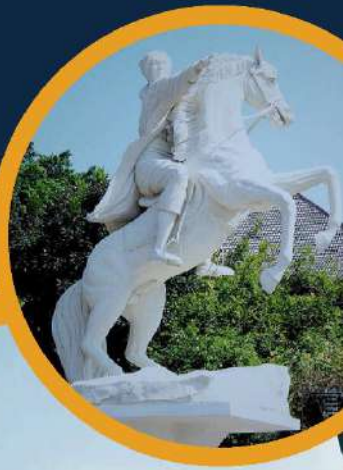
UNDERGRADUATE PROGRAM
DEPARTMENT OF CHEMICAL ENGINEERING

PROGRAM SPECIFICATION

2024



Department of Chemical Engineering
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Universitas Diponegoro

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VISION

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

MISION

1. *Enhance the quality of education to produce graduates with a strong foundation of knowledge and skills in chemical engineering, aligned with the evolving demands of an increasingly competitive job market.*
2. *Advance the quality of chemical engineering research, focusing on increasing the number of intellectual property rights and publications in national and international scientific journals.*
3. *Improve the quality and quantity of community service by providing consultation services, supervision, and professional training in chemical engineering expertise.*

PROGRAM BACKGROUND

Profile

Awarding institution	:	Universitas Diponegoro
Nama of the program	:	Chemical Engineering Undergraduate Program
Degree awarded	:	ST (sarjana Teknik) or B.Enging (Bachelor of Engineering)
Year established	:	1965
Mode of Studi	:	Full time
Languanger	:	Indonesian (Reguler) and English (IUP)
Study of duration	:	(4 years (normal)- 7 years (maximum)
Accreditation	:	LAM Teknik (National) and IABEE

Department of Chemical Engineering (DCE), Faculty of Engineering, Universitas Diponegoro has been providing the chemical and allied industries with first-class engineers ever since its foundation in 1965. DCE consist of 3 study program undergraduate program (S1), master program (S2), and doctoral program (S3). The Undergraduate Program of Chemical Engineering (UPCE) received the first legal acknowledgment from the government through a decree from the Director of Higher Education, the Ministry of Education and Culture No. 106/DIKTI/Kep/1984. In 1998, the UPCE was accredited by BAN-PT (Badan Akreditasi Nasional – Perguruan Tinggi / National Accreditation Board for Higher Education). The Board awarded grade A (Excellent) to the UPCE, as it was stated in the Accreditation Certificate by the Number of 00875/Ak-I.1/UDETNI/VIII/1998. The same grade was awarded in the following re-accreditations in 2003, 2008, 2013 and 2018. In 2023, DCE received excellent accreditation status (Unggul) from LAM TEKNIK based on 0031/SK/LAM Teknik/PYT/IV/2023. UPCE also

obtained international accreditation by IABEE until 31 March 2028.

Currently, UPCE has had an International Undergraduate Program (IUP Program) since 2017. The IUP program provides double degree facilities in collaboration with Hull University (UK), Curtin University (Australia), and New Castle University (Australia). IUP students also have the opportunity for international experience (student exchange, international research) at several universities, such as Universiti Teknologi MARA, Universiti Teknologi Malaysia, University of Brunei Darussalam, etc.

Today, UPCE is recognized as one of the best program in Indonesia. Its impressive national and international networks of academic and industrial experience to maintain the quality of teaching and learning process. The diverse curriculum and training offered make the chemical engineering graduates employable not only for process industries, but also for other areas such as research and development in government or private sectors, academic, and transferable skills for pursuing the next level of education degree. To achieve the goals, UPCE always improves its quality.

TEACHING and LEARNING PROCESS

Most courses in UPCE, Universitas Diponegoro are delivered by lecturers, active learning, student centered learning (problem based learning, project based, etc) and laboratory working. These learning processes are delivered in Indonesian for

reguler program and in english for IUP program. Commonly, course assesments are conducted twice per semester (mid term and final examination). Furthermore, lecturers can provide some assignment to ensure students meet the course learning outcome.

The Study Program continuously improves the learning facilities such as the availability of text books, lecture notes, computer/information system, laboratories, scientific journals, student's visit/excursion to industries, guest lecturers as well as visiting professors. Since 2007, the department also supports the implementation of online learning developed by the university, the e-learning can be accesed from the SSO system or provided website (http://kulon.undip.ac.id). Through the *e-learning* portal, the students easily access the courses and exercise materials, submit home-works documents or even having discussion.

PROGRAM LEARNING OUTCOMES (PLO)

UPCE commits to provide a learning process based on student competences. UPCE determines 8 competences based on international standards used by IABEE (The Indonesian Accreditation Board for Engineering Education) which are considered as Program Learning Outcomes (PLO). The detailed PLO is presented in Table 1.

Table 1. Program Learning Outcomes (PLO)

	No	PLO	Teaching and Learning Methods	Assessment
Specific Knowledge/ The main competences	A	Able to apply mathematics, natural science, and engineering principles to solve complex engineering problems on processes, equipment and processing systems needed to convert raw materials into added value products through chemical reactions.	Lectures, laboratory works, tutorials, seminars, directed reading	Examinations, laboratory reports, home task, written and oral examinations
	B	Able to carry out investigations, analysis, interpretation of data and information, and formulate alternative solutions to solve complex engineering problems in processes, equipment and processing systems needed to convert raw materials into products that have added value by considering economic, public health and safety, cultural, social and environmental, as well as sustainability factors.	Lectures, laboratory works, indepen-dent research, reading, seminars	Examinations, research reports, written and oral presentations
	C	Able to carry out laboratory experiments/research which includes identification, formulation and analysis of engineering problems in processes, equipment and processing systems needed to convert raw materials into products that have added value.	Laboratory works, independent / dependent research, reading, seminars	Laboratory /research reports, practical exam, written and oral examinations

Specific Knowledge/ The main competences	D	Able to design processes, equipment and processing systems needed to convert raw materials into products that have added value with an analytical approach and considering technical standards, performance aspects, fitness, ease of application, poverty, as well as paying attention to economic, public health and safety, cultural, social and environmental factors.	Lectures, tutorials, seminars, directed reading, computer-based exercises	Take home tasks, quizz, written and oral examination
	E	Able to select resources and utilize design tools and engineering analysis based on appropriate technological and computational information to carry out engineering activities in the field of processes, equipment and processing systems needed to convert raw materials into products that have added value.	Lectures, tutorials, directed reading, computer-based exercises, final task	Practical reports, written and oral examination
Supporting Competence	F	Able to communicate effectively both verbally and in writing, as well as working in cross-disciplinary and cross-cultural teams.	Laboratory task, research, lectures, internship, community service	Written and oral examinations
	G	Able to plan, complete and evaluate tasks within existing constraints, and have a willingness to learn throughout life.	Group projects, seminars	Written and oral examinations
Others	H	Have an understanding of professional responsibility, ethics, social sensitivity and concern for society and the environment.	Group discussion, tutorial, writing paper, seminars, internship, fieldwork	Written and oral examinations

GRADUATE PROFILE

Autonomous Professional Profile of UPCE is the reflection of the capacities of the graduates after 5 (five) years serving in any kinds of profession as chemical engineers. The details of the profile are as follows:

1. Develop the Chemical Engineering profession by implementing Chemical Engineering-based principles and approaches that uphold safety, environmental sustainability, as well as professional ethics,
2. Become an effective and tough individual with leadership character in the world of work,
3. Become an individual who develops and continues their education to a higher level in the fields of engineering, science, business, or other relevant fields of study, obtains certification or professional training, and is actively involved in professional development activities in their work.

The graduates of UPCE are mostly developing their careers in the following areas:

No.	GRADUATE PROFILE	DESCRIPTION OF GRADUATE PROFILE
1	*Project Engineer*	Bachelor of Chemical Engineering who is able to carry out process innovation, process and product engineering based on engineering principles by considering economic, health, safety, environmental and sustainability factors, and has the ability to think out of the box, advanced design technology, building technical capability and digital applications.

2	*Process Engineer*	Bachelor of Chemical Engineering who is able to prepare process documents to be implemented and analyze production processes to increase work efficiency and productivity.
3	*Product Developer*	Bachelor of Chemical Engineering who is able to innovate in process and product design through chemical engineering and understands the concept of technology push and market pull.
4	*Academician*	Bachelor of Chemical Engineering who is able to apply the basic knowledge of chemical engineering, is able to formulate chemical engineering problems, and has the ability as a professional educator, has a broad view on contemporary issues in the field of Chemical Engineering and has the ability to improve the level of education.
5	*Researcher*	Bachelor of Chemical Engineering who is able to formulate, analyze, study problems in research in the field of chemical science and technology so that they can obtain solutions related to improving processes, products and creating new products.
6	*Leader*	Bachelor of Chemical Engineering who is able to demonstrate his ability as a leader, able to communicate effectively, and understand innovation in his field along with knowing contemporary issues so that he has broad insight.

7	*Entrepreneur*	Bachelor of Chemical Engineering who has the ability and skills in the field of chemical engineering and is able to communicate his abilities and the products he produces to others, knows the latest issues and has the will to always learn and create.
8	*Engineering Consultant*	Bachelor of Chemical Engineering who is able to find the cause of a problem, analyze and recommend solutions to obtain optimal, efficient and effective solutions.
9	*Sales Engineer*	Bachelor of Chemical Engineering who has the ability to master the basic knowledge of chemical engineering and its applications and has good communication skills to market their products.

PROGRAM STRUCTURES AND CURRICULUM

The PLO is transformed into the curriculum of UPCE. For each academic year, it is divided into two instructional semesters which consist of 14 weeks of teaching/instruction and 2 weeks of examination for each semester . A total of 63 courses with 149 credit units (CU) are required to complete the chemical engineering bachelor degree program.

CU is a measure of learning activity time charged to students per week per semester in the learning process through various forms of learning or the amount of recognition for the success of student efforts in participating in curricular activities in a Study Program. The study load of 1 CU is equivalent to 45 hours per semester.

Table 2. Correlation between Courses and PLO

Codes	Courses	CU	Program Learning Outcome							
			A	B	C	D	E	F	G	H
1st Semester										
TKM1624101	Mathematics I	3	√							
TKM1624102	Physics I	2	√							
TKM1624103	Analytical Chemistry	3	√							
TKM1624104	Inorganic Chemistry	3	√							
TKM1624105	Introduction to Chemical Engineering	2		√				√		√
TKM1624106	Basic Chemical Engineering Labwork I	2	√		√				√	√
UUW1624004	Indonesia	2						√		

UUW16240XX	Religious Education	2								√
UUW1624107	English I	1						√		
2nd Semester										
TKM1624201	Mathematics II	2	√							
TKM1624202	Physics II	2	√							
TKM1624203	Physical Chemistry	3	√							
TKM1624204	Organic Chemistry	3	√							
TKM1624205	Fundamentals of Bioprocess	2	√							
TKM1624206	Thermodynamics I	3	√							
TKM1624207	Basic Chemical Engineering Labwork II	2	√		√				√	√
UUW1624006	Internet of Things	2					√			

UUW1624207	English II	1						√		
3rd Semester										
TKM1624301	Chemical Engineering Mathematics I	3	√							
TKM1624302	Thermodynamic s II	3	√							
TKM1624303	Chemical Engineering Principles I	3	√							
TKM1624304	Materials Science	3	√							
TKM1624305	Sustainable Technology Development	2		√						
TKM1624306	Bioprocess Labwork	2	√		√				√	√
UUW1624002	Pancasila	2								√
UUW1624005	Sports	1						√		

UUW1624307	English III	1						√		
4th Semester										
TKM1624401	Chemical Engineering Mathematics II	2	√							
TKM1624402	Chemical Engineering Principles II	2	√							
TKM1624403	Transport Phenomena	3	√							
TKM1624404	Chemical Reaction Engineering	3	√							
TKM1624405	Unit Operation I : Mechanical Process	2		√						
TKM1624406	Heat Transfer	2	√			√				

