STUDENT GUIDE BOOK
MSTER DEGREE PROGRAM OF CHEMISTRY
Institut Teknologi Sepuluh Nopember

DEPERTMENT OF CHEMISTRY
2020

ACADEMIC STUDENT GUIDEBOOK

Curriculum 2018-2023

Master's degree Program
(Version 2020)

Chemistry Department
Institut Teknologi Sepuluh Nopember
2020

INTRODUCTION

This academic guidebook was prepared as a reference for all students regarding the curriculum of the chemistry master study program as well as providing instructions for students in compiling a thesis in order to produce a good and uniform thesis quality. This book can also help supervisors to carry out their task of guiding students more easily. The preparation of this academic guidebook has not been optimal, especially with the limited time, therefore constructive suggestions are expected to be improved.

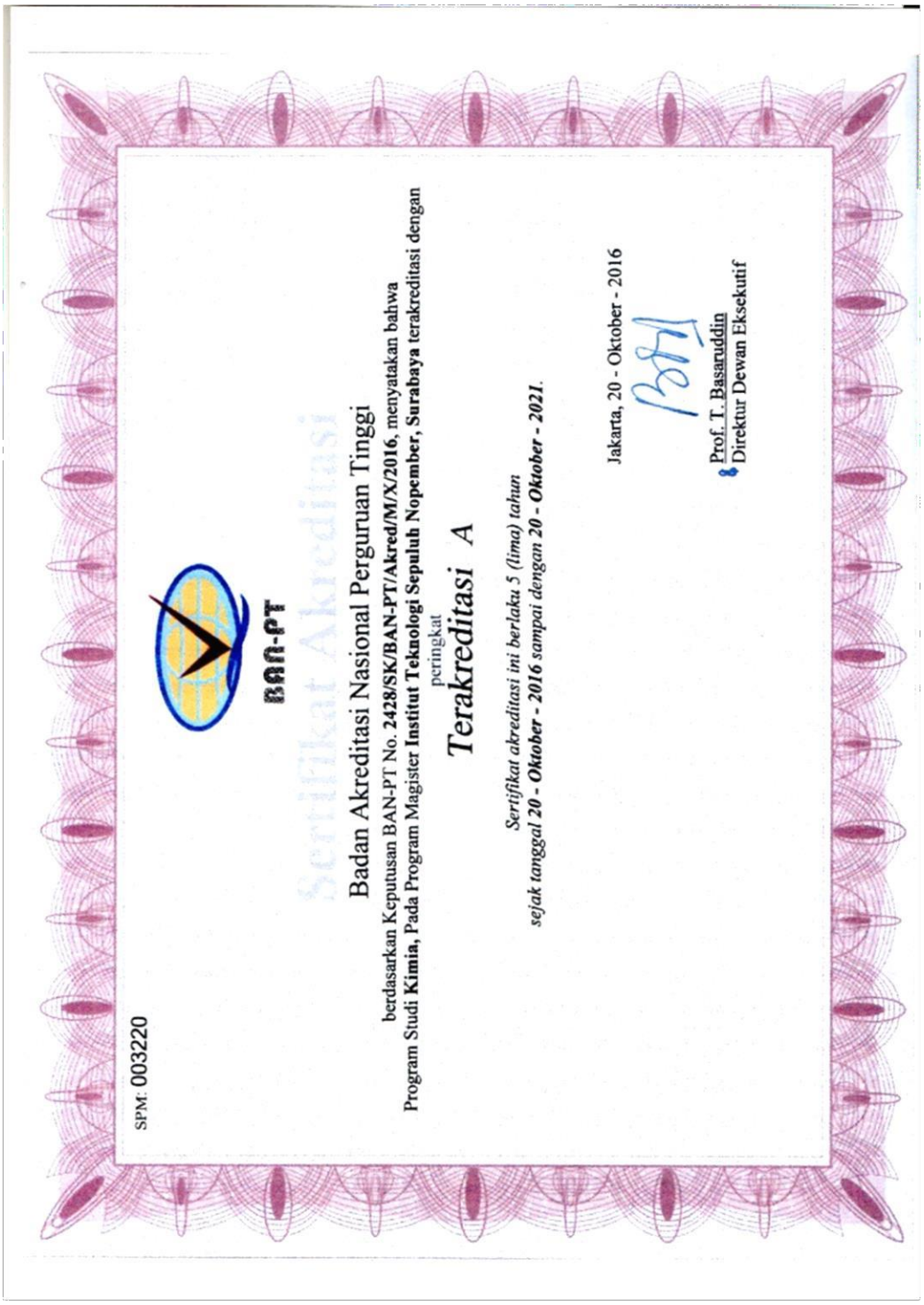
Surabaya, 9th January 2020Head of
Chemistry Master's Degree
Program

Prof. Dr. Didik Prasetyoko, M. Sc .

Program Education Objectives

- To produce graduates who able to use their knowledge, skills, and competence in the area of chemistry for their professional career (PEO1).
- To produce graduates who able to develop themselves through further studies (doctoral degree) both domestic and abroad by training or research (PEO2)
- To produce graduates who can carry out their profession responsibly, ethically, have leadership characteristics and are able to develop a network system (PEO3)

I. NATIONAL ACCREDITATION



SPM. 003220

BAN-PT

Badan Akreditasi Nasional Perguruan Tinggi

berdasarkan Keputusan BAN-PT No. **2428/SK/BAN-PT/Akred/M/X/2016**, menyatakan bahwa Program Studi **Kimia**, Pada Program Magister **Institut Teknologi Sepuluh Nopember, Surabaya** terakreditasi dengan peringkat

Terakreditasi A

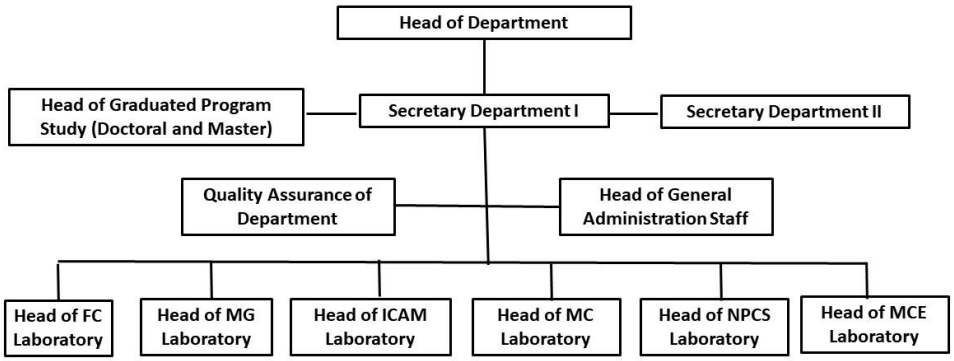
Sertifikat akreditasi ini berlaku 5 (lima) tahun
*sejak tanggal **20 - Oktober - 2016** sampai dengan **20 - Oktober - 2021**.*

Jakarta, 20 - Oktober - 2016

Prof. T. Basaruddin
Direktur Dewan Eksekutif

II. Organization structure and the Lecturer Staff of Master Degree

Program of Chemistry ITS



FC = Fundamental Chemistry
MG = Molecular Geochemistry
ICAM = Instrumental and Chemical Analysis Method
NPCS = Natural Product and Chemical Synthesis
MC = Microbiology Chemistry
MCE = Material Chemistry and Energy

Secretary Department I : Academic, students and research affairs
Secretary Department II: Financial, Human resources department and facilities

Official Management in Chemistry Department

Head of Department	:	Prof. Dr. rer.nat Fredy Kurniawan, M. Si
Secretary Department I	:	Dr. Yuly Kusumawati, MSi.
Secretary Department II	:	Yatim Lailun Ni'mah, M. Si, Ph. D
Head of Graduated program	:	Prof. Dr. Didik Prasetyoko, M. Sc
Doctoral Degree Quality Assurance Team	:	Prof. Dr. Taslim Ersam Prof. Dr. R. Y. Perry Burhan, M. S Prof. Drs. Syafsir Akhlus, M. Prof. Drs. Surya Rosa Putra, M.S Prof. Dr.rer.nat. Irmina Kris M, M. Si Prof. Drs. Mardi Santoso, Ph. D Prof, Dr. Didik Prasetyoko, M. Sc

Master Degree Quality Assurance Team	:	Suprapto, Ph. D (Kimia Analitik) Prof. Dr.rer.nat. Irmina K. Murwani, MSi. (Kimia Anorganik) Dr. Hendro Juwono (Kimia Fisik) Prof. Dr. Taslim Ersam, MS (Kimia Organik)
Bachelor Degree Quality Assurance Team		Suprapto, Ph. D (Kimia Analitik) Dra. Ratna Ediati, Ph. D (Kimia Anorganik) Drs. Eko Santoso, M. S (Kimia Fisik) Drs. Agus Wahyudi, M. S. (Kimia Organik) Herdayanto S. Putro, M. Si (Biokimia)
Head of Laboratory		
FC Lab	:	Dr. Hendro Juwono, M. Si.,
MG Lab	:	Dr. Yulfi Zetra, M. S.
ICAM Lab	:	Dra. Ita Ulfin, M. Si.
MCE Lab	:	Prof. Dr. Djoko Hartanto, M. S.
NPCS Lab	:	Prof. Dr. Mardi Santoso
MC Lab	:	Adi Setyo Purnomo, Ph. D

Lecturer of Chemistry Master Degree Program ITS

No	Name	Edcuation
1	Prof. Dr. TaslimErsam, MS.	S1 Universitas Andalas
		S2 Universitas Gadjah Mada
		S3 Institut Teknologi Bandung
2	Dr. Ir. Endah Mutiara Marhaeni Putri, M. Si	S1 Institut Teknologi Sepuluh Nopember
		S2 Universitas Airlangga
		S3 Universitas Airlangga
3	Dra. Ratna Ediati, M. S., Ph.D	S1 Institut Teknologi Bandung
		S2 Institut Teknologi Bandung
		S3 University of Manchester Institute of Science and

No	Name	Education
		Technology, Inggris
4	Prof. Dr. R. Y. Perry Burhan, M. S	S1 Universitas Andalas
		S2 Institut Teknologi Bandung
		DEA University of Louis Pasteur,Perancis
		S3 University of Louis Pasteur,Perancis
5	Prof. Drs. Syafsir Akhlus, M. S	S1 Universitas Andalas
		S2 Institut Teknologi Bandung
		S3 ENSIC-NPL, Perancis
6	Prof. Drs. SuryaRosa Putra, M.S	S1 Institut Teknologi Bandung
		S2 Institut Teknologi Bandung
		S3 University of Louis Pasteur,Perancis
7	Drs. Lukman Atmaja, M. S.,Ph. D.	S1 Institut Teknologi Bandung
		S2 Institut Teknologi Bandung
		S3 The University Birmingham, Inggris
8	Prof. Dr. rer. nat. Irmina Kris Murwani, M. Si.	S1 Institut Teknologi SepuluhNopember
		S2 Universitas Gadjah Mada
		S3 Humboldt University, Jerman
9	Prof. Drs. MardiSantoso, Ph. D	S1 Institut Teknologi SepuluhNopember
		S3 The University of New SouthWales, Australia
10	Dr. Fahimah Martak, M. Si	S1 Institut Teknologi SepuluhNopember

No	Name	Education
		S2 Institut Teknologi Bandung
		S3 Institut Teknologi Bandung
11	Hamzah Fansuri, M. Si.,Ph. D	S1 Institut Teknologi SepuluhNopember
		S2 Institut Teknologi Bandung
		S3 Curtin University of Tech.,Australia
12	Nurul Widiastuti, M.Si., Ph. D	S1 Institut Teknologi SepuluhNopember
		S2 Institut Teknologi Bandung
		S3 Curtin University of Tech.,Australia
13	Prof, Dr. Didik Prasetyoko, M.Sc	S1 Institut Teknologi SepuluhNopember
		S2 Universiti Teknologi Malaysia
		S3 Universiti Teknologi Malaysia
14	Dr. rer. nat. Fredy Kurniawan, M.Si	S1 Institut Teknologi SepuluhNopember
		S2 Institut Teknologi Bandung
		S3 University of Regensburg,Jerman
15	Suprapto, M.Si., Ph. D	S1 Institut Teknologi SepuluhNopember
		S2 Institut Teknologi Bandung
		S3 University of Manchester,Inggris
16	Dr. Afifah Rosyidah, M.Si	S1 Institut Teknologi SepuluhNopember
		S2 Institut Teknologi Bandung
		S3 Institut Teknologi Bandung

No	Name	Education
17	Sri Fatmawati, M. Sc., Ph. D.	S1 Institut Teknologi SepuluhNopember
		S2 Kyushu University, Jepang
		S3 Kyushu University, Jepang
18	Adi Setyo Purnomo, M.Sc., Ph. D	S1 Institut Teknologi SepuluhNopember
		S2 Kyushu University, Jepang
		S3 Kyushu University, Jepang
19	Dr. Hendro Juwono, M. Si	S1 Universitas Gadjah Mada
		S2 Institut Tenologi Bandung
		S3 Universitas Gadjah Mada
20	Dr. Yuly Kusumawati, M.Si.	S1 Institut Teknologi Bandung
		S2 Institut Teknologi Bandung
		S3 Institut Teknologi Bandung double degree dengan UniversitePierre Marie Curie
21	Yatim Lailun Ni'mah, M. Si.,Ph. D	S1 Institut Teknologi SepuluhNopember
		S2 Institut Teknologi SepuluhNopember
		S3 Taiwan
22	Dr. Yulfi Zetra, M. S	S1 Universitas Andalas
		S2 Institut Teknologi Bandung
		S3 Institut Teknologi SepuluhNopember
23.	Prof. Dr. Djoko Hartanto, M. Si	S1 Universitas Gajah Mada
		S2 Universitas Gajah Mada

No	Name	Education
		S3 Instiut Teknologi SepuluhNopember
24.	Dsc. Arif Fadlan	S1 Chemistry ITS
		S2 Chemistry ITS
		S3 Nara Inst of Science &Techology Jepang

CURRICULUM and MODUL

FACULTY OF SCIENCE AND ANALYTICAL DATA

Program Study	**Chemistry**
Educational Level	**Postgraduate**

LIST OF SUBJECTS FOR POST GRADUATE PROGRAM

A. GENERAL CURRICULUM

No.	Code	Subject Name	Credits
		1ST SEMESTER	
1	SK185101	Research Methodology	3
2	SK185102	Solid State Spectroscopy	3
3	SK1851XX	Compulsory Courses	3-4
		Total Credits	**9-10**
		2ND SEMESTER	
1	SK185201	Pre-Thesis	2
2	SK1852XX	Compulsory Courses	8-10
3	SK1852XX	Elective Courses	0-2
		Total Credits	**10-11**
		3RD SEMESTER	
1	SK1853XX	Compulsory Courses	0-4
2	SK1853XX	Elective Courses	6-10
		Total Credits	**10**
		4TH SEMESTER	
1	SK185401	Thesis	6
		Total Credits	**6**

B. ANALYTIC CHEMISTRY CURRICULUM

No.	Code	Subject Name	Credits
		1ST SEMESTER	
1	SK185101	Research Methodology	3
2	SK185102	Solid State Spectroscopy	3
3	SK185111	Chemical Instrumentation	2
4	SK185112	Chemoinformatics	2
		Total Credits	**10**
		2ND SEMESTER	
1	SK185201	Pre-Thesis	2
2	SK185211	Electroanalysis	2
3	SK185212	Micro Project	2
4	SK185213	Separation and Speciation	2
5	SK185214	Thermal Analysis	2

		Total Credits	**10**
		3RD SEMESTER	
1	SK185311	Bioanalytics	2
2	SK185312	Electrochemistry Sensors	2
3	SK1853XX	Elective Courses	6
		Total Credits	**10**
		4TH SEMESTER	
1	SK185401	Thesis	6
		Total Credits	**6**

C. INORGANIC CHEMISTRY CURRICULUM

No.	Code	Subject Name	Credits
		1ST SEMESTER	
1	SK185101	Research Methodology	3
2	SK185102	Solid State Spectroscopy	3
3	SK185121	Structures and Reactivities of Inorganic Compounds	2
4	SK185122	Characterization of Inorganic Materials I	2
		Total Credits	**10**
		2ND SEMESTER	
1	SK185201	Pre-Thesis	2
2	SK185221	Characterization of Inorganic Materials II	3
3	SK185222	Material Properties and Performance	2
4	SK185223	Inorganic Solids	3
		Total Credits	**10**
		3RD SEMESTER	
1	SK1853XX	Elective Courses	10
		Total Credits	**10**
		4TH SEMESTER	
1	SK185401	Thesis	6
		Total Credits	**6**

D. BIOCHEMISTRY CURRICULUM

No.	Code	Subject Name	Credits
		1ST SEMESTER	
1	SK185101	Research Methodology	3
2	SK185102	Solid State Spectroscopy	3
3	SK185131	Bioinformatics	3
		Total Credits	**9**
		2ND SEMESTER	
1	SK185201	Pre-Thesis	2
2	SK185231	Advanced Biochemistry	3
3	SK185232	Microorganism Metabolisms	3

4	SK185233	Elective Courses	3
		Total Credits	**11**
		3RD SEMESTER	
1	SK185331	Biosynthesis	3
2	SK1853XX	Elective Courses	7
		Total Credits	**10**
		4TH SEMESTER	
1	SK185401	Thesis	6
		Total Credits	**6**

E. PHYSICAL CHEMISTRY CURRICULUM

No.	Code	Subject Name	Credits
		1ST SEMESTER	
1	SK185101	Research Methodology	3
2	SK185102	Solid Phases Chemistry	3
3	SK185141	Quantum Chemistry	3
		Total Credits	**9**
		2ND SEMESTER	
1	SK185201	Pre-Thesis	2
2	SK185241	Molecular Dynamics	3
3	SK185242	Statistical Thermodynamics	3
4	SK185243	Molecular Computational Chemistry	3
		Total Credits	**11**
		3RD SEMESTER	
3	SK1853XX	Elective Courses	10
		Total Credits	**10**
		4TH SEMESTER	
1	SK185401	Thesis	6
		Total Credits	**6**

F. ORGANIC CHEMISTRY CURRICULUM

No.	Code	Subject Name	Credits
		1ST SEMESTER	
1	SK185101	Research Methodology	3
2	SK185102	Solid State Spectroscopy	3
3	SK185151	Advanced Physical Organic Chemistry	3
		Total Credits	**9**
		2ND SEMESTER	
1	SK185201	Pre-Thesis	2
2	SK185251	Advanced Organic Synthesis	3
3	SK185252	Natural Product Organic Chemistry	3
4	SK185253	Organic Geochemistry	3

		Total Credits	**11**
		3RD SEMESTER	
1	SK185351	Structure Determination of Organic Compounds	3
2	SK1853XX	Elective Courses	7
		Total Credits	**10**
		4TH SEMESTER	
1	SK185401	Thesis	6
		Total Credits	**6**

G. ELECTIVE COURSES

No.	Code	Subject Name	Credits
1	SK185301	Green Chemistry	2
2	SK185302	Elective	2
3	SK185313	Nanomaterials for Sensors	2
4	SK185314	Specific Analysis	2
5	SK185315	Corrosion Analysis	2
6	SK185316	Conductive Polymers	2
7	SK185321	Organometallic Chemistry	2
8	SK185322	Catalysis	2
9	SK185323	Coordination Chemistry	2
10	SK185324	Porous Materials	3
11	SK185325	Advanced Inorganic Synthesis	2
12	SK185326	Energy Storage Materials	3
13	SK185327	Modern Ceramics	2
14	SK185328	Physical Inorganic Chemistry	2
15	SK185332	Biodegradation	3
16	SK185333	Food Chemistry	2
17	SK185334	Bioassay	3
18	SK185341	Surface Structure and Analysis	3
19	SK185342	Membrane Synthesis	2
20	SK185343	Carbon Materials	2
21	SK185344	Photochemistry	2
22	SK185345	Industrial Processes Chemistry	2
23	SK185346	Functional Polymers	2
24	SK18552	Phenolate Chemistry	2
25	SK18553	Pigments Chemistry	2
26	SK18554	Petroleum Chemistry	2
27	SK18555	Heterocyclic Chemistry	3
28	SK18556	Medicinal Chemistry	2
29	SK18557	Essential Oils Chemistry	2
30	SK18558	Rearrangement and Pericyclic Chemistry	2

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
FAKULTAS SAINS DAN ANALITIKA DATA
DEPARTEMEN KIMIA

Kode Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits	SEMESTER	Compilation date
Research Methodology	SK185101	General Mandatory	3	I	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Prof. Dr.rer.nat. Irmina Kris Murwani, MSi; Prof. Dr. Didik Prasetyoko, MSc	Prof.Dr. Didik Prasetyoko	Prof.Dr. Didik Prasetyoko

Learning Outcome		
	Learning Outcome Targeted From The Course	
	(LO 1)	Show good moral, ethics, personality, and responsibility in task's completion
	(LO 2)	Show an independent spirit in the group for task's completion
	(LO 3)	Able to solve complex problem and analyze them to be developed using logical thinking based on scientific principles
	(LO 5)	Able to show responsibility of their individual and team work
	Learning Outcome of The Course	
	CP MK 1	Students can compile a research plan and present a scientific journal in a good manner.

Peta LO – CP MK

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1	√	√	√		√				

Subject Description

The Topics Covered in The Subject

1. This subject covers the meaning of research, how to make a research plan, and compile and present a scientific journal.
   - Research: what, why, and how
   - Research suggestion, hypothesis, and planning an experiment
   - Conducting research, data collecting and processing, evaluating the observations, and statistic tests.

