Madhania, Tantular Nurtono**

Study Material	• Definition CFD • General equations in the CFD methods • Three Steps CFD (*pre-processor, solver,* and *post-processor*) • Simulation fluid flow • Simulation separation process • Simulation homogen combustion process • Simulation heterogen combustion process
PLO charge by Course	PLO – 1 Able to master engineering science theory, design engineering, the latest methods and techniques required for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into products that have added value PLO – 3 Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community PLO – 4 Able to develop themselves and compete at national and international levels PLO – 5 Able to deepen or expand knowledge in the field of processes, processing systems, and equipment needed to convert raw materials into products that have added value with chemical, physical and biological processes to make original and tested contributions through independent research. PLO – 6 Able to formulate new ideas (new research questions) from the results of research carried out for the development of science and technology in the fields of processes, processing systems, and equipment needed to convert raw materials into products that have added value through chemical, physical and biological processes. PLO – 7 Show an attitude of responsibility for work in their field of expertise independently PLO – 8 Working together to be able to make the most of their potential
Course Code	**TK185205**

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
1	Able to explain the definition of CFD	1. History of development CFD 2. Overview fluid dynamic	Learning is carried out by the SCL method (*Student Centered Learning*) through *cooperative and active learning*, Question answer, assignment. **LEARNING STEPS** **Initial activity** The lecturer explained the scope of the material at the meeting after previously conducting a review of the previous material. **Core activities** Discussion about overview of related material where the lecturer tries to	1 x 3 x 50”	1. Practice 2. Final Project 3. Activities 4. Structured tasks: journal review, presentation and working on *problem-based learning* practice questions Character assessment is carried out through performance appraisal on portofolio based in in completing the assignment	1. Students can explain again about the definition of CFD 2. Students can explain again about fluid dynamics	5%
2 - 3	Able to analyze phenomena and correlate with relevant equations	1. *Governing equation of CFD*		2 x 3 x50”		1. Students can describe the governing equation of CFD 2. Students are able to correlate a phenomenon in the industry with *governing equation*	5%
4 - 6	Able to explain 3 steps of CFD (*pre-processor, solver,* and *post-processor*)	*1. Pre-processor* *2. Solver* *3. Post-Processor*		3 x 3 x50”		1. Students can explain again about the 3 stages of CFD 2. Students can demonstrate the ability to operate the features of 3 stages of CFD on	5%

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
			explore student opinions. After that the topic is elaborated together. **End Activities.** Summarizing the importance of related subjects and giving assignments to students to study the next material.			the relevant software	
7 - 8	Able to demonstrate expertise in process simulation on fluid flow in pipes	1. *Pre-processor* fluid flow simulation 2. *Solver* fluid flow simulation 3. *Post-processor* fluid flow simulation		2 x 3 x50”		1. Students are able to demonstrate the ability to draw 2D-based geometry on fluid flow in pipes 2. Students are able to choose the right grid generation method in simulation fluid flow in pipes 3. Students are able to present simulation results in the form of temperature distribution and vector velocity 4. Students are able to interpret the simulation results into something meaningful	20%

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
9 - 10	Able to demonstrate expertise in simulating the separation process on *cyclone*	1. Introduction to unsteady state simulation 2. Simulation solver on cyclone 3. Post-processor simulation on cyclone		2 x 3 x 50”		1 Students are able to elaborate on the difference between steady state and unsteady state simulations 2 Students are able to demonstrate the ability to choose models in cyclone simulation 3 3 Students are able to present simulation results in the form of velocity vector data and particle rate distribution at each outlet 4 Students are able to interpret the simulation results into efficiency data on the cyclone	10 %
11 - 12	Able to demonstrate expertise in simulating homogeneous	1. Introduction to homogeneous chemical reaction based simulation		2 x 3 x 50 ”		1 Students are able to elaborate on the basics of CFD simulation with chemical reactions	10 %

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
	combustion processes	2. Solver simulation on homogeneous combustion process 3. Post-processor simulation on homogeneous combustion process				2 Students are able to demonstrate the ability to choose a model in a homogeneous combustion simulation 3 Students are able to present simulation results in the form of temperature distribution data and exhaust gas composition 4 Students are able to evaluate the efficiency of the combustion process based on the simulation results	
13 - 14	Able to demonstrate expertise in simulating heterogeneous combustion processes	1. Introduction to heterogeneous chemical reaction based simulation 2. Solver simulation on heterogeneous		2 x 3 x 50 ”		1 1 Students are able to elaborate on the basics of CFD simulation with heterogeneous chemical reactions 2 2 Students are able to	10 %

Week	Final ability Sub CP-MK (LO)	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience	Assessment Criteria and Indicators	Rating Weight (%)
		combustion processes 3. Post-processor simulation on heterogeneous combustion processes				demonstrate the ability to choose models in heterogeneous combustion simulations 3 Students are able to present simulation results in the form of temperature distribution data and exhaust gas composition 4 Students are able to evaluate the efficiency of the combustion process based on the simulation results	
15 - 16	*Final Project*						30 %

Study Program Name	**S2 Chemical Engineering**
Course Name	**Membrane Technology**
Course Code	**TK185301**
Semester	**3**
Credit (SKS)	**3 SKS**
The Name of Lecture	**Ali Altway, Susianto, Yeni Rahmawati**