TKM1624407	Chemical Industrial Processes	3		√						
TKM1624408	Chemical Process Labwork	2	√		√				√	√
UUW1624003	Nationality	2								√
5th Semester										
TKM1624501	Unit Operation II : Fluid Mechanics	3	√							
TKM1624502	Unit Operation III : Heat Transfer Separation	3	√			√				
TKM1624503	Reactor	3				√				
TKM1624504	Process Modeling and Computation	3					√			

TKM1624505	Research Methodology and Statistics	3	√						√	
TKM1624506	Research Proposal	1			√			√	√	
TKM1624507	Product and Chemical Process Design	3				√				
TKM1624508	Unit Operation Labwork	2	√		√				√	√
6th Semester										
TKM1624601	Unit Operation IV : Multistage Separation	3	√			√				
TKM1624602	Research	2		√	√				√	
TKM1624603	Process Control	3	√				√			
TKM1624604	Construction Materials and Process	3				√	√			

	Equipment Design									
TKM1624605	Chemical Engineering Economics	2				√				
TKM1624606	Chemical Plant Design	3		√		√	√			
UUW1624008	Entrepreneurship	2								√
7th Semester										
TKM1624701	Waste Treatment Technology	2		√						
TKM1624702	Utility	2					√			
TKM1624703	Project and Industrial Management	2						√		√
TKM1624704	Chemical Process Safety	2		√						√

TKM1624705	Industrial Fieldwork	1						√		√
TKM1624706	Industrial Internship	3		√				√		√
TKM16247XX	**Elective Courses***	**8**		√			√			
8th Semester										
TKM1624801	Final Project : Preliminary Chemical Plant Design	6	√	√	√	√	√	√		
UUW1624009	Community Service Lecture	3						√		√

ELECTIVE COURSE

Elective Courses I			
No	**Code**	**Elective Course**	**cu**
1	TKM16 24711	Functional Food Technology	2
2	TKM16 24712	Petroleum Technology	2
3	TKM16 24713	Catalyst Technology	2
4	TKM16 24714	Clean Technology	2
5	TKM16 24715	Bioprocess Engineering	2

Elective Courses II			
No	**Code**	**Elective Course**	**cu**
1	TKM16 24721	Food Processing and Preservation Technology	2
2	TKM16 24722	Coal Technology	2
3	TKM16 24723	Polymer Technology	2
4	TKM16 24724	Management and Energy Conversion	2
5	TKM16 24725	Green Chemical Technology	2

Elective Courses III			
No	**Code**	**Elective Course**	**cu**
1	TKM16 24731	Enzyme and Fermentation Technology	2
2	TKM16 24732	Gas Processing Technology	2
3	TKM16 24733	New Material Technology	2
4	TKM16 24734	Emulsion and Surfactant Technology	2
5	TKM16 24735	Particle Technology	2

Elective Courses IV			
No	**Code**	**Elective Course**	**cu**
1	TKM16 24741	Food Packaging and Safety Technology	2
2	TKM16 24742	Renewable Energy Technology	2
3	TKM16 24743	Membrane Technology	2
4	TKM16 24744	Pinch Technology	2
5	TKM16 24745	Food Product Design	2

Course of Freedom to Learn - Independent Campus			
No	**Code**	**Course**	**cu**
1	TKM1624751	Selected Topic in Modelling and Process Computation	2
2	TKM1624752	Selected Topics in Bioprocess Technology	2
3	TKM1624753	Selected Topics in Food Processing	2
4	TKM1624754	Selected Topics in Process and Product Engineering	2
5	TKM1624755	Selected Topics in Gas and Petroleum Technology	2
6	TKM1624756	Selected Topics in Polymeric Materials, Metals and Minerals	2
7	TKM1624757	Selected Topics in Chemical Industry	2

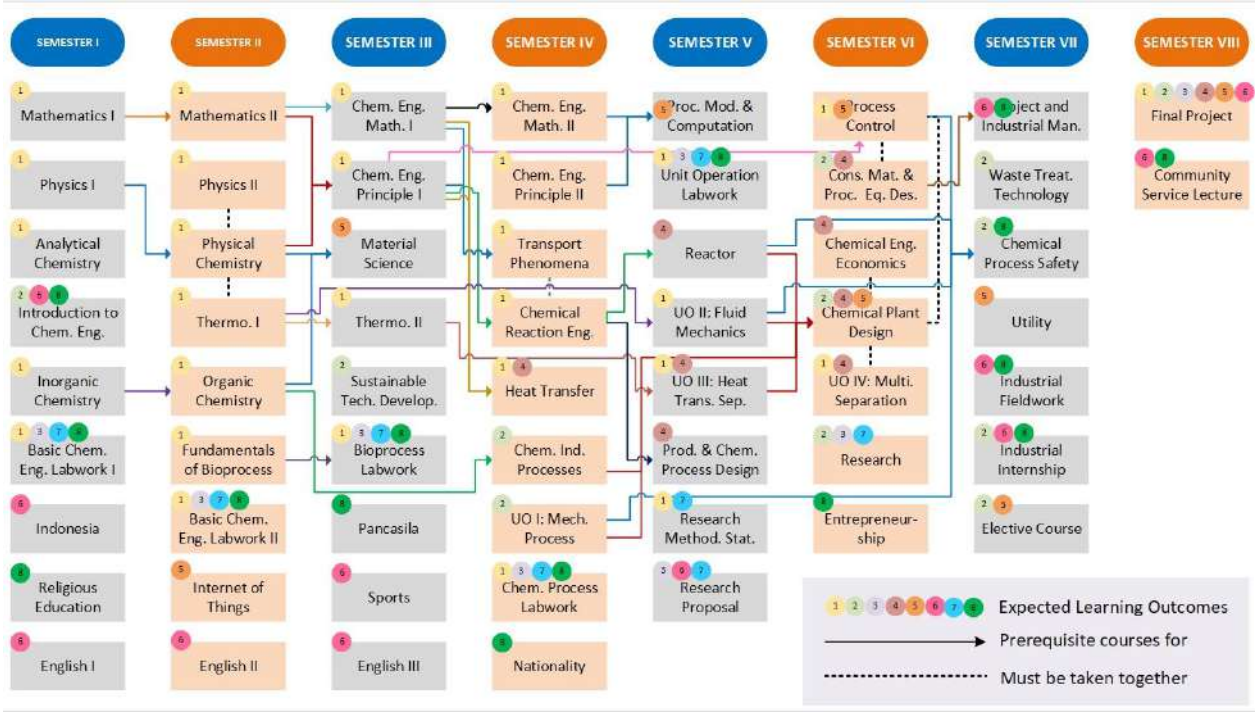
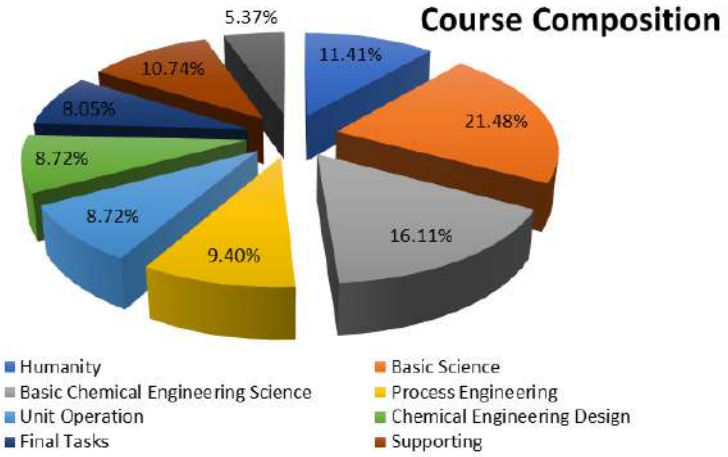


Figure 1 (a). Diagram of Correlation between Courses and PLO

COURSE CLASSIFICATION

The minimum study load to be accomplished by a student to be awarded a Bachelor in Chemical Engineering degree is 149 cu which must be completed within 8 to 14 semesters for maximum. The study load is delivered through 6 classification of courses.



Humanity courses provide a basic knowledge of religions, social, culture, art and history such that the students can understand and deal with non-engineering aspects to support their technical competence. The **Basic science courses** construct the basic capability of systematic and logical thinking for students by applying laws and fundamentals in basic sciences (mathematics, physics and chemistry) and taking into account health, safety and environmental issues to solve chemical engineering problems, while **Basic Chemical Engineering Science Courses** are delivered to provide knowledge, understanding and basic competence in chemical engineering field by emphasizing on the capability to design chemical processing plants through application of synthesis and separation technologies with focus on energy conversion and food processing areas. The

Engineering Design Courses are given to strengthen competencies in chemical engineering fields, to enhance the capability to understand the principles and rules in applying those competencies. These groups of courses are strengthened by **Supporting Courses** which are given to improve the expertise and competencies in particular fields of chemical engineering (utility, environmental science, waste treatment, statistics, research methodology as well as entrepreneurship). Finally, the students must take **Final Task courses** in terms of research, industrial internship and final project (Preliminary Chemical Plant Design).

Table 3. Course Composition

Groups	Courses	cu
Humanity 17 cu	Pancasila	2
	Nationality	2
	Religion	2
	Bahasa Indonesia	2
	Sport	1
	English I	1
	English II	1
	English III	1
	Community Service Lecture (KKN)	3
	Internet of Things (IoT)	2
Basic Science 32 cu	Mathematics I	3
	Mathematics II	2
	Inorganic Chemistry	3
	Analytical Chemistry	3
	Organic Chemistry	3
	Fundamental Chemical Engineering Labwork I	2
	Fundamental Chemical Engineering Labwork II	2
	Physics I	2
	Physics II	2
	Physical Chemistry	3
	Material Science	3
	Fundamental of Bioprocess	2
	Bioprocess Labwork	2
Basic Chemical Engineering Science 24 cu	Chem. Eng. Mathematics I	3
	Chem. Eng. Mathematics II	2
	Thermodynamics I	3
	Thermodynamics II	3
	Chem. Eng. Principles I	3
	Chem. Eng. Principles II	2
	Chem. Reaction Engineering	3
	Transport Phenomena	3
	Heat Transfer	2

Process Engineering 14 cu	Reactor Chemical Industrial Processes Process Modeling and Computation Chemical Process Labwork Process Control	3 3 3 2 3
Unit Operation 13 cu	Unit Operation I: Mechanical process Unit Operation II: Fluid mechanic Unit Operation III: Heat Separation Unit Operation IV: Multistage Separation Unit Operation Labwork	2 3 3 3 2
Chemical Engineering Design 13 cu	Chemical Engineering Economics Chemical Process Safety Construction Materials and Process Equipment Design Chemical Plant Design Product and Chemical Process Design	2 2 3 3 3
Final Tasks 12 cu	Industrial Internship Research Proposal Research Final Project : Preliminary Chemical Plant Design	3 1 2 6
Supporting 16 cu	**Ethic and Profession** ● Introduction to Chem. Eng.w ● Industrial Fieldwork **Management and Entrepreneurship** ● Entrepreneurship ● Project and Industrial Management **Auxillary** ● Utility ● Sustainable Technology Development ● Waste Treatment Technology ● Research Methodology and Statistics	 2 1 2 2 2 2 2 3

Elective courses 8 cu	Elective courses 1 Elective courses 2 Elective courses 3 Elective courses 4	2 2 2 2

COURSE DESCRIPTION

1st SEMESTER

Course Title	:	**Mathematics I**
Code	:	TKM1624101
Credit unit	:	3
Pre-requisite	:	-
Competency	:	A
Objectives	:	After completion of this course, the student should be able to to describe mathematics concept (differential, integral calculus, vector and matrix operations), and manipulate mathematics analytical for specific cases.
Syllabus	:	1. Ordinary Differential Equation 2. Application of Differential 3. Integral and Trigonometric Integral 4. Graph and Function 5. Limit, Continuity and Discontinuity 6. Theory and Operation of Vectors 7. Theory and Operation of Matrix
References	:	1. Dajan, A., "Pengantar Metode Statistik", Jilid II LP3ES, Jakarta, 1986 2. Leithold, L., Kalkulus dan Ilmu Ukur Analitik", Edisi Kelima, Jilid 1, Penerbit Erlangga, Jakarta, 1988 3. Schaum,"Theory and Problems of Calculus, 2nd edition, Mc Graw Hill, 1972

4. Soemartojo, "Kalkulus", Edisi 3, Penerbit Erlangga, 1988
5. Stroud, KA, Erwin Sucipto, "Matematika Untuk Teknik", Edisi Ketiga, Penerbit Erlangga
6. Pinem, MD, "Kalkulus untuk Perguruan Tinggi", 2015, Rakayas Sains
7. Brokate, M., Manchanda, P., Siddiqi, A. H., "Calculus for Scientists and Engineers", 2019, Springer

Course Title	:	**Physics I**
Code	:	TKM1624102
Credit unit	:	2
Pre-requisite	:	-
Competency	:	A
Objectives	:	After completion of this course, the student should be able to describe the basic concept of physics, and apply it to analyze the simple common events and a basic understanding of chemical engineering sciences.
Syllabus	:	1. Light and Optics 2. Magnetism and Electrostatics 3. Electrodynamics 4. Energy and Heat 5. Heat Transfer
References	:	1. Halliday, H., Resnick, R., and Walker, J. (1997). *Fundamentals of Physics. Extended*. 5ed. John Wiley & Sons, Inc., New York. 2. Zears, F.W. dan Zemansky, M.W., 1987, *University Physics*, Addison Wisley Publishing Company Inc.