	• Scientific journal or report, system framework, and their counterparts. 2. Presenting the research orally
Reference	1. E.B. Wilson, "An Introduction to Scientific Research", New York, McGraw Hill. 2. Related articles. **Support:**
Lecturer	**Prof. Dr.rer.nat. Irmina Kris Murwani, MSi; Prof. Dr. Didik Prasetyoko, MSc**
Pre-requisite	-

Week-	**The final ability of each learning stage**	**Scoring**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**
1	Knowledgable about research			Lectures on parts of research: what, why, how, each with an example **[**3x50**]**	Lectures on parts of research: what, why, how, each with an example **[**3x50**]**	Parts of research including preparation, proposal arrangement, observations, the arrangement of research reports	
2	Knowledgable about the research methodology			Lecture on the characteristics of research methodology **[**3x50**]**	Lecture on the characteristics of research methodology **[**3x50**]**	Characteristics of the research methodology	

3	Knowledgable about the stages of the research process			Lecture on the stages of the research process **[**3x50**]**	Lecture on the stages of the research process **[**3x50**]**	The stages of the research process	
4	Able to formulate research problems	Ability to determine research problems	Assignment 1	Lecture on how to formulate research problems including the identification of variables and hypotheses constructs **[**3x50**]**	Lecture on how to formulate research problems including the identification of variables and hypotheses constructs **[**3x50**]**	Formulating research problems	**10**
5-6	Able to determine research problems			Presentation and discussion from journals whose problems have been determined from assignment 1 2x **[**3x50**]**	Presentation and discussion from journals whose problems have been determined from assignment 1 2x **[**3x50**]**	Determine problems in research	
7	Able to compile research designs	Ability to compile research designs	Assignment 2	Research design courses: Instrument construction for data collection	Research design courses: Instrument construction	Research design	**10**

				Research proposal Writing a report [3x50]	for data collection Research proposal Writing a report [3x50]		
8	**Mid-Term Evaluation**						**30**
9	Knowledgable about writing journal			Lectures on why you should write a journal and what to watch out for if you do [3x50]	Lectures on why you should write a journal and what to watch out for if you do [3x50]	Journal writing process	
10	Know the various types of journals			Lectures on various types of journals, their characteristics, and differences [3x50]	Lectures on various types of journals, their characteristics, and differences [3x50]	Different types of journals	
11	Knowledgable about the criteria of writing a good journal and the stages in writing a journal until the submission process			Lectures on the stages of journal writing until the submission process on the target journal [3x50]	Lectures on the stages of journal writing until the submission process on the target journal [3x50]	Journal writing stages	

12	Understand how to review a literature			Literature review Lecture [3x50]	Literature review Lecture [3x50]	Literature review	
13-14	Able to compile a review journal			Presentations and discussions about reviews that have been arranged according to topics in each area of interest 2x [3x50]	Presentations and discussions about reviews that have been arranged according to topics in each area of interest 2x [3x50]	Write a review journal	
15	Understand how to choose a target journal and submit it to the journal	Ability to compile journal manuscripts	Assignment 3	A lecture on how to choose a target journal, what to pay attention to, how to submit it as well as the ethics when submitting a journal [3x50]	A lecture on how to choose a target journal, what to pay attention to, how to submit it as well as the ethics when submitting a journal [3x50]	Selection of target journal and submission	**20**
16	**Final Evaluation**						**30**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
FAKULTAS SAINS DAN ANALITIKA DATA
DEPARTEMEN KIMIA

Kode Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits	SEMESTER	Compilation date
Solid State Chemistry	SK185102	General Mandatory	3	I	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Lukman Atmaja, PhD; Dr. Hendro Juwono, MSi	Dr. Hendro Juwono, MSi	Prof.Dr. Didik Prasetyoko

Learning Outcome		
	Learning Outcome Targeted From The Course	
	(LO 4)	Able to develop leadership attitudes, creativity and communication skills in solving a chemistry-related problem
	(LO 5)	Able to show responsibility of their individual and team work
	(LO 6)	Able to analyze and synthesis the concept of structure, properties and substance changes at the micro- or macromolecular level based on the dynamic and energetic phenomenon the dynamic and energetic aspect
	(LO 8)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach
	Learning Outcome of The Course	
	CP MK 1	Students can implement the knowledge of Solid Substances Spectroscopy on the research topics that concern energy, health, environment, and other related fields.
	CP MK 2	Students have a deep awareness of the relationships between the molecular structure of a solid substance with both its physical and macroscopic characteristics.
	CP MK 3	Students can think critically about the uses of spectroscopy techniques to solve life problems, such as developing materials for renewable energy, developing synthesis medicine, developing materials for analysis methods, and other related topics.

Peta LO – CP MK	

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1					√				
CP MK 2					√			√	
CP MK 3				√	√	√		√	

Subject Description	
The Topics Covered in The Subject	• Crystal shapes, amorphous solids, chemical bonds in solid substances, lattice energy, correlations between energy lattice and ionic solid substances. • Vibration-rotation-electronic energy levels, selection rules vibration-rotation-electronic transitions, spectrum production, qualitative and quantitative methods, adsorption on solid surfaces, imaging basic concepts.
Reference	**Support:**
Lecturer	**Lukman Atmaja, PhD; Dr. Hendro Juwono, MSi**
Pre-requisite	-

Meeting -	**The final ability of each learning stage**	**Scoring**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**
1	Able to understand crystal structure in the context of spectroscopy	The degree of clarity in explaining crystal structure	Lecture	Lecture [100]	Lecture [100]	Bulk crystal: a three-dimensional lattice	3

2	Able to understand crystal structure in the context of spectroscopy	The degree of clarity in explaining crystal structure	Lecture	Lecture [100]	Lecture [100]	Crystal plane: two-dimensional lattice	3
3	Able to understand the structure of amorphous solids in the context of spectroscopy	The degree of clarity in explaining the structure of amorphous solids	Lecture	Lecture [100]	Lecture [100]	Amorphous solid	3
4	Able to understand the types of chemical bonds present in the solid phase	The degree of clarity in explaining the types of bonds	Lecture	Lecture [100]	Lecture [100]	Chemical bonds in the solid phase - 1	3
5	Able to understand the types of chemical bonds present in the solid phase	The degree of clarity in explaining the types of bonds	Lecture	Lecture [100]	Lecture [100]	Chemical bonds in the solid phase - 2	3
6	Able to understand the reality of electromagnetic radiation and the theoretical procedures for its amplification	The degree of clarity in explaining the interaction between radiation and matter in solids	Group Discussion	Lecture [100]	Lecture [100]	Interaction between radiation and solids - Hertzian Dipole and Fourier transformation	4
7	Understand the concepts of coherence and correlation for radiation applications in spectroscopy	The degree of clarity in explaining the interaction between radiation and matter in solids	Group Discussion	Lecture [100]	Lecture [100]	Interaction between radiation and solids - Limited frequency, coherence, and correlation	4
8	Understand the relationship between the lattice energy	The degree of clarity in explaining the	Lecture	Lecture [100]	Lecture [100]	Relationship between lattice	4

	of a material and its solubility properties	relationship between energy as a general concept and physical properties, especially its solubility properties				energy and ionic solid solubility - 1	
9	Understand the relationship between the lattice energy of a material and its solubility properties	The degree of clarity in explaining the relationship between energy as a general concept and physical properties, especially its solubility properties	Lecture	Lecture [100]	Lecture [100]	Relationship between lattice energy and ionic solid solubility - 2	4
10	Understand the behavior of solids in response to the radiation that hits them	The degree of clarity in explaining the response of solids and their use as one axis in the spectrum	In-Class Discussion	Lecture [100]	Lecture [100]	Dielectric response functions	4
11	Understand the origin of rotational, vibrational, and electronic energy levels	The degree of clarity in explaining the formation of energy levels in a molecule	Lecture	Lecture [100]	Lecture [100]	Rotational-vibrational-electronic energy levels - 1	3
12	Understand the origin of rotational, vibrational, and electronic energy levels	The degree of clarity in explaining the formation of energy levels in a molecule	Lecture	Lecture [100]	Lecture [100]	Rotational-vibrational-electronic energy levels - 2	3

13	Understand the relationship between molecular symmetry and selection rules	The degree of clarity in explaining molecular symmetry and the rules of selection for rotational, vibrational, and electronic transitions	Lecture	Lecture [100]	Lecture [100]	Symmetry and selection rules - 1	5
14	Understand the relationship between molecular symmetry and selection rules	The degree of clarity in explaining molecular symmetry and the rules of selection for rotational, vibrational, and electronic transitions	Lecture	Lecture [100]	Lecture[100]	Symmetry and selection rules - 2	4
15-16	**Mid-Term Evaluation**						
17	Understand the transitions that produce a spectrum	The degree of clarity in explaining the process of spectrum formation	Lecture	Lecture [100]	Lecture [100]	Vibration-rotational-electronic transition – 1	4
18	Understand the transitions that produce a spectrum	The degree of clarity in explaining the process of spectrum formation	Lecture	Lecture [100]	Lecture [100]	Vibration-rotational-electronic transition – 2	4
19	Understand the special features of the solids IR spectra	The degree of clarity in explaining the presence and appearance of	Lecture	Lecture [100]	Lecture [100]	IR Spectra	4

		peaks at the vibrational transition					
20	Understand the special features of the solid-looks-alike spectra	The degree of clarity in explaining the presence and appearance of peaks in electronic transitions	Lecture	Lecture [100]	Lecture [100]	Visible Spectra	4
21	Understand the special features of a solid UV spectra	The degree of clarity in explaining the presence and appearance of peaks in electronic transitions	Lecture	Lecture [100]	Lecture [100]	UV Spectra	4
22	Understand the special features of the solid X-ray spectra	The degree of clarity in explaining the presence and appearance of peaks in X-ray-based spectroscopy	Lecture	Lecture [100]	Lecture [100]	X-rays spectra	4
23	Understand the basic theory of NMR spectroscopy and its spectra	The degree of clarity in explaining the interaction of magnetic fields in solid molecules and the process by which the spectrum appears	Lecture	Lecture [100]	Lecture [100]	NMR Spectroscopy - 1	5
24	Understand the basic theory of NMR spectroscopy and its spectra	The degree of clarity in explaining the interaction of magnetic	Group Discussion	Lecture [100]	Lecture [100]	NMR Spectroscopy - 2	5

		fields in solid molecules and the process by which the spectrum appears					
25	Understand the basic theory of NMR spectroscopy and its spectra	The degree of clarity in explaining the interaction of magnetic fields in solid molecules and the process by which the spectrum appears	Presentation	Lecture [100]	Lecture [100]	NMR Spectroscopy - 3	5
26	Understand the procedures of qualitative and quantitative methods using different types of spectroscopy	The degree of clarity in explaining the stages of preparation for qualitative and quantitative analysis	Lecture	Lecture [100]	Lecture [100]	Qualitative and quantitative methods - 1	4
27	Understand the procedures of qualitative and quantitative methods using different types of spectroscopy	The degree of clarity in explaining the stages of preparation for qualitative and quantitative analysis	Lecture	Lecture [100]	Lecture [100]	Qualitative and quantitative methods - 2	4
28	Understand the basic concepts of 3-dimensional spectroscopy	The degree of clarity in explaining the main ideas of space spectroscopy.	Lecture	Lecture [100]	Lecture [100]	Basic imaging concepts	3
29-32	**Final Evaluation**						

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Kode Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits		SEMESTER	Compilation date
Chemical Instrumentation	**SK185111**	Analytic Chemistry (Mandatory)	2		I	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Yatim Lailun Ni'mah, PhD; Dr.rer.nat. Fredy Kurniawan, MSi	Suprapto, Ph. D	Prof.Dr. Didik Prasetyoko

Learning Outcome		
	Learning Outcome Targeted From The Course	
	(LO 1)	Show good moral, ethics, personality, and responsibility in task's completion
	(LO 4)	Able to develop leadership attitudes, creativity and communication skills in solving a chemistry-related problem
	(LO 7)	Able to analyze and synthesis concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right instrument and the substance side effect in order to develop the chemistry
	(LO 9)	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation
	Learning Outcome of The Course	
	CP MK 1	Students can explain the purposes of instruments being taught, and
	CP MK 2	Students able to explain data interpretations given by the instruments.
	CP MK 3	Students able to express their ideas or suggestions orally or in written forms.

Peta LO – CP MK

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1							√		
CP MK 2							√		√
CP MK 3	√			√					√

Subject Description	
The Topics Covered in The Subject	Analytic method classification and their types, simple instrument measurements, electrical circuit components, amplifier, transducer, feedback and control, signal, noise and noise reduction, digital electronic and microcomputer.
Reference	1. D.A. Skoog, F.J. Holler, S.R. Crouch, "Principles of Instrumental Analysis", John Wiley and Sons, 2006. **Support:** 1. J. Wang, "Electroanalytical Chemistry," Wiley VCH, USA, 2000.
Lecturer	**Yatim Lailun Ni'mah, PhD; Dr.rer.nat. Fredy Kurniawan, MSi**
Pre-requisite	-

Week-	**The final ability of each learning stage**	**Scoring**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**
1	Students know the a learning plan for one semester						
2	Students can explain classification of analytic methods and their types	Conformity with concept, Questions, and answers		Tutorial, Discussion **[2x50]**	Tutorial, Discussion **[2x50]**	Classification of analytical methods and their types	
3,4	Students can explain simple instrument measurements	Conformity with concept, Questions, and answers		Tutorial, Discussion **2[2x50]**	Tutorial, Discussion **2[2x50]**	Simple instrument measurement	20

5,6	Students can explain the electrical components and circuits in the instrument	Conformity with concept, Questions, and answers		Tutorial **2[2x50]**	Tutorial **2[2x50]**	Electrical components and circuits	
7	Students can classify analytical methods, using simple instruments as well as the components in the instrument.	Quiz		Discussion **[2x50]**	Discussion **[2x50]**	Classification of methods, measurement of instruments and electrical components therein	20
8	**Mid-Term Evaluation**						**30**
9-10	Students can explain about amplifiers and transducers	Conformity with concept, Questions, and answers		Lecture, Discussion **2[2x50]**	Lecture, Discussion **2[2x50]**	Amplifiers, transducers	
11-12	Students can explain orally or in writing some examples of radionuclide separation analysis taken from articles/journals (4 examples of different methods)	Conformity with concept, Questions, and answers		Lecture, Discussion **2[2x50]**	Lecture, Discussion **2[2x50]**	Feedback and control	
13	Students can explain signal, noise, and noise reduction as well as Digital electronics and microcomputers	Conformity with concept, Questions, and answers		Lecture, Discussion **[2x50]**	Lecture, Discussion **[2x50]**	• Signal, Noise, and noise reduction • Digital electronics and microcomputers	
14	Students can apply theories in chemical instrumentation with their respective research	Conformity with concept, Questions, and answers		Lecture, Discussion **[2x50]**	Lecture, Discussion **[2x50]**	Application of chemical instrumentation theory	20
15-16	**Final Evaluation**						**30**

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Kode Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits		SEMESTER	Compilation date
Chemoinformatics	SK185112	Analytic Chemistry (Mandatory)	2		I	
AUTHORIZATION / LEGALIZATION	**RPS Development Lecturer**		**RMK Coordinator**		**Head of Study Program**	
	Dr.rer.nat. Fredy Kurniawan, MSi		Suprapto, Ph. D		Prof.Dr. Didik Prasetyoko	

Learning Outcome	**Learning Outcome Targeted From The Course**	
	(LO 3)	Able to solve complex problem and analyze them to be developed using logical thinking based on scientific principles
	(LO 5)	Able to show responsibility of their individual and team work
	Learning Outcome of The Course	
	CP MK 1	Students can explain the types of publications
	CP MK 2	Studen can use software such as word processors, reference manager, data processing, and picture processing.

Peta LO – CP MK

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1			√		√				
CP MK 2			√		√				

Subject Description	
The Topics Covered in The Subject	*Word processor*, *Optimasi MS-Word* (*Style, Table of Content, Caption, Reference Manager* (Zotero, Mendeley), Origin (Gambar Vektor, Mengatur Gambar), Scopus, Thomson Reuters, pengiriman artikel (*Journal Topic*, *Author Guide*, *Supplementary files*)

Reference	1. www.sciencedirect.com, www.scopus.com; www.office.com, www.originlab.com, 2. www.zotero.org, www.mendeley.com, www.onenote.com **Support:**
Lecturer	Dr.rer.nat. Fredy Kurniawan, MSi
Pre-requisite	-

Week-	The final ability of each learning stage	Scoring		Learning Forms; Learning methods; Student Assignment; [Estimated time]		Learning materials [References]	Score Rating (%)
		Indicator	Criteria & Techniques				
(1)	(2)	(3)	(4)	Tatap Muka (5)	Daring (6)	(7)	(8)
1	Students can explain the types of publications	• Accuracy in explaining the importance of publication • Accuracy in explaining the type of publication • Describing the quality of the publication • Accuracy in explaining the quality of the researcher	Non-Test	Lecture, brainstorming 2x(2×50)	Lecture, brainstorming 2x(2×50)	• General definition of scientific work • Types of publication of scientific papers • Quality of publication (Index, IF, Quartile and the like) • Research quality	10
2-4	Students can use word processor software	• Accuracy in using Style, Caption in MS-Word	Non-Test	Lecture, brainstorming, Practical training **2x(2×50)**	Lecture, brainstorming, Practical training	Optimizing the use of software to write scientific papers • MS Word	20

		• Accuracy in displaying Table of Content (TOC), Index • Accuracy in utilizing citations in MS-Word • Accuracy using the Track Change system • The accuracy of using one note to create research logbooks stored in the cloud		**2×50**	**2x(2×50)** **2×50**	• One note	
5-7	Students can use reference manager software	• Accuracy in making personal libraries for reference purposes • Accuracy in using Zotero and Mendeley	Non-Test	Lecture, brainstorming, Practical training **2x(2×50)** **1x(2×50)**	Lecture, brainstorming, Practical training **2x(2×50)** **1x(2×50)**	• Optimization of the use of software related to reference managers (Zotero, Mendeley)	20
8	**Mid-Term Evaluation**						
9-11	Students can use data processing	The accuracy in using Origin, MS Excel,	Non-Test	Lecture, brainstorming, Practical training **3x(3×50)**	Lecture, brainstorming, Practical training	Optimizing the use of software for data processing purposes	20

		MATLAB for data processing		**1x(3×50)**	**3x(3×50)** **1x(3×50)**	(MS Excel, Origin, MATLAB)	
12-13	Students can use image processing devices	Accuracy in using Origin, MS Excel, MATLAB for image processing	Non-Test	Lecture, brainstorming, Practical training **1x(2×50)** **1x(2×50)**	Lecture, brainstorming, Practical training **1x(2×50)** **1x(2×50)**	Optimizing the use of software for image processing purposes (MS Excel, Origin, MATLAB)	15
14-15	Students understand how to publish articles in international journals	The accuracy in explaining the structure of articles in international journals, rating good scientific articles, compiling a good flow of scientific articles, and describing the need for article complementary need in the registration of an article to an international journal	Non-Test	Lecture, brainstorming **2x(2×50)**	Lecture, brainstorming **2x(2×50)**	How to publish in international journals (structure of articles in international journals, logic flow in writing articles in international journals, comprehensiveness on publication in international journals)	15
15-16	**Final Evaluation**						

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Kode Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits		SEMESTER	Compilation date
Structures and Reactivities of Inorganic Compound	**SK185121**	**Inorganic Chemistry (Mandatory)**	2		I	
AUTHORIZATION / LEGALIZATION	**RPS Development Lecturer**		**RMK Coordinator**		**Head of Study Program**	
	Prof. Dr. rer. nat. Irmina Kris Murwani, MSi; Dra. Ratna Ediati, MS, PhD		Prof. Dr. rer. nat. Irmina Kris Murwani, MSi		Prof.Dr. Didik Prasetyoko	

Learning Outcome	**Learning Outcome Targeted From The Course**	
	(LO 3)	Able to solve complex problem and analyze them to be developed using logical thinking based on scientific principles
	(LO 4)	Able to develop leadership attitudes, creativity and communication skills in solving a chemistry-related problem
	(LO 6)	Able to develop the concept of structure, properties, and substance changes at the micro- or macromolecular level based on the dynamic and energetic aspect
	(LO 8)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach
	Learning Outcome of The Course	
	CP MK 1	Students can correlate inorganic material's properties, structures, and reactivities.
	CP MK 2	Students can determine factors that influence inorganic compound reactivities.
	CP MK 3	Students can present an example of structures and their reactivities through their chosen journal, as well as their determining reactivity factors.

Peta LO – CP MK

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1						√		√	
CP MK 2						√		√	

	CP MK 3			√	√					

Subject Description	
The Topics Covered in The Subject	• This course provides a similar view on the structure and reactivity of inorganic compounds • Calculating electrons on molecule nucleus to discover the reactivities of a molecule, acid-base molecule that influence reactivities, symmetrical orbital interactions in a reaction, predicting redox reactions, oxidation number in a molecule, substituent effects, steric effect, mechanochemistry interactions. • Journals with the topic of structure and reactivity that will be used to determine the determining factor for reactivity
Reference	1. J.E. Huheey, "Inorganic Chemistry Principles of Structure and Reactivity", edisi keempat, Harper and Row Publisher, New York, 1993. 2. B.E. Douglas, D.H. McDaniel, J.J. Alexander, "Concepts and Models of Inorganic Chemistry", John Wiley & Sons 3. C.E. Housecroft, A.G. Sharpe," Inorganic Chemistry", edisi kedua, Pearson Education Limited, 2005 4. G.L. Miessler, D.A. Tarr, "Inorganic Chemistry", edisi ketiga, Pearson Education International, Minnesota, 2001 5. J.E. House, "Inorganic Chemistry", Academic Press, London, 2008. 6. D.F. Shriver, P.W. Atkins, "Inorganic Chemistry", edisi kelima, W.H. Freeman and Company, Oxford, 2010. 7. Journals with the topic of structure and reactivity will be presented to determine the determinants of reactivity **Support:**
Lecturer	**Prof. Dr. rer. nat. Irmina Kris Murwani, MSi; Dra. Ratna Ediati, MS, PhD**
Pre-requisite	-

Week-	**The final ability of each learning stage**	**Scoring**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**
1	Students can determine the factors that affect the reactivity of inorganic compounds			Lectures on the relationship between the structure and reactivity of	Lectures on the relationship between the structure and	Introduction to the relationship between the structure and reactivity of	

				inorganic compounds **[2x50]**	reactivity of inorganic compounds **[2x50]**	inorganic compounds	
2-3	Students can count the electrons in the central atom of the molecule to find out the reactivity of the molecule			Lectures and exercises on the calculation of electrons in the central atom of a molecule to determine the reactivity of molecules **2x [2x50]**	Lectures and exercises on the calculation of electrons in the central atom of a molecule to determine the reactivity of molecules **2x [2x50]**	Calculation of the electrons in the molecular center atom to determine the reactivity of the molecule	
4	Students can relate the acid-base properties of molecules that affect reactivity			Lecture on molecular acids and bases that affect reactivity **[2x50]**	Lecture on molecular acids and bases that affect reactivity **[2x50]**	The acid-base molecule which affects reactivity	
5	Students can determine the factors that affect the reactivity of inorganic compounds			Lecture on symmetric orbital interactions in reactions **[2x50]**	Lecture on symmetric orbital interactions in reactions **[2x50]**	Symmetric orbital interactions in reactions	
6-7	Students can present examples of structure and reactivity through selected journals and their	Be able to determine the determining factor	Assignment 1	Discussion and presentation of examples of structure and	Discussion and presentation of examples of structure and	Presentation of examples of structure and reactivity through	20

	determining factors for reactivity.	for reactivity in sample structure		reactivity through selected journals and their determining factor for reactivity. **2x [2x50]**	reactivity through selected journals and their determining factor for reactivity. **2x [2x50]**	selected journals and their determining factor for reactivity.	
8	Mid-Term Evaluation						**30**
9	Students can predict redox reactions in reactivity			Lectures on the prediction of redox reactions in reactivity **[2x50]**	Lectures on the prediction of redox reactions in reactivity **[2x50]**	• Predictions of redox reactions in reactivity	
10	Students can determine oxidation numbers that affect the reactivity of inorganic compounds			Lecture on the effect of oxidation numbers in molecules on their reactivity **[2x50]**	Lecture on the effect of oxidation numbers in molecules on their reactivity **[2x50]**	• Effect of the oxidation number in a molecule on its reactivity	
11	Students can determine the factors that affect the reactivity of inorganic compounds, namely substituent and steric effects that affect reactivity.			Lectures on the effects of substituents, steric effects on molecular reactivity **[2x50]**	Lectures on the effects of substituents, steric effects on molecular reactivity **[2x50]**	• Substituent effect, the steric effect on molecular reactivity	

12	Students can determine the mechanochemical factors that affect the reactivity of inorganic compounds			Lecture on mechanochemical interactions **[2x50]**	Lecture on mechanochemical interactions **[2x50]**	• Mechanochemical interactions	
13-15	Students can present examples of structure and reactivity through selected journals and their determining factors for reactivity.	• Be able to determine their determining factor for reactivity	• Assignment 2	Presentation and discussion of examples of structure and reactivity through selected journals and their determining factor for reactivity **2x [2x50]**	Presentation and discussion of examples of structure and reactivity through selected journals and their determining factor for reactivity **2x [2x50]**	• Presenting examples of structure and reactivity through selected journals their determining factor for reactivity	20
16	**Final Evaluation**						**30**

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Kode Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits		SEMESTER	Compilation date
Characterization of Inorganic Materials I	**SK185122**	**Inorganic Chemistry (Mandatory)**	2		I	
AUTHORIZATION / LEGALIZATION	**RPS Development Lecturer**		**RMK Coordinator**		**Head of Study Program**	
	Prof. Dr.rer.nat. Irmina Kris Murwani, MSi; Prof. Dr. Didik Prasetyoko, MSc		Prof. Dr.rer.nat. Irmina Kris Murwani		Prof.Dr. Didik Prasetyoko	

Learning Outcome	**Learning Outcome Targeted From The Course**	
	(LO 6)	Able to develop the concept of structure, properties, and substance changes at the micro- or macromolecular level based on the dynamic and energetic aspect
	(LO 8)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach
	Learning Outcome of The Course	
	CP MK 1	Students can utilize and develop inorganic materials characterization methods to obtain more in-depth information, in particular crystallography.