Study Material	• Introduction and selection of membrane material properties • Membrane manufacturing process • Membrane characterization • The phenomenon of displacement in the membrane • Membrane applications
PLO Charge by Course	PLO – 1 Able to master engineering science theory, design engineering, the latest methods and techniques required for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into products that have added value PLO – 3 Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community PLO – 4 Able to develop themselves and compete at national and international levels PLO – 5 Able to deepen or expand knowledge in the field of processes, processing systems, and equipment needed to convert raw materials into products that have added value with chemical, physical and biological processes to make original and tested contributions through independent research. PLO – 6 Able to formulate new ideas (new research questions) from the results of research carried out for the development of science and technology in the fields of processes, processing systems, and equipment needed to convert raw materials into products that have added value through chemical, physical and biological processes. PLO – 7 Show an attitude of responsibility for work in their field of expertise independently PLO – 8 Working together to be able to make the most of their potential
Course Code	TK185301

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
1	Able to explain about membranes (introduction)	1. Separation process 2. Definition membrane 3. Membrane process	1. Lecture 2. Group Discussion 3. Question&Answer	1x3x50”	1. Interaction with lecturer 2. Discussion 3. Duty	Understanding of membrane definition	5%
2 3	Able to understand the introduction and selection of membrane material properties	1. Membrane material properties 2. Polymer Membrane 3. Inorganic Membrane	1. Lecture 2. Case Study 3. Group Discussion 4. Question&Answer 5. Problem based learning	2x3x50”	1.Interaction with lecturer 2.Discussion 3.Duty 4.Presentation	Understanding of the properties of materials used for membrane fabrication	10%
4 5	Able to understand how to make membranes	1. Synthetic membrane manufacturing technique (phase inversion method) 2. Immersion precipitation 3. Composite membrane manufacturing techniques (dip-coating, surface polymerization, plasma polymerizationPengaruh parameter terhadap morfologi membran 1. Inorganic membrane manufacturing technique	1. Group Discussion 2. Case Study 3. Problem based learning 4. Lecture 5. Question&Answer	2x3x50”	1. Interaction with lecturer 2. Discussion 3. Duty 4. Presentation	Understanding of how to make membranes	10%
6 7	Able to understand how to characterize membranes	1. Porous membrane characterization 2. Ionic membrane characterization	1. Group Discussion 2. Case Study 3. Problem based learning 4. Lecture	2x3x50”	1. Interaction with lecturer 2. Discssion 3. Presentation 4. Duty	Understanding of membrane characterization	10%

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
		3. Characterization of the nonporous membrane	5. Quention&Answer				
8	Quiz 1	Materials include material selection and properties, manufacture, and characterization of membranes	Question & Answer (QA)	1x3x50”	Quiz	• Accuracy in answering problems • Accuracy in solving problems • Understanding	10%
9 10	Able to understand the phenomenon of displacement in the membrane	1. Movement through a porous membrane 2. Movement through nonporousmembranes 3. Movement through the ion exchange membrane	1. Group discussion 2. Case Study 3. Lecture 4. Question&Answer	2x3x50”	1. Interaction with lecturer 2. Discussion 3. Presentation 4. Duty	Understanding of the displacement phenomena that occur when processes use membranes	10%
11	Able to understand the phenomenon of polarization and fouling	1.Concentration polarization 2. Membrane fouling	1. Group discussion 2. Case Study 3. Lecture 4. Question&Answer	1x3x50”	1. Interaction with lecturer 2. Discussion 3. Presentation 4. Duty	Understanding of common problems with membranes such as polarization and fouling	5%
12	Quiz 2	The material includes the phenomenon of displacement in the membrane and problems with the membrane,	Question&Answer (QA)	1x3x50”	Quiz	• Accuracy in answering problems • Accuracy in solving problems • Understanding	10%

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
		namely polarization and fouling					
13 14	Able to understand membrane applications in industry	1. Microfiltration Membrane 2. Ultrafiltration Membrane 3. Reverse osmosis membrane and nanofiltration	1. Group discussion 2. Case Study 3. Problem based learning 4. Lecture 5. Question&Answer	2x3x50”	1. Interaction with lecturer 2. Discussion 3. Presentation 4. Duty	Understanding of membrane applications in various industries	10%
15 16	EAS	All material that has been taught	Question&Answer (QA)	1x3x50”	Exam	• Accuracy in answering problems • Accuracy in solving problems • Understanding	20%

REFERENCES:

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

Program Study Name	**S2 Chemical Engineering**
Course Name	**Coal Processing and Utilization**
Course Code	**TK185302**
Semester	**3**
Credit (SKS)	**3**
The Name of Lecturer	**Susianto, Siti Zullaikah, Achmad Roesyadi**

Study Material	• Preparation of coal to be used as direct fuel or to be converted into other materials including the formation, mining, preparation and processing and transportation of coal. • Coal analysis • Coal for electricity: steam turbine/pulverized coal combustion, integrated gasification combined cycle, and fluidized bed combustion. • Coal for liquid fuel • Utilization of by-products of coal processing
CPL charge by Course	PLO – 1 Able to master engineering science theory, design engineering, the latest methods and techniques required for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into products that have added value PLO – 3 Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community PLO – 4 Able to develop themselves and compete at national and international levels PLO – 5 Able to deepen or expand knowledge in the field of processes, processing systems, and equipment needed to convert raw materials into products that have added value with chemical, physical and biological processes to make original and tested contributions through independent research. PLO – 6 Able to formulate new ideas (new research questions) from the results of research carried out for the development of science and technology in the fields of processes, processing systems, and equipment needed to convert raw materials into products that have added value through chemical, physical and biological processes. PLO – 7 Show an attitude of responsibility for work in their field of expertise independently PLO – 8 Working together to be able to make the most of their potential
Course Code	TK185302