Course Title	:	**Analytical Chemistry**
Code	:	TKM1624103
Credit unit	:	3
Pre-requisite	:	-
Competency	:	A
Objectives	:	After completion of this course, the student should be able to explain the concept of analytical chemistry and practice the analysis procedure (both quantitative and qualitative), the student also expected to be able to determine and choose the proper method.
Syllabus	:	1. Introduction of basic principle of chemical analysis and reagent preparation procedure. 2. Qualitative Analytical Chemistry (Cation, Anion, Mixed) 3. Volumetric Analysis (Standard Solution) 4. Acidi-Alcalimetric 5. Argentometric and gravimetric 6. Quantitative analysis based on Redox Reaction 7. Complexometric 8. Introduction to instrumental analysis techniques 9. Spectrophotometry UV-visible 10. Spectrophotometry IR, and Atomic Absorption Spektrofotometry (AAS) 11. Potentiometric and Conductometric 12. Basic Chomatography 13. Liquid gas chromatography (LGC), and Solid Gas Chromatography (SGC)
references	:	1. Ewing, 1985, "Instrumental Methods of Chemical Analysis", 5th ed., Mc. Graw Hill. 2. Vogel, A.I., 1978, "Text book of Macro and Semi Micro Qualitative Inorganics Analysis", 4th ed. Longman Green and Corp, New York. 3. Vogel, A.I., 1961, "Text book of quantitative Inorganics Analysis", 4th ed. Longman Green and Corp, New York.

4. Day, R.A. and Underwood, A.L., 1981, "Analisa Kimia Kuantitatif", edisi ke-4, Penerbit Erlangga, Jakarta.

Course Title	:	**Inorganic Chemistry**
Code	:	TKM1624104
Credit unit	:	3
Pre-requisite	:	-
Competency	:	A
Objectives	:	After completion of this course, the student should be able to describe structure, characteristic, and basic principle of atom, chemical bond, acid base theory, acid-base reaction equilibrium, and oxidation-reduction reaction.
Syllabus	:	1. Material components 2. Ionic and covalent bond 3. Quantum theory and atomic structure 4. Quantum mechanical model of the atom 5. Atomic electron configuration 6. Chemical and physical properties of atom based on periodic system 7. Intermolecular force: Molecule polarity 8. Chemical equilibrium and Le-Chatelier principal 9. Acid-base theory 10. Acid-base equilibrium 11. Oxidation and reduction reaction
references	:	1. Keenan, C.W., Kleinfelter, D.C., Wood, J.H., Pudjaatmaka, A.H., 1984, Kimia untuk Universitas, edisi keenam, Penerbit Erlangga, Jakarta. 2. Silberberg, M. S. (2006). *Chemistry: The Molecular Nature of Matter and Change*. 4th ed. McGraw-Hill Book, Inc., New York.

Course Title	:	**Introduction of Chemical Engineering**
Code	:	TKM1624105
Credit unit	:	2
Pre-requisite	:	-
Competency	:	B, F, H
Objectives	:	The objective of the course is to make the student understanding about the role of the chemical engineer in chemical processing and gives a basic knowledge and critical way of thinking about chemical engineering tools, design and process.
Syllabus	:	1. Introduction to Chemical Engineering (definition and history) 2. Chemical engineering component (basic law, theory, and skill) 3. Chemical engineering tools 4. Contemporary issue about chemical engineering 5. Chemical engineer career prospect 6. Chemical engineering for environmental management
References	:	1. Rase, H.F., 1961, " The Philosophy and Logic of Chemical Engineering", Gulf Publishing Co., Houston. 2. Andersen, L.B. and Wenzel, L.A., 1961, " Introduction to Chemical Engineering", Mc Graw Hill Book Company, International Student Edition, Tokyo. 3. Kho, K.H., 1989, " Industri Kimia di Indonesia Pada Waktu Ini dan Prospeknya di Masa yang Akan Datang", Makalah Lokakarya Teknik Kimia, ITB. 4. Harjosuparto, S., 1990, " Filsafat dan Logika Teknik Kimia", Makalah Penataran Dosen PTS Teknik Kimia, Cisarua Bogor. 5. Charpentier, J.C., 2005, " Four main objectives for the nature of chemical and process engineering mainly concerned by the science and technologies of new materials

production", Chem. Eng. Journal, Article in Press.
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8. Bishop P.L., 2000, "Pollution Prevention : Fundamentals and Practice", International edition, McGraw-Hill Book Co, Singapore.
9. Freeman H.M., (editor) , 1989, "Standard Handbook of Hazardous Waste Treatment and Disposal", McGraw-Hill Book Company, New York.

Course Title	:	**Basic Chemical Engineering Labwork I**
Code	:	TKM1624106
Credit unit	:	2
Pre-requisite	:	Taken together with organic and inorganic chemistry
Competency	:	A, C, G, H
Objectives	:	After completion of this course, the student should be able to analysis the organic and inorganic compounds using quantitative and qualitative analytical methods.
Syllabus	:	1. Anion and cation analysis 2. Acidimetric, Alkalimetric and potentiometric 3. Iodometry-Iodimetry and Permanganometry Analysis 4. Argentometry and Gravimetry Analysis 5. Complexometry Analysis 6. Spectrophotometric Analysis
References	:	1. Felder, R. (2005). *Elementary Principles of Chemical Processes*. 3rd ed. Wiley. 2. Donaldson, K. (1999). *The Engineering Student Survival Guide*. McGraw-Hill, New York. 3. Solen, K. A., and Harb, J. N. (1998). *Introduction to Chemical Process*

Fundamentals & Design. 3rd edn. McGraw-Hill, New York, 1998.
4. Vogel, A.I., 1978, "Text book of Macro and Semi Micro Qualitative Inorganics Analysis", 4th ed. Longman Green and Corp, New York.

2nd SEMESTER

Course Title	:	**Mathematics II**
Code	:	TKM1624201
Credit unit	:	2
Pre-requisite	:	Mathematics I
Competency	:	A
Objectives	:	After completion of this course, the students will be able to explain and solve analytical problems related to complex numbers, ordinary differential equations, partial differential equations, simultaneous differential equations, series, and Fourier series.
Syllabus	:	1. Basic theory and concept of complex number and its operation 2. Ordinary differential equation 3. Partial differential equations 4. Simultaneous differential equations 5. Series and The Expansion of Infinite Series (Fourier Series)
References	:	1. Stroud, K.A. (1984) Engineering Mathematics: Programmes and Problems 3d ed. Springe-Verlag, New York. 2. Stroud, K.A., Booth, D.J. (2020) Engineering Mathematics 8th ed. Springe-Verlag, New York

Course Title	:	**Physics II**
Code	:	TKM1624202
Credit unit	:	2
Pre-requisite	:	-
Competency	:	A

Objectives	:	After completion of this course, students will be able to explain and solve problems related to solid mechanics, fluid mechanics, and energy (potential and kinetic).
Syllabus	:	1. Parabolic movements 2. Rotation movements 3. Fluid Properties and Mechanics 4. Concept and Theory of Energy 5. Fluid mechanics and Energy
References	:	1. Halliday, D., Resnick,R., dan Silaban, P., 1994, Fisika, Jilid I, Penerbit Erlangga, Jakarta. 2. Zears, F.W. dan Zemansky, M.W., 1987, University Physics, Addison Wisley Publishing Company Inc.

Course Title	:	**Physical Chemistry**
Code	:	TKM1624203
Credit unit	:	3
Pre-requisite	:	Physics I and taken together with physics II
Competency	:	A
Objectives	:	After completion of this course, the student should be able to explain physical characteristics of gases, liquids, and solids, physical and chemical changes in solution and colloid, interface (liquid-liquid; liquid-gas; liquid-solid), and electrochemistry
Syllabus	:	1. The relation of volume, pressure, temperature, number of moles with ideal gas equation and real gas equation 2. Heat, works, and internal energy, heat capacity 3. Exothermic and endothermic reaction, enthalpy, and heat reaction 4. Carnot cycle, energy conservation law, entropy, gibbs free energy, and chemical potential 5. Equilibrium constant 6. Phase equilibrium

7. Partial molar volume, ideal and non-ideal solution
8. Physical of characteristics of gases, liquids, and solids, kinetics theory of gas
9. Colloid and suspension
10. Electrochemical

References :

1. Mortimer, R. G. (2008). *Physical Chemistry*. 3rd ed. Academic Press, San Diego, California.
2. Monk, P. (2004). *Physical Chemistry: Understanding Our Chemical World*. John Wiley & Sons, Inc., Hoboken.

Course Title : **Organic Chemistry**

Code : TKM1624204

Credit unit : 3

Pre-requisite : Inorganic Chemistry

Competency : A

Objectives : After completion of this course, the student should be able to describe characteristics, structures, and making of organic compounds.

Syllabus :

1. Introduction to organic chemistry (characteristic, structure, functional group, basic reaction, organic chemistry software)
2. Electronegativity, bond, and resonation in organic chemistry
3. Stereochemistry, geometric isometry, and conformation of organic substance
4. Alkyl halide compounds
5. Alkane and cycloalkane compounds
6. Alkene and alkyne compounds
7. Carbonyl compound
8. Benzene compound
9. Amine compound
10. Carbohydrate, Fat, Protein
11. Determination of organic structure using Fourier Transform Infrared spectroscopy (FTIR)

References :

1. Solomon, T. W, Fryhle, C. B., Synder, S. A. (2014). Organic Chemistry. 11th ed. John Wiley and Sons., New Jersey

2. Morrison and Boyd (1992). Organic Chemistry. 6th ed. Prentice Hall, New Jersey.
3. Fesenden and Fesenden, R. (1998). Organic Chemistry, 4th edition, Cole Publishing Company, California
4. Fieser, L.F. and Fieser, M. (1959). Basic Organic Chemistry. D.C. Heath and Company., Boston.
5. Suherman and Aryanti, N (2017). Buku Ajar Kimia Organik, Yoga Pratama, Semarang.
6. Aryanti, N. (2022),. Buku Ajar Kimia Organik : Senyawa Aromatik, Undip Press, Semarang
7. Nandiyanto, A.D., Oktiani, R, Ragadhita R., 2019, How to How to Read and Interpret FTIR Spectroscope of Organic Material, Indonesian Journal of Science & Technology,Vol. 4(1), pp. 97-118.