Peta LO – CP MK

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1						√		√	

Subject Description

The Topics Covered in The Subject	Inorganic material characterization using X-ray (XRD, XANES, EXAFS, XPS), performing XRD using treor, dicvol, fullprof, Rietveld, Rietica, and MAUD software.
Reference	• S.E. Dann, "Reactions and Characterization of Solids", RSC London, 2000 • A.R. West, "Solid State Chemistry (bab III)", 1992, John Wiley & Sons • M. Ladd, R. Palmer, "Structure Determination by X-Ray Crystallography", Kluwer Academic/Plenium Publishers, 2003 • R. Jenkins, "X-Ray Fluorescence Spectrometry", John Wiley and Sons Inc, 1999 • V.E. Buhrke, R. Jenkins, D.K. Smith, "Preparation of Specimens for X-ray fluorescence and X-ray Diffraction Analysis", Wiley-VCH, 1998 **Support:**
Lecturer	**Prof. Dr.rer.nat. Irmina Kris Murwani, MSi; Prof. Dr. Didik Prasetyoko, MSc**
Pre-requisite	

Week-	**The final ability of each learning stage**	**Scoring**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**
1	Knowledgeable in the way to characterize inorganic material			Introduction to the characterization of inorganic materials with examples	Introduction to the characterization of inorganic materials with examples	Introduction of inorganic material characterization, visual observation and physical properties of inorganic material	
2	Knowledgeable in the way to characterize inorganic materials using X-ray			Lecture on the characterization of inorganic materials by X-ray diffraction	Lecture on the characterization of inorganic materials by	Characterization of inorganic materials by X-ray diffraction	

					X-ray diffraction		
3	Knowledgeable in the way of using a free download program for the interpretation of X-ray diffraction patterns			Lecture on the required programs and installment of a free download program for interpreting X-ray diffraction patterns	Lecture on the required programs and installment of a free download program for interpreting X-ray diffraction patterns	Another program that must be prepared to install a free download program for the interpretation of X-ray diffraction patterns	
4	Knowledgeable in the use of free download programs Treor and dicvol and powder cell to interpret X-ray diffraction patterns	Students can use the Treor and divcol programs and powder cell for interpretation of X-ray diffraction patterns	Assignment 1	Practice on how to install and use the free download programs Treor and dicvol and powder cell to interpret X-ray diffraction patterns	Practice on how to install and use the free download programs Treor and dicvol and powder cell to interpret X-ray diffraction patterns	How to install and use the free download program Treor and dicvol and powder cell to interpret X-ray diffraction patterns	10
5	Knowledgeable in the use of Winplot and MAUD free download programs to interpret X-ray diffraction patterns			Practice on how to install and use Winplot and MAUD free download programs to interpret X-ray diffraction patterns	Practice on how to install and use Winplot and MAUD free download programs to	How to install and use Winplot and MAUD free download programs to interpret X-ray diffraction patterns	

					interpret X-ray diffraction patterns		
6-7	Knowledgeable in the use of Fullprof and Rietica free download programs for interpretation of X-ray diffraction patterns	Students can use the Fullprof and Rietica programs for the interpretation of X-ray diffraction patterns	Assignment 2	Practice on how to install and use the free download programs Fullprof and Rietica to interpret X-ray diffraction patterns	Practice on how to install and use the free download programs Fullprof and Rietica to interpret X-ray diffraction patterns	How to install and use the free download programs Fullprof and Rietica to interpret X-ray diffraction patterns	10
8	Mid-Term Evaluation						**30**
9-10	Knowledgeable in the way to characterize inorganic materials with single crystal X-Ray			Lecture on the characterization of inorganic materials with single crystal X-Ray	Lecture on the characterization of inorganic materials with single crystal X-Ray	Characterization of inorganic materials with single crystal X-Ray	
11-13	Knowledgeable in the way to characterize inorganic materials with XANES and EXAFS	Students can understand the characterization of inorganic materials with XANES and EXAFS	Quiz	Lecture on the characterization of inorganic materials with XANES and EXAFS	Lecture on the characterization of inorganic materials with XANES and EXAFS	Characterization of inorganic materials with XANES and EXAFS	20
14-15	Knowledgeable in the way to characterize inorganic materials with XPS and Mösbouer			Lecture on the characterization of inorganic materials	Lecture on the characterization of inorganic materials with	Characterization of inorganic materials with XPS and Mösbouer	

				with XPS and Mösbouer	XPS and Mösbouer		
16	**Final Evaluation**						**30**

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Kode Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits		SEMESTER	Compilation date
Bioinformatics	**SK185131**	**Biochemistry (Mandatory)**	3		I	
AUTHORIZATION / LEGALIZATION	**RPS Development Lecturer**		**RMK Coordinator**		**Head of Study Program**	
	Adi Setyo Purnomo, MSc, PhD; Prof. Dr. Drs. Surya Rosa Putra, MS		Adi Setyo Purnomo, MSc, PhD		Prof.Dr. Didik Prasetyoko	

Learning Outcome	**Learning Outcome Targeted From The Course**	
	(LO 8)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach
	(LO 9)	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation
	Learning Outcome of The Course	
	CP MK 1	Students can utilize software for genomic and proteomic researches.
	CP MK 2	Students can utilize websites for biochemistry.

Peta LO – CP MK

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1								√	√
CP MK 1								√	

Subject Description	This subject teaches the applications of information technology and communication in biochemistry researches.
The Topics Covered in The Subject	Basic computation and technology information, genomic analysis, proteomic analysis, phylogenetic trees, biochemistry websites, biochemistry data processing software.
Reference	1. A.D. Baxevanis, B. F. F. Ouellette (Editors), "Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins", edisi ketiga, John Wiley & Sons Inc., 2004. 2. S.A. Krawetz, D.D. Womble, "Introduction to Bioinformatics: A Theoretical and Practical Approach", edisi pertama, Humana Press, 2003 3. Articles from related journals. **Support:**
Lecturer	**Adi Setyo Purnomo, MSc, PhD; Prof. Dr. Drs. Surya Rosa Putra, MS**
Pre-requisite	

Week-	**The final ability of each learning stage**	**Scoring**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**
1	Understand the basic computing concepts	Accuracy in understanding the history and importance of bioinformatics		Lecture **1x(3x50)**	Lecture **1x(3x50)**	Introduction and history of bioinformatics	5
2	Understanding the basic computing concepts	Accuracy in describing websites for biochemistry		Lecture **1x(3x50)**	Lecture **1x(3x50)**	Introduction to Computing to Biochemistry	

3	Mapping genomic and proteomic research	Accuracy in understanding genomic analysis.		Lecture **1x(3x50)**	Lecture **1x(3x50)**	Genomic analysis	
4-5	Mapping genomic and proteomic research	Accuracy in understanding proteomic analysis	Quis I	Lecture **2x(3x50)**	Lecture **2x(3x50)**	Proteomic analysis	20
6	Mapping genomic and proteomic research	Accuracy in understanding the phylogenetic tree.		Lecture **1x(3x50)**	Lecture **1x(3x50)**	Phylogenetic tree	
7	Mapping genomic and proteomic research	Accuracy in understanding sequences		Lecture **1x(3x50)**	Lecture **1x(3x50)**	Sequence	
8	Mid-Term Evaluation						**25**
9-10	Using software for genomic and proteomic research.	Accuracy in using the web about nucleotides	Presentasi	Lecture **2x(3x50)**	Lecture **2x(3x50)**	Web Nukleotida Nucleotide Web	10
11-13	Using general software for data processing and making presentation materials.	Accuracy in using software to process data and make presentations	Presentasi	Lecture **2x(3x50)**	Lecture **2x(3x50)**	Software pengolahan data biokimia Biochemical data processing software	10
14-15	Using websites for biochemistry	Accuracy in using the web related to biochemistry	Presentasi	Lecture **2x(3x50)**	Lecture **2x(3x50)**	Web Situs Biokimia Biochemistry Web Site	10

15-16	**Final Evaluation**	**25**

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Kode Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits		SEMESTER	Compilation date
Quantum Chemistry	SK185141	Physical Chemistry (Mandatory)	3		I	
AUTHORIZATION / LEGALIZATION	**RPS Development Lecturer**		**RMK Coordinator**		**Head of Study Program**	
	Nurul Widiastuti, PhD; Dr. Yuly Kusumawati, S.Si., M.Si; Prof. Dr. Syafsir Akhlus		Dr. Hendro Juwono, MSi		Prof.Dr. Didik Prasetyoko	

Learning Outcome	**Learning Outcome Targeted From The Course**	
	(LO 1)	Show good moral, ethics, personality, and responsibility in task's completion
	(LO 6)	Able to develop the concept of structure, properties, and substance changes at the micro- or macromolecular level based on the dynamic and energetic aspect
	(LO 9)	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation
	Learning Outcome of The Course	
	CP MK 1	Able to understand the concepts of Quantum Chemistry to explain the structures of atoms and molecules.

Peta LO – CP MK

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1	√					√			√

Subject Description

The Topics Covered in The Subject

Quantum theory, classic wavelength equation, Schrodinger particle equation in a box, postulates and principles of quantum mechanics, harmonic oscillator and vibration spectroscopy, rigid rotor and rotation spectroscopy, hydrogen atoms, atoms with

	many electrons, chemical bonds: molecules with single and double electrons, chemical bonds qualitative theories, Hartree Fock Roothaan method.
Reference	
	Support:
Lecturer	**Nurul Widiastuti, PhD; Dr. Yuly Kusumawati, S.Si., M.Si; Prof. Dr. Syafsir Akhlus**
Pre-requisite	

Week-	**The final ability of each learning stage**	**Scoring**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**
1	Students can explain the concept of quantum theory Students can explain the concept of the classical wave equation	Accuracy in explaining the concepts of quantum theory and classical wave equations	Quiz	Lectures and exercises	Lectures and exercises	Quantum theory, Classical wave equation	2
2	Students can explain and solve the Schrodinger equation of particles in the box	Accuracy in describing and solving the Schrodinger equation of particles in a box	Quiz	Lectures and exercises	Lectures and exercises	The Schrodinger equation of particles in a box	3
3	Students can explain the postulates and principles of quantum mechanics	Accuracy in explaining the	Quiz	Lectures and exercises	Lectures and exercises	Postulates and principles of quantum mechanics	2

		postulates and principles of quantum mechanics					
4-5	Students can explain and solve harmonic oscillator equations and vibration spectroscopy	Accuracy in describing and solves equations of harmonic oscillators and vibrational spectroscopy	Quiz	Lectures and exercises	Lectures and exercises	Harmonic oscillator and vibration spectroscopy	4
6-7	Students can explain and solve the equations of the rigid rotor and rotational spectroscopy	Accuracy in describing and solves the equations of the rigid rotor and rotational spectroscopy	Quiz	Lectures and exercises	Lectures and exercises	Rigid rotor and rotational spectroscopy	4
8	Mid-Term Evaluation						**20**
9	Students can explain and solve the hydrogen atom equation	Accuracy in describing and solving the equation for the hydrogen atom	Assignment	Lectures and exercises	Lectures and exercises	Hydrogen atom	3
10	Students can explain and solve many-electron atomic equations	Accuracy in explaining the concept and analyzing the characterization results by using	Assignment	Lectures and exercises	Lectures and exercises	Many-Electron atom	3

		secondary ion mass spectroscopy (Secondary Ion Mass Spectroscopy)					
11	Students can explain and solve molecular equations with one and two electrons	Accuracy in describing and solving the equations of one- and two-electron molecules	Assignment	Lectures and exercises	Lectures and exercises	Chemical bond: A molecule with one and two electrons	2
12-13	Students can explain various theories on chemical bonds and their consequences on molecular properties	Accuracy in explaining the various theories on chemical bonding and its consequences for molecular properties	Assignment	Lectures and exercises	Lectures and exercises	Qualitative theory of chemical bonds	3
14-15	Students can explain the Hartree Fock method in determining atomic and molecular structures Students can compute using the HF method in determining atomic and molecular structures	• Accuracy in explaining the Hartree Fock method in determining atomic and molecular structures • Accuracy in performing computations using the HF method in determining atomic and molecular structures	Assignment	Lectures and exercises	Lectures and exercises	the Hartree Fock roothaan method	4

15-16	**Final Evaluation**	**20**

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Kode Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits		SEMESTER	Compilation date
Advanced Physical Organic Chemistry	**SK185151**	**Organic Chemistry (Mandatory)**	3		I	
AUTHORIZATION / LEGALIZATION	**RPS Development Lecturer**		**RMK Coordinator**		**Head of Study Program**	
	Prof. Dr. R.Y. Perry Burhan, MS; Dr. Yulfi Zetra, MS		Prof. Dr. Mardi Santoso		Prof.Dr. Didik Prasetyoko	

Learning Outcome	**Learning Outcome Targeted From The Course**	
	(LO 1)	Show good moral, ethics, personality, and responsibility in task's completion
	(LO 6)	Able to analyze and synthesis the concept of structure, properties and substance changes at the micro- or macromolecular level based on the dynamic and energetic phenomenonthe dynamic and energetic aspect
	(LO 8)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach
	Learning Outcome of The Course	
	CP MK 1	Students can predict the physical and chemical properties of organic compounds based on both intramolecular and intermolecular properties.
Peta LO – CP MK		

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1	√					√		√	

Subject Description	

The Topics Covered in The Subject	Intramolecular properties: bond localizations and delocalizations, carbocation, carbanion, radical, carbene, acid-base. Intermolecular properties: reaction mechanisms and their determination (thermodynamics and reaction kinetics), reaction types (addition, elimination, substitution, rearrangement).
Reference	**Support:**
Lecturer	**Prof. Dr. R.Y. Perry Burhan, MS; Dr. Yulfi Zetra, MS**
Pre-requisite	

Week-	**The final ability of each learning stage**	**Scoring**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**
1,3	Students can explain and apply knowledge about intramolecular properties in organic compounds in a case study	Accuracy in explaining and applying knowledge of intramolecular properties in organic compounds in a case study	Assignment I	• Introductory lectures and brain-storming • Lectures and discussions • Task I	• Introductory lectures and brain-storming • Lectures and discussions • Task I	• Bond localization and delocalization • Carbocation • Carbanion • Radical • Carbine • Acid-base	10
4-7	Students can explain and apply knowledge about the	Accuracy in explaining and applying	Assignment 2	• Lectures,	• Lectures,	• The reaction mechanism	10

	properties between molecules in organic compounds in a case study	knowledge of the intermolecular properties of organic compounds in a case study		• group discussion	• group discussion	of organic compounds • Determining the thermodynamic factors in an organic compound reaction • Determining the kinetics factors in an organic compound reaction	
8	Mid-Term Evaluation						20
9-10	Students can explain and apply knowledge about the properties between molecules in organic compounds in a case study	Accuracy in explaining and applying knowledge of the intermolecular properties of organic compounds in a case study	Assignment 3	• Lectures, group discussions	• Lectures, group discussions	• Reaction mechanism of organic compounds • Determining the thermodynamic factors in a reaction of organic compounds • Determining the kinetics factors in a reaction of	10

						organic compounds	
11-15	Students can explain and apply knowledge about the types of reactions inorganic compounds and their influencing factors	• Accuracy in explaining and applying knowledge about the types of reactions inorganic compounds and their influencing factors	Task 4 (paper and presentation)	• Lectures, group discussions, • Paper assignments and presentations	• Lectures, group discussions, • Paper assignments and presentations	• Addition reactions • Elimination reaction • Substitution reactions • Reordering reaction • Thermodynamic factors, in addition, elimination, substitution, and PU reactions • Kinetics factors, in addition, elimination, substitution, and PU reactions	25
15-16	**Final Evaluation**						**25**

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Kode Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits	SEMESTER	Compilation date
Pre-Thesis	SK185201	General Mandatory	2	II	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Prof.Dr. Didik Prasetyoko	Prof.Dr. Didik Prasetyoko	Prof.Dr. Didik Prasetyoko

Learning Outcome	**Learning Outcome Targeted From The Course**	
	(LO 1)	Show good moral, ethics, personality, and responsibility in task's completion
	(LO 3)	Able to solve complex problem and analyze them to be developed using logical thinking based on scientific principles
	(LO 5)	Able to show responsibility of their individual and team work
	Learning Outcome of The Course	
	CP MK	Students can compile and present a thesis research proposal.

Peta LO – CP MK

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1	√		√		√				

Subject Description	
The Topics Covered in The Subject	1. Compiling a thesis research proposal. 2. Presenting a thesis proposal in a thesis defense.

Reference	**Support:**
Lecturer	
Pre-requisite	-

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CODE Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits		SEMESTER	Compilation date
ELECTROANALYSIS	SK185211	Kimia Organik	2	0	II	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Suprapto, PhD; Dr.rer.nat. Fredy Kurniawan; MSi, Yatim Lailun nikmah, PhD	Suprapto, PhD	Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.

Learning Outcome	**Learning Outcome Targeted From The Course**	
	LO 7	Able to develop concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right instrument and the substance side effect in order to develop the chemistry
	LO 8	Able to create a chemical mindset and take advantage of science and technology in their fields in solving problems through the accurate and innovative theoretical, experimental or computational approach
	LO 9	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation
	Learning Outcome Mata Kuliah (CPMK)	
	CP MK 1	Students are able to perform chemical analysis using electroanalysis method (P4)

Peta CPL – CP MK

	CPL 1	CPL 2	CPL 3	CPL 4	CPL 5	CPL 6	CPL 7	CPL 8	CPL 9
CP MK 1									

Diskripsi Singkat MK

The Topics Covered in The Subject	Electrode interface reaction, quantitative test using potentiostatic method, quantitative test using potentiodynamic method, material characterization using electrochemical impedance spectroscopy method, non-aqueous electrolysis
References	**Utama:** ▪ Wang, J., "Analytical Electrochemistry", 3rd edition, John Wiley & Sons, New Jersey, 2006. **Pendukung:** Bard, A.J. and Faulkner, R.L., "Electrochemical Methods: Fundamental and Applications", John Willey and Sons, New York, 2001
Lecturer	Suprapto, PhD; Dr.rer.nat. Fredy Kurniawan; MSi, Yatim Lailun nikmah, PhD
Mata Kuliah syarat	

Week-	**The final ability of each learning stage**	**Penilaian**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**
1	Students are able to explain interfacial reactions that are affected by mass transfer and charge transfer			**Lecture Face to face [TM: 2×(2×50')] [BM: 2×(2×50')]**	**Responsi *Small Group discussion* [TM: 2×(2×50')] [BM: 2×(2×50')] [PT: 1x(1x60')]**		
2-4	Students are able to apply the concept of potentiostatic analysis for quantitative testing			**Face to face 3x(2x50)**			

5-7	Students are able to apply potentiodynamic concepts for qualitative and quantitative tests	Individual and group assessment		**Group discussion**			**20%**
8	**Mid Semester Evaluation**						**30%**
9-10	Students are able to analyze the effect of electrode modification on sensitivity and selectivity of electrode			**Face to face and Group discussion**			
11-13	Students are able to design input-output models of potentiodynamic measurement methods for qualitative and quantitative tests in both aqueous and non-aqueous solvents.			**Face to face, Group discussion and presentation**			
14	Students are able to interpret the measurement results using the electrochemical impedance spectroscopy method			**Presentation**			**20%**
15-16	**Final Semester Evaluation**						**30%**

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CODE Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits		SEMESTER	Compilation date
MICRO PROJECT	SK185212	Kimia Analitik	2	0	II	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Yatim Lailun Ni'mah, Ph. D	Suprapto, PhD	Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.

Learning Outcome		
	Learning Outcome Targeted From The Course	
	LO 1	Show moral, ethical, responsibility and good personality in completing their duties
	LO 4	Able to develop leadership attitudes, creativity and communication skills in solving a chemistry-related problem national/international level through a research object
	LO 7	Able to develop concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right instrument and the substance side effect in order to develop the chemistry
	LO 9	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation
	Learning Outcome Mata Kuliah (CPMK)	
	CP MK 1	Students are able to design and conduct a laboratory experiment, analyse on the experiment being performed, and write an experiment report

Peta CPL – CP MK

	CPL 1	CPL 2	CPL 3	CPL 4	CPL 5	CPL 6	CPL 7	CPL 8	CPL 9
CP MK 1									

Subject Description

The Topics Covered in The Subject	Design an experiment, review a journal, conducting an experiment, analyzing experiment results, writing an experiment report.
References	**Utama:** ▪ **Pendukung:**
Lecturer	Dr.rer.nat. Fredy Kurniawan, Msi
Mata Kuliah syarat	

Week-	**The final ability of each learning stage**	**Penilaian**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**
1	Students are able to determine the topic of the experiment for the Master's research plan	The accuracy in determining experimental topics that support the Master's research plan		**Kuliah** ***Small Group discussion*** **[TM: 2×(2×50')]** **[BM: 2×(2×50')]** ● **Lecture & brainstorming, group discussion** ● **Assignment: find a topic according to the Master's research plan**	**Responsi** ***Small Group discussion*** **[TM: 2×(2×50')]** **[BM: 2×(2×50')]** **[PT: 1x(1x60')]**		**10%**

2	Students are able to make experimental designs	The accuracy of planning the experimental flow		• **Lecture & brainstorming, group discussion** • **Assignment: find a topic according to the Master's research plan**			**10%**
3-7	Students are able to conduct experiments in the laboratory	The accuracy of conducting an experiment according to a predetermined experimental flow		**Practice in the laboratory**			**20%**
8	**Mid Semester Evaluation**						**10%**
9	Students are able to analyze the experiments	The accuracy of analyzing the experiments		**Practice in the laboratory**			**10%**
10-13	Students are able to make improvements to the experiments	The accuracy of analyzing the experiments		**Practice in the laboratory**			**10%**
14	Students are able to present the experiments	The accuracy of presenting the experiments		**Presentation**			**10%**
15	Students are able to make reports of the experiments	The accuracy of making experiments' reports		• **Lecture & brainstorming, group discussion**			**10%**

				• **Assignment: find a topic according to the master's research plan**			
16	**Final Semester Evaluation**						**30%**

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CODE Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits		SEMESTER	Compilation date
SEPARATION AND SPECIATION	SK185213	Kimia Analitik	2	0	II	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Suprapto, Ph. D		Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.