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
1	Able to understand the process of coal formation	1. Supply and demand of coal in the world 2. Factors affecting the process of coal formation	1. Lecture 2. Discussion	1x3x50”	1. Interaction with lecture 2. Discussion	1. Correct understanding of the formation process and the factors that influence the formation of coal 2. Accuracy in classifying coal ranking	10%
2	Able to understand the process of preparing coal to be used further	1. Coal mining process. 2. Coal extraction process 3. The washing process to remove dirt and increase the heating value and other processes so that the coal is ready to be distributed for various purposes.	1. Lecture 2. Discussion	1x3x50”	1. Interaction with lecture 2. Assignment		
3				1x3x50”			

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
		4. Coal transportation process.					
4-5	• Able to understand the process of coal formation and the factors that influence it • Able to understand various classifications of coal • Understand the process of preparing coal for further processing • Able to perform coal analysis and process analysis data	Various methods of coal analysis and processing analytical data	1. Lecture 2. Special based learning	2x3x50”	1. Interaction with lecturer 2. Discussion 3. Assigment		
6	• Able to understand the process of coal formation and the factors that influence it • Able to understand various	1. Supply and demand of coal in the world 2. Factors affecting the process of coal formation.	QA	1x3x50”	QUIZ I		20%

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
	classifications of coal • Understand the process of preparing coal for further processing • Able to perform coal analysis and process analysis data	3. Coal mining process. 4. Coal extraction process 5. The washing process to remove dirt and increase the heating value and other processes so that the coal is ready to be distributed for various purposes. 6. Coal transportation process 7. Various methods of coal analysis and processing analytical data					
7	Understand the various benefits of coal and its processing	Coal for electricity Coal for liquid fuel	1. Lecture 2. Discussion 3. Assigment	1x3x50”	1. Interaction with lecture 2. Discussion 3. Assigment		10%

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
		Coal for chemicals					
8-10	Coal for electricity	Coal burning Coal Gasification	1. Group discussion 2. Case-based learning (reference/journal studies)	3x3x50”	1. Interaction with lecture 2. Discussion 3. Assignment 4. Presentation		
11	Understand and analyze the utilization and processing of coal for electricity	Coal combustion and gasification The conversion process from burning and gasification of coal to electricity	QA	1x3x50”	QUIZ II		20%
12-13	Understand and analyze the utilization and processing of coal for fuel	Coal bed methane Coal liquifaction	1. Group discussion 2. Case-based learning (reference/journal studies)	2x3x50”	1. Interaction with lecture 2. Discussion 3. Assigment 4. Presentation		10%
14	Understand and analyze the utilization and processing of coal processing by-products	Utilization of fly ash, bottom ash etc Coal biorefinery	1. Group discussion 2. Case-based learning (reference/journal studies)	1x3x50	1. Interaction with lecturer 2. Discussion 3. Assigment 4. Presentation		10%
15	1. Understand and analyze the utilization and	Coal bed methane	QA	1x3x50”	EAS (End of Semester Exam)		30%

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
16	processing of coal for fuel. 2. Understand and analyze the utilization and processing of coal processing by-products. 3. Coal Biorefinery	Coal liquefaction Pemanfaatan fly ash, bottom ash dll		1x3x50”			

Program Study Name	**S2 Chemical Engineering**
Course Name	**Electrochemical Reaction Engineering**
Course Code	**TK185303**
Semester	**3**
Credit (SKS)	**3**
The Name of Lecturer	**Heru Setyawan, Widiyastuti**

Study Material	• Reactor performance criteria, electrochemical and catalytic reactions • Kinetic reaction electrode • Design of electrochemical reactor • Electrochemical reaction in electrolysis/battery/corrosion process
CPL charge by Course	PLO – 1 Able to master engineering science theory, design engineering, the latest methods and techniques required for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into products that have added value PLO – 3 Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community PLO – 4 Able to develop themselves and compete at national and international levels PLO – 5 Able to deepen or expand knowledge in the field of processes, processing systems, and equipment needed to convert raw materials into products that have added value with chemical, physical and biological processes to make original and tested contributions through independent research. PLO – 6 Able to formulate new ideas (new research questions) from the results of research carried out for the development of science and technology in the fields of processes, processing systems, and equipment needed to convert raw materials into products that have added value through chemical, physical and biological processes. PLO – 7 Show an attitude of responsibility for work in their field of expertise independently PLO – 8 Working together to be able to make the most of their potential
Course Code	TK185303