Course Title	:	**Bioprocess Fundamental**
Code	:	TKM1624205
Credit unit	:	2
Pre-requisite	:	-
Competency	:	A
Objectives	:	After completion of this course, the student should be able to describe and explain the role of microbe/enzyme in bioprocess.
Syllabus	:	1. Introduction: Biotechnology, biochemical engineer, biology process, fermentation definition. 2. Microorganism and part of cell for bioprocess 3. Microorganism medium and sterilization methods 4. Cell counting and isolation process 5. Microorganism growth in batch system 6. Enzyme kinetics in batch reactor 7. Competitive inhibition and non-competitive inhibition for enzymatic reaction 8. Enzyme immobilization 9. Fermenter and enzyme application in industry

10. Enzyme analysis methods
11. Case study : bioprocess product : production concept and its application

References :

1. Duta, R. (2008). *Fundamentals of Biochemical Engineering*. Springer, Ane Books India.
2. Shuler, M. L. and Kargi, F. (2002). *Bioprocess Engineering–Basic Concepts*. 2nd ed. Prentice Hall International Series, New Jersey.
3. McNeil, B., Harvey, L. (2008) "*Practical Fermentation Technology*" Wiley
4. Vogel, H C., Haber, C C. (Ed.), (2014) "*Fermentation and Biochemical Engineering Handbook*" 3rd Ed, William Andrew
5. Stanbury P.F., Whitaker, A., Hall, S. J., (2017) "*Principles of Fementation Technology*" 3rd Ed, Elsevier Ltd.
6. Bhatt, A K., Bhatia, R K., Bhala, T C. (2023) "*Basic Biotechniques for Bioprocess and Bioentrepreneurship*" Elsevier

Course Title : Thermodynamics I

Code : TKM1624206

Credit unit : 3

Pre-requisite : Taken together with physical chemistry

Competency : A

Objectives : After completion of this course, the student should be able to describe thermodynamics characteristic of pure fluids, application of the first law on various processes; The second law of thermodynamics.

Syllabus :

1. Introduction of thermodynamics
2. Volumetric characteristic
3. First law of thermodynamics
4. Pure solution properties
5. Heat effect in industry
6. Second law of thermodynamic
7. Fundamental equation
8. Application of thermodynamic on various process

9. Energy production from heat
10. Refrigeration and liquefied gas

References :
1. Smith, J. M., Van Ness, H. C., and Abbott, A. (2001). *Introduction to Chemical Engineering Thermodynamics*. 6th ed. McGraw-Hill, Boston.
2. Potter, M. C. and Somerton, C. W. (1993). *Schaum's Outline of Theory and Problems of Thermodynamics for Engineers*. McGraw-Hill, New York.

Course Title : **Basic Chemical Engineering Labwork II**
Code : TKM1624207
Credit unit : 2
Pre-requisite : Taken together with physical chemistry and organic chemistry
Competency : A, C, G, H
Objectives : After completion of this course, the student should be able to perform electrochemical reaction and phase equilibrium, and to determine physical properties of materials.
Syllabus :
1. Determination of heat of solution and solubility as function of temperature
2. Determination of density, viscosity and surface tension; refraction index
3. Determination of boiling point elevation and freezing point depression
4. Electrochemical
5. Phase equilibrium
6. Carbohydrate
7. Protein
8. Fat
9. Instrumental analysis

References :
1. Bernardini, E.(1983).Vegetable oils and Fats Processing. Volume I & II. Interstampa, Rome.
2. Bird, T. (1993). Kimia Fisik untuk Universitas. PT. Gramedia, Jakarta.
3. Daniel, F. (1962). Experimental Physical Chemistry. 6thedn. International Student

Edition, Mc Graw Hill Book Co. Inc., Kogakusha Co, Ltd., Tokyo

3RD SEMESTER

Course Title	:	**Chemical Engineering Mathematics I**
Code	:	TKM1624301
Credit unit	:	3
Pre-requisite	:	Mathematics II
Competency	:	A
Objectives	:	After completion of this course, the student should be able to solve chemical engineering problems in non-linear ordinary differential equations
Syllabus	:	1. Systematical data presentation 2. Equation model (semi log coordinate, log-log coordinate, linear regression, multiple regression, least square, lagrange) 3. Preparation and completion of an empirical equation 4. Graphics methods for solving mathemathics problem in chemical engineering 5. Fourier series 6. Integral transformation methods 7. Bessel function and its application 8. Legendre function and its application 9. Laplace transform and its application
References	:	1. Andersen, L.B., Wenzel, L.A., "Introduction to Chemical Engineering", International Student Edition, 1961. 2. Creese, T.M., Haralick, R.M., "Differential Equation- For Engineers", International Student Edition, Mc. Graw Hill, Inc., 1978. 3. Jenson, V.G., Jeffreys, G.V., "Mathematical Methods in Chemical Engineering", 2 nd Ed.,Academic Press, London.

4. Mickley, H.S., Sherwood, T.K., "Applied Mathematics in Chemical Engineering", 2 nd Ed., Mc. Graw Hill Book Company, New York.
5. Pipes, L.A., Harvill, R.L., "Applied Mathematics for Engineers and Physicists", 3 th Ed., International Student Edition, 1971
6. Stroud, K.E, "Further Engineering Mathematics (Programs and Problems", 2 nd Ed., Springer Science+Business Media, LLC, 1990

Course Title	:	**Thermodynamics II**
Code	:	TKM1624302
Credit unit	:	3
Pre-requisite	:	Thermodynamics I
Competency	:	A
Objectives	:	After completion of this course, the student should be able to describe phase equilibrium (vapor-liquid), phase rule, Duhem's theory, solution thermodynamics, equilibrium in single and multiple reaction
Syllabus	:	1. Liquid-gas equilibrium, duhem theory 2. Ideal and non-ideal solution, fugacity and fugacity coefficient, activity coefficient and Gibbs energy 3. Gibbs energy standard 4. Chemical reaction equilibrium 5. Phase equilibrium 6. Application of fluid's thermodynamic characteristics 7. Vapor-liquid, solid-liquid, and solid-gas equilibrium 8. Chemical reaction equilibrium
References	:	1. Smith, J. M., Van Ness, H. C., and Abbott, A. (2001). *Introduction to Chemical Engineering Thermodynamics*. 6th ed. McGraw-Hill, Boston. 2. Potter, M. C. and Somerton, C.W., (1993). *Schaum's Outline of Theory and Problems of Thermodynamics for Engineers*. McGraw-Hill, New York.

Course Title	:	**Chemical Engineering Principles I**
Code	:	TKM1624303
Credit unit	:	3
Pre-requisite	:	Mathematics II, Physical Chemistry
Competency	:	A
Objectives	:	After completion of this course, the student should be able to apply mass and energy balances to determine unknown process/operation variables.
Syllabus	:	1. Single system mass balance 2. Multi system mass balance 3. Mass balance for recycle system 4. Mass balance for bypass system 5. Mass balance for purge system 6. Energy balance for close system without reaction 7. Energy balance for open system without reaction 8. Energy balance for chemical reaction system 9. Heat of solubilization and heat of mixing 10. Humidity chart
References	:	1. Holman, J.P., 2010, Heat Transfer, tenth edition, McGraw Hill, Ltd., New York. 2. Kern, D.Q., 1965, Process Heat Transfer, International Student Edition, McGraw Hill Kogakusha, Ltd., New York. 3. Buchori, L. dan Soemardjo, M., 2011, Buku Ajar Perpindahan Panas, edisi pertama, BP Undip, Semarang 4. Incopera, F.P. and Weitt, D.P., 2007, Fundamentals of Heat Transfer, sixth edition, John Willey & Sons Inc., New York 5. Ozisik, M. N., 1985, Heat Transfer, a Basic Approach, Mc. Graw-Hill International Editions, Kogakusha, Ltd

Course Title	:	**Material Science**
Code	:	TKM1624304

Credit unit	:	3
Pre-requisite	:	Analytical chemistry, Inorganic Chemistry, Organic Chemistry, Physical Chemistry
Competency	:	A
Objectives	:	After completion of this course, the student should be able to describe properties, structures, material testing, phase diagram of material, and the utilization of various materials (metals and non-metals) for industrial equipment
Syllabus	:	1. Introduction to material science engineering 2. Classification of solid 3. Crystal and non-crystal structure 4. Mechanical properties of metal 5. Material failure 6. Alloy of iron-C 7. Metal alloy system 8. Degradation and corrosion 9. Classification of polymer 10. Polymer transition, degradation and deformation 11. Definition, structure and properties of ceramics 12. Ceramics processing 13. Mechanical properties of ceramics
References	:	1. William D. Callister, Jr., David G. Rethwisch, 2009, Materials science and engineering: an introduction 8th ed, John Wiley & Sons, Inc. 2. Callister, W. D, Jr. Fundamentals of Materials Science & Engineering; An Integrated approach, John Wiley & Sons, 2008 3. Donald R. Askeland, Pradeep P Fulay., Wendelin J. Wright, The sciene and engineering of materials, 2010, 4. Van Vlack, H.L., "Elements of Materials Science and Engineering" Addison – Wesley Publishing Company, 1985 5. Jacobs, J.A. and Kilduff, T.A., " Engineering Material Technology", 1994

6. Manas Chanda,"Science of Engineering Material", vol 1 – 3, 1979.
7. Smith, W.F., " Principles of Materials Science and Engineers", 1986.

Course Title	:	**Sustainable Technology Development**
Code	:	TKM1624305
Credit unit	:	2
Pre-requisite	:	-
Competency	:	B
Objectives	:	After completion of this course, the student should be able to describe and explain the development of sustainable technologies based on an understanding of sustainable development goals, the causes and impacts of climate change, and the concept of sustainability through the introduction of product life cycles, circular economy, and the efficiency of energy, water, and the management of groundwater and water pollution.
Syllabus	:	1. Introduction to sustainable development goals (SDGs) 2. Sustainability aspects in chemical industries 3. Principles of sustainable technology development 4. Introduction to life cycle assesment (LCA) 5. Concept and theory of circular economy 6. Sustainable raw material supplies and efficiencies 7. Sustainable process and technology developments in chemical industries 8. Process efficiency optimization in chemical plants 9. Management of water, air, and soil pollution

References :

1. Calvin, K., et al. (2023). IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland
2. Cavani, Fabrizio. (2009). Sustainable industrial processes. Wiley-VCH.
3. CIRCULAR ECONOMY PLAYBOOK FOR CHEMICAL COMPANIES Sustainable and circular business models for the chemical industry. (2020).
4. Fundamentals and Applications of Renewable Energy (2020). (n.d.).
5. Hauschild, M. Z., Rosenbaum, R. K., & Olsen, S. I. (2017). Life Cycle Assessment: Theory and Practice. In Life Cycle Assessment: Theory and Practice. Springer International Publishing.
6. HILIR FRESH Midstream Direktorat Jenderal Pengendalian Pencemaran dan Kerusakan Lingkungan
7. Kementerian Lingkungan Hidup dan Kehutanan, H. (2021). PEDOMAN PENYUSUNAN LAPORAN PENILAIAN DAUR HIDUP (LCA).
8. Lichtfouse, Eric., Schwarzbauer, Jan., & Robert, D. (Environmental chemist). (2005). Environmental chemistry : green chemistry and pollutants in ecosystems. Springer.
9. Maranghi, S., & Brondi, C. (2020). Life cycle assessment in the chemical product chain: Challenges, methodological approaches and applications. In Life Cycle Assessment in the Chemical Product Chain: Challenges,

Methodological Approaches and Applications. Springer International Publishing.