Learning Outcome		
	Learning Outcome Targeted From The Course	
	LO 1	Show moral, ethical, responsibility and good personality in completing their duties
	LO 6	Show moral, ethical, responsibility and good personality in completing their duties
	LO 7	Able to develop concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right instrument and the substance side effect in order to develop the chemistry
	Learning Outcome Mata Kuliah (CPMK)	
	CP MK 1	• Students having the general idea on the concepts of chemical separation as a basis to analyse chemical specimens. • Students having the general idea on how to implement chemistry speciations that are related to assessing the environment and materials toxicit (P4).

Peta CPL – CP MK

	CPL 1	CPL 2	CPL 3	CPL 4	CPL 5	CPL 6	CPL 7	CPL 8	CPL 9
CP MK 1									

Diskripsi Singkat MK

The Topics Covered in The Subject	1. The concepts and working principles of solvent extraction, column chromatography, gas chromatography, and high performance liquid chromatography. 2. Physicochemistry properties, toxicity, chemical specimen bioavailabilities and distributions in nature and in living beings. 3. Quantitative and qualitative analysis based on a chemical specimen of an element.
References	**Utama:** ▪ **Pendukung:**
Lecturer	Suprapto, PhD
Pre-requisite	

Week-	**The final ability of each learning stage**	**Penilaian**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**
1	Students are able to explain the concept of chemical separation			**Lecture** ***Small group discussion*** **[TM: 2×(2×50')]** **[BM: 2×(2×50')]**	**Responsi** ***Small group discussion*** **[TM: 2×(2×50')]** **[BM: 2×(2×50')]** **[PT: 1x(1x60')]**		
2-5	Students are able to classify separations based on phase differences, polarity, adsorption, and precipitation			**Lecture**			

6-7	Students are able to apply chemical separation techniques	Individual and group assessment		**Group discussion**			**20%**
8	**Mid Semester Evaluation**						**30%**
9	Students are able to understand the concept of species and chemical speciation			**Lecture and group discussion**			
10-14	Students are able to design separation applications in chemical speciation techniques			**Lecture, group discussion, and presentation**			**20%**
15-16	**Final Semester Evaluation**						**30%**

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CODE Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits		SEMESTER	Compilation date
THERMAL ANALYSIS	SK185214	Kimia Analitik	2	0	II	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Yatim Lailun Ni'mah, Ph. D		Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.

Learning Outcome

Learning Outcome Targeted From The Course	
LO 1	Show moral, ethical, responsibility and good personality in completing their duties
LO 6	Able to analyze and synthesis the concept of structure, properties and substance changes at the micro or macro molecular level based on the dynamic and energetic phenomenon
LO 7	Able to develop concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right instrument and the substance side effect in order to develop the chemistry
LO 8	Able to create a chemical mindset and take advantage of science and technology in their fields in solving problems through the accurate and innovative theoretical, -experimental or -computational approach

Learning Outcome Mata Kuliah (CPMK)	
CP MK 1	• Students are able to review and solve problems, both qualitatively and quantitatively, in particular those that are related to thermal analysis, and also able to use thermal based instruments. • Students have the experience to plan thermal based analysis, and are able to express their ideas or suggestions orally or in written forms

Peta CPL – CP MK

	CPL 1	CPL 2	CPL 3	CPL 4	CPL 5	CPL 6	CPL 7	CPL 8	CPL 9
CP MK 1									

Diskripsi Singkat MK	
The Topics Covered in The Subject	Further applications of TG, DSC and DTA data include deconvolution of the superimposed endotherm, the kinetics of the decomposition of TG, TMA, DMA and their applications.
References	**Utama:** ▪ R. Speyer, "Thermal Analysis of Materials", Marcel Decker, Inc, 1994, New York. **Pendukung:** J. Wang, "Electroanalytical Chemistry," Wiley VCH, USA, 2000.
Lecturer	Yatim Lailun Ni'mah, PhD; Dr.rer.nat. Fredy Kurniawan, MSi; Suprapto, PhD
Pre-requisite	

Week-	**The final ability of each learning stage**	**Penilaian**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**
1	Students understand the application of the Thermal Analysis course lesson plan for one semester			**Lecture** ***Small group discussion*** **[TM: 2×(2×50')]** **[BM: 2×(2×50')]** **Tutorial, discussion**	**Responsi** ***Small group discussion*** **[TM: 2×(2×50')]** **[BM: 2×(2×50')]** **[PT: 1x(1x60')]**		
2	Students can explain TGA and its further applications			**Tutorial, discussion**		TGA and its further applications	**10%**

3	Students can explain DTA and its further applications			**Tutorial, discussion**		DTA and its further applications	**10%**
4	Students can explain DSC and its further applications			**Tutorial, discussion**		DSC and its further applications	**10%**
5, 6	Students can explain TMA and its further applications			**Tutorial, Discussion**		TMA and its further applications	**10%**
7	Students can explain DMA and its further applications			**Tutorial, discussion**		DMA and its further applications	**10%**
8	**Mid Semester Evaluation**						**20%**
9, 10	Students can explain deconvolution from endoterm superimposed			**Lecture, discussion**		Deconvolution from endoterm superimposed	
11, 12	Students can explain the kinetics of TGA decomposition			**Lecture, discussion**		TGA decomposition kinetics	
13, 14	Students can differentiate between applying TGA, DTA, DSC, TMA and DMA			**Lecture, discussion**		The differences between TGA, DTA, DSC, TMA and DMA and their applications	

15, 16	**Final Semester Evaluation**	**30%**

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CODE Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits		SEMESTER	Compilation date
CHARACTERIZATIONS OF INORGANIC MATERIALS II	SK185221	Kimia Inorganik	3	0	II	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Prof. Dr. rer. nat. Irmina Kris muwarni		Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.

Learning Outcome	Learning Outcome Targeted From The Course	
	LO 2	Show a spirit of independence, team work, leadership and entrepreneurship
	LO 7	Able to develop concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right instrument and the substance side effect in order to develop the chemistry
	LO 9	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation
	Learning Outcome Mata Kuliah (CPMK)	
	CP MK 1	Students are able to use and develop the inorganic materials characterization methods in order to obtain a more in depth information, in particular those that involve thermal properties, morphology, surface, and porosity.

Peta CPL – CP MK

	CPL 1	CPL 2	CPL 3	CPL 4	CPL 5	CPL 6	CPL 7	CPL 8	CPL 9
CP MK 1									

Diskripsi Singkat MK

The Topics Covered in The Subject	• Thermal properties characterization and morphology analysis of the solids, where they are being conducted using TGA-DTA and SEM/TEM, N2 adsorption and desorption, and TPD. • Characterization using other spectroscopy methods (FT-IR, Raman UV-Visible, NMR, MS).
References	**Utama:** 1. S.E. Dann, "Reactions and Characterization of Solids" RSC London, UK, 2000 2. West, A.R., "Solid State Chemistry (bab III)", 1992, John Wiley & Sons 3. K. Nakamoto, "Infrared and Raman Spectra of Inorganic and Coordination Compounds", Wiley-Interscience Publication 4. G. Engelhardt, D. Michel, "High-Resolution Solid-State NMR of Silicates and Zeolites", 1987, John Wiley & Sons 5. T. Allen, "Powder Sampling and Particle Size Determination", Elsevier, 2003 6. Z.H. Gross, "Mass Spectrometry", Springer, 2004 7. J. Goldstein, D. Newbury, D. Joy, C. Lyman, P. Echlin, E. Lifshin, L. Sawyer, J. Michael, "Scanning Electron Microscopy and X-Ray Microanalysis", Springer, 2003 ▪ **Pendukung:**
Lecturer	Prof. Dr. Didik Prasetyoko, MSc; Ratna Ediati, Ph.D
Pre-requisite	

Week-	**The final ability of each learning stage**	**Penilaian**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**

1	Knowing how to characterize the thermal properties and morphology of inorganic materials			***Small group discussion*** **[TM: 2×(2×50')]** **[BM: 2×(2×50')]** **Lecture on introduction of the characterization of thermal properties and morphology of inorganic materials with examples**	**Responsi** ***Small group discussion*** **[TM: 2×(2×50')]** **[BM: 2×(2×50')]** **[PT: 1x(1x60')]**	Introduction to the characterization of thermal and morphological properties of inorganic materials	
2, 3	Understanding how to characterize the thermal properties of inorganic materials using DTA, TGA, DSC, DTG	Students can understand the characterization of thermal properties of inorganic materials using DTA, TGA, DSC, DTG		**Lecture on the characterization of thermal properties of inorganic materials using DTA, TGA, DSC, DTG**		Characterization of thermal properties of inorganic materials using DTA, TGA, DSC, DTG	**10%**
3, 4	Understanding the morphology of inorganic materials by SEM, TEM			**Lecture on observation of the morphology of inorganic materials by SEM, TEM**		Observation of the morphology of inorganic materials by SEM, TEM	
5-7	Understanding the surface properties and porosity of inorganic materials with the gas desorption adsorption method and TPD	Students can understand how to characterize the surface properties and porosity of inorganic materials using the gas desorption adsorption method and TPD		**Lecture on how to characterize the surface properties and porosity of inorganic materials using gas desorption**		Characterization of surface properties and porosity of inorganic materials using gas desorption adsorption and TPD methods	**10%**

				adsorption and TPD methods			
8	**Mid Semester Evaluation**						**30%**
9-11	Knowing how to characterize inorganic materials using UV-Vis, FT-IR, Raman			**Lecture on the characterization of inorganic materials with UV-Vis, FT-IR, Raman**		Characterization of inorganic materials using UV-Vis, FT-IR, Raman	
11-13	Knowing how to characterize inorganic materials by using NMR	Students are able to understand the characterization of inorganic materials with NMR, including solid NMR		**Lecture on the characterization of inorganic materials by NMR, including solid NMR**		Inorganic material characterization by NMR, including solid NMR	**20%**
14-15	Knowing how to characterize inorganic materials with MS			**Lecture on the characterization of inorganic materials with MS**		Characterization of inorganic materials by MS	
16	**Final Semester Evaluation**						**30%**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
FAKULTAS SAINS DAN ANALITIKA DATA
DEPARTEMEN KIMIA

CODE Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits		SEMESTER	Compilation date
PROPERTIES AND PERFORMANCE OF MATERIALS	SK185222	Kimia Inorganik	2	0	II	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.		Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.

Learning Outcome		
	Learning Outcome Targeted From The Course	
	LO 1	Show moral, ethical, responsibility and good personality in completing their duties
	LO 6	Able to analyze and synthesis the concept of structure, properties and substance changes at the micro or macro molecular level based on the dynamic and energetic phenomenon
	LO 8	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach
	LO 9	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation
	Learning Outcome Mata Kuliah (CPMK)	
	CP MK 1	● Students are able to determine the structures, physically, mechanically, or chemically, of a material, as well as determining the performance of a material whose properties are already recognized. ● Students are able to link the structures, properties, and performance of a material based on the basic concepts of the structures and properties of kinetics-thermodynamics of molecules. ● Students are able to express their ideas or suggestions both orally or in written forms.

Peta CPL – CP MK

	CPL 1	CPL 2	CPL 3	CPL 4	CPL 5	CPL 6	CPL 7	CPL 8	CPL 9

	CP MK 1
Diskripsi Singkat MK	
The Topics Covered in The Subject	● Introduction to a variety of materials : ceramics, composites, plastics, steel. ● The structures of materials and conducting tests to see their resistance towards heat by thermal analysis (DTA/TGA/DSC), their physical and mechanical properties (BM, stress, strain, dll.), and their chemical properties (reactivities : chromatography, similar properties). ● The uses of materials according to their suitabilities, for example, composites are suitable to use as a body of a ship or airplane, ceramics are suitable to use as a cutting material to cut through hard objects, etc.
References	**Utama:** 1. A.R. West, "Solid State Chemistry (bab IV)", John Wiley & Sons, 1992 2. J.C. Bernier, "Chemical Processing for Electronic Ceramics: A Challenge, Material Science and Engineering", A109, 233, 1989. 3. D.W. Richerson, "Modern Ceramic Engineering", edisi kedua, Marcel Dekker, New York ▪ **Pendukung:**
Lecturer	Dr. Fahimah Martak. MSi; Prof. Dr. Didik Prasetyoko, MSc
Pre-requisite	

Week-	**The final ability of each learning stage**	**Penilaian**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**

1, 2	Knowing several types of materials			**Kuliah** ***Small group discussion*** **[TM: 2×(2×50')]** **[BM: 2×(Lecture on introduction of several types of materials: ceramics, composites, plastics, steel)]**	**Responsi** ***Small group discussion*** **[TM: 2×(2×50')]** **[BM: 2×(2×50')]** **[PT: 1x(1x60')]**	Introduction of several types of materials	
3, 4	Able to determine the structure and thermal properties of materials			**Lecture on the structure of materials and their properties to heat through thermal analysis (DTA / TGA / DSC)**		Thermal analysis (DTA / TGA / DSC)	
5	Able to determine the structure and physical properties of materials			**Lecture on the correlation between the structure and physical properties of materials**		Physical properties of the material	
6, 7	Able to determine the structure and mechanical properties of materials	Able to determine the correlation between the structure and mechanical properties of materials		**Presentation and discussion on the correlation between structure and mechanical properties including BM, stress, strain etc.**		Mechanical properties of the material	**20%**
8	**Mid Semester Evaluation**						**30%**

9, 10	Able to determine the structure and chemical properties of materials			**Lecture on the relationship between the structure and chemical properties of materials including reactivity: chromatography, acidity properties**		Chemical properties of the material	
11, 12	Able to relate the structure, properties and performance of materials based on the basic concepts of molecular structure and thermodynamic-kinetics properties			**Lecture on the relations of structure, properties and performance of materials based on the basic concepts of structure and properties of molecular thermodynamics-kinetics**		Structure, properties and performance of materials	
13, 14	Able to correlate the structure, properties and performance of materials based on the basic concepts of molecular structure and thermodynamic-kinetics properties	Able to correlate the structure, properties and performance of materials based on the basic concepts of structure and properties of molecular thermodynamics-kinetics		**Presentation and discussion on the relations of structure, properties and performance of materials based on the basic concepts of structure and molecular thermodynamic-kinetics properties**		Structure, properties and performance of materials	**20%**

15	Able to express perspectives or ideas verbally and in writing	Ability to compile a journal manuscript		**Lecture and discussion on the structure, properties and performance of materials**		Structure, properties and performance of materials	
16	**Final Semester Evaluation**						**30**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
FAKULTAS SAINS DAN ANALITIKA DATA
DEPARTEMEN KIMIA

CODE Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits		SEMESTER	Compilation date
INORGANIC SOLIDS	SK185223	Kimia Inorganik	2	0	II	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Prof. Fahimah Martak		Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.

Learning Outcome	**Learning Outcome Targeted From The Course**	
	LO 6	Able to analyze and synthesis the concept of structure, properties and substance changes at the micro or macro molecular level based on the dynamic and energetic phenomenon
	LO 8	Able to create a chemical mindset and take advantage of science and technology in their fields in solving problems through the accurate and innovative theoretical, experimental or computational approach
	LO 9	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation
	Learning Outcome Mata Kuliah (CPMK)	
	CP MK 1	● Students are able to determine the crystal structure, type, and lattice energy. ● Students are able to determine the system of crystal and symmetrical solids.

Peta CPL – CP MK

	CPL 1	CPL 2	CPL 3	CPL 4	CPL 5	CPL 6	CPL 7	CPL 8	CPL 9
CP MK 1									

Diskripsi Singkat MK

The Topics Covered in The Subject	• Types of crystal structures, cation: coordinated anion number, ionic radius, ion size trends, radius ratio, covalent arrangements, metal crystals, ionic crystals, interactions between atoms, atom radius, molecule structure, types of bonds, silicates, Born-haber cycle, lattice energy. • Seven crystal systems, index Miller, interplanar distance, fraction coordinates, ionic and covalent solids, simple solids crystal structures, polyhedral representations. • Close packing structures, hcp, fcc, density, tetrahedral and octahedral holes, body and primitive centered structures, crystal solids, lattice and cell units, 2-dimensional planar lattices. • Symmetry, proper rotation, mirror planes, inversion, improper axis, symmetrical translations
References	**Utama:** 1. U. Müller, “Inorganic Structural Chemistry“, second edition, John Wiley and Sons, England, 2006 2. L.E. Smart, Moore, "Solid State Chemistry. An Introduction", fourth edition. 3. J.E. Huheey, “Inorganic Chemistry principles of Structure and Reactivity'', fourth edition, Harper and Row Publisher, New York, 1993 **Pendukung:**
Lecturer	Dr. Afifah Rosyidah, MSi.; Dr. Fahimah Martak MSi
Pre-requisite	

Week-	**The final ability of each learning stage**	**Penilaian**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**

				Kuliah ***Small group discussion*** **[TM: 2×(2×50')]** **[BM: 2×(2×50')]**	**Responsi** ***Small group discussion*** **[TM: 2×(2×50')]** **[BM: 2×(2×50')]** **[PT: 1x(1x60')]**		

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DEPARTEMEN KIMIA

CODE Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits		SEMESTER	Compilation date
ADVANCED BIOCHEMISTRY	SK185231	Kimia Inorganik	3	0	II	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Adi Setyo Purnomo, Ph. D		Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.

Learning Outcome	**Learning Outcome Targeted From The Course**	
	LO 1	Show moral, ethical, responsibility and good personality in completing their duties
	LO 4	Able to develop leadership attitudes, creativity and communication skills in solving a chemistry-related problem national/international level through a research object
	LO 8	: Able to create a chemical mindset and take advantage of science and technology in their fields in solving problems through the accurate and innovative theoretical, experimental or computational approach
	Learning Outcome Mata Kuliah (CPMK)	
	CP MK 1	Understand the in vitro synthesis of biomolecules with and without enzymes, biomolecular bios pathways, biomolecule structure and function, and several case studies

Peta CPL – CP MK

	CPL 1	CPL 2	CPL 3	CPL 4	CPL 5	CPL 6	CPL 7	CPL 8	CPL 9
CP MK 1									

Diskripsi Singkat MK

The Topics Covered in The Subject	Biomolecule biosynthesis pathways, biomolecule structures and functions, gene structures and functions.
References	**Utama:** ▪ **Pendukung:**
Lecturer	Adi Setyo Purnomo, MSc, PhD; Prof. Dr. Drs. Surya Rosa Putra, MS
Pre-requisite	

Week-	**The final ability of each learning stage**	**Penilaian**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**
1-4	Determine the biosynthetic pathway of biomolecules	Accuracy in explaining biomolecular biosynthetic pathways		**Kuliah** ***Small group discussion*** **[TM: 2×(2×50')]** **[BM: 2×(2×50')]**	**Responsi** ***Small group discussion*** **[TM: 2×(2×50')]** **[BM: 2×(2×50')]** **[PT: 1x(1x60')]**	Biomolecular biosynthetic pathways	**20%**
5-7	Determine the in vitro synthesis of biomolecules with and without enzymes.	Accuracy in explaining the in vitro synthesis of biomolecules with and without enzymes.		**Lecture**		Gene structure and function	
8	**Mid Semester Evaluation**						**25%**

9-11	Knowing the structure and function of biomolecules.	Accuracy in explaining the structure and function of biomolecules		**Lecture**		Structure and function of biomolecules.	**20%**
12-15	Understand multiple case studies	Accuracy in understanding several case studies		**Presentation**		Related Journal Presentations	**10%**
16	**Final Semester Evaluation**						**25%**

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DEPARTEMEN KIMIA

CODE Dokumen

RENCANA PEMBELAJARAN SEMESTER

SUBJECT NAME	CODE	Subject Cluster	Credits		SEMESTER	Compilation date
MICROORGANISM METABOLISMS	SK185232	Kimia Organik	3	0	II	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Adi Setyo Purnomo, Ph. D		Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.

Learning Outcome	**Learning Outcome Targeted From The Course**	
	LO 6	Able to analyze and synthesis the concept of structure, properties and substance changes at the micro or macro molecular level based on the dynamic and energetic phenomenon
	Learning Outcome Mata Kuliah (CPMK)	
	CP MK 1	Understanding the types of beneficial microorganisms, developing the function of microorganisms in the metabolic pathways of biomolecules, knowing the metabolic pathways of biomolecules by microorganisms, utilizing microorganisms in biochemical processes, several case studies

Peta CPL – CP MK

	CPL 1	CPL 2	CPL 3	CPL 4	CPL 5	CPL 6	CPL 7	CPL 8	CPL 9
CP MK 1									

Diskripsi Singkat MK

The Topics Covered in The Subject	Biotechnology, tissue culture, nucleic acids, plasmids, genetic engineering, bioplastics, biopigments
References	**Utama:** ▪ **Pendukung:**
Lecturer	Adi Setyo Purnomo, MSc, PhD; Prof. Dr. Drs. Surya Rosa Putra, MS
Pre-requisite	

Week-	**The final ability of each learning stage**	**Penilaian**		**Learning Forms; Learning methods; Student Assignment; [Estimated time]**		**Learning materials [References]**	**Score Rating (%)**
		Indicator	**Criteria & Techniques**				
(1)	**(2)**	**(3)**	**(4)**	**Tatap Muka (5)**	**Daring (6)**	**(7)**	**(8)**
1, 2	Knowing the metabolic pathways of biomolecules by microorganisms	The accuracy in explaining the metabolic pathways of biomolecules by microorganisms		**Lecture** ***Small group discussion*** **[TM: 2×(2×50')]** **[BM: 2×(2×50')]**	**Responsi** ***Small group discussion*** **[TM: 2×(2×50')]** **[BM: 2×(2×50')]** **[PT: 1x(1x60')]**	Biotechnology	
3, 4	Knowing the types of microorganisms that are useful	Accuracy in explaining tissue culture		**Lecture**		Plant tissue isolation method	**15%**
5, 6	Knowing the types of beneficial microorganisms	Accuracy in describing nucleic acids and plasmids		**Lecture**		Nucleic Acids and Plasmids	

7	Developing the function of microorganisms in the metabolic pathways of biomolecules	Accuracy in explaining genetic engineering		**Lecture**		Genetic Manipulation	
8	**Mid Semester Evaluation**						**25%**
9, 10	Applying microorganisms in biochemical processes.	Accuracy in explaining the application of microorganisms in bioplastics.		**Lecture**		Bioplastics	
11-13	Applying microorganisms in biochemical processes.	Accuracy in explaining the application of microorganisms in biopigments		**Lecture**		Biopigment	**15%**
14, 15	Understand multiple case studies.	Accuracy in understanding several case studies		**Presentation**		Case Studies	**10%**
16	**Final Semester Evaluation**						**25%**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
FACULTY OF SCIENCES AND ANALYTICAL DATA
DEPARTMENT OF CHEMISTRY

Kode Dokumen

SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course disciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Data
STATISTICAL THERMODYNAMICS	SK 185242	Physical Chemistry	3	0	II	07 Januari 2020

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Dr. Hendro Juwono M.Si., Drs. Lukman Atmaja M.Si., Ph.D	Dr. Hendro Juwono M.Si.	Prof.Dr. Didik Prasetyoko S.Si., M.Sc.