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
1-2	Students can apply the Nernst equation to electrochemistry and the concept of overpotential.	1. Introduction and review of the electrode process 2. Cell potential and thermodynamics	1. Studying/response 2. Group discussion 3. Case study	Face to face (TM) = 2 x 3 x 50” Structured learning (BT) = 2 x 3 x 60” Independent Learning (BM) = 2 x 3 x 60”	1. Two-way Lecturer-Student Interaction 2. Discussion 3. Assignment / assessment	Able to correctly apply Nernst equations to electrochemistry and the concept of overpotential.	15% Total:15 %
3-5	Students can explain the difference between kinetic and mass controlled electrochemical processes.	1. Kinetics and electrode reactions 2. Mass transfer due to migration and diffusion	1. Studying/response 2. Group discussion 3. Simulation	Face to face (TM) = 3 x 3 x 50” Structured learning (BT) = 3 x 3 x 60” Independent Learning (BM) = 3 x 3 x 60”	1. Two-way Lecturer-Student Interaction 2. Discussion 3. Assignment / assessment	Can precisely explain the kinetic process, mass transfer due to migration or diffusion in electrochemical processes	20% Total:35 %
6-8	Students can apply electrochemical methods such as chronoamperometry, cyclic voltammetry, chronopotentiometry, and AC impedance.	1. Basic potential step methods 2. Potential sweep methods 3. Polarography and pulse voltammetry 4. Controlled current techniques	1. Studying/response 2. Collaborative 3. Problem based learning	Face to face (TM) = 3 x 3 x 50” Structured learning (BT) = 3 x 3 x 60” Independent Learning (BM) = 3 x 3 x 60”	1. Two-way Lecturer-Student Interaction 2. Discussion 3. Assignment / assessment	Able to properly apply various electrochemical methods	20% Total:50 %

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
		5. Impedance concepts					
9-11	Students can apply the properties and behavior of electrochemical processes to certain electrochemical process applications	1. General properties and behavior of electrochemical processes	1. Studying/response 2. Group discussion 3. Case Study	Face to face (TM) = 3 x 3 x 50" Structured learning (BT) = 3 x 3 x 60" Independent Learning (BM) = 3 x 3 x 60"	1. Two-way Lecturer-Student Interaction 2. Discussion 3. Assignment /assessment	Can apply the properties and behavior of electrochemical processes in general	20% Total:70 %
12-14	Students can develop electrochemical reaction engineering for practical applications such as battery material synthesis (electrolysis), electro-chemical-based instrumentation, corrosion, etc..	1. Practical application of material synthesis 2. Battery practical application 3. Practical application of electrochemical-based instruments 4. corrosion	1. Studying/response 2. Group discussion 3. Case Study	Face to face (TM) = 3 x 3 x 50" Structured learning (BT) = 3 x 3 x 60" Independent Learning (BM) = 3 x 3 x 60"	1. Two-way Lecturer-Student Interaction 2. Discussion 3. Assignment /assessment	Able to develop practical applications of electrochemistry in the synthesis of electrochemical/corrosion-based materials/batteries/instruments	20% Total:90 %
15-16	Students can apply electrochemical principles in specific applications such as nanomaterial synthesis and corrosion prevention. Students	All material that has been taught	Question&Answer (QA)	Face to face (TM) = 2 x 4 x 50" Structured learning (BT) = 2 x 4 x 60"	Exam	1. Accuracy in answering problems 2. Accuracy in solving problems	10% Total:100 %

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
	can also explain the method of synthesis, characterization, and use of nanomaterials.			Independent Learning (BM) = 2 x 4 x 60”			

Program Study Name	**S2 Chemical Engineering**
Course Name	**Heterogeneous Catalyst**
Course Code	**TK185304**
Semester	**3**
Credit (SKS)	**3 SKS**
The Name of Lecturer	**Achmad Roesyadi, F Kurniawansyah, Mahfud**

Study material	1. Preparation and characterization of heterogeneous catalysts 2. Operation of heterogeneous catalytic reactor
CPL charge by Course	PLO – 1 Able to master engineering science theory, design engineering, the latest methods and techniques required for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into products that have added value PLO – 3 Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community PLO – 4 Able to develop themselves and compete at national and international levels PLO – 5 Able to deepen or expand knowledge in the field of processes, processing systems, and equipment needed to convert raw materials into products that have added value with chemical, physical and biological processes to make original and tested contributions through independent research. PLO – 6 Able to formulate new ideas (new research questions) from the results of research carried out for the development of science and technology in the fields of processes, processing systems, and equipment needed to convert raw materials into products that have added value through chemical, physical and biological processes. PLO – 7 Show an attitude of responsibility for work in their field of expertise independently PLO – 8 Working together to be able to make the most of their potential
Course Code	TK185304
References	1. M Albert Vannice, “Kinetics of Catalytic Reactor”, Springer Science and Business Media, 2005 2. J.M.Smith, “Reaction Kinetics” 3rd ed, McGraw-Hill,1982 3. C Bartholomew, R Farrauto, “Fundamental of Industrial Catalytic Processes”, 2nd Ed, Abe Books, 1997 4. Octave Levenspiel, “ Chemical Reaction Engineering” 3rd Ed. McGraw-Hill, 2000. 5. Fogler,” Elements of Chemical Reaction Engineering ”, 3rd ed, Prentice-Hall, 1999.