Course Title	:	**Bioprocess Labwork**
Code	:	TKM1624306
Credit unit	:	2
Pre-requisite	:	Fundamentals of Bioprocess
Competency	:	A, C, G, H
Objectives	:	After completion of this course, the student should be able to describe and perform microbe breeding, enzyme isolation, and fermentation process
Syllabus	:	1. Biosynthesis of Alcohol 2. Biosynthesis of Acetic Acid 3. Enzyme isolation 4. Oil production from fermentation process 5. Solid state fermentation : making of tempe 6. Biosynthesis of citric acids 7. Making of yogurt 8. Making nata 9. Making of soya milk (optional) 10. Water investigation and aseptic transfer
References	:	1. Bailey, J.F., &Ollis, D.F. (1988).Biochemical Engineering Fundamentals. Second edition. McGraw Hill Book Co., Singapore. 2. Darwis, A.Z. & Said, E.G. (1992).Teknologi Fermentasi. PAU Bioteknologi IPB, Rajawali Press, Jakarta. 3. Prescott & Dunn.(1959).Industrial Microbiology. 3rd edition. Mc Graw Hill Book Co. Inc., New York

4TH SEMESTER

Course Title	:	**Chemical Engineering Mathematics II**

Code	:	TKM1624401
Credit unit	:	2
Pre-requisite	:	Chemical Engineering Mathematics I
Competency	:	A
Objectives	:	After completion of this course, the student should be able to develop mathematical model for various phenomena related to chemical engineering problems and to solve it both analytically and numerically
Syllabus	:	1. Introduction to chemical engineering tools 2. Mathematic modelling in transfer processes 3. Integral function with numeric methods 4. Numeric methods for ordinary differential equation 5. Numeric methods for partial differential equation 6. Ordinary differential equation (Completion of single and simultaneous first order linear equations) 7. Ordinary differential equation (Completion of single and simultaneous second order linear equations) 8. Ordinary differential equation (Completion of single and simultaneous second order non-linear equations) 9. Preparation, completion, and application of partial differential equation
References	:	1. Mickley, H.S., T.K., Sherwood, C.E., Reed,. 1975, " Applied Mathematics in Chemical Engineering", 2th ed., MC Graw Hill Book Co. Inc. 2. Jenson, V.G., dan G.V., Jeffreys, 1977, "Mathematics for Chemical Engineering", Academic Press. 3. Raman, 1985, "Chemical Process Computation", Elsevier. 4. Rice, R.S. dan D.D. Do, 1995, "Applied Mathematics and Modelling for Chemical Engineers", John Wiley & Sons, Inc.

Course Title	:	**Chemical Engineering Principles II**
Code	:	TKM1624402
Credit unit	:	2
Pre-requisite	:	Chemical Engineering Principles I
Competency	:	A
Objectives	:	After completion of this course, the student should be able to explain dimensional analysis and apply the theoretical model for the process scale-up tool
Syllabus	:	1. Dimensional analysis 2. Units and dimensions 3. Dimensional analysis Rayleigh 4. Dimensional analysis Buckingham 5. Dimensions matrix 6. Process study, study progress 7. Similarity 8. Regime concept 9. Concept of heat transfer 10. Theoretical model
References	:	1. Greenkorn, R. A., Kessles, D. P. (1972). *Transfer Operations*. 2. Johnstone, R. E., Thring, M. W. (1957). *Pilot Plants, Models, and Scale up Method in Chemical Engineering*. 3. Langhaar, H. L. (1995). *Dimensional Analysis and Theory of Models*.

Course Title	:	**Transport Phenomena**
Code	:	TKM1624403
Credit unit	:	3

Pre-requisite	:	Chemical Engineering Mathematics I, Chemical Engineering Principles I
Competency	:	A
Objectives	:	After completion of this course, the student should be able to describe and explain the concepts of mass, energy, and momentum transfer and to apply the concepts in chemical engineering problems.
Syllabus	:	1. Basic law of momentum conservation and transport 2. Momentum transfer mechanism for steady state and laminar flow 3. Flux distribution of momentum and velocity 4. Continuity equation for flat sheet, cylinder, ball 5. Momentum equation for flat sheet (x, y, and z) 6. Velocity distribution concept for unsteady state and the methods to solve velocity equation 7. Fourier's law 8. Basic law of heat transport 9. Simultaneous energy and momentum transport 10. Fick's diffusion law 11. Basic law of mass transport 12. Simultaneous mass, energy, and momentum transport
References	:	1. Bird, R. B., Stewart, W. E., and Lightfoot, E. N. (2002). *Transport Phenomena*. 2nd ed. John Wiley and Sons, Inc., New York. 2. Welty, J. E., Wilson, R. E., and Wicks, C. E. (1984). *Fundamental of Momentum, Heat, and Mass Transfer*. John Wiley and Sons, Inc., New York. 3. Broadkey, R.S. and Hershey, H.C., 1988, *Transport Phenomena, A Unified Approach*, Mc-Graw Hill, New York, USA. 4. Utomo, Tj., 1984, Teori Dasar Fenomena Transpor, Binacipta, Bandung.

Course Title	:	**Chemical Reaction Engineering**
Code	:	TKM1624404
Credit unit	:	3

Pre-requisite	:	Chemical Engineering Principles I, taken together with transport phenomena
Competency	:	A
Objectives	:	After completion of this course, the student should be able to describe classification, rate, and mechanism of reaction, and to analyze data of homogeneous and heterogeneous reaction. After completion of this course, the student should be able to describe and explain mechanism of reaction and catalytic and non-catalytic reaction kinetics.
Syllabus	:	1. The basic concept of chemical kinetics-the determination of the rate of a chemical reaction, the reaction mechanism 2. Elementary and non-elementary reaction 3. Preparation, completion, and application of reaction kinetics equation for real experiment data 4. Completion of reaction kinetics by differential, partial differential, isolation, and least square 5. Interpretation of experimental data on batch reactor 6. Multiple reaction 7. Kinetics of non elementary reaction 8. Definition of heterogeneous catalyst 9. Kinetics of heterogeneous catalytic reaction 10. Kinetics of Heterogeneous multi phase and non-catalytic reaction
References	:	1. Fogler, H. S. (2004). *Elements of Chemical Reaction Engineering*. 3rd ed. Prentice Hall International, New Jersey. 2. Levenspiel, O. (1999). *Chemical Reaction Engineering*. John Wiley & Sons, New York. 3. Twigg, M.V. (1989). *Catalyst Handbook*. 2nd ed. Wolfe Publishing Ltd., London. 4. Hill, Charles G.,Ir., 1977, "An Introduction to Chemical Engineering Kinetics & Reactor design". John Wiley & Sons, New York.

Course Title	:	**Unit Operation I: Mechanical Process**
Code	:	TKM1624405
Credit unit	:	2
Pre-requisite	:	-
Competency	:	B
Objectives	:	After completion of this course, the student should be able to describe and explain process and equipment for transporting fluid and solid
Syllabus	:	1. Solid particulate characteristics 2. Momentum transfer, solid separation, operation, and storage 3. Fluidization 4. Pneumatic conveying 5. Floatation, flowrate and pressure, and its application in industry 6. Size reduction and enlargement 7. Agglomeration 8. Size segregation 9. Mixing solids 10. Solid transportation
References	:	1. Richardson, J.F., Harker, J.H., Backhurst, J.R. (2002). *Coulson and Richardson's Chemical Engineering. Particle Technology and Separation Processes*. 5th ed., Butterworth & Heinemann, New York. 2. Oldshue and James, (1983), *Fluid Mixing Technology*, McGraw Hill Book Co. 3. Tatterson and Gary, (1991), *Fluid Mixing and Gas Dispersion in Agitated Tanks*, 2nd Ed, 4. Edward L. Paul, Victor A. Atiemo-Ob, Suzanne Kresta, (2004), *Handbook of Industrial Mixing-Science and Practice*, John Wiley & Sons, Inc., New Jersey. 5. Reiji Mezaki, Masafumi Mochizuki, Kohei Ogawa, (2000), *Engineering Data on Mixing*, Elsevier Science & Technology Books

6. Keairs and Dale, (1976), *Fluidization Technology*, Vol 1&2, McGraw Hill Book Co
7. Yang, W.C., 1998, Fluidization, Solids Handling, and Processing, Industrial Applications, Noyes Publications, New Jersey
8. P. G. Smith, (2007), *Applications of Fluidization to Food Processing*, Blackwell Publishing company, Oxford

Course Title	:	**Heat Transfer**
Code	:	TKM1624406
Credit unit	:	2
Pre-requisite	:	Chemical engineering principle I, Chemical Engineering mathematic I,
Competency	:	A, D
Objectives	:	After completion of this course, the students are expected to understand the modes, laws and rules, types and heat transfer equipment design consideration
Syllabus	:	1. Review and basic concept of conductive; Convective and convective heat transfers; 2. One dimensional Conductive heat transfer 3. Simultaneous conduction and convection; 4. Double dimension conductive transfer 5. Basic concept of radiation heat transfer 6. Classification of heat exchanger 7. Heat transfer parameter 8. Temperature profile, single pass and multi-pass LMTD, correction factor 9. Design of heat exchanger 10. NTU methods for heat transfer calculation

References :

1. Kern, D. Q. (1950). *Process Heat Transfer*. McGraw-Hill Kogakusha, Ltd., Tokyo.
2. Slattery, J. C. (1972). *Momentum, Heat and Mass Transfer in Continua*. Mc Graw Hill Kogakusha, Ltd., Tokyo.
3. Holman, J. P. (1989). *Heat Transfer*. McGraw-Hill Book Company, Singapore.
4. Incropera, F. P and De Witt, D. P. (1990). *Introduction to Heat Transfer*. 2nd ed. John Wiley & Sons, New York.
5. Buchori, L. dan Soemardjo, M., (2011), *Buku Ajar Perpindahan Panas*, BP Undip, Semarang.
6. Ozisik, M. N., (1985), *Heat Transfer, a Basic Approach*, Mc. Graw-Hill International Editions, Kogakusha, Ltd
7. Pitts, D.R., and Sissom, L.E., (1987), *Perpindahan Kalor*, Erlangga, Jakarta

Course Title : Chemical Industrial Processes

Code : TKM1624407

Credit unit : 3

Pre-requisite : Inorganic chemistry, Organic chemistry

Competency : B

Objectives : After completion of this course, the student should be able to describe and explain processes in organic and inorganic chemical industry (petrochemical, polymer, fertilizer, steel, and cement) based on thermodynamic, catalysis, and transport phenomena concepts.

Syllabus :

1. Introduction to chemical industry (definition, classification, processes, and basic concepts)
2. Polymer industry processes
3. Petrochemical industry processes
4. Pulp and paper industry processes
5. Cement industry process
6. Food industry
7. Pharmaceutical industry

8. Basic Chemical Industry (cement, fertilizer, soda, sulfuric acids, etc.)

References : 1. Shreve, N. (1984). *Chemical Process Industry*. Mc Graw-Hill, Boston.
2. George T. Austin. (1984). *Shreve's Chemical Process Industries* (5th ed.). McGraw-Hill.
3. Ali, S., Smith, B., & Johnson, C. (2005). *Handbook of Industrial Chemistry – Organic Chemicals*. McGraw-Hill.
4. Kent, J. A. (2007). *Riegel's Handbook of Industrial Chemistry and Biotechnology*, 10th ed. Springer.