Learning Outcomes (LO)	LO-PRODI Charged to The Course	
	A.5 (LO 2)	Show a spirit of independence and team work in completing their duties
	C.1 (LO 6)	Able to develop the concept of structure, properties, and substance changes at the micro- or macromolecular level based on the dynamic and energetic phenomenon
	C.4 (LO 9)	Able to build a chemical knowledge especially in the energy, environmental, marine, and medical, in order to develop the research, industry and employment creation
	Course Learning Outcomes (LO MK)	
	CP MK 1	Students are able to employ the basic concepts of atom structures and molecules to predict the properties of atoms and molecules

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1		√				√			√

Course Short Description

Study Material: Subject matter	Discussion review, molecules with many atoms/polyatomic, molecular condition distribution, internal energy and entropy, canonical partition function, thermodynamic function, molecular partition function, free energy average, heat capacity, state function, liquid phase molecular interaction, residual entropy, and equilibrium constant
Reference	**Main:** 1. P. W. Atkins and J. de Paula, "Physical Chemistry", 9th edition, W.H. Freeman & Co, New York, 2009. **Supporting:** 1. D. A. McQuarrie, "Quantum Chemistry", 2nd edition, University Science Books, California, 2007.
Supporting Lecturer	Dr. Hendro Juwono M.Si., Drs. Lukman Atmaja M.Si., Ph.D
Pre-Requisite Courses	

Session	**Learning outcome of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1	Students are able to understand and employ the partition function in molecules with many atoms/polyatomic	• The accuracy, The order/ logic, The calculations in solving chemical problems related to the partition function of molecules with many atoms/ polyatomic	**Technical :** Quiz **Criteria :**	**Lecture and exercise 2x(2x50")**		• partition function in molecules with many atoms/polyatomic	**5**

2	Students are able to understand and employ the internal energy function in homo/heteronuclear molecules	• The accuracy, The order/ logic, The calculations in solving chemical problems related to the application of internal energy function in homo/heteronuclear molecules	**Technical :** Assignment **Criteria :**	**Lecture and exercise 2x(2x50")**		• Internal energy function in homo/heteronuclear molecules	**5**
3	Students are able to understand and employ the entropy concept in homo/heteronuclear molecules	• The accuracy, The order/ logic, The calculations in solving chemical problems related to the entropy concept in homo/heteronuclear molecules	**Technical :** Assignment **Criteria :**	**Lecture and exercise 2x(2x50")**		• The entropy concept in homo/heteronuclear molecules	**5**
4	Students are able to understand and employ the entropy concept in homo/heteronuclear molecules	• The accuracy, The order/ logic, The calculations in solving chemical problems related to the spectra of complex atom	**Technical :** Quiz **Criteria :**	**Lecture and exercise 2x(2x50")**		• The entropy concept in homo/heteronuclear molecules	**10**
5	Students are able to understand the magnitude of the canonical ensemble	• The accuracy, The order/ logic, The calculations in solving chemical problems	**Technical :** Assignment **Criteria :**	**Lecture and exercise 2x(2x50")**		• the magnitude of the canonical ensemble	**5**

		related to the magnitude of the canonical ensemble					
6	Students are able to understand and employ the theory of the partition function and its thermodynamics	• The accuracy, The order/ logic, The calculations in solving chemical problems related to the theory of the partition function and its thermodynamics	**Technical :** **Criteria :**	**Lecture and exercise 2x(2x50")**		• the theory of the partition function and its thermodynamics	**10**
7	Students are able to understand and employ the theory of the partition function with its thermodynamics to independent molecules	• The accuracy, The order/ logic, the calculations in solving chemical problems related to the theory of the partition function with its thermodynamics to independent molecules	**Technical :** Assignment **Criteria :**	**Lecture and exercise 2x(2x50")**		• the theory of the partition function with its thermodynamics to independent molecules	**5**
8	**Mid-term evaluation**						**25**
9-10	Students are able to understand and apply the thermodynamic function of molecular properties	• The accuracy, the order/ logic, the calculations in solving chemical problems related to the theory and the application of the	**Technical :** Assignment **Criteria :**	**Lecture and exercise 4x(2x50")**		• the thermodynamic function of molecular properties	**10**

		thermodynamic function of molecular properties					
11	Students are able to understand and apply the thermodynamic function and the partition function of molecules	• The accuracy, the order/ logic, the calculations in solving chemical problems related to the application of the thermodynamic function and the partition function of molecules	**Technical :** Assignment • **Criteria :**	**Lecture and exercise 2x(2x50")**		• the thermodynamic function and the partition function of molecules	**10**
12-13	Students are able to understand and apply the concepts of the partition function and thermodynamics to heat capacity, average energy, and molecular state equations	• The accuracy, the order/ logic, the calculations in solving chemical problems related to the partition function and thermodynamics to heat capacity, average energy, and molecular state equations	**Technical :** Quiz **Criteria :**	**Lecture and exercise 4x(2x50")**		• the partition function and thermodynamics to heat capacity, average energy, and molecular state equations	**15**
14	Students are able to understand and apply the concepts of the molecular interactions in liquid phase,	• The accuracy, the order/ logic, the calculations in solving chemical problems related to the	**Technical :** Quiz and Assignment **Criteria :**	**Lecture and exercise 2x(2x50")**		• the molecular interactions in liquid phase, residual entropic, and	**5**

	residual entropic, and equilibrium constant.	molecular interactions in liquid phase, residual entropic, and equilibrium constant.				equilibrium constant.	
15-16	**End-term evaluation**						**7.5**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
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DEPARTMENT OF CHEMISTRY

Kode Dokumen

SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course disciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Data
MOLECULAR COMPUTATIONAL CHEMISTRY	SK 185243	Physical Chemistry	3	0	II	07 Januari 2020

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Dr. Hendro Juwono M.Si., Drs. Lukman Atmaja M.Si., Ph.D, Dr. Yuly Kusumawati S.Si, M.Si.	Dr. Hendro Juwono M.Si.	Prof.Dr. Didik Prasetyoko S.Si., M.Sc.

Learning Outcomes (LO)		
	LO-PRODI Charged to The Course	
	A.2 (LO 1)	Show moral, ethical, responsibility and good personality in completing their duties
	A.5 (LO 2)	Show a spirit of independence and team work in completing their duties
	C.3 (LO 8)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach
	C.4 (LO 9)	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation industry and employment creation
	Course Learning Outcomes (LO MK)	
	CP MK 1	Familiarizing the use of software to predict the physical and chemical properties and able to make decisions amongst the different properties obtained

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1	√	√						√	√

Course Short Description	
Study Material: Subject matter	1. Types of molecular computation methods: Ab-initio, HF, DFT, QM/MM 2. Mechanical molecules.
Reference	**Main:** 1. P. W. Atkins and J. de Paula, "Physical Chemistry", 9th edition, W.H. Freeman & Co, New York, 2009. **Supporting:** 1. D. A. McQuarrie, "Quantum Chemistry", 2nd edition, University Science Books, California, 2007.
Supporting Lecturer	Dr. Hendro Juwono M.Si., Drs. Lukman Atmaja M.Si., Ph.D, Dr. Yuly Kusumawati S.Si, M.Si.
Pre-Requisite Courses	

Session	**Learning outcome of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1	Students are able to explain numerical methods as the basis of calculations in computational chemistry calculations	• The accuracy in analogizing the understanding of numerical methods for solving computational chemistry calculations	**Technical :** Quiz **Criteria :**	**Lecture and exercise 2x(2x50")**		• Reviewing about numerical method for computational chemistry	**3**

2	Students are able to explain kinds of methods/approaches in computational chemistry calculations	• The accuracy in explaining methods/approaches in computational chemistry calculations	**Technical :** Quiz **Criteria :**	**Lecture and exercise** **2x(2x50")**		• Computational method solving approach: ab-initio, DFT, QM/MM	**3**
3-4	Students are able to explain the concept of molecular mechanics Students are able to calculate and analyze the calculated result using the concept of molecular mechanics	• The accuracy of completing calculations and explaining the results of calculations using the concept of molecular mechanics	**Technical :** Quiz and practical assignment **Criteria :**	**Lecture, assignment, practice** **4x(2x50")**		• Molecular mechanics, force fields	**3**
5	Students are able to explain the concept of the Monte Carlo simulation Students are able to calculate and analyze the calculated result using the Monte Carlo simulation	• The accuracy in describing molecule and its solid structure using Chemsketch and Avogadro	**Technical :** Practice/ assignment **Criteria :**	**Lecture and practice** **2x(2x50")**		• Monte Carlo simulation	**3**
6-7	Students are able to explain the concept of molecular dynamics simulation Students are able to calculate and analyze the calculated result using the concept of molecular dynamics simulation	• The accuracy in calculating and analyzing the results of calculations using the concept of molecular dynamics simulation	**Technical :** Practice/ assignment **Criteria :**	**Lecture and exercise** **4x(2x50")**		• Molecular dynamics simulation	**3**

8	**Mid-term evaluation**						**20**
9	Students are able to explain the application of quantum chemistry concepts in computational chemistry calculations	• The accuracy in explaining the application of quantum chemistry concepts in computational chemistry calculations	**Technical :** Assignment/ practice **Criteria :**	**Lecture, exercise, practice 2x(2x50")**		• Quantum Mechanics for Computational Chemistry	**3**
10	Students are able to calculate and analyze the results of geometric optimization and frequency calculations using the concept of quantum mechanics	• The accuracy in calculating and analyzing the results of geometric optimization and frequency calculations using the concept of quantum mechanics	**Technical :** Assignment/ practice • **Criteria :**	**Lecture, exercise, practice 2x(2x50")**		• Quantum mechanical calculations I: Geometrical optimization and frequency calculation	**3**
11-12	Students are able to calculate and analyze the results of the electronical property calculations using the concept of quantum mechanics	• The accuracy in calculating and analyzing the results of the electronical property calculations using the concept of quantum mechanics	**Technical :** Assignment/ practice **Criteria :**	**Lecture, exercise, practice 4x(2x50")**		• Quantum mechanical calculations II: The electronical properties	**3**
13-15	Students are able to calculate and analyze the calculated results of transition state to determine the reaction	• The accuracy in calculating and analyzing the calculated results of transition state to determine the	**Technical :** Assignment/ practice **Criteria :**	**Lecture, exercise, practice 6x(2x50")**		• Quantum mechanical calculations II: The transition state	**3**

	mechanism using the concept of quantum mechanics	reaction mechanism using the concept of quantum mechanics					
15-16	**End-term evaluation**						**20**

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SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course disciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Data
ADVANCED ORGANIC SYNTHESIS	SK 185251	Organic Chemistry	3	0	II	07 Januari 2020

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Prof. Dr. Mardi Santoso, Arif Fadlan D.Sc	Prof. Dr. Mardi Santoso	Prof.Dr. Didik Prasetyoko S.Si., M.Sc.

Learning Outcomes (LO)	LO-PRODI Charged to The Course	
	A.5 (LO 2)	Show a spirit of independence and team work in completing their duties
	C.2 (LO 7)	Able to analyze and synthesis concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right intrument and the substance side effect in order to develop the chemistry
	C.3 (LO 8)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach
	Course Learning Outcomes (LO MK)	
	CP MK 1	Students are able to think critically on the organic chemical reactions and synthesis strategies, as well as carrying out synthesis for the researched organic compounds.
	CP MK 2	Students are able to express their ideas or suggestions orally or in written forms.

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1		√					√	√	
CP MK 2		√							

Course Short Description

Study Material: Subject matter	Reviewing in detail the reactions that occur in organic chemicals and using the correct synthesis strategy, study case in synthesis the researched chemical compounds.
Reference	**Main:** **Supporting:**
Supporting Lecturer	Prof. Dr. Mardi Santoso, Arif Fadlan D.Sc
Pre-Requisite Courses	

Session	**Learning outcome of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1-3	Students are able to explain and demonstrate the process of organic compound reactions and the disconnection of organic compound	• The accuracy in explaining and demonstrating the process of organic compound reactions and the disconnection of organic compound	**Technical :** Assignment I **Criteria :**	**Introduction lecture and brainstorming (3x50")** **Lecture and discussion 2x(3x50")** **Assignment I [BT+BM:(1+1)x(3x60")**		• Reactions in organic compounds • Disconnections in organic compounds	**10**

4-7	Students are able to explain and demonstrate the strategy of organic synthesis	• The accuracy in explaining and demonstrating the strategy of organic synthesis	**Technical :** Assignment II **Criteria :**	**Lecture and group discussion** **4x(3x50")**		• the strategy of organic synthesis (from synthons to the targeted molecules)	**15**
8	**Mid-term evaluation**						**25**
9-15	Students are able to explain, demonstrate, and apply knowledge of organic compound synthesis strategies to produce the desired target compounds in a case study	• The accuracy in explaining, demonstrating, and applying knowledge of organic compound synthesis strategies to produce the desired target compounds in a case study	**Technical :** Assignment III (paper work and presentation) **Criteria :**	**Lecture and study group** **7x(3x50")**		• Study cases about the targeted compounds	**25**
15-16	**End-term evaluation**						**25**

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SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course disciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Data
NATURAL PRODUCT ORGANIC CHEMISTRY	SK 185251	Organic Chemistry	3	0	II	07 Januari 2020

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Prof. Dr. Taslim Ersam, M.S., Sri Fatmawati, M.Sc, Ph.D.	Prof. Dr. Mardi Santoso	Prof.Dr. Didik Prasetyoko S.Si., M.Sc.

Learning Outcomes (LO)	LO-PRODI Charged to The Course	
	B.1 (LO 3)	Able to solve complex problem and analyze them to be developed using logical thinking based on scientific principles
	C.3 (LO 8)	Able to explain science and technology problems related to structure and chemical change through problems through the accurate and innovative theoretical, -experimental or -computational approach
	C.4 (LO 9)	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation industry and employment creation
	Course Learning Outcomes (LO MK)	
	CP MK 1	Students are able to develop the ideas and activities critically through plant chemosystematics approach in planning a sustainable research and then deciding a plant from a biological variety of tropical rainforest.

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1			√					√	√

Course Short Description

Study Material: Subject matter	The chemical backgrounds of plants through chemosystematics approach and taxonomy; metabolism variations and phylogenetics diagram correlation; biogenesis pathway in forming secondary metabolite compounds; grouping secondary metabolite compounds (alkaloids, terpenoids, flavonoids, and steroids); chemical compound separation techniques through extraction, fractionation; bioactivity tests and determining structures.
Reference	**Main:** **Supporting:**
Supporting Lecturer	Prof. Dr. Taslim Ersam, M.S., Sri Fatmawati, M.Sc, Ph.D.
Pre-Requisite Courses	

Session	**Learning outcome of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1-2	Students are able to explain the chemical background of plants	• The accuracy in explaining the chemical background of plants	**Technical :** **Criteria :**	**Introduction lecture and brainstorming (3x50")** **Lecture and discussion (3x50")**		• The chemical background of plants by chemosystematics approach • The chemical background of plants by taxonomy approach	

3-4	Students are able to explain the variation in plant metabolism and its relationship with phylogenetic diagram	• The accuracy in explaining the variation in plant metabolism and its relationship with phylogenetic diagram	**Technical :** Assignment I **Criteria :**	**Lecture and group discussion** **2x(3x50")** **Assignment I** **[BT+BM:(1+1)x(3x60")**		• Variation in plant metabolism • Phylogenetic diagram	**10**
5-6	Students are able to explain the biogenesis pathway for the formation of secondary metabolite compounds	• The accuracy in explaining the biogenesis pathway for the formation of secondary metabolite compounds	**Technical :** Assignment II **Criteria :**	**Lecture and group discussion** **2x(3x50")** **Assignment II** **BT+BM:(1+1)x(2x60")**		• Biogenesis pathway for the formation of secondary metabolite compounds	**10**
7	Students are able to explain and classify secondary metabolite compounds, namely derivatives of alkaloids, terpenoids, flavonoids and steroids.	• The accuracy in explaining and classifying secondary metabolite compounds, namely derivatives of alkaloids, terpenoids, flavonoids and steroids.	**Technical :** **Criteria :**	**Lecture and group discussion** **(3x50")**		• Kinds of secondary metabolites (derivatives of alkaloids, terpenoids, flavonoids and steroids)	
8	**Mid-term evaluation**						**25**
9-10	Students are able to explain and classify secondary metabolite compounds, namely derivatives of alkaloids, terpenoids, flavonoids and steroids.	• The accuracy in explaining and classifying secondary metabolite compounds, namely derivatives of alkaloids,	**Technical :** Assignment III **Criteria :**	**Lecture and study group** **2x(3x50")** **Assignment III** **BT+BM:(1+1)x(3x60")**		• Kinds of secondary metabolites (derivatives of alkaloids, terpenoids, flavonoids and steroids)	**15**

		terpenoids, flavonoids and steroids.					
11-14	Students are able to explain and perform separation techniques (by extraction, fractionation, purification), bioactivity assays, and structure elucidation.	The accuracy in explaining and performing separation techniques (by extraction, fractionation, purification), bioactivity assays, and structure elucidation.	**Technical :** Assignment IV **Criteria :**	**Lecture and study group (3x50")** **Assignment IV BT+BM:(1+1)x(1x60")** **Laboratory works (4x160")**		• Separation techniques (extraction, fractionation, purification) • Bioactivity assay • Structure elucidation	**20**
15-16	**End-term evaluation**						**20**

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SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course disciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Data
ORGANIC GEOCHEMISTRY	SK 185253	Organic Chemistry	3	0	II	07 Januari 2020
AUTHORIZATION / LEGALIZATION	**RPS Development Lecturer**		**RMK Coordinator**		**Head of Study Program (PRODI)**	
	Prof. Dr. R.Y. Perry Burhan, M.Sc., Dr. Yulfi Zetra, M.S.		Prof. Dr. Mardi Santoso		Prof.Dr. Didik Prasetyoko S.Si., M.Sc.	

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	B.2 (LO 4)	Able to develop leadership attitudes, creativity and communication skills in solving a chemistry-related problem related problem
	C.1 (LO 6)	Able to develop the concept of structure, properties and substance changes at the micro- or macromolecular level based on the dynamic and energetic phenomenon
	C.2 (LO 7)	Able to analyze and synthesis concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right intrumentand the substance side effect in order to develop the chemistry
	C.4 (LO 9)	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation industry and employment creation
	Course Learning Outcomes (LO MK)	
	CP MK 1	Students are able to evaluate molecules for new sediments, old sediments, and how natural oil is produced.
	CP MK 2	Students are able to understand how organic materials inside the Earth is being produced, biogenic chemical compositions, organic materials deposition system, how humate compounds are formed, coal and kerogen, natural gas composition and how it is formed, molecular evaluation for new sediments, the roles of molecules for old sediments and in forming crude oil.

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1						√			
CP MK 2				√			√		√

Course Short Description	
Study Material: Subject matter	Organic materials production inside the Earth, biogenic chemical composition, organic materials deposition system, the production of humate compounds, kerogen, and coal; natural gas composition and how it is formed, molecular evaluation for new sediments, the roles of molecules on old sediments and the production of crude oil.
Reference	**Main:** **Supporting:**
Supporting Lecturer	Prof. Dr. R.Y. Perry Burhan, MS; Dr. Yulfi Zetra, MS
Pre-Requisite Courses	

Session	**Learning outcome of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**

1-2	Students are able to explain the production process of organic compounds in the Earth	• The accuracy in explaining the chemical background of plants	**Technical :** **Criteria :**	**Lecture and discussion 2x(3x50")** **Lecture and discussion (3x50")**		• The production process of organic matters	
3-4	Students are able to explain the biogenic composition of organic matters in the Earth	• The accuracy in explaining the biogenic composition of organic matters in the Earth	**Technical :** Assignment I **Criteria :**	**Lecture and group discussion 2x(3x50")** **Assignment I [BT+BM:(1+1)x(2x60")**		• the biogenic composition of organic matters in the Earth	**15**
5-6	Students are able to explain the organic material deposition system	• The accuracy in explaining the organic material deposition system	**Technical :** **Criteria :**	**Lecture and group discussion 2x(3x50")**		• the organic material deposition system	
7	Students are able to explain the formation process of humic compounds, coal and kerogen	• The accuracy in explaining the formation process of humic	**Technical :** **Criteria :**	**Lecture and group discussion (3x50")**		• The formation process of humic compounds, coal and kerogen	

		compounds, coal and kerogen					
8	**Mid-term evaluation**						**25**
9	Students are able to explain the formation process of humic compounds, coal and kerogen	• The accuracy in explaining the formation process of humic compounds, coal and kerogen	**Technical :** **Criteria :**	**Lecture and group discussion (3x50")**		• The formation process of humic compounds, coal and kerogen	
10-11	Students are able to explain the formation process and chemical compositions of crude oil	The accuracy in explaining the formation process and chemical compositions of crude oil	**Technical : Assignment 2** **Criteria :**	**Lecture and group discussion 2x(3x50")** **Assignment 2 BT+BM:(1+1)x(2x60")**		• The formation process and chemical compositions of crude oil	**15**
12-13	Students are able to explain the process and results of molecular evaluation for new sediments	The accuracy in explaining the process and results of molecular evaluation for new sediments	**Technical : Assignment 3** **Criteria :**	**Lecture and group discussion 2x(3x50")** **Assignment 2 BT+BM:(1+1)x(1x60")**		• The molecular evaluation for new sediments	**20**
14-15	Students are able to explain the molecular role of old sediments and the formation of crude oil.	The accuracy in explaining the molecular role of old sediments and the formation of crude oil.	**Technical :** **Criteria :**	**Lecture and group discussion 2x(3x50")**		• The molecular role of old sediments and the formation of crude oil.	
15-16	**End-term evaluation**						**25**

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Kode Dokumen

SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course disciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Data
BIOANALYTICS	SK 185311	Analytical Chemistry	2	0	III	07 Januari 2020

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Dr. Yatim Lailun Ni'mah, M.Si.	Suprapto, M.Si., Ph.D.	Prof.Dr. Didik Prasetyoko S.Si., M.Sc.