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
1	Students can know in general: Catalyst function, catalyst classification, catalyst working principle	1. History of catalyst 2. Heterogeneous catalyst theory 3. Catalyst components 4. Overview of catalyst applications in industry and related fields	1. Lecture/Studying 2. Discussion	1x3x50'	Interaction and discussion with Lecturers	1. Understanding the material 2. Material application capability 3. Critical review	10%
2-3	1.Understanding the material 2.Material application capability 3.Critical review	1. Catalyst classification 2. Working principle and function of catalyst 3. Examples of industrial applications	1. Studying 2. Discussion 3. Presentation	2x3x50'	Interaction and discussion with lecturers		10%
4-5	Students understand the basic techniques of catalyst preparation and synthesis	1.Impregnation method 2. Sol-gel method 3.Precipitation method 4.Spray drying method	1. Presentation and pre-test 2. Laboratory skills 3.Final presentation/report	2x3x50'	Interaction and discussion with lecturers	1.Understanding the material 2.Application capabilities 3. Critical review	10%
6-7	Students understand the basic techniques of catalyst characterization	1. Analisa morfologi (SEM) 2. Analisa kristalinitas (XRD)	1.Presentation and pre-test 2. Laboratory skills 3.Final presentation/report	2x3x50'	Interaction and discussion with lecturers	1.Understanding the material 2.Application capabilities 3. Critical review	10%

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
		3. Analisa dimensi katalis (Particle Analyzer) 4. Analisa luasan (BET) 5. Analisa thermal (DSC/TGA)					
8	Students know the practice of preparing and characterizing heterogeneous catalysts in practical applications	Week 1-7 Materi	1. Presentation	1x3x50”	Interaction and discussion with lecturers	1. Understanding the material 2. Aplication Capabilities 3. Critical review	15%
9-10	Students can evaluate the kinetic/mass transfer regime in solid catalysts	1. Thiele Modulus 2. Effectiveness factor	1. Studying 2. Discussion 3. Presentation	2x3x50’	Interaction and discussion with lecturers	1. Understanding the material 2. Aplication Capabilities 3. Critical review	10%
11-13	Students can evaluate the rate of catalytic reactions	1. Langmuir: adsorpsi isother 2. Prinsip Langmuir – Hinshelwood 3. Prinsip Eley – Rideal 4. Reaktor eksperimental multifasa	4. Studying 5. Discussion 6. Presentation	3x3x50’	Interaction and discussion with lecturers	1. Understanding the material 2. Aplication Capabilities 3. Critical review	10%

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
14	Students can apply the principle of deactivation in evaluating the rate of catalytic reactions	1.Catalyst deactivation 2.Catalyst regeneration	1. Studying 2. Discussion 3. Presentation	1x3x50'	Interaction and discussion with lecturers	1. Understanding the material 2. Aplication Capabilities 3. Critical review	10%
15	Students can apply chemical engineering concepts in catalyst engineering and heterogeneous catalytic reactions	All material that has been taught as a final evaluation material	Comprehensive written exam	1x2x50"	Exam	1. Understanding the material 2. Material application capability 3. Accuracy in problem solving	15%
16				1x2x50"			

Program Study Name	**S2 Chemical Engineering**
Course Name	**Aerosol Technology**
Course Code	**TK185305**
Semester	**3**
Credit (SKS)	**3 SKS**
The Name of Lecturer	**Heru Setyawan, Widiyastuti, Kusdianto**

Study Material	• Definition and characterization of aerosols • Aerosol measuring instruments • Dispersal of aerosols in the atmosphere • Aerosol fabrication method • Aerosols in industrial processes
CPL charge by Course	PLO – 1 Able to master engineering science theory, design engineering, the latest methods and techniques required for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into products that have added value PLO – 3 Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community PLO – 4 Able to develop themselves and compete at national and international levels PLO – 5 Able to deepen or expand knowledge in the field of processes, processing systems, and equipment needed to convert raw materials into products that have added value with chemical, physical and biological processes to make original and tested contributions through independent research. PLO – 6 Able to formulate new ideas (new research questions) from the results of research carried out for the development of science and technology in the fields of processes, processing systems, and equipment needed to convert raw materials into products that have added value through chemical, physical and biological processes. PLO – 7 Show an attitude of responsibility for work in their field of expertise independently PLO – 8 Working together to be able to make the most of their potential
Course Code	TK185305

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
1	Able to explain the meaning of aerosol and examples	1. Definition aerosol 2. Examples aerosol di nature and industry 3. Membrane Process	1. Lecture 2. Discussion kelompok 3. Question answer	1x3x50"	1. Interaction witch lecturer 2. Discussion	Understanding about definition aerosol	-
2 3	Able to understand the characteristics of aerosols and measuring instruments	1. Aerosol property 2. Measurement of aerosol particles 3. Measuring instruments: Scanning Mobility Particle Analyzer (SMPS) Differential Mobility Analyzer (DMA), Condensation Particle Counter (CPC), Impactors	1. Lecture 2. Discussion kelompok 3. Question answer 4. Pembelajaran berbasis masalah	2x3x50"	1. Interaction witch lecturer 2. Discussion	Understanding of aerosol properties and tools used for aerosol measurement	-