Course Title : Chemical Process Labwork

Code : TKM1624408

Credit unit : 2

Pre-requisite : Basic Chemical Engineering Labwork I & II

Competency : A, C, G, H

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

Syllabus :
1. Hydrodynamics of airlift reactor (sodium thiosulfite oxidation)
2. Continuous-flow ideal reactor for saponification reaction
3. Hydrolysis kinetics of starch and oil
4. Gas-liquid reaction (carbon dioxide absorption using caustic soda)
5. Esterification (Ethyl acetate or methyl ester)
6. Preparation of catalysts by impregnation and coprecipitation
7. Level control (Feedback and no-off controller)
8. Electroplating using copper solution

References : 1. Levenspiel, Octave. (1999). *Chemical Reaction Engineering 3rd Ed*. John Wiley & Sons: New York

2. Fogler,H.S. (2006). *Element of Chemical Reaction Engineering. 4th Ed*. Prentice Hall PTR
3. Fessenden, R.J, dan Fessenden, J.S. (1999). *Kimia Organik. Ed 3*. Hal 83. Jakarta : Erlangga
4. Groggins, P.H. (1958). *Unit Processes in Organic Synthesis*. Pp.669. New York: McGraw Hill.Inc
5. Kirk, R.E. and Othmer, D. F. (1953). *Encyclopedia of Chemical Technology* 6, pp. 231-236. New York : The Interscience Encyclopedia. Inc.,
6. Coulson. J. M., & Richardson. J. F. (1996). *Chemical Engineering : Volumme I: Fluid flow. Heat transfer and mass transfer (5th ed)*. London : Butterworth Heinemann.
7. Hill, GC., (1997). *An Introducing to Chemical Engineering Kinetic and Reactor Design*. 1 ed, John Willey, New York.
8. Danckwerts. P.V. (1970). *Gas Liquid Reaction 5th ed*. New York : McGraw-Hill Book Company.Inc
9. William, J.A., (2002). *Key to Bioreactor Selection*. Chem Eng. Prog, Hal 3441

5TH SEMESTER

Course Title	:	**Unit Operation II: Fluid Mechanics**
Code	:	TKM1624501
Credit unit	:	3
Pre-requisite	:	Thermodynamics I
Competency	:	A
Objectives	:	After completion of this course, the student should be able to explain the mechanism and the concept of handling equipment for handling fluids and solids mixture.
Syllabus	:	1. Definition of fluid

2. The concept of fluid mechanics and fluid transport
3. The laws of conservation of mass and conservation of energy
4. Piping system
5. Gas transportation
6. Liquid fluid transport
7. Fluid flow rate measuring devices
8. Conveyor selection (Screw conveyor, Belt conveyor, Bucket elevator, Vibrating conveyor, Pneumatic conveyor)
9. Fluid transport with continuous system

References :

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

Course Title	:	**Unit Operation III: Heat Transfer Separation**
Code	:	TKM1624502
Credit unit	:	3
Pre-requisite	:	Thermodynamics II
Competency	:	A, D
Objectives	:	After completion of this course, the student should be able to explain the mechanism and the concept of separation processes based on heat transfer is applied to the operation of evaporation, condensation, crystallization, drying and humidification.
Syllabus	:	1. Separation process by diffusion 2. Phase equilibrium 3. Adsorption and desorption 4. Multistage operation 5. Design of tower 6. Design of separator 7. Evaporation 8. Crystallization 9. Drying 10. Humidification
References	:	1. Richardson, J. F., Harker, J. H., Backhurst, J. R. (2002). *Coulson and Richardson's Chemical Engineering. Particle Technology and Separation Processes*. 5th ed. Butterworth & Heinemann, New York. 2. Badger, W.L & Banchero, J.T, 1957, Introduction to chemical engineering, Mc Graw Hill International Editions New York. 3. McCabe, W. L., Smith, J. L., and Harriot, P., 2001, Unit Operation of Chemical Engineering, 6th ed., Mc GrawHill Book Co, New York. 4. Geankoplis, C.J., 1997, Transport Processes and Unit Operation, 3rd ed., Prentice Hall of India, New Delhi.

5. Treybal, R.E., 1981, Mass-Transfer Operations, 3rd. Ed., International Student Edition, Tokyo.
6. Perry, R.H., Green, D.W., and Maloney, J.O., 1997, Perry's Chemical Engineers Handbook, seven ed., Mc Graw Hill, New York.

Course Title	:	**Reactor**
Code	:	TKM1624503
Credit unit	:	3
Pre-requisite	:	Chemical Reaction Engineering
Competency	:	D
Objectives	:	After completion of this course, the students are expected to be able to design catalytic and non-catalytic homogeneous and heterogeneous reactors
Syllabus	:	1. Introduction (basic concept of reactor design) 2. Reactor design for single reaction 3. Design of reactor with recycle and autocatalysis reaction 4. Design of reactor for double reaction 5. Effect of temperature and energy in reactor design. 6. Liquid-gas heterogeneous reactor 7. Design of catalytic reactor 8. Design of Solid-gas heterogeneous reactor
References	:	1. Fogler, H. S. (2004). *Element of Chemical Reaction Engineering*. 3rd ed. Prentice-Hall, Englewood-Cliffs, New Jersey 2. Levenspiel, O. (2003). *Chemical Reaction Engineering*. John Wiley & Sons, New York. 3. Smith, J.M., 1981, "Chemical Engineering Kinetics", 3nd ed., Mc. Graw Hill, Kogakusha, Ltd., Tokyo. 4. Hill, Charles G., 1977, "An Introduction to Chemical Engineering Kinetics & Reactor design", John Wiley & Sons, New York.

Course Title	:	**Process Modeling and Computations**
Code	:	TKM1624504
Credit unit	:	3
Pre-requisite	:	Chemical Engineering Principles I & II, Chemical Engineering Mathematic I & II
Competency	:	E
Objectives	:	After completion of this course, the students are expected to be able to identify and develop a model of chemical engineering problems, and solve it using computation models
Syllabus	:	1. Basics of computer programming 2. Solving a linear equation system by numerical method 3. Application of numerical methods to find the suitable curve 4. Differential and integral with numerical methods 5. Find the roots of equations with numerical method 6. Solving single ordinary differential equation with numerical methods 7. Completion of single ordinary differential by numerical methods simultaneously 8. Application and Programming of Linear Equation Systems 9. Application and Programming for Curve fitting 10. Application and Programming of equation roots 11. Application and programming of a single ordinary differential equation 12. Application and programming of ordinary simultaneous differential Equations. 13. Introduction to Ready-to-Use Programs for Non-Reaction and Steady State Systems
References	:	1. Bambang Triatmodjo, "Metoda Numerik", Beta Offset, 1992. 2. Bequette, B.W, "Process Dynamics, Modeling, Analysis, and Simulation", Prentice Hall, 1998. 3. Constantinides, A and Mostoufi, N, "Numerical Methods for Chemical Engineers with MATLAB Applications", John Wiley & Sons, Inc, NY, 1999.

4. Deutsch, D. J., "Microcomputer Programs for Chemical Engineers", Vol. II, Mc Graw Hill Book Comp., 1987.
5. Koyode, C. A., "Fortran Programs for Chemical Process Design, Analysis, and Simulation", Gulf Publishing Comp., 1995.
6. Luyben, WL., "Plantwide dynamic simulators in Chemical Processing and Control", Marcel Dekker, 2002
7. Riggs, J. B., "An Introduction to Numerical Methods for Chemical Engineers", Texas Tech University Press, Lubbock, Texas, USA, 1988
8. Seider, WD., Seader, JD & Lewin DR., 1999, " Process Design Principles, Synthesis, Analysis and Evaluation", John Wiley & Sons, New York.
14. Sasongko, S.B., 2010, "Metode Numerik dengan Scilab, Andi Offset, Yogyakarta

Course Title	:	**Research Methodology and Statistics**
Code	:	TKM1624505
Credit unit	:	3
Pre-requisite	:	-
Competency	:	A, G
Objectives	:	After completion of this course, students are expected to posses' basic principles, procedures and analyses as well as to accomplish a research project comprehensively
Syllabus	:	1. Research Philosophy 2. Basic concept of research 3. Problem statement and research objectives 4. Thinking Framework 5. Hypothesis 6. Fundamentals of Statistics: Experimental Design, ANOVA, Linear regression, Post-Hoc analysis 7. Writing a research proposal 8. Solving the research problem by modeling 9. Measuring (basic concept, accuracy, and precision)

10. Research report, writing procedures and preparation of scientific papers.

References :

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

Course Title : **Research proposal**

Code : TKM1624506

Credit unit : 1

Pre-requisite : Taken together with Research Methodology and Statistics

Competency : C, F, G

Objectives : After completion of this course, the student should be able to prepare a research proposal, presented the proposal to the examiner and ready to conduct the research procedure based on the approved research concept during Research Proposal Seminar.

Course Title	:	**Product and Chemical Process Design**
Code	:	TKM1624507
Credit unit	:	3
Pre-requisite	:	Chemical reaction engineering
Competency	:	D
Objectives	:	After attending this course, students are expected to develop an innovative chemical product design as the integration between the ability of chemical engineering knowledge with managerial skills.
Syllabus	:	1. The basic concept of chemical product design. 2. Energy, Environtment, Sustainability, Safety, and Engineering Ethics. 3. Molecular and mixture-blended products. 4. Product design process: market identification, product spesification, concept design. 5. Cases study: refrigerant, surfactant, active ingridient, polymers, bioethanol, biodiesel, chitosan, carageenan, biodegrdable plastics. 6. The basic principle and design stages of a chemical process. 7. Structure and synthesis of process flow diagrams. 8. Heuristic / rule of thumb synthesis process. 9. Selection of separator system. 10. The selection of the reactor system. 11. Simulator / software for synthesis and simulation process. 12. Design optimization. 13. Six-sigma methodology. 14. Fundamentals of heater network synthesis. 15. Reactor-separator network design. 16. The concept of the process integration.
References	:	1. Seider, W.D., J.D. Seider, Lewin, D.R., 2004, Product & Process Design Principles: Synthesis, Analysis and Evaluation, John Wiley & Sons, Inc., New York

2. Turton, R., et al, 2003, Analysis, Synthesis and Design of Chemical Process, Prentice Hall PTR, New Jersey

Course Title	:	**Unit Operation Labworks**
Code	:	TKM1624508
Credit unit	:	2
Pre-requisite	:	-
Competency	:	A, C, G, H
Objectives	:	After completion of this course, the student should be able to develop a procedure of the experiment, select and assemble experimental apparatus, measure, analyze and discussion of the data in the operations of chemical engineering as well as reporting
Syllabus	:	1. Batch Distillation, 2. Filtration (Plate and Frame Filter Press; Cross-flow filtration), 3. Heat transfer (Shell and Tube HE), 4. Size Reduction (Hammer Mill), 5. Drying (Tray dryer), 6. Fluid Flow, 7. Fluidization (solid-gas), 8. Continuous crystallization, 9. Wetted Wall Column
References	:	1. Brown, G.G. 1979. Unit Operation. Modern Asia Edition. Hal. 20-22; 26. Mc Graw Hill Book. Co.Ltd.Tokyo. Japan. 2. Coulson. J.M, et al. 2002. Chemical Engineering Particle Technology and Separation Process. Pg. 105-106 Butterworth and Heinemann Oxford. England. 3. Foust, A. 1960. Principles of Unit Operation. 2nd ed. New York: John Wiley and Sons Inc.

4. Kern, D. G. 1980. Process Heat Transfer. McGraw Hill Book Co. Ltd. Kogakusha, Tokyo.
5. Mc Cabe, W. S. 2001. Unit Operations of Chemical Engineering. 6th ed. New York: Mc GrawHill Book. Co.

6th SEMESTER

Course Title	:	**Unit Operation IV: Multistage Separations**
Code	:	TKM1624601
Credit unit	:	3
Pre-requisite	:	-
Competency	:	A, D
Objectives	:	After completion of this course, the student should be able to explain the mechanism and the concept of separation based on mass transfer processes that apply to the operation of adsorption, absorption, distillation, and extraction.
Syllabus	:	1. Theory of diffusion, Raoult law, multiphases diagram, equilibrium curve, azeotropic point 2. Rectification of distillation system 3. Differential, simple, and batch distillation 4. Single stage operation and multistages distillation 5. Mass and energy balance in distillation system 6. Open steam distillation, double feed system and side stream system 7. Types of extraction and extraction multistages 8. Equailibrium phase and mass balance in extraction system 9. Graphical analysis of extraction column design
References	:	1. McCabe, W. L., Smith, J. L., and Harriot, P., 2001, Unit Operation of Chemical Engineering, 6th ed., Mc GrawHill Book Co, New York. 2. Foust, A.S., 1979, Principles of Unit Operations, 2nd ed., John Wiley & Sons, New York.

3. Geankoplis, C.J., 1997, Transport Processes and Unit Operation, 3rd ed., Prentice Hall of India, New Delhi.
4. Treybal, R.E., 1981, Mass-Transfer Operations, 3rd. Ed., International Student Edition, Tokyo.
5. Perry, R.H., Green, D.W., and Maloney, J.O., 1997, Perry's Chemical Engineers Handbook, 7th ed., Mc Graw Hill, New York.