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	A.2 (LO 1)	Show moral, ethical, responsibility and good personality in completing their duties
	C.1 (LO 6)	Able to develop the concept of structure, properties and substance changes at the micro- or macromolecular level based on the dynamic and energetic phenomenon
	C.2 (LO 7)	Able to analyze and synthesis concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right intrumentand the substance side effect in order to develop the chemistry
	Course Learning Outcomes (LO MK)	
	CP MK 1	Students are able to explain the analysis techniques for biological materials and combining it with classical and/or instrumental techniques

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1	√					√		√	

Course Short Description

Study Material: Subject matter	Cholesterol, carbohydrate, and protein tests classically and instrumentally based on the standard methods: AOAC and ASTM.
Reference	**Main:** 1. A. Manz, N. Pamme, D. Iossifidis, "Bioanalytical Chemistry", Mainland Press, Singapore, 2004 2. ASTM 3. AOAC **Supporting:** 1. A. I. Vogel, "Macro and Semi Micro Quantitative in Organic Analysis", 1954.
Supporting Lecturer	Yatim Lailun Ni'mah, PhD
Pre-Requisite Courses	

Session	**Learning outcome of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1	Students are able to explain the basic concepts of sampling, sample preparation and analysis of biological materials		**Technical :** **Criteria :**	**Lecture**			

2-7	Students are able to explain the analysis techniques of biological materials: protein, carbohydrates, fatty acids, and vitamins using classical techniques		**Technical :** **Criteria :**	**Lecture, group discussion, and presentation**			**10**
8	**Mid-term evaluation**						**25**
9-13	Students are able to explain the analysis techniques of biological materials: protein, carbohydrates, fatty acids, and vitamins using instrumental techniques		**Technical :** **Criteria :**	**Lecture, group discussion, and presentation**			**10**
14	Students are able to describe the history, the initial research and the main reference and leading edge research in the field of bioanalytic.		**Technical :** **Criteria :**	**Presentation**			**20**
15-16	**End-term evaluation**						**30**

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SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course disciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Data
ELECTROCHEMISTRY SENSORS	SK 185312	Analytical Chemistry	3	0	III	07 Januari 2020

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Prof. Dr.rer.nat. Fredy Kurniawan, M.Si.	Suprapto, M.Si., Ph.D.	Prof.Dr. Didik Prasetyoko S.Si., M.Sc.

Learning Outcomes (LO)	LO-PRODI Charged to The Course	
	A.2 (LO 1)	Show moral, ethical, responsibility and good personality in completing their duties
	C.1 (LO 6)	Able to develop the concept of structure, properties and substance changes at the micro- or macromolecular level based on the dynamic and energetic phenomenon
	C.2 (LO 7)	Able to analyze and synthesis concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right intrumentand the substance side effect in order to develop the chemistry
	Course Learning Outcomes (LO MK)	
	CP MK 1	The students are able to apply the knowledge of fabrication system and data acquisition based on the tests using Electrochemistry Sensors (P4).

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1	√					√	√		

Course Short Description

Study Material: Subject matter	The basic concepts of electrochemistry sensors, classifying Electrochemistry Sensors based on the examined parameters, the general ways of fabricating electrochemical sensors, active materials and modifying electrochemical sensors, applications of electrochemical sensors.
Reference	**Main:** 1. T.C. Pearce, S.S. Schiffman, H. T. Nagle, J.W. Gardner (editors), "Handbook of Machine Olfaction", Wiley VH, Weinheim, 2003. 2. Y. Fraden, "Handbook of Modern Sensor", Springer Verlag, New York, 2010. **Supporting:** 1. Wang, J., "Electroanalytical Chemistry", Wiley VCH, USA, 2000.
Supporting Lecturer	Dr.rer.nat. Fredy Kurniawan, M.Si
Pre-Requisite Courses	

Session	Learning outcome of each learning stage (Sub-LOMK)	Assessment		Learning Design; Learning Method; Student Assignment; [Time Estimation]		Learning Material [Reference]	Assessment (%)
		Indicator	Criteria and Technical				
(1)	(2)	(3)	(4)	Face-to-face Class (5)	Online Class (6)	(7)	(8)
1	Students are able to explain the basic concepts of electrochemical sensors		**Technical :** **Criteria :**	**Lecture**			

2-4	Students are able to classify electrochemical sensors based on the parameters tested		**Technical :** **Criteria :**	**Lecture**			**10**
2-4	Students are able to classify electrochemical sensors based on the parameters tested		**Technical :** **Criteria :**	**Lecture**			**10**
5-7	Students are able to apply general techniques of electrochemical sensor fabrication	Individual and Group Assessments	**Technical :** **Criteria :**	**Group discussion**			**20**
8	**Mid-term evaluation**						**30**
9-10	Students are able to design active ingredients and modify electrochemical sensor		**Technical :** **Criteria :**	**Lecture and group discussion**			
11-14	Students are able to design electrochemical sensor applications in the fields of food, health and the environment		**Technical :** **Criteria :**	**Lecture, group discussion, presentation**			**20**
15-16	**End-term evaluation**						**30**

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SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course disciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Data
BIOSYNTHESIS	SK 185331	Biochemistry	3	0	III	07 Januari 2020

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Adi Setyo Purnomo, M.Sc., Ph.D., Prof. Dr. Drs. Surya Rosa Putra, MS	Adi Setyo Purnomo, M.Sc., Ph.D.	Prof.Dr. Didik Prasetyoko S.Si., M.Sc.

Learning Outcomes (LO)		
	LO-PRODI Charged to The Course	
	C.1 (LO 6)	Able to develop the concept of structure, properties and substance changes at the micro- or macromolecular level based on the dynamic and energetic phenomenon
	C.2 (LO 7)	Able to analyze and synthesis concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right instrument and the substance side effect in order to develop the chemistry
	C.3 (LO 8)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach
	Course Learning Outcomes (LO MK)	
	CP MK 1	The students are able to understand the biosynthetic and biotransformation pathways of biomolecules, as well as several case studies

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1						√	√	√	

Course Short Description	
Study Material: Subject matter	Bioorganic biosynthesis pathways, biomolecule biotransformation, primary and secondary metabolism pathways, biosynthesis techniques.
Reference	**Main:** 1. Herbert, R.B., "The Biosynthesis of Secondary Metabolites", Springer, 1989. 2. Richard J. Petroski, Susan P. McCormick, "Secondary-Metabolite Biosynthesis and Metabolism", Springer, 1992. **Supporting:** 3.
Supporting Lecturer	Adi Setyo Purnomo, MSc, PhD; Prof. Dr. Drs. Surya Rosa Putra, MS
Pre-Requisite Courses	

Session	**Learning outcome of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**

1-2	Students are able to understand the biosynthesis pathways of biomolecules	• The accuracy in explaining the metabolic pathways of biomolecules by microorganisms	**Technical :** **Criteria :**	**Lecture 2x(3x50")**		The primary metabolic pathways	
3-4	Students are able to understand the biosynthesis pathways of biomolecules	• The accuracy in explaining tissue cultures	**Technical :** **Quiz 1** **Criteria :**	**Lecture 2x(3x50")**		The secondary metabolic pathways	**15**
5-7	Students are able to understand the biosynthesis pathways of biomolecules	• The accuracy in explaining nucleic acids and plasmids	**Technical :** **Criteria :**	**Lecture 3x(3x50")**		Biosynthetic techniques	
8	**Mid-term evaluation**						**25**
9-10	Students are able to understand the biotransformation pathways of biomolecules	• The accuracy in explaining the application of microorganism in bioplastics	**Technical :** **Criteria :**	**Lecture 2x(3x50")**		The biosynthetic pathways of poly ketone	
11-12	Students are able to understand the biotransformation pathways of biomolecules	• The accuracy in explaining the application	**Technical :** **Quiz 2** **Criteria :**	**Lecture 2x(3x50")**		The biosynthetic pathways of terpenes and steroids	**15**

		of microorganism in biopigment					
13-14	Students are able to understand the biotransformation pathways of biomolecules		**Technical :** **Criteria :**	**Lecture 2x(3x50")**		The biosynthetic pathways of alkaloids	
15	Students are able to understand some case studies	• The accuracy in understanding some case studies	**Technical : Presentation** **Criteria :**	**Presentation 1x(3x50")**		Case studies	**10**
15	**End-term evaluation**						**25**

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SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course disciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Data
STRUCTURE DETERMINATION OF ORGANIC COMPOUNDS	SK 185351	Organic Chemistry	3	0	III	07 Januari 2020

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Prof. Dr. Taslim Ersam, M.S.	Prof. Dr. Mardi Santoso	Prof.Dr. Didik Prasetyoko S.Si., M.Sc.

Learning Outcomes (LO)	LO-PRODI Charged to The Course	
	A.5 (LO 2)	Show a spirit of independence and team work in completing their duties
	B.2 (LO 4)	Able to develop leadership attitudes, creativity and communication skills in solving a chemistry-related problem related problem
	C.2 (LO 7)	Able to analyze and synthesis concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right instrument and the substance side effect in order to develop the chemistry
	C.3 (LO 8)	Able to explain science and technology problems related to structure and chemical change through problems through the accurate and innovative theoretical, -experimental or -computational approach
	Course Learning Outcomes (LO MK)	
	CP MK 1	Students are able to develop their way of thinking critically and dynamically in producing alternative solutions to real life problems based on their experience of combining the spectra data when determining compound structures.
	CP MK 2	Students have the knowledge on deciding the signal characteristics contained in a spectrum in order to identify the basic framework and particular functional groups, which in the end they combine both to construct a compound structure.
	CP MK 3	Students are able to make a decision by taking advantage of the data analysis used and use the decision made in everyday life.

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1		√							

	CP MK 2				√			√		
	CP MK 3								√	

Course Short Description	
Study Material: Subject matter	The basic theory of spectroscopy (review) HS, HMBC, HMQC, COSY, DEPT. Study case using secondary data from the journal and its analysis. Determining a structure by combining the spectrum data obtained from different researches on xanthone and flavonoid. Presenting the analysis in front of the class at the end of the course in a group.
Reference	**Main:** 1. **Supporting:** 2.
Supporting Lecturer	Prof. Dr. Taslim Ersam, MS.
Pre-Requisite Courses	

Session	**Learning outcome of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**

1-4	Students are able to explain the basic theory of spectroscopy (review) which includes MS, HMBC, HMQC, COSY, DEPT and the use of coupling constants (*J*)	• The accuracy in explaining the basic theory of spectroscopy (review) which includes MS, HMBC, HMQC, COSY, DEPT and the use of coupling constants (*J*)	**Technical :** **Assignment 1** **Criteria :**	**Lecture and discussion** **[TM: 4x(3x50")]** **Assignment 1** **[BT+BM:(1+1)x(4x60")]**		• The basic theory of MS • The basic theory of HMBC • The basic theory of HMQC • The basic theory of COSY, DEPT and the use of coupling constants (*J*)	**10**
5-7	Students are able to solve the problem of determining the structure of organic compounds using secondary data from journals	• The accuracy in solving the problem of determining the structure of organic compounds using secondary data from journals	**Technical :** **Assignment 2** **Criteria :**	**Lecture and discussion** **[TM: 3x(3x50")]** **Assignment 2** **[BT+BM:(1+1)x(3x60")]**		• Journals about determining the structures of organic compounds	**15**
8	**Mid-term evaluation**						**20**
9-12	Students are able to determine the structure of the organic compound in the form of xanthones and flavonoid derivatives from the resulted research	• The accuracy in determining the structure of the organic compound in the form of xanthones and flavonoid derivatives from the resulted research	**Technical :** **Assignment 3** **Criteria :**	**Lecture and discussion** **[TM: 4x(3x50")]** **Assignment 3** **[BT+BM:(1+1)x(4x60")]**		• IR, NMR, MS, GC spectra obtained from the analysis of organic compounds	**25**

13-15	Students are able to present their work in determining the structure of the organic compound	• The accuracy and clarity in presenting their work in determining the structure of the organic compound	**Technical :** **Presentation** **Criteria :**	**Discussion** **[TM: 3x(3x50")]**		• The result of structure determination	**10**
15	**End-term evaluation**						**20**

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Kode Dokumen

SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course disciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Data
THESIS	SK 185401		6	0	IV	07 Januari 2020

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
			Prof.Dr. Didik Prasetyoko S.Si., M.Sc.

Learning Outcomes (LO)		
	LO-PRODI Charged to The Course	
	A.2 (LO 1)	Show moral, ethical, responsibility and good personality in completing their duties
	B.1 (LO 3)	Able to solve complex problem and analyze them to be developed using logical thinking based on scientific principles
	B.3 (LO 5)	Able to show responsibility of their individual and team work
	C.2 (LO 7)	Able to analyze and synthesis concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right instrument and the substance side effect in order to develop the chemistry
	Course Learning Outcomes (LO MK)	
	CP MK 1	Students are able to compile and present the results of thesis research

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1	√		√		√		√		

Course Short Description

Study Material: Subject matter	1. Laboratory research 2. Publication 3. Compiling thesis research report 4. Presenting the written report orally
Reference	**Main:** 2. **Supporting:** 4.
Supporting Lecturer	Lecturer teams of Master program of Chemistry
Pre-Requisite Courses	

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Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course disiplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
GREEN CHEMISTRY	SK 185301	General	2	0	III	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Dr. Afifah Rosyidah, M.Si.; Drs. Eko Santoso, M.Si.	Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.	Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.

Learning Outcomes (LO)		
	LO-PRODI Charged to The Course	
	B.3 (LO 5)	Able to show responsibility of their individual and team work
	Course Learning Outcomes (COURSE LO)	
	COURSE LO 1	Students are able to understand the knowledge of green chemistry on undergoing research in the field of energy, health, environment, and othe related fields.
	COURSE LO 2	Students have a deep knowledge on the correlations between green chemistry and their physical properties and macroscopic chemical substances.
	COURSE LO 3	Able to solve complex problem and analyze them to be developed using logical thinking based on scientific principles renewable energy sources, health, and analysis methods

LO - Course LO MAP

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
COURSE LO 1					√				
COURSE LO 2					√				
COURSE LO 3					√				

Course Short Description	-
Study Material: Subject Matter	Introduction to Green Chemistry, Waste Prevention and Processing, The 12 Pillars of Green Chemistry, Environment Toxicology, The Implementations of Green Chemistry in the Industry, The Implementations of Green Chemistry in Solving Industrial Problems, Environment Issues and Climates that support Green Chemistry, Environmentally Friendly Energy and Chemicals, The Chemical Processes that support Green Chemistry.
Reference	**Primary:** 1. E. Lichtfouse, J. Schwarzbauer, D. Robert, "Green Materials for Energy, Products and Depollution", Springer, London, 2013 2. A. Valavanidis., T. Vlachogianni, "Green Chemistry and Green Engineering, From Theory to Practice for Protection of the Environment and Sustainable Development", Synchrona Themata, Aehens, 2012 3. European Commission, DG Environment, "Analysis of the Evolution of Waste Reduction and the Scope of Waste Prevention", Arcadis, 2010 4. F. M. Kerton, "Alternative Solvents for Green Chemistry", The Royal Society of Chemistry, Cambridge, 2009 5. J. Clark, J., D. Macquarrie, "Handbook of Green Chemistry and Technology", Blackwell Publishing, Oxford, 2002. **Secondary:**
Lecturer	Dr. Afifah Rosyidah, M.Si.; Drs. Eko Santoso, M.Si.
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Estimated Time]**		**Learning Material [Reference]**	**Assesment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1-2	Able to understand the principles for reducing or eliminating waste	• The accuracy in explaining waste classification		**Lecture** **Quiz** **[TM: 2x(2x50")]**		• Waste classification based on the type of compound	**Take part in Quiz-1**

3-4	Able to understand the 12 Pillars of Green Chemistry	• The accuracy in explaining the 12 Pillars of Green Chemistry		**Lecture** **Class discussion** **Quiz** **[TM: 2x(2x50")]**		• Waste Prevention • Economical atom • Synthesis with harmless chemicals • Harmless chemical design • Safer solvents and auxiliary compounds • Energy efficiency design • The use of renewable basic materials • Reduce the reaction stage • Catalyst • Breakdown Design • Spontaneous analysis for pollution prevention • Naturally safe chemicals to prevent accidents	**Take part in Quiz-1**
5	Quiz-1						**25**
6	Students are able to understand and explain environmental toxicology	• The level of accuracy in using environmentally friendly solvents		**Lecture** **Discussion** **Quiz** **[TM: 1x(2x50")]**		• The use of environmentally friendly solvents	**Take part in Mid-semester Evaluation**
7	Students are able to understand and implement green chemistry to challenges and solutions in the industry			**Lecture** **Discussion** **Quiz** **[TM: 1x(2x50")]**		• Selection of an environmentally friendly process	**Take part in Mid-semester**

							Evaluation
8	**Mid-semester Evaluation**						**25**
9, 10	Understanding the Climate Issues that Support Green Chemistry	• The accuracy in describing the climate that supports green chemistry		**Lecture Quiz [TM: 2x(2x50")]**		• The use of non-toxic reagents	
11	Energy and Green Chemistry	• The accuracy in describing the relation between energy and green chemistry		**Lecture [TM: 1x(2x50")]**		• Utilization of alternative energy	
12, 13	Principles of chemical processes that are supported by Green Chemistry	• The accuracy in describing the principle during the process in reaction that supported by green chemistry		**Lecture Quiz [TM: 2x(2x50")]**			**15**
14, 15	Green chemistry to solve life's problems such as developing materials for renewable energy, health, analytical methods, and others.	• The accuracy in describing green chemistry to solve daily life problem such as the development of material for renewable energy, health, analysis methods, etc		**Lecture Discussion Presentation [TM: 2x(2x50")]**			
16	**Final Semester Evaluation**						**20**

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Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course disiplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
ELECTIVE	SK 185302	General	2	0	III	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	-	Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.	Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	B.3 (LO 5)	Able to show responsibility of their individual or team work by show the free plagiarism result
	Course Learning Outcomes (COURSE LO)	
	COURSE LO 1	-

LO - Course LO MAP

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
COURSE LO 1	-	-	-	-	-	-	-	-	-

Course Short Description

-

Study Material:
Subject Matter

-

Reference

Primary:

-

	Secondary:
Lecturer	-
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Estimated Time]**		**Learning Material [Reference]**	**Assesment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1							
2							
3							
4							
5							
6							
7							
8	**Mid-semester Evaluation**						
9							
10							
11							

12							
13							
14							
15							
16	**Final Semester Evaluation**						

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DEPARTMENT OF CHEMISTRY

Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	**CODE**	**Course disiplines (RMK)**	**Semester Credit Units**		**SEMESTER**	**Compilation Date**
NANOMATERIALS FOR SENSORS	SK 185313	Analytical Chemistry	2	0	III	
AUTHORIZATION / LEGALIZATION	**RPS Development Lecturer**		**RMK Coordinator**		**Head of Study Program (PRODI)**	
	Dr.rer.nat. Fredy Kurniawan, Msi		Suprapto, PhD		Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.	

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	B.1 (LO 3)	Able to collect, document and analyze data and information and develop them using logical thinking based on scientific principles
	C.3 (LO 7)	Able to develop concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right instrument and the substance side effect in order to develop the chemistry
	D.1 (LO 9)	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation
	Course Learning Outcomes (COURSE LO)	

	COURSE LO 1	Students are able to understand how nanomaterials work for sensors in various analytical techniques
LO - Course LO MAP		

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
COURSE LO 1			√				√		√

Course Short Description	-
Study Material: Subject Matter	Nanomaterial applications using fluorescence spectrometry technique, voltammetry, amperometry, potentiometry, Quartz Crystal Microbalance, Surface Plasmon Resonance, LSPR, Spectroscopy impedance.
Reference	**Primary:** **Secondary:**
Lecturer	Dr.rer.nat. Fredy Kurniawan, MSi; Suprapto, PhD; Yatim Lailun Nikmah, PhD
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Estimated Time]**		**Learning Material [Reference]**	**Assesment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**

1, 2	Students are able to understand nanomaterial applications using fluorescent spectrometry techniques	• The accuracy in finding the appropriate journal articles • The accuracy in reviewing and analyzing journals articles were obtained • The accuracy in describing the content of the article journal that discussed		**Lectures Presentation Discussions [TM: 2x(2x50")]**			**10**
3, 4	Students are able to understand nanomaterial applications using voltammetry techniques	• The accuracy in finding the appropriate journal articles • The accuracy in reviewing and analyzing journals articles were obtained • The accuracy in describing the content of the article journal that discussed		**Lectures Presentation Discussions [TM: 2x(2x50")]**			**10**
5, 6	Students are able to understand nanomaterial applications using amperometry techniques	• The accuracy in finding the appropriate journal articles • The accuracy in reviewing and analyzing journals articles were obtained • The accuracy in describing the content		**Lectures Presentation Discussions [TM: 2x(2x50")]**			**10**

		of the article journal that discussed					
7	Students are able to apply nanomaterials in the laboratory	• The accuracy in doing the laboratory practice		**Laboratory Practice [TM: 1x(2x50')]**			
8	**Mid-semester Evaluation**						**30**
9, 10	Students are able to understand nanomaterial applications using potentiometry techniques	• The accuracy in finding the appropriate journal articles • The accuracy in reviewing and analyzing journals articles were obtained • The accuracy in describing the content of the article journal that discussed		**Lectures Presentation Discussions [TM: 2x(2x50")]**			**10**
11	Students are able to understand nanomaterial applications using the Quartz Crystal Microbalance technique	• The accuracy in finding the appropriate journal articles • The accuracy in reviewing and analyzing journals articles were obtained • The accuracy in describing the content of the article journal that discussed		**Lectures Presentation Discussions [TM: 1x(2x50")]**			**10**
12	Students are able to understand nanomaterial applications using the Surface	• The accuracy in finding the appropriate journal articles		**Lectures Presentation Discussions**			**10**

	Plasmon Resonance (SPR) technique	• The accuracy in reviewing and analyzing journals articles were obtained • The accuracy in describing the content of the article journal that discussed		**[TM: 1x(2x50")]**			
13	Students are able to understand nanomaterial applications using the Localized Surface Plasmon Resonance (LSPR) technique	• The accuracy in finding the appropriate journal articles • The accuracy in reviewing and analyzing journals articles were obtained • The accuracy in describing the content of the article journal that discussed		**Lectures Presentation Discussions [TM: 1x(2x50")]**			**10**
14	Students are able to understand nanomaterial applications using impedance spectroscopy techniques	• The accuracy in finding the appropriate journal articles • The accuracy in reviewing and analyzing journals articles were obtained • The accuracy in describing the content of the article journal that discussed		**Lectures Presentation Discussions [TM: 1x(2x50")]**			**15**

15	Students are able to apply nanomaterials in the laboratory	• The accuracy in doing the laboratory practice		**Laboratory Practice [TM: 1x(2x50')]**			
16	**Final Semester Evaluation**						**10**

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Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	**CODE**	**Course disiplines (RMK)**	**Semester Credit Units**		**SEMESTER**	**Compilation Date**
SPESIFIC ANALYSIS	SK 185314	Analytical Chemistry	2	0	III	
AUTHORIZATION / LEGALIZATION	**RPS Development Lecturer**		**RMK Coordinator**		**Head of Study Program (PRODI)**	
	Yatim Lailun Ni'mah, Ph.D		Suprapto, PhD		Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.	