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
4 5	Able to understand the process of spreading aerosols in the atmosphere	1. Respiratory deposition 2. PM2.5 and PM10 3. Impact of aerosol on global warming & ozone depletion 4. Atmospheric aerosols	1. Lecture 2. Discussion kelompok 3. Question answer	2x3x50”	1. Interaction witch lecturer 2. Discussion 3. Tugas	Understanding of the spread of aerosols in the atmosphere and their impact on health	5%
6	Able to explain and understand the definition of aerosols, characteristics, and distribution of aerosols in the atmosphere	Material from the previous lecturer	1. Question answer (QA) 2. Quiz I	1x3x50”	Quiz	1. Accuracy in answeringproblem 2. Accuracy in solving problems 3. Understanding	25%
7 8 9 10	Able to understand and analyze the fabrication process of aerosols including the mechanisms and forces that work in the deposition process	1. Spray Pyrolyis 2. Flame pyrolysis 3. Chemical Vapor Deposition and Plasma-enhanced chemical vapor deposition	1. Lecture 2. Discussion kelompok 3. Question answer	4x3x50”	1. Interaction witch lecturer 2. Discussion	Understanding of the aerosol fabrication process and its mechanism	-

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
		4. Evaporation and Condensation 5. Electro-static forces of inertia, diffusion, Brownian and impaction 6. Adhesion of particles					
11	Able to understand and analyze aerosol applications in industry and the factors that influence it	Aerosol applications in the electronics, pharmaceutical, manufacturing, environmental, energy industries	1. Lecture 2. Discussion 3. Case study 4. Lecture 5. Question answer	3x3x50”	1. Interaction witch lecturer 2. Discussion 3. Presentation 4. Assignments	Understanding and ability to analyze problems regarding aerosol application in industry along with the accompanying styles	15%
12							
13							
14	Able to understand and analyze aerosol fabrication methods and their working forces and mechanisms	Materials include fabrication methods and industrial applications of aerosols	Question answer (QA)	1x3x50”	Quiz	1. Accuracy in answering problem 2. Accuracy in solving problems 3. Understanding	25%
15	Students understand the nature, behavior and measurement of	All material that has been taught	Question answer (QA)	1x3x50”	Exam	1. Accuracy in answering problem	30%

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
16	aerosols and can analyze aerosol fabrication mechanisms & are able to use aerosol science for practical applications such as instruments to measure them, their distribution in the atmosphere, industrial processes, etc.					2. Accuracy in solving problems 3. Understanding	

REFERENCES:

1. Hinds, W. C., Aerosol Technology: Properties, Behavior, and Measurement of Airborne Particles, John Wiley & Sons, 2nd ed. (1999).
2. Artikel terbaru yang sudah di publikasikan pada jurnal internasional yang bereputasi.

Program Study Name	**S2 Chemical Engineering**
Course Name	**Natural Gas Processing**
Course Code	**TK185306**
Semester	**3**
Credit (SKS)	**3 SKS**
The Name of Lecturer	**Gede Wibawa, Fadlilatul Taufany, Renanto H**

Study Materal	1. Natural gas reserves and utilization 2. Thermodynamic properties of natural gas 3. Technology and basic design of natural gas processing 4. Natural gas products and specifications 5. Natural gas transmission system
CPL charge by Course	PLO – 1 Able to master engineering science theory, design engineering, the latest methods and techniques required for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into products that have added value PLO – 3 Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community PLO – 4 Able to develop themselves and compete at national and international levels PLO – 5 Able to deepen or expand knowledge in the field of processes, processing systems, and equipment needed to convert raw materials into products that have added value with chemical, physical and biological processes to make original and tested contributions through independent research. PLO – 6 Able to formulate new ideas (new research questions) from the results of research carried out for the development of science and technology in the fields of processes, processing systems, and equipment needed to convert raw materials into products that have added value through chemical, physical and biological processes. PLO – 7 Show an attitude of responsibility for work in their field of expertise independently PLO – 8 Working together to be able to make the most of their potential
Course Code	TK185306

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
1	Natural gas reserves and utilization	- Natural gas balance map: reserves, production and demand. - Classification of natural gas: associated and non-assocated; sour and sweet gases; dry and wet gases. - Utilization of natural gas: gas fuel and industrial raw materials. - Natural gas infrastructure	1. Lecture 2. Question answer 3. Presentation 4. Lecture 5. Question answer 6. Presentation	1x3x50”	1. Interaction witch lecturer 2. Discussion 3. Assignments 4. Presentation	1. Accuracy in answeringproblem 2. Understanding 3. Mastery of the material and its presentation in the presentation	T&A-1: 10
2-3	Thermodynamic properties of natural gas	- Compressibility factor - Spesific gravity - Viscosity - Heating value - Wobbe number - Methane number	1. Lecture 2. Question answer 3. Presentation 4. Lecture 5. Question answer 6. Presentation	2x3x50”	1. Interaction witch lecturer 2. Discussion 3. Assignments 4. Presentation	1. Accuracy in answeringproblem 2. Understanding 3. Mastery of the material and its presentation in the presentation	

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
4	Product and specification natural gas	- Pipeline / sales gas - CNG - LPG - LNG - NGL	1. Lecture 2. Question answer 3. Presentation 4. Lecture 5. Question answer 6. Presentation	1x3x50”	1. Interaction witch lecturer 2. Discussion 3. Assignments 4. Presentation	1. Accuracy in answeringproblem 2. Understanding 3. Mastery of the material and its presentation in the presentation	
5	Natural gas processing technology: *Acid gas removal*	- Acid gas contents and its purification levels - Solvent absorption (Chemical, Physical, Hybrid), solid adsorption, membranes, cryogenic fractionation - Process licencor selection - Basic design	1. Lecture 2. Question answer 3. Presentation 4. Lecture 5. Question answer 6. Presentation	1x3x50”	1. Interaction witch lecturer 2. Discussion 3. Assignments 4. Presentation	1. Accuracy in answeringproblem 2. Understanding 3. Mastery of the material and its presentation in the presentation	
6	Natural gas processing technology: *Gas dehydration*	- Water contents - Hydrates - Liquid and solid dessicant dehydration	1. Lecture 2. Question answer 3. Presentation 4. Lecture 5. Question answer 6. Presentation	2x3x50”	1. Interaction witch lecturer 2. Discussion 3. Assignments 4. Presentation	1. Accuracy in answeringproblem 2. Understanding 3. Mastery of the material and its presentation in the presentation	