Course Title	:	**Research**
Code	:	TKM1624602
Credit unit	:	3
Pre-requisite	:	Research Proposal
Competency	:	B, C, G
Objectives	:	After completion of this course, the student should be able to carry out the steps of the scientific research in accordance with the proposals that have been presented at a seminar.

Course Title	:	**Process Control**
Code	:	PTKM6602
Credit unit	:	3
Pre-requisite	:	-
Competency	:	A, E
Objectives	:	After completion of this course, the student should be able to explain the process control systems, stability analysis and conditioning controllers, as well as the design of control systems in chemical engineering.
Syllabus	:	1. Introduction to Process Control: the importance of process control in industry 2. The theory of choosing the proper process control for various system (feed-back control, feed forward control, cascade)

3. Analysis and response of chemical process first and second order
4. Laplace Transforms: Fundamentals of transformation, the method of partial fractions
5. Modeling in process control: Static and Dynamics, Linear and non-linear, Linearization Model
6. Dynamic Respond: Respond model of order 1 and order 2, the determination of the time constant and the gain constant, over damping, system delay, overshoot, frequency response and Bode analysis
7. Signals and instrumentation
8. System design of feed-back, feed forward, and cascade process control
9. PID control design: system tuning, performance of Proportional, Integral and Dynamic Control
10. Control instruments: level control, temperature control and indicators
11. Process Control Design by Precitive control model, and multiunit control for chemical engineering problem
12. SISO and MIMO systems, RGA calculation, and application in chemical engineering problem

References :

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

Course Title	:	**Construction Materials and Process Equipment Design**
Code	:	TKM1624604
Credit unit	:	3
Pre-requisite	:	Taken together with Process Control
Competency	:	D, E
Objectives	:	After completion of this course, the student should be able to specify the basic design information, pressure vessels design, liquid storage tanks design, heat exchangers design, and assessing the feasibility of the equipment design.
Syllabus	:	1. Chemical engineer role in process equipment design 2. Construction material characteristics 3. Corrosion, material selection, and fabrication process 4. Liquid storage tanks (definition, design, and various operation condition) 5. Selecting Colom type, and design of tray tower 6. Calculation of effective operation condition, and plat ideal 7. Design of packed tower 8. Selecting heat exchanger and fluid route 9. Design of heat exchanger
References	:	1. Roud, D. F., and C. C., Watson, 1968, "*Strategy of Prosess Engineering*". 2. Petter, M. S., and K. D., Timmerhaus, 1980, "Plant Design and Economic for Chemical Engineers". 3. Backhurt, J. R., and J. H., Horker, 1973, "Process Plant Design", Heineman Chemical Engineering Series, London. 4. Foust, A. S. and Associate, 1980, "Principles of Unit Operation", Topan Company Ltd, Japan.

5. Smith, B. D., "Design of Equilibrium Stage Processes", Mc Graw Hill Book Company, New York.
6. Walas, S. M., "Chemical Process Equipment Selection and Design".
7. Winkle, M. V., 1967, "Distillation", Mc Graw Hill Book Company, New York.
8. Ozisik, 1984, "Heat Transfer, A Basic Approach".
9. Sinnot, R. K. (2005). *Chemical Engineering Design*. *Coulson & Richardson's Chemical Engineering Series*. Vol. 6. 4th ed. Elsevier, Amsterdam.
10. ASME Boiler and Pressure Vessel Code (2204), American Society of Mechanical Engineers, New York.
11. API 620 (2002) Design and construction of large, welded, low pressure storage tanks, 10th edn, American Petroleum Institute, Washington DC.
12. Bronwnell, L.E. & Young, E.H. (1959). Process Equipment Design: Vessel design, 1st ed., John Wiley & Son, Inc., New York
10. Kern, D.Q. (1965), Process Heat Transfer, 1st ed., McGraw-Hill Book Co., Inc., Tokyo

Course Title	:	**Chemical Engineering Economics**
Code	:	TKM1624605
Credit unit	:	2
Pre-requisite	:	Taken together with Chemical Plant Design
Competency	:	D
Objectives	:	After completion of this course, the student should be able to explain and calculate the economic aspects of a system or a process of chemical plant equipment.

Syllabus	:	1. Introduction to chemical engineering economics 2. Cost and capital efficiency 3. Total Capital Investment and Working Capital 4. Time value of money (Present, future, and annual worth) 5. Cash flow, cumulative cash flow 6. Analysis of time value of money 7. Concept of fixed capital, working capital 8. Physical plant cost and manufacturing cost 9. General expense 10. Optimasi forcasting interest 11. Depreciation, taxes organization 12. Profitability analysis (ROI, DCF, ROR, POT)
References	:	1. Peters, M. S. (1991). *Plant Design and Economics for Chemical Engineers*. McGraw-Hill Book Co., Singapore. 2. Coupers, J. R. (2003). *Process Engineering Economics*. Marcel Dekker, Inc., New York. 3. Aries RS, Newton RD, 1955, "Chemical Eng. Cost Estimation," Mc Graw Hill Book Company, New York. 4. Hani Handoko T, 1985," Man personalia dan SDM," BPFE, Yogyakarta. 5. Mardiasmo,1997, " Perpajakan" Penerbit ANDI Yokyakarta.

Course Title	:	**Chemical Plant Design**
Code	:	TKM1624606
Credit unit	:	3
Pre-requisite	:	Chemical Industrial Process, Unit Operation I, II, and III, taken together with Unit Operation IV, Chemical Engineering Economics, and Process Control
Competency	:	B, D, E

Objectives :

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

Syllabus :

1. The basic concept of chemical plant design
2. Design strategies: design characteristics, chemical manufactur process anatomy, codes and standard, unit system, and optimization
3. The determinatio of plant capacity, plant site, and process selection
4. Raw material and product specification, properties calculation of mixture components
5. Process description and control philosophy
6. Mass and energy balance principles
7. Unit process and unit operation integration
8. The Selection and integration of utility and storage unit
9. Introduction of process flow diagram (PFD) and piping & instrumentation diagram (P&ID)
10. Utility, cost estimation, and economic analysis
11. The use of Chemical Engineering software as a tool of plant design and Flowsheeting
12. Equipment lay-out dan plant lay-out determination
13. HAZOP (Hazard and Operability)

References :

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

5. Perry, R. H. (ed). (1997). *Perry's Chemical Engineers' Handbook*. 7th ed. McGraw-Hill, New York.

Course Title	:	**Entrepreneurship**
Code	:	UUW1624008
Credit unit	:	3
Pre-requisite	:	-
Competency	:	H
Objectives	:	After completion of this course, the student should be able to explain the concepts of entrepreneurship and business in the field of chemical engineering in small and large scale industries.
Syllabus	:	1. Definition and concept of entrepreneurship 2. Entrepreneurial profile and identification of entrepreneurs 3. Entrepreneurship factors and definition of intra-preneurship 4. Professionalism in chemical engineering 5. The concept of self-employment and entrepreneurship 6. Creative process (Herbert G. Hicks and Robert D. Hisrich) 7. The basics of business plan and strategy 8. Business organizations 9. Risk management and Techno-preneurship
References	:	1. Smith, J.M., Van Ness, H.C., and Abbott, A., (2001), "Introduction to Chemical Engineering Thermo-dynamics", 6th ed, McGraw-Hill, Boston 2. Walas, S. M. (19..), "Phase Equilibria In Chemical Engineering", 1st edition, Butterworth-Heinemann. 3. Prausnitz, J. M., Lichtenthaler, R. N., de Azevedo, E. G., (1986), "Molecular Thermodynamics of Fluid-Phase Equilibria", 2nd edition, Prentice-Hall Inc., Englewood Cliffs, N. J.

7th SEMESTER

Course Title	:	**Waste Treatment Technology**
Code	:	TKM1624701
Credit unit	:	2
Pre-requisite	:	-
Competency	:	B
Objectives	:	After completion of this course, the student should be able to describe and explain the concepts of liquid, solid, and gas waste treatment.
Syllabus	:	1. Gaseous pollutants, sources and impacts on environment 2. The effects of climate and weather on air pollution 3. Air pollution pervention attempts 4. Atmospheric pollution: sources and particulate emission control 5. Volatile organic compounds (VOC) pollutants: characteristics and management 6. Sulfur pollution: Sources, waste characteristics, and emission control 7. Nitrogeneous pollution: Sources, waste characteristics, and emission control 8. Pollutants dispersion: meteorogical data, windrose, and dispersion modelling 9. Physico-chemical characteristics of wastewater 10. Wastewater sources: domestic and industry 11. Physical treatment process and design for wastewater 12. Chemical treatment process and design for wastewater 13. Biological treatment process and design for wastewater 14. Hybrid treatment process and design for wastewater from various industries

References : 1. Sonune, A., and Ghate, R., Developments in wastewater treatment methods, Desalination 167 (2004) 55-63
2. Sew, et al. Review on Wastewater Treatment Technologies, International Journal of Applied Environmental Sciences, ISSN 0973-6077 Volume 11, Number 1 (2016), pp. 111-126
3. Crini and Lichtfouse, Advantages and disadvantages of techniques used for wastewater treatment, Environmental Chemistry Letters (2019) 17:145–155
4. Ahmed, S. F., Mofijur, M., Nuzhat, S., Chowdhury, A. T., Rafa, N., Uddin, M. A., & Show, P. L. (2021). Recent developments in physical, biological, chemical, and hybrid treatment techniques for removing emerging contaminants from wastewater. J. Hazard. Mat., 416, 125912

Course Title : **Utility**
Code : TKM1624702
Credit unit : 2
Pre-requisite : -
Competency : E
Objectives : After completion of this course, the student should be able to explain the importance of utility, how to provide utility, and the utility system in industry. Including, heating medium supply system, cooling media, and electricity to support the plant production process.
Syllabus : 1. Introduction: importance, definition, basic concept of utility
2. Water supply in industry (resource, analysis, unit operation, intake system, various procedure for water treatment)

3. Cooling supply (type of cooling system, cooling water requirement, cooling tower, cooling water balance, air conditioner, refrigerator, and problem solving)
4. Steam generation
5. Fuel and Electricity supply;
6. Refrigeration system in chemical industry
7. Compressed air and inert gas supply
8. Vacuum system
9. Case studies: oil and gas, cement, fertilizers, foods, chemical industries

References :

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

Course Title : Project and Industrial Management
Code : TKM1624703
Credit unit : 2
Pre-requisite : Product and Chemical Process Design
Competency : F, H

Objectives	:	After completion of this course, the student should be able to explain the principles of project management and industry as well as how to obtain economic efficiency in the production process
Syllabus	:	1. Definition of project and project management 2. Basic principle of leadership, and leadership character 3. Project organization structure, teamwork, intergroup problem solving 4. Power and motivation to lead a process system 5. The procedure to take a decision 6. Network planning 7. Management of quality 8. Project funding (Cash flow and interest) 9. Investation feasibility parameters 10. Inventory management 11. Techniques and methods of time planning and preparing work schedules
References	:	1. Tonchia, S. (2008). *Industrial Project Management*. Springer-Verlag, Berlin. 2. Imam Soeharto. (1999). *Manajemen Proyek*. Jilid 1, Penerbit Airlangga. 3. Newman, D. G. (2006). *Engineering Economic Analysis*. 9nd edn. Engineering Press Inc., California 4. Busairi, A dan Buchori, L (2022). Buku Ajar Manajemen Industri, Undip Press, Semarang

Course Title	:	**Chemical Process Safety**
Code	:	TKM1624704
Credit unit	:	2
Pre-requisite	:	Reactor, Unit Operation I & II, Process Control
Competency	:	B, H
Objectives	:	After completion of this course, the student should be able to explain the philosophy of safety process

and related regulations, safety process support aspects particularly associated with the use of high pressure equipment and high temperature, the concept of danger and risk, and hazards control system due to exposure to B3, equipment operation and emergency control

Syllabus :

1. Process safety philosophy, basic concept, factor standard
2. Management of health and safety environment
3. Fire and explosion in industry
4. Material and safety data sheet (MSDS) for hazard identification
5. Hazard and risk analysis (liquid chemical, gas)
6. Emergency response planning
7. Management and regulation for chemical controlling
8. Safety procedure for indoor
9. Safety procedure for offshore exploration and operation production
10. Inspection standard, observation and safety supervision
11. Hazardous waste and toxic materials and hazardous materials management
12. HAZID and HAZOP in chemical storage unit
13. HAZID and HAZOP in chemical process and purification unit
14. Layer of protection analysis on preparation system, chemical reaction, and chemical purifcation industry
15. Incident and accident reports in chemical industry

References :

1. Smith, J.M., Van Ness, H.C., and Abbott, A., (2001), "Introduction to Chemical Engineering Thermo-dynamics", 6th edition, McGraw-Hill, Boston

2. Walas, S. M. (19..), "Phase Equilibria In Chemical Engineering", 1st edition, Butterworth-Heinemann.
3. Prausnitz, J. M., Lichtenthaler, R. N., de Azevedo, E. G., (1986), "Molecular Thermodynamics of Fluid-Phase EquilibriA, 2nd edition, Prentice-Hall Inc., Englewood Cliffs N. J.