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	B.2 (LO 4)	Able to develop leadership attitudes, creativity and communication skills in solving a chemistry-related problem problem
	C.3 (LO 7)	Able to develop concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right instrument and the substance side effect in order to develop the chemistry
	Course Learning Outcomes (COURSE LO)	
	COURSE LO 1	Students are able to study the problems faced in chemical science by utilizing the appropriate instruments
	COURSE LO 2	Students know the basic principles of laboratory instruments
	COURSE LO 3	Students are able to express their ideas orally and in writing

LO - Course LO MAP

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
COURSE LO 1							√		

COURSE LO 2				√						
COURSE LO 3										

Course Short Description	-
Study Material: Subject Matter	1. XPS (X-Ray Photoemission Spectrophotometry), XPS related UPS, AES), Flow injection analysis, Surface plasmon resonance (SPR), quartz crystal microbalance (QCM), adsorption analysis. Measurement modification based on ATR, DR and fibre optic modules. 2. Study case
Reference	**Primary:** 1. J. Homola, "Surface Plasmon Resonance Based Sensors", Springer Verlag, Berlin, 2006. 2. C. Steinem, A. Janshoff, "Piezoelectric Sensors", Springer Verlag, Berlin, 2007. **Secondary:** 1. J. Wang, "Electroanalitical Chemistry," Wiley VCH, USA, 2000.
Lecturer	Yatim Lailun Ni'mah, Ph.D.; Suprapto, Ph.D.; Dr.rer.nat. Fredy Kurniawan, M.Si.
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Estimated Time]**		**Learning Material [Reference]**	**Assesment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**

1	Students know the lecture plan for the semester						
2	Students are able to explain basic instruments	• Conformity with the concept • Question and answer		**Tutorial Discussions**		• Basic Instruments	
3, 4	Students are able to explain the principles, the procedure, and the results of XPS	• Conformity with the concept • Question and answer		**Tutorial Discussions**		• The principles, the procedure, and the results of XPS	**5**
5, 6, 7	Students are able to explain and apply different principles, procedures, and the results of XPS-related (UPS, AES)	• Conformity with the concept • Question and answer		**Tutorial Discussions**		• The principles, the procedures, and the results of XPS-related (UPS, AES)	**15**
8	**Mid-semester Evaluation**						**30**
9	Students are able to explain the principles, the procedures, and the results of flow injection analysis	• Conformity with the concept • Question and answer		**Lecture Discussions**		• The principles, the procedures, and the results of flow injection analysis	
10	Students are able to explain the principles, the procedures, and the results of the surface plasmon resonance (SPR)	• Conformity with the concept • Question and answer		**Lecture Discussions**		• The principles, the procedures, and the results of the surface plasmon resonance (SPR)	**15**
11	Students are able to explain the principles, the procedures, and the results of QCM (Quartz crystal microbalance)	• Conformity with the concept • Question and answer		**Lecture Discussions**		• The principles, the procedures, and the results of the QCM (Quartz crystal microbalance)	
12	Students are able to explain the principles, the	• Conformity with the concept		**Lecture Discussions**		• The principles, the procedures, and the	

	procedures, and the results of the adsorption analysis	• Question and answer				results of the adsorption analysis	
13, 14	Students are able to apply theories in chemical instrumentation with their respective research	• Conformity with the concept • Question and answer		**Lecture Discussions**		• Modification of measurement based on ATR, DR, and fiber optic modules. Case study	**20**
15, 16	**Final Semester Evaluation**						**30**

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Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	**CODE**	**Course disiplines (RMK)**	**Semester Credit Units**		**SEMESTER**	**Compilation Date**
CORROSION ANALYSIS	SK 185315	Analytical Chemistry	2	0	III	
AUTHORIZATION / LEGALIZATION	**RPS Development Lecturer**		**RMK Coordinator**		**Head of Study Program (PRODI)**	
	Prof. Dr.rer.nat. Fredy Kurniawan, M.Si.		Suprapto, PhD		Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.	

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	A.5 (LO 2)	Show a spirit of independence and team work in completing their duties
	C.3 (LO 7)	Able to develop concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right instrument and the substance side effect in order to develop the chemistry
	C.4 (LO 8)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach and innovative theoretical, -experimental or -computational approach
	D.1 (LO 9)	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation
	Course Learning Outcomes (COURSE LO)	

	COURSE LO 1	Students are able to correctly explain the type of corrosion and its control methods
	COURSE LO 2	Students are able to design and analyze case studies of corrosion creatively in teamwork and present them
	COURSE LO 3	Students are able to operate instruments related to corrosion testing using the Echem program

LO - Course LO MAP

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
COURSE LO 1		√					√		√
COURSE LO 2							√		√
COURSE LO 3								√	

Course Short Description

-

Study Material: Subject Matter

1. The fundamentals of corrosion: what corrosion is, electrochemical review, types of corrosion, corrosion control and testing. Corrosion analysis: types of corrosion, corrosion control system, measurement, and data processing.
2. Industrial study case.

Reference

Primary:

1. Jones, D. A., “Principles and prevention of corrosion”, Second edition, Prentice-Hall, Inc., USA, 1996.
2. “Echem user’s guide & using chart & scope software for electrochemistry”, Version 1.5, PowerLab System, 1999.
3. Perez, N., “Electrochemistry and corrosion science”, Kluwer Academic, Boston, 2004.
4. Marcus, P., Mansfeld, F., “Analytical methods in corrosion science and engineering”, CRC Press Taylor & Francis, 2006.
5. Wang, J., “Analytical electrochemistry”, Jons Wiley & Sons, 2006.
6. Popov, B. N., “Corrosion engineering: principles and solved problems”, Elsevier, 2015.

Secondary:

2. Kurniawan, F., Madurani, K.A., “Electrochemical and optical microscopy study of red pepper seed oil corrosion inhibition by self-assembled monolayers (SAM) on 304 SS”, Progress in Organic Coatings, vol. 88, p. 256-262, 2015.

	3. Firdausi, S., Kurniawan, F., "Corrosion inhibition by tihonia diversifolia (Hemsl) A. Gray leaves extract for 304 SS in hydrochloric acid", Journal of Physics: Conference Series, vol.710, p. 012042, 2016.
Lecturer	Prof. Dr.rer.nat. Fredy Kurniawan, M.Si.
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Estimated Time]**		**Learning Material [Reference]**	**Assesment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1, 2	Students are able to explain the type of corrosion according to case studies in Industry correctly	• Able to explain		**Lectures Discussions [TM: 2x(2x50")]**		• The general theory of corrosion, mechanism of corrosion, types of corrosion	
3, 4	Students are able to correctly explain the control method according to case studies in Industry	• Able to explain and present		**Lectures Discussions Presentations [TM: 2x(2x50")]**		• Corrosion control mechanisms and types of corrosion control methods	**20**
5, 6, 7	Students are able to formulate, analyze and carefully solve problems of metal corrosion and effective control methods	• Able to explain		**Lectures Group Discussions Presentations [TM: 2x(2x50")]**		• Case studies of corrosion problems and their solutions	
8	**Mid-semester Evaluation**						**30**
9, 10	Students are able to operate instruments related to corrosion testing using the Echem program and obtain data and process them	• Able to explain		**Laboratory practice Presentations [TM: 2x(2x50")]**		• Operating instruments related to corrosion testing using the Echem program and obtaining data and	

	properly using the Origin program					processing them properly using the Origin program	
11, 12, 13, 14	Students are able to explain and present the results of teamwork in the laboratory	• Able to perform literature studies, laboratory practice, and presentations		**Laboratory practice Group discussions Presentations [TM: 4x(2x50")]**		• Formulating the problems, solving the problems, and presenting the results of laboratory practice	**20**
16	**Final Semester Evaluation**						**30**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)

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DEPARTMENT OF CHEMISTRY

Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	**CODE**	**Course disiplines (RMK)**	**Semester Credit Units**		**SEMESTER**	**Compilation Date**
CONDUCTIVE POLYMERS	SK 185316	Analytical Chemistry	2	0	III	
AUTHORIZATION / LEGALIZATION	**RPS Development Lecturer**		**RMK Coordinator**		**Head of Study Program (PRODI)**	
	Suprapto, PhD		Suprapto, PhD		Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.	

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	C.3 (LO 7)	Able to develop concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right instrument and the substance side effect in order to develop the chemistry
	C.4 (LO 8)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach and innovative theoretical, -experimental or -computational approach

<table>
<tr><td></td><td>D.1 (LO 9)</td><td>Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation</td></tr>
<tr><td></td><td colspan="2">Course Learning Outcomes (COURSE LO)</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td>COURSE LO 1</td><td>Students are able to understand the synthesis-structure-properties-application related with conductive polymers</td></tr>
<tr><td>LO - Course LO MAP</td><td colspan="2">
<table>
<tr><th></th><th>LO 1</th><th>LO 2</th><th>LO 3</th><th>LO 4</th><th>LO 5</th><th>LO 6</th><th>LO 7</th><th>LO 8</th><th>LO 9</th></tr>
<tr><td>COURSE LO 1</td><td></td><td></td><td></td><td></td><td></td><td></td><td>√</td><td>√</td><td>√</td></tr>
</table>
</td></tr>
<tr><td>Course Short Description</td><td colspan="2">-</td></tr>
<tr><td>Study Material:
Subject Matter</td><td colspan="2">1. Monomer/polymer structures for the general conductive polymers.
2. The general methods on synthesis conductive polymers.
3. Understanding the principles of doping-dedoping.
4. Applications of conductive polymers.
5. The explanations of history, the initial and updated research, and main reference on conductive polymers.</td></tr>
<tr><td>Reference</td><td colspan="2">Primary:
1. Nalwa, N.H., “Handbook of Organic Conductive Molecules and Polymers”, Jon Wiley
Secondary:
1. Wang , J., ”Electroanalytical Chemistry”, Wiley VCH, USA, 2000.</td></tr>
<tr><td>Lecturer</td><td colspan="2">Dr.rer.nat. Fredy Kurniawan, MSi; Suprapto, PhD; Yatim Lailun Nikmah, PhD</td></tr>
<tr><td>Pre-Requisite Courses</td><td colspan="2">-</td></tr>
</table>

Session	Learning outcomes of each learning stage (Sub-LOMK)	Assessment		Learning Design; Learning Method; Student Assignment; [Estimated Time]		Learning Material [Reference]	Assesment Portion (%)
		Indicator	Criteria and Technical				
(1)	(2)	(3)	(4)	Face-to-face Class (5)	Online Class (6)	(7)	(8)
1	Students are able to explain the structure of monomer/polymer molecule for common conductive polymer			**Lecture [TM: 1x(2x50")]**			
2, 3, 4	Students are able to draw the general method of conductive polymery synthesis			**Lecture [TM: 3x(2x50")]**			
5, 6, 7	Students are able to understand the principles of doping-dedoping	• Individual and group assesments		**Group discussions**			**20**
8	**Mid-semester Evaluation**						**30**
9, 10	Students are able to apply conductive polymer	• Question and answer		**Group discussions [TM: 2x(2x50")]**			
11, 12, 13, 14	Students are able to describe the history, the initial research, the main references, and the cutting-edge research of conductive polymers	• Question and answer		**Group discussions Presentations [TM: 4x(2x50")]**			**20**
15, 16	**Final Semester Evaluation**						**30**

SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course disiplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
ORGANOMETALLIC CHEMISTRY	SK 184654	Inorganic Chemistry	2	0	III	
AUTHORIZATION / LEGALIZATION	**RPS Development Lecturer**		**RMK Coordinator**		**Head of Study Program (PRODI)**	
	Dra. Ratna Ediati, MS, PhD		Prof. Dr.rer.nat. Irmina Kris Murwani, M.Si.		Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.	

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	C.2 (LO 6)	Able to analyze and synthesis the concept of structure, properties and substance changes at the micro- or marcomolecular level based on the dynamic and energetic phenomenon
	C.3 (LO 7)	Able to develop concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right instrument and the substance side effect in order to develop the chemistry
	D.1 (LO 9)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach and innovative theoretical, -experimental or -computational approach
	Course Learning Outcomes (COURSE LO)	
	COURSE LO 1	Students are able to understand the types of organometallic and their properties
	COURSE LO 2	Students are able to explain the latest developments research about organometallic

LO - Course LO MAP

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
COURSE LO 1						√			√
COURSE LO 2						√	√		√

Course Short Description	-
Study Material: Subject Matter	1. Bonds on organometallic compounds for stable electrons configuration.

	2. Varieties of ligands, which cover carbon monoxide, phosphine and its compounds, hydride and its dihydrogen complex, 1-alkyl, alkenyl, alknyl and anyl ligands, 2-alkene ligands, unconjugated dienes, butadienes, cyclobutadienes, cyclotetraene, benzene, alil, cyclopentadiene, carbenes, alkane, asgostic hydrogen and noble gas, dinitrogen and monoxide nitrogen compounds, -d block carbonyl, metallocene. 3. Reactions: ligand substitution, oxidative addition and reductive elimination, metathesis bonds, 1,1-migratory insertion reaction, 1,2-insertions and 1-hydride elimination, cyclometalation. 4. Organometallic compounds application as a homogenous catalyst, such as alkene metathesis, hydroformylation, Wacker oxidation from alkene, Ziegler-Natta polymerization, metallocene polymerization, asymmetric oxidation, and many others.
Reference	**Primary:** 1. S. Komiya, "Synthesis of Organometallic Compounds. A Practical Guide (Inorganic Chemistry-A Textbook Series)", John Wiley and Sons, 1997 2. G.B. Stringfellow, "Organometallic Vapor-Phase Epitaxy. Theory and Practice", edisi kedua, Elsevier, 1999 (http://www.sciencedirect.com/science/book/ 9780126738421) 3. Shriver, Atkins, "Inorganic Chemistry", edisi kelima, W.H. Freeman and Company, Oxford, 2010 4. J.E. Huheey, E.A. Keiter, R.L. Keiter, "Inorganic Chemistry, Principles of Structure and Reactivity", edisi keempat, Harper Collins College Publishers, London 1993 5. G.L. Miessler, D.A. Tarr, "Inorganic Chemistry", edisi ketiga, Pearson Education International, Minnesota 2001 6. J.E. House, "Inorganic Chemistry", Academic Press, London, 2008 **Secondary:**
Lecturer	Dra. Ratna Ediati, MS, PhD
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Estimated Time]**		**Learning Material [Reference]**	**Assesment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**

1	Able to know about organometallic compounds (basic organometallic chemistry of s-block, p-block, and d-block metals)			**Lectures [TM: 1x(2x50")]**		• Organometallic bond	
2	Able to know the ligands of carbon monoxide, phosphines and their compounds, hydrides, and dihydrogen complexes in organometallic compounds			**Lectures [TM: 1x(2x50")]**		• Carbon monoxide ligands • phosphines and their compounds • hydrides and dihydrogen complexes	
3	Able to know the 1-alkyl ligands. - alkenyl, - alkynyl and aryl, 2-alkene, non-conjugated diene in organometallic compound			**Lectures [TM: 1x(2x50")]**		• 1-alkyl ligands. • - alkenyl, - alkynyl and aryl, 2-alkene, non-conjugated diene	
4	Able to know butadiene, cyclobutadiene, cyclotetraene, benzene, allyl, cyclopentadiene in organometallic compounds			**Lectures [TM: 1x(2x50")]**		• butadiene, cyclobutadiene, cyclotetraene, benzene, allyls, cyclopentadiene	
5	Able to know about carbenes ligands, alkanes, agostic hydrogen, and noble gases in organo-metal compounds			**Lectures [TM: 1x(2x50")]**		• Carbenes ligands, alkanes, agostic hydrogen, and noble gases	
6	Able to know about dinitrogen ligands and nitrogen monoxide compounds, -d-block carbonyl, metallocene			**Lectures [TM: 1x(2x50")]**		• Dinitrogen ligands and nitrogen monoxide compounds, –d-block carbonyl, metallocene	

7	Able to know about the substitution, addition, oxidation, and reductive elimination of organometallic compounds reaction			**Lectures [TM: 1x(2x50")]**		• Ligand substitution reactions, oxidative addition and reductive elimination, metathesis bonds	
8	**Mid-semester Evaluation**						**50**
9	Able to know about the insertion, elimination and cyclomelation reactions in organometallic			**Lectures [TM: 1x(2x50")]**		• 1,1-Migratory insertion, 1,2-Insertions and 1-hydride elimination, and cyclomethalation reaction.	
10	Able to know about the metathesis reaction of alkenes			**Lectures [TM: 1x(2x50")]**		• alkene metathesis, hydroformylation	
11	Able to know about the Wacker oxidation principle			**Lectures [TM: 1x(2x50")]**		• Wacker oxidation of alkenes, Ziegler-Natta polymerization	
12	Able to know about the Metallocene polymerization			**Lectures [TM: 1x(2x50")]**		• Metallocene polymerization, asymmetric oxidation, and others.	
13, 14, 15	Able to express ideas orally and in writing regarding organometallic compounds	• Know about organometallic compounds (basic organometallic		**Presentation Assignment [TM: 3x(2x50")]**		• Journal of Organometallic Chemistry, Science Direct Online	**20**

		chemistry of s-block, p-block, and d-block metals)					
16	**Final Semester Evaluation**						**30**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
FACULTY OF SCIENCES AND ANALYTICAL DATA
DEPARTMENT OF CHEMISTRY

Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	**CODE**	**Course disiplines (RMK)**	**Semester Credit Units**		**SEMESTER**	**Compilation Date**
CATALYSIS	SK 185322	Inorganic Chemistry	2	0	III	
AUTHORIZATION / LEGALIZATION	**RPS Development Lecturer**		**RMK Coordinator**		**Head of Study Program (PRODI)**	
	Prof. Dr. rer. nat. Irmina Kris Murwani, MSi; Dra. Ratna Ediati, MS, PhD		Prof. Dr.rer.nat. Irmina Kris Murwani, M.Si.		Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.	

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	A.5 (LO 2)	Show a spirit of independence and team work in completing their duties
	C.2 (LO 6)	Able to analyze and synthesis the concept of structure, properties and substance changes at the micro- or marcomolecular level based on the dynamic and energetic phenomenon
	C.3 (LO 7)	Able to develop concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right instrument and the substance side effect in order to develop the chemistry
	D.1 (LO 9)	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation
	Course Learning Outcomes (COURSE LO)	
	COURSE LO 1	Students are able to understand the types of catalysts and their properties

	COURSE LO 2 Students are able to explain the latest developments research about catalyst
LO - Course LO MAP	

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
COURSE LO 1							√		√
COURSE LO 2		√				√			√

Course Short Description	-
Study Material: Subject Matter	1. Structure analysis in determining the molecule equatuons of organic compounds. 2. Basic measurement theories and principles of spectroscopies UV-Vis, IR, MS, NMR. 3. Identification study case of spectrum UV-Vis, IR, MS, NMR (Integrated problems)
Reference	**Primary:** 1. M. Beller, A. Renken, R.A. van Santen (editor), "Catalysis: From Principles to Applications", Wiley-VCH, Weinheim, 2012 **Secondary:** 1. D. Murzin, T. Salmi, "Catalytic Kinetics", Elsevier. (http://www.sciencedirect.com/ science/book/9780444516053) 2. S.D. Jackson, J.S.J. Hargreaves, D. Lennon, "Catalysis in Application", RSC, 2003. 3. V.J. Inglezakis, S.G. Poulopoulos, "Adsorption, Ion Exchange and Catalysis Design of Operations and Environmental Applications", Elsevier, 2006 (http://www.sciencedirect.com/science/book/9780444527837)
Lecturer	Prof. Dr. rer. nat. Irmina Kris Murwani, MSi; Dra. Ratna Ediati, MS, PhD
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**	**Learning Design; Learning Method;**	**Learning Material [Reference]**	

		Indicator	Criteria and Technical	Student Assignment; [Estimated Time]			Assesment Portion (%)
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1	Able to know about the definition of catalyst and its history			**Introductory lectures [TM: 1x(2x50")]**		• Catalysis in perspective (history of catalysis)	
2	Students are able to distinguish catalysis reactions for homogeneous and heterogeneous catalysts			**Lectures [TM: 1x(2x50")]**		• Homogeneous and heterogeneous catalyst	
3	Able to explain the kinetics of the catalysis reaction for heterogeneous catalysts and homogeneous reactions			**Lectures [TM: 1x(2x50")]**		• The kinetics in homogeneous catalyst	
4, 5	Able to explain the kinetics of the catalysis reaction for heterogeneous catalysts and homogeneous reactions			**Lectures [TM: 2x(2x50")]**		• Kinetics in heterogeneous catalysts	
6, 7	Students are able to demonstrate the fragmentation process in organic molecules	• Differentiating catalyzed reaction for homogeneous catalysts and heterogeneous catalysts		**Presentation Discussions [TM: 2x(2x50")]** **Assignment 1**		• Basics of catalysis reaction techniques	**20**
8	**Mid-semester Evaluation**						**30**
9, 10	Students are able to explain the catalysis process including its mechanism and reactivity			**Lectures Discussions [TM: 2x(2x50")]**		• Chemical catalytic reactivity for homogeneous catalysts	

11, 12	Students are able to explain the catalysis process including its mechanism and reactivity			**Lectures** **Discussions** **[TM: 2x(2x50")]**		• Chemical catalytic reactivity for biocatalysis	
13	Students are able to explain the catalysis process including its mechanism and reactivity			**Lectures** **Discussions** **[TM: 1x(2x50")]**		• Chemical Catalytic Reactivity for Electrocatalysis	
14, 15	Students use H-NMR, C-NMR, MS, IR and UV-Vis spectrum data to determine the structure of organic compounds	• Describing the catalysis process including its mechanism and reactivity		**Presentation** **Discussions** **[TM: 2x(2x50")]** **Assignment 2**		• Catalysis reactivity	**20**
16	**Final Semester Evaluation**						**30**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)

FACULTY OF SCIENCES AND ANALYTICAL DATA

DEPARTMENT OF CHEMISTRY

Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	**CODE**	**Course disiplines (RMK)**	**Semester Credit Units**		**SEMESTER**	**Compilation Date**
COORDINATION CHEMISTRY	SK 185323	Inorganic Chemistry	2	0	III	
AUTHORIZATION / LEGALIZATION	**RPS Development Lecturer**		**RMK Coordinator**		**Head of Study Program (PRODI)**	
	Prof. Dr.rer.nat. Irmina Kris Murwani, MSi; Dr. Fahimah Martak, M.Si.		Prof. Dr.rer.nat. Irmina Kris Murwani, M.Si.		Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.	