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
		- Process licencor selection - Basic design					
7	Quiz I (Q1)	1. Natural gas Properties 2. Acid gas removal 3. Gas dehydration	1. Written exam	1x3x50"	1. Team Discussion 2. Self study	1. Accuracy in answeringproblem 2. Understanding 3. Accuracy in analyzing data to produce a decision	Q1 : 20
8	Natural gas processing technology and *basic design*: *Sulfur recovery*	- Clauss process - Clauss process considerations - Mechanical considerations - Clauss unit tail gas handling - Basic design	1. Lecture 2. Question answer 3. Presentation 4. Lecture 5. Question answer 6. Presentation	1x3x50"	1. Interaction witch lecturer 2. Discussion 3. Assignments 4. Presentation	1. Accuracy in answeringproblem 2. Understanding 3. Mastery of the material and its presentation in the presentation	T&A-2: 10
9	Natural gas processing technology: Nitrogen rejection	- Nitrogen rejection for gas upgrading: cryogenic distillation, pressure swing adsorption, membrane - Nitrogen rejection for	1. Lecture 2. Question answer 3. Presentation 4. Lecture 5. Question answer 6. Presentation	1x3x50"	1. Interaction witch lecturer 2. Discussion 3. Assignments 4. Presentation	1. Accuracy in answeringproblem 2. Understanding 3. Mastery of the material and its presentation in the presentation	

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
		enhanced oil recovery.					
10	Natural gas processing technology: *Compression*	- Fundamental of compression - Compressor type - Capacity and power calculations - Comparison of Reciprocating and Centrifugal compressors	1. Lecture 2. Question answer 3. Presentation 4. Lecture 5. Question answer 6. Presentation	1x3x50”	1. Interaction witch lecturer 2. Discussion 3. Assignments 4. Presentation	1. Accuracy in answeringproblem 2. Understanding 3. Mastery of the material and its presentation in the presentation	
11	Natural gas processing technology: *Refrigeration*	- Process classification: External Refrigerant type, Self-refrigerant Process, Nitrogen Cycle (Peak-shaving & On-board) - Existing process licensor: Single MR Process (PRICO),	1. Lecture 2. Question answer 3. Presentation 4. Lecture 5. Question answer 6. Presentation	1x3x50”	1. Interaction witch lecturer 2. Discussion 3. Assignments 4. Presentation	1. Accuracy in answeringproblem 2. Understanding 3. Mastery of the material and its presentation in the presentation	

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
		TEALARC Dual MR (Technip), CASCADE Process (Phillips), C3 Pre-cooled MR Process (Air Products and Chemicals Inc.; APCI)					
12	Quiz II (Q2)	1. Sulfur recovery 2. Nitrogen rejection 3. Compression 4. Refrigeration	1. Written exam	1x3x50”	1. Team discussion 2. Seft study	1. Accuracy in answeringproblem 2. Understanding 3. Accuracy in analyzing data to produce a decision	Q2: 25
13-14	Natural gas transmission system	- Pipeline - Trucking - Shipping	1. Lecture 2. Question answer 3. Presentation 4. Lecture 5. Question answer 6. Presentation	1x3x50”	1. Interaction witch lecturer 2. Discussion 3. Assignments 4. Presentation	1. Accuracy in answeringproblem 2. Understanding 3. Mastery of the material and its presentation in the presentation	T&A-3: 10
15-16	End of semester evaluation (EAS)	Transmision natural gas system	1.Written Examination	2x2x50”	1. Team discussion 2. Self study	1. Accuracy in answeringproblem 2. Understanding 3. Ketelitian dalam menganalisa data untuk menghasilkan suatu keputusan	EAS: 25

SUPPORTING LIBRARY
1. Gas Processors Suppliers Association, Engineering Data Book, 12th Ed., 2004. 2. Kidnay, Athur J. and Parrish, William R., Fundamental of Natural Gas processing, CRC Press, 2006. 3. Campbell, John Morgan, Gas conditioning and processing (Campbell Petroleum Series), 3rd Ed., Campbell Petroleum; 1974. 4. Mokhatab, Saeid; Poe, William; Mak, John, Handbook of Natural Gas Transmission and Processing, 3rd Ed., Gulf Professional Publishing, 2015. 5. Poling, Bruce E.; Prausnitz, John M.; O' Connell, John, The Properties of Gases and liquids, 5th Ed., McGraw-Hill Education, 2001.