ACADEMIC STAFF PROFILE

In 2024, DCE has 32 academic staffs, consists of 25 Professors, 3 Associate Professors, 3 Assistant Professors, and 1 lecturer. The department also invites visiting lecturers, especially from industries to give their experience and practical aspects to the students. About 91% of academic staffs are doctoral graduates, while the rest are master graduates.

Prof. Dr. Ir. Bambang Pramudono, MS
Professor
Separation technology, Emulsion

Prof. Dr. Ir. Abdullah, MS
Professor
Fermentation

Prof. Dr. Ir. Purwanto, DEA
Professor
Chem. Reaction, Clean Tech.

Prof. Dr. Ir. Bakti Jos, DEA
Professor
Separation Technology

Prof.Dr. Ir. Setia Budi Sasongko, DEA
Professor
Computation Process

Prof. Dr. T. Ir. Indro Sumantri, MEng
Professor
Waste Treatment

Prof. Dr. Ir. Hargono, MT
Professor
Engineering Process

Prof.Dr. Ir. Ratnawati, MT
Professor
Thermodynamics, Polymer

Prof. Dr. Ir. Budiyono, M.Si
Professor
Waste Treatment Technology

Prof. Ir. Didi Dwi Anggoro, MEng, PhD
Professor
Chemical Reaction, Catalyst

Prof. Dr. T. Aji Prasetyaningrum, ST, MSi
Professor
Separation Technology

Prof.Dr. Luqman Buchori, ST, MT
Professor
Computation Process, Heat Transfer

Prof. Dr. M. Djaeni, ST, MEng
Professor
Energy, Drying

Prof. Dr. Istadi, ST, MT
Professor
Catalyst, Plasma Technology

Prof. Dr. I Nyoman Widiasa, ST, MT
Professor
Membrane Tech., Water Treatment

Prof. Dr. Widayat, ST, MT
Professor
Energy, Biofuel

Prof. Dr. Tutuk Djoko Kusworo, ST, M.Eng, PhD
Professor
Membran, pemisahan gas

Prof. Dr. rer. nat. Heru Susanto, ST, MM, MT
Professor
Membrane, Polymer

Prof. Andri Cahyo Kumoro, ST, MT, PhD
Professor
Agricultural Product Processing | Industrial Waste

Prof. Nita Aryanti, ST, MT, PhD
Professor
Membrane, Emulsion Technology

Prof. Dr. Hadiyanto, ST, MSc
Professor
Bioprocess, Energy

Prof. Dr.-Ing Suherman, ST, MT
Professor
Drying Technology

Prof.Dr. nat. tech. Siswo Sumardiono, ST, MT
Professor
Drying, Food Process Technology

Prof. Dyah Hesti Wardhani, ST, MT, PhD
Professor
Bioproces, Functional Food

Prof. Dr.-Ing. Silviana, ST, MT, IPM, ASEAN ENG.
Professor
Advance Material Engineering

Prof.Dr. Aprilina Purbasari, ST, MT
Professor
Advance Material

Dr. Ir. Nur Rokhati, MT
Asociate Professor
Process Engineering

Ir. Kristinah Haryani, MT
Asociate Professor
Thermodynamics

Dessy Ariyanti, ST., MT., PhD
Asociate Professor
Fermentation

Ir. Hantoro Satriadi, MT
Asociate Professor
Process Safety

Dr. Noer Abyor Handayani, ST., MT
Assistant Professor
Functional Food, Microencapsulation

Dr.Asep Muhamad Samsudin, ST, MT
Assistant Professor
Membrane, Corrosion

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Lecturer
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FACILITIES

Laboratories

The laboratories in the chemical engineering undergraduate study program are divided into two categories: (1). Instructional laboratories and (2) research laboratories. Instructional laboratory serves as part of the supporting educational process. Currently, the study program has 6 instructional laboratories: Chemical Engineering Fundamental Laboratory I and II, Bioprocess Laboratory, Process Computation Laboratory, Chemical Process Laboratory and Unit Operation Laboratory. These laboratories follow safety standard requirements and are supported by laborants.

Meanwhile, the research laboratory is mainly used for research activities for the staffs and the students. The department has 10 research laboratories: Bioprocess Engineering, Food Process Engineering, Waste Water Treatment, Analysis and Instrument, Energy - Process Engineering, Membran Technology and Scince, Advanced Material, Infarma, Surfactant and Emulsion, and Thermal Process Engineering laboratory.

Libraries

All students of this department have an acces to the University Central Library, the Engineering Faculty Library, and the Department Library. The Department Library has textbooks, manuscripts, and journals to support all students and faculty members' activities. The libraries open five days a week from 8 a.m. to 4 p.m.

Moreover, the University has subscribed several international e-journals to facilitate students in working on their research and assignments. The students could access this facility either for reading or downloading the articles by login via SSO freely.

LAN/Internet

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

Engineering-Workshop

The Department provides workshop to facilitate the fabrication of the laboratory equipments for laboratories, researches, and community service.

INDUSTRIAL EXPERIENCES

Each student of chemical engineering undergraduate study program has at least two opportunities to gain industrial experiences, i.e. an industrial fieldtrip and an industrial intership. Both experiences are conducted in the seventh semester. The industries that elligible for these industrial experiences are the one that involved reaction and separation process as mostly found in oil, petrochemical and food industries such as PT PETROKIMIA, PERTAMINA, PT Semen Gresik, Unilever, LNG Badak, PT Pupuk Sriwijaya, PT Semen cibinong, PT Lotte Chemical, and many more .

The industrial fieldtrip which introduce students to the *insitu* industries, takes about one week. This fieldtrip is conducted together for one-batch year student.

Meanwhile, the industrial intership which is part of the final assignment takes place for 4-8 weeks. The students allow to propose the industrial internship after obtaining 80 credits. The placement of this intership is arranged by an industrial intership coordinator, appointed by the Department. At the end of program, the student must deliver a report consist of general report and special task report.

RULES OF ASSESSMENT and ACADEMIC STANDARD

In the first and second semester, the fresh students of the undergraduates are allowed to take courses maximum of 20 credits. The maximum course load for the next semester is determined by the GPA achieved in the previous semester:

- grade point ≥ 3.00 : maximum course load = 24 credits
- 2.50 ≤ grade poin ≤ 2.99 : maximum course load = 22 credits
- 2.00 ≤ grade poin ≤ 2.49 : maximum course load = 20 credits
- grade poin < 2.00 : maximum course load = 18 credits

The students evaluation of each course consist of three components of evaluation: *the midterm exam, the final exam, and one or a combination of regular evaluations* such as homework, weekly tasks, project tasks, making scientific papers, presentations, assignments, discussion groups, participatory activity, and quizzes which can give better impact to the teaching and learning process.

The final score is a weighted sum of components of evaluation, which later changes into a grade system following this classification:

- ✓ A (>=85)
- ✓ AB (80 - 84.99)
- ✓ B (75 - 79.99)
- ✓ BC (70 - 74.99)
- ✓ C (60 - 69.99)
- ✓ D (40 - 59.99)
- ✓ E (<40)

This sytem is followed by a conversion from grade to scale is as follows: A (4.00), AB (3.50), B (3.00), BC (2.50), C (2.00), D (1.00), and E (0.00). The minimum grade or scale required to pass is C (2.00). There is no remedial for students who fail. They must retake the subject.

The study progress evaluation is conducted in 3 stages:

i. The beginning of the third semester: passed minimum 25 credits with GPA ≥ 2.50
ii. The beginning of the fifth semester: passed minimum 50 credits with GPA ≥ 2.50
iii. The beginning of the thirteenth semester: passed minimum 108 credits with GPA ≥ 2.50

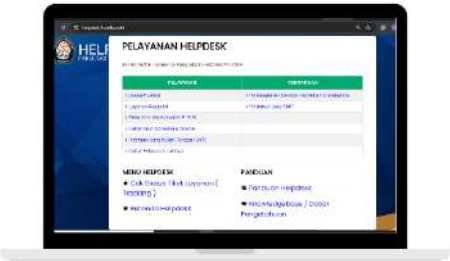
Graduation honor is awarded based on their final GPA acheievement. The honorary level are:

Predicate	GPA
Cum laude	**3.51 – 4.00**
Very satisfactory	**3.01 – 3.50**
Satisfactory	**2.76-3.00**
Good	**2.50 – 2.75**

Evaluation, quality improvement and standards of teaching and learning

- The curriculum and outcome standards are reviewed every 5 years
- Students give feed-backs on the teaching methods of the course twice in each academic year for every member of academic staff
- Active involvement of staff in research and development in chemical engineering fields
- Staff appraisal system and institutional staff development courses
- Up-dating professional skill and ICT development
- Academic advisor to advice, give guidance and monitor students' academic development

STUDENT APPEALS



The Faculty has established a dedicated helpdesk to address any issues or concerns related to the services provided by the department. This includes matters related to teaching and learning, the assessment system, administration, and other departmental functions. Students are encouraged to utilize the helpdesk for any complaints or inquiries they may have. The helpdesk can be accessed through the following link: https://helpdesk.ft.undip.ac.id/. In addition to the helpdesk, each student is assigned a lecturer who acts as their academic advisor. This advisor is available to offer guidance, support, and personalized assistance throughout the student's academic journey.

COLLABORATIONS

The study program has established collaborations with various national companies, including **PT Pupuk Kalimantan Timur Tbk., PT Badak LNG, and PERTAMINA, PTPN** for research collaboration.

Additionally, Department has established collaborations with several prestigious international universities to enhance academic opportunities and global exposure for students. Notably, the double degree program with **Hull University in the United Kingdom**, **Curtin University in Australia**, and **Newcastle University in Australia**. These programs allow students to earn degrees from both institutions.

Furthermore, the faculty actively promotes international experiences, including student exchanges and collaborative research projects. These initiatives are conducted in partnership with institutions such as **Universiti Teknologi MARA (UiTM) in Malaysia**, **Universiti Teknologi Malaysia (UTM)**, and the **University of Brunei Darussalam**.

CAREER PROSPECTS

The graduates of the program can work as project engineer, process engineer, product developer, academician, leader, engineering consultant, researchers, sales engineer or entrepreneurs in related fields of Chemical Engineering, Food technology, Bioprocess engineering, Agrochemicals, Pharmaceuticals, Environmental Engineering and Petrochemical. The potential graduate can also proceed their study to continue their study to Master and Doctoral programs.

Disclaimer

This department booklet must be read in conjunction with Diponegoro University Undergraduate prospectus and Faculty of Engineering handbook, The information given in this booklet is correct at the time of going to press and UNDIP will make every effort to provide the programmes described herein.

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