Program Study Name	**S2 Chemical Engineering**
Course Name	**Combustion Technology**
Course Code	**TK185307**
Semester	**3**
Credit (SKS)	**3 SKS**
The Name of Lecturer	**Tantular Nurtono**

Study Material	1. Fuel and its properties 2. Stoichiometry of combustion 3. Thermodynamics in combustion 4. Combustion kinetics 5. Fire structure and propagation 6. Turbulent mixing 7. Liquid fuel combustion process 8. Solid fuel combustion process
CPL charge by Course	PLO – 1 Able to master engineering science theory, design engineering, the latest methods and techniques required for the analysis and design of processes, processing systems, and equipment needed to convert raw materials into products that have added value PLO – 3 Able to compile ideas, thoughts, and scientific arguments responsibly and based on academic ethics, and communicate them through the media to the academic community and the wider community PLO – 4 Able to develop themselves and compete at national and international levels PLO – 5 Able to deepen or expand knowledge in the field of processes, processing systems, and equipment needed to convert raw materials into products that have added value with chemical, physical and biological processes to make original and tested contributions through independent research. PLO – 6 Able to formulate new ideas (new research questions) from the results of research carried out for the development of science and technology in the fields of processes, processing systems, and equipment needed to convert raw materials into products that have added value through chemical, physical and biological processes. PLO – 7 Show an attitude of responsibility for work in their field of expertise independently PLO – 8 Working together to be able to make the most of their potential
CourseCode	TK185307

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
1 - 2	Able to re-explain the spectrum of various fuels and their general properties	1. Natural Gas 2. Liquid fuel 3. Solid Fuel 4. Properties and analysis of fuels(gas, liquid and solid)	Learning is carried out by the method SCL (*Student Centered Learning*) melalui *cooperative and active learning*, Question answer, assignment. LANGKAH-LANGKAH PEMBELAJARAN Initial activity The lecturer explained the scope of the material at the meeting after previously reviewing the previous material. Initial activity Discussion about the general description of the related material where the lecturer tries to explore student opinions. After that the topic	2 x sks x 50”	1. Quiz 2. Short test 3. Final Project 4. Activity 5. Mid-Semester Exam 6. End of Semester Exam 7. Structured assignments: journal reviews, presentations and doing practice-based questions *problem-based learning* 8. Character assessment is carried out through portfolio-based performance assessment in completing	1. Students can explain again about the fuel spectrum 2. Students can explain again about the analysis of fuel properties	10%
3 - 4	Able to perform calculations on the stoichiometric combustion process	1. Discussion of elements in combustion stoichiometry 2. Calculation of the composition of combustion products and their impurities		2 x sks x50”		1. Students can analyze the stoichiometry of a combustion process 2. Students are able to calculate the composition of combustion products	10%
5 - 8	Able to apply thermodynamic principles in calculating the nature of the combustion process	1. 1. Energy balance in the combustion process based on the Laws of Thermodynamics 2. *Adiabatic flame temperature*		4 x sks x50”		1. Students can calculate the energy balance in the combustion process which leads to the properties of the combustion process (HHV,	20%

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
		3. Chemical equilibrium 4. *Combustion equilibria*	is elaborated together. End activities Summarizing the importance of related subjects and giving assignments to students to study the next material.		the tasks given	LHV, enthalpy of combustion, etc.) 2. Students can calculate adiabatic flame temperature 3. Students can analyze the composition approach of combustion products based on chemical equilibrium. 4. Students can explain again about the concept *combustion equilibria*.	
9 - 10	Able to analyze the chemical kinetics of the hydrocarbon combustion process.	1. Detailed kinetics of the hydrocarbon combustion process 2. Simplification of the kinetics of the combustion process		2 x sks x50”		1. Students are able to detail the reaction kinetics of the combustion process 2. Students are able to simplify the kinetics of combustion reactions to *global rate reaction*.	10%

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
11	Able to diagnose the structure and propagation of fire based on the character of the combustion process	1. Structure and propagation of fire on *laminar premixed combustion* 2. Structure and propagation of fire on *turbulent premixed combustion* 3. Structure and propagation of fire on *laminar diffusion combustion* 4. Structure and propagation of fire on *turbulent diffusion combustion*		2 x sks x 50”		1 Students are able to diagnose the structure and propagation of fire in laminar and tubulent combustion for the combustion process of premixed and diffusion systems 2 Students are able to explain the structure and propagation of fire in various combustion systems	5 %
12	Able to analyze the role of turbulent mixing in the combustion process	1. *Mixing time* 2. Kinetic Energy		1 x sks x 50 ”		1. Students are able to estimate the mixing time in the combustion process	5 %

Week	Final ability Sub CP-MK	Breadth (learning materials)	Learning methods	Estimated Time (weeks x credits x minutes/meeting)	Student Learning Experience*	Assessment Criteria and Indicators	Rating Weight (%)
13 - 14	Able to analyze the properties of liquid fuel combustion processes	1. The concept of liquid fuel combustion process (untuk *single component*) 2. Evaporation rate and combustion property for liquid fuel		2 x sks x 50 ”		1. Students are able to explain again about the process of burning liquid fuel 2. Students are able to calculate the properties of the liquid fuel combustion process	10 %
14 - 15	Able to analyze the properties of solid fuel combustion processes	1. Stages of solid fuel combustion process (for single component) 2. Combustion property for solid fuel		2 x sks x 50 ”		1. Students are able to explain again about the stages of the solid fuel combustion process 2. Students are able to calculate the properties of solid fuel combustion processes	10 %
16	End of Semester Evaluation						20 %