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	C.2 (LO 6)	Able to analyze and synthesis the concept of structure, properties and substance changes at the micro- or marcomolecular level based on the dynamic and energetic phenomenon

<table>
<tr><td></td><td>D.1 (LO 9)</td><td>Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation</td></tr>
<tr><td></td><td colspan="2">Course Learning Outcomes (COURSE LO)</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td>COURSE LO 1</td><td>Students are able to explain the process of coordination compounds and their properties that can be utilized</td></tr>
<tr><td>LO - Course LO MAP</td><td colspan="2">
<table>
<tr><th></th><th>LO 1</th><th>LO 2</th><th>LO 3</th><th>LO 4</th><th>LO 5</th><th>LO 6</th><th>LO 7</th><th>LO 8</th><th>LO 9</th></tr>
<tr><td>COURSE LO 1</td><td></td><td></td><td></td><td></td><td></td><td>√</td><td></td><td></td><td>√</td></tr>
</table>
</td></tr>
<tr><td>Course Short Description</td><td colspan="2">-</td></tr>
<tr><td>Study Material:
Subject Matter</td><td colspan="2">1. Crystal field theory: the effects of crystal fields, crystal field assumption theories, splitting crystal field on octahedral geometry, splitting crystal field on tetrahedral-diagram qualitatively, high-spin and low-spin complex, CFSP and factors that influence it, CFSE computation, splitting crystal field, spectrochemical sequence.
2. Abnormal oxidation stability level in coordinated compounds.
3. Ligand field theory, splitting orbital d on low symmetrical environments.
4. Jahn-Teller Effects, electronic spectra interpretation including spectra transfer on charges, nephelauxetic sequence, dia-para-ferro-magnetic and antiferromagnetic, damping orbital angular momentum, spinorbit, coupling, inorganic reaction mechanisms.
5. Substitution reactions, trans effect and electron transfer reactions, phytochemistry reactions on chromium and ruthenium complexes.
6. Crossover spin on corrdinated compounds.</td></tr>
<tr><td>Reference</td><td colspan="2">Primary:

1. J.R. Gispert, “Coordination Chemistry”, Wiley, 2008.
2. R.K. Sharma, “Text Book of Coordination Chemistry”, Discovery Publishing House, 2007.
3. G.A. Lawrance, “Introduction to Coordination Chemistry”, Australia, Wiley, 2010.
4. G.L. Miessler, “Inorganic Chemistry”, Pearson Education, 2008.
5. K. Burger, “Coordination Chemistry: Experiment Methods”, Akademiai Kiado, Budapest, 1973.</td></tr>
</table>

	6. J.E. Huheey, E.A. Keiter, R.L. Keiter, O.K. Medhi, "Inorganic Chemistry: Principles of Structure and Reactivity", Pearson Education, 2006 **Secondary:**
Lecturer	Prof. Dr.rer.nat. Irmina Kris Murwani, MSi; Dr. Fahimah Martak, M.Si.
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Estimated Time]**		**Learning Material [Reference]**	**Assesment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1	Able to know about the formation of complexes from crystal field theory and ligand fields and their electronic spectra			**Lecture [TM: 1x(2x50")]**		• Crystal Field Effects & Crystal Field Assumption Theory	
2	Able to know about the formation of complexes from crystal field theory and ligand fields and their electronic spectra			**Lecture [TM: 1x(2x50")]**		• Splitting field of crystal on the octahedral geometry and tetrahedral-diagram splitting field of qualitative crystal and complex high-spin and low-spin	
3	Able to know about the formation of complexes from crystal field theory and ligand fields and their electronic spectra			**Lecture [TM: 1x(2x50")]**		• CFSP and the factors that influence it	

4	Able to know about the formation of complexes from crystal field theory and ligand fields and their electronic spectra	• Students possess the formation complex with crystals or ligands field knowledge		**Quiz 1 [TM: 1x(2x50')]**		• CFSE Computing	**20**
5	Able to know about the formation of complexes from crystal field theory and ligand fields and their electronic spectra			**Lecture [TM: 1x(2x50")]**		• Crystal field splitting, spectrochemical series.	
6	Able to know about the stability and magnetic properties of complex compounds			**Lecture [TM: 1x(2x50")]**		• Stabilitating the oxidation level that is not normal in coordination compounds.	
7	Able to know about the stability and magnetic properties of complex compounds			**Lecture [TM: 1x(2x50")]**		• Ligand field theory, d orbital splitting in a low symmetry environment	
8	**Mid-semester Evaluation**						**30**
9	Able to know the Jahn-Teller effect and its interpretation			**Lecture [TM: 1x(2x50")]**		• Effects of Jahn-Teller, the interpretation of the spectra of electronics including spectra transfer charge	
10	Able to know the Jahn-Teller effect and its interpretation			**Lecture [TM: 1x(2x50")]**		• Dia - parafero - magnetic and antiferromagnetic nephelauxetic series	

11	Able to know the Jahn-Teller effect and its interpretation			**Lecture [TM: 1x(2x50")]**		• The damping of orbital angular moment, spinorbit, and copling	
12	Able to know the Jahn-Teller effect and its interpretation			**Lecture [TM: 1x(2x50")]**		• Ligand Substitution in Complex Metals	
13	Able to know and analyze the reactions of complex compounds			**Lecture [TM: 1x(2x50")]**		• The substitution reactions, the effect of trans and electrons transfer, the photochemical reaction of chromium complex, and ruthenium	
14	Able to know and analyze the reactions of complex compounds	• Students know about complex magnetic compounds and complex substitution reactions		**Quiz 2 [TM: 1x(2x50")]**		• The molecular fluxional of iso- and heteropoly acids	**20**
15	Able to know and analyze the reactions of complex compounds			**Lecture [TM: 1x(2x50")]**		• Complex Compounds Reaction Mechanisms	
16	**Final Semester Evaluation**						**30**

COURSE (MK)	CODE	Course disiplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
POROUS MATERIALS	SK 185324	Inorganic Chemistry	2	0	III	
AUTHORIZATION / LEGALIZATION	RPS Development Lecturer		RMK Coordinator		Head of Study Program (PRODI)	
	Prof. Dr. Didik Prasetyoko, MSi; Dra. Ratna Ediati, MS, PhD		Prof. Dr.rer.nat. Irmina Kris Murwani, M.Si.		Prof. Dr. Didik Prasetyoko, S.Si., M.Sc.	

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	B.2 (LO 4)	Able to provide alternative solutions armed with leadership attitudes, creativity and communciation skills at the national/intarnationa level through a research object
	C.2 (LO 6)	Able to analyze and synthesis the concept of structure, properties and substance changes at the micro- or marcomolecular level based on the dynamic and energetic phenomenon
	C.3 (LO 7)	Able to develop concepts, theories and methods on the analysis and synthesis of chemical substances by consider the right instrument and the substance side effect in order to develop the chemistry
	D.1 (LO 9)	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation
	Course Learning Outcomes (COURSE LO)	
	COURSE LO 1	Students are able to understand the types of porous materials and their properties
	COURSE LO 2	Students are able to explain the latest developments in research about porous materials

LO - Course LO MAP

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
COURSE LO 1				√		√			√
COURSE LO 2							√		√

Course Short Description	-
Study Material: Subject Matter	

	The porous materials that will be covered are structures, properties and applications of metal organic framework, mesoporous silicate, metal oxides with regular pores, carbon, and zeolite.
Reference	**Primary:** 1. D. W. Bruce, D. O'Hare, R.I. Walton, "Porous Materials", edisi pertama, John Wiley & Sons, 2011. **Secondary:**
Lecturer	Prof. Dr. Didik Prasetyoko, MSi; Dra. Ratna Ediati, MS, PhD
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Estimated Time]**		**Learning Material [Reference]**	**Assesment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1	Students have knowledge of the structure, properties, characterization, and application of several porous materials			**Lectures Discussions [TM: 1x(3x50")]**		• Introduction to porous materials	
2	Students have knowledge of the structure, properties, characterization, and application of mesoporous silicates			**Lectures Discussions [TM: 1x(3x50")]**		• Structures, properties, and applications of mesoporous silicates	
3, 4	Students have knowledge of the structure, properties,			**Lectures Discussions [TM: 2x(3x50")]**		• Structures, properties, and	

	characterization, and application of zeolites.					applications of zeolite	
5	Students have knowledge of the structure, properties, characterization, and application of regular porous metal oxides			**Lectures Discussions [TM: 1x(3x50")]**		• Structure, properties and applications of regular porous metal oxides	
6, 7	Students are able to develop ideas related to porous materials (zeolites and aluminosilicates)	• Able to explain the latest developments on porous materials		**Presentation Discussions Assignment 1 [TM: 2x(3x50")]**		• The theory of mass spectrometer, mass spectrum, determination of molecular weight from molecular formula and mass spectrum, the rule of thirteen, double bond equivalent (DBE), isotopes.	
8	**Mid-semester Evaluation**						**30**
9, 10	Students have knowledge of the structure, properties, and applications of several organic metal frameworks.			**Lectures Discussions [TM: 2x(3x50")]**		• Structure, properties, and applications of organic metal framework	
11, 12	Students have knowledge of the structure, properties, characterization, and application of carbon.			**Lectures Discussions [TM: 2x(3x50")]**		• Structure, properties, and applications of carbon	
13, 14, 15	Students are able to develop ideas related to porous materials (organic metal framework and carbon)	• Able to explain the latest developments regarding porous materials		**Presentation Discussions Assignment 2 [TM: 3x(3x50")]**		• Recent developments in porous materials (organic metal	**20**

						framework and carbon)	
16	**Final Semester Evaluation**						**30**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
FACULTY OF SCIENCE AND DATA ANALYTICS
CHEMISTRY DEPARTMENT

Document Code

SEMESTER LEARNING PROGRAMME

COURSE (MK)	CODE	Course Diciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
ADVANCED INORGANIC SYNTHESIS	SK 185325	Inorganic Chemistry	2	0	III	1 March 2021

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Prof. Dr. Drs. Djoko Hartanto, M.Si; Dr. Afifah Rosyidah, M.Si.	Dra. Ratna Ediati, M.S., Ph.D.	Prof. Dr. Didik Prasetyoko, M. Sc.

Learning Outcomes (LO)	**LO-PRODI Charged to the Courses**	
	B.1 (LO 2)	Show a spirit of independence, team work, leadership and entrepreneurship
	C.4 (LO 7)	Able to analyze and synthesis the concept, theories and methods on the analysis and synthesis of chemical substances by consider the right intrument and the substance side effect in order to develop the chemistry
	D.1 (LO 8)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach and inovative theoretical, -experimental or -computational approach
	Course Learning Outcomes (LO MK)	
	LO MK 1	Students are able to describe the synthesis reactions on solids; differentiating how solids are formed from a gas, liquid, or melting phases using a variety of ways; differentiating synthesis inorganic polymers and nano materials.

LO – LO MK Map									
	LO 1	**LO 2**	**LO 3**	**LO 4**	**LO 5**	**LO 6**	**LO 7**	**LO 8**	**LO 9**
CP MK 1		√					√	√	

Course Description	-

Study Material: Subject matter	1. Reactions on solids (between solids, solid to gas reaction, interconnected chemical reactions). 2. Forming solids from a gas phase (transporting and depositing steam chemicals, aerosol process). 3. Forming solids from liquid or melting state (glass, precipitation, biomaterial, solvothermal, sole-gel). 4. Preparing and modifying inorganic polymers (the general aspects, polysiloxanes (silicones), polyphosphazenes, polysilanes, polymers that contain metal). 5. Template method synthesis (synthesis porous materials), synthesis nano materials.
References	**Primary:** 1. U. Schubert, N. Husing, "Synthesis of Inorganic Material", Wiley, 2012 **Secondary:** 1. S. Komiya, "Synthesis of Organometallic Compounds", John Wiley & Sons, New York, 1997 2. H. Amouri, M. Gruselle, "Chirality in Transition Metal Chemistry", John Wiley & Sons, Ney York, 2008 3. W. Henderson, J.C. McIndoe, " Mass Spectrometry of Inorganic, Coordination and Organometallic Compounds", John Wiley & Sons, New York, 2005
Lecturer	Prof. Dr. Drs. Djoko Hartanto, M.Si; Dr. Afifah Rosyidah, M.Si.
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assesment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assesment portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face class (5)**	**Online (6)**	**(7)**	**(8)**

1	The students should be able to undestand the synthesis reactions on solids		**Technical:** Lecture **Criteria:** •	**Lecture** **[TM: 1×(2×50')]**		• Reaction between solids	
2	The students should be able to undestand the synthesis reactions on solids	•	**Technical:** Lecture **Criteria:** •	**Lecture** **[TM: 1×(2×50')]**		• Gas-solid reactions	
3	The students should be able to undestand the synthesis reactions on solids	•	**Technical:** Lecture **Criteria:**	**Lecture** **[TM: 1×(2×50')]**		• Intercalation reaction	
4	The students should be able to undestand how solids are formed from a gas phase	•	**Technical:** Lecture **Criteria:**	**Lecture** **[TM: 1×(2×50')]**		• Transporting and depositing steam chemicals	

5	The students should be able to undestand how solids are formed from a gas phase	•	**Technical:** Lecture **Criteria:**	**Lecture** **[TM: 1×(2×50')]**		• Aerosol process	
6	The students should be able to undestand how solids from liquid or melting state	•	**Technical:** Lecture **Criteria:**	**Lecture** **[TM: 1×(2×50')]**		• Glass and precipitation	
7	The students should be able to undestand how solids from liquid or melting state	•	**Technical:** Lecture, presentation, assignment 1 **Criteria:**	**Lecture** **[TM: 1×(2×50')]**		• Biomaterial and solvothermal	**20**
8	**Mid Semester Evaluation**						**30**
9,10	The students should be able to undestand how solids from liquid or melting state	•	**Technical:** Lecture, exercise **Criteria:** •	**Lecture** **[TM: 2×(2×50')]**		• Sol-gel	
11	The students should be able to undestand the synthesis of inorganic polymer	•	**Technical:** Lecture **Criteria:** •	**Lecture** **[TM: 1×(2×50')]**		• Polysiloxane	

12	The students should be able to undestand the synthesis of inorganic polymer	•	**Technical:** Lecture **Criteria:**	**Lecture [TM: 1×(2×50')]**		• Polyphosphazenes & Polysilanes	
13	The students should be able to undestand the synthesis of inorganic polymer	•	**Technical:** Lecture, presentation, assignment 2 **Criteria:**	**Lecture [TM: 1×(2×50')]**		• Polymer containing metal	**20**
14	The students should be able to undestand the synthesis of nanomaterials	•	**Technical:** Lecture **Criteria:**	**Lecture [TM: 1×(2×50')]**		• Synthesis with template method (porous materials)	
15	The students should be able to undestand the synthesis of nanomaterials	•	**Technical:** Lecture **Criteria:**	**Lecture [TM: 1×(2×50')]**		• Synthesis of nanomaterial	
16	**End Semester Evaluation**						**30**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
FACULTY OF SCIENCE AND DATA ANALYTICS
CHEMISTRY DEPARTMENT

Document Code

SEMESTER LEARNING PROGRAMME

COURSE (MK)	CODE	Course Diciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
ENERGY STORAGE MATERIALS	SK 185326	Inorganic Chemistry	3	0	III	1 March 2021

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Prof. Hamzah Fansuri, M.Si., Ph.D.	Dra. Ratna Ediati, M.S., Ph.D.	Prof. Dr. Didik Prasetyoko, M. Sc.

Learning Outcomes (LO)		
	LO-PRODI Charged to the Courses	
	C.4 (LO 7)	Able to analyze and synthesis the concept, theories and methods on the analysis and synthesis of chemical substances by consider the right intrument and the substance side effect in order to develop the chemistry
	D.2 (LO 9)	Able to build a chemical knowledge especially in the energy, enviromental, marine and medical in order to develop the research, industry and empolyment
	Course Learning Outcomes (LO MK)	
	LO MK 1	After taking this subject, students will have the knowledge on the properties, structures, and reactivities of materials used as energy storing media. Some of these examples are battery, hydrogen storage, and fuel cells, as well as their characterization and testing methods.

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1							√		√

Course Description

This subject covers the basic concepts on energy storage materials in its everyday life applications such as battery, hydrogen container, fuel cells, and super capacitors. The scope of this subject is the theories and their developments, material properties, design, and fabricating the energy storage.

	This subject is aimed at postgraduate students, however, it could also be taken by undergraduate students as an optional subject. Furthermore, this subject is also open to students from other department who either are at their undergraduate 7th semester or other postgraduate students. This subject is delivered in English as introduction, although in the latter stages, the lessons are given multibilingually (in English and Indonesian). The learning method used is student centered learning (SCL) based interactive method.
Study Material: Subject matter	This lecture describe the basic concept of energy storage materials for application in battery, hydrogen storage, fuel cell and super capacitor. The scope of this lecture include material characteristic, design, and fabricating their energy storage. This lecture was design for postgraduate student (master student) but also can be taken for undergradute student in final year as optional course. Furthermore, this lecture are open for the 7th semester or higher or for postgraduate student in other department in ITS. This lecture using english for the introduction. However, in learning process still possible to use bilingual language (Indonesian-English). The interactive method based on student centered learning (SCL) was used as learning method in this lecture .
References	**Primary:** 1. D. W. Bruce, D. O'Hare and R. I. Walton (editors), "Energy Materials, Inorganic Materials Series", John Wiley & Sons, 2011 2. R. A. Huggins, "Energy Storage", Springer, New York, 2010 **Secondary:** 1. R. Zito, "Energy Storage: A New Approach", Scrivener Publishing, Salem-Massachusetts, 2010. 2. Y. Brunet (editor), "Energy Storage", ISTE Ltd., London, 2011 3. Artikel-artikel ilmiah yang terkait dengan topik-topik perkuliahan
Lecturer	Prof. Hamzah Fansuri, M.Si., Ph.D.
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assesment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assesment portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face class (5)**	**Online (6)**	**(7)**	**(8)**
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15-16	**Mid Semester Evaluation**						
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31-32	**End Semester Evaluation**						**25**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
FACULTY OF SCIENCE AND DATA ANALYTICS
CHEMISTRY DEPARTMENT

Document Code

SEMESTER LEARNING PROGRAMME

COURSE (MK)	CODE	Course Diciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
MODERN CERAMICS	SK 185327	Inorganic Chemistry	2	0	III	2 March 2021

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Dr. Afifah Rosyidah, MSi	Dra. Ratna Ediati, M.S., Ph.D.	Prof. Dr. Didik Prasetyoko, M. Sc.

Learning Outcomes (LO)	**LO-PRODI Charged to the Courses**	
	C.1 (LO 4)	Able to develop leadership attitudes, creativity and communication skills in solving a chemistry-related problem level through a research object
	C.4 (LO 7)	Able to analyze and synthesis the concept, theories and methods on the analysis and synthesis of chemical substances by consider the right intrument and the substance side effect in order to develop the chemistry
	D.1 (LO 8)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach and inovative theoretical, -experimental or -computational approach
	D.2 (LO 9)	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation
	Course Learning Outcomes (LO MK)	
	LO MK 1	Students are able to differentiate the type of ceramics.
	LO MK 2	Students are able to think critically on the uses of modern ceramics to solve real life problems based on their understanding of combination of spectra data to determine the compound structure

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1				√			√	√	√

Course Description	
Study Material: Subject matter	The concepts of advanced processing to increase the ceramic reliabilities, wet forming process, electronic ceramic manufacturing process, composite ceramic process, thin film deposition process for electronics, nano ceramic process, membrane ceramic process, and structurized ceramics.
References	**Primary:** 1. H. Elssner, G. Hoven, P. Kiessler, R. Wellner, R. Wert, "Ceramics and Ceramic Composites Engineering", edisi ketiga, John Wiley & Sons, New York, 1999. **Secondary:** 2. A.G. King, "Ceramic Technology and Processing", William Andrew Publishing/ Noyes, 2002. 3. J.G.P. Binner, "Advanced Ceramic Processing and Technology", William Andrew Publishing/Noyes, 1990. 4. D.E Clark, B.K. Zoitos, "Corrosion of Glass, Ceramics and Ceramic Superconductors", William Andrew Publishing/Noyes, 1992. 5. F. Shi, "Ceramic Materials–Progress in Modern Ceramics", InTech Croatia, 2012
Lecturer	Dr. Afifah Rosyidah, MSi
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assesment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assesment portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face class (5)**	**Online (6)**	**(7)**	**(8)**

1-3	The students should be able to undestand the manufacturing process, the terms and properties or modern ceramics.	• The level of understanding for grouping the manufacturing processes, terms and properties of modern ceramics based on the types of components	**Technical:** Lecture **Criteria:**	**Lecture [TM: 3×(2×50')]**		• Grouping the manufacturing processes, terms and properties of modern ceramics based on the types of components	
4,5	The students should be able to understand the wetting process of modern ceramics	• The level of understanding for the wetting process of modern ceramics	**Technical:** Lecture and discussion **Criteria**	**Lecture and discussion [TM: 2×(2×50')]**		• The wetting process of modern ceramics	**10**
6,7	The students should be able to understand the process of manufacturing electronic ceramics	• The level of understanding for the process of manufacturing electronic ceramics	**Technical: Group discussion** **Criteria:**	**Lecture and discussion [TM: 2×(2×50')]**		• The process of manufacturing electronic ceramics	**20**
8	**Mid Semester Evaluation**						**20**
9-10	The students should be able to understand the process of manufacturing composite ceramics	• The level of understanding for the process of	**Technical:** Lecture, group discussion **Criteria:**	**Lecture and group discussion [TM: 2×(2×50')]**		• The process of manufacturing modern ceramics and process of composite ceramics	**10**

		manufacturing composite ceramics					
11	The students should be able to understand the manufacturing process of thin film deposition for electronic ceramics	• The level of understanding for the manufacturing process of thin film deposition for electronic ceramics	**Technical:** Lecture, group discussion **Criteria:** •	**Lecture and group discussion [TM: 2×(2×50')]**		• Menufacturing process of thin film deposition for electronic ceramics	**5**
12, 13	The students should be able to understand the manufacturing process of nano-ceramics	• The level of understanding for the manufacturing process of nano-ceramics	**Technical:** Group discussion **Criteria:**	**Lecture and group discussion [TM: 2×(2×50')]**		• The manufacturing process of nano-ceramics	**10**
14,15	The students should be able to understand the manufacturing process and characterization of structured ceramics	• The level of understanding for the manufacturing process and characterization of structured ceramics	**Technical:** Group discussion **Criteria:**	**Lecture and group discussion [TM: 2×(2×50')]**		• The manufacturing process and characterization of structured ceramics	**10**
16	**End Semester Evaluation**						**30**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
FACULTY OF SCIENCE AND DATA ANALYTICS
CHEMISTRY DEPARTMENT

Document Code

SEMESTER LEARNING PROGRAMME

COURSE (MK)	CODE	Course Diciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
PHYSICAL INORGANIC CHEMISTRY	SK 185328	Inorganic Chemistry	2	0	III	2 March 2021

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Prof. Dr.rer.nat Irmina Kris Murwani, Prof. Dr. Djoko Hartanto	Dra. Ratna Ediati, M.S., Ph.D.	Prof. Dr. Didik Prasetyoko, M. Sc.

Learning Outcomes (LO)	**LO-PRODI Charged to the Courses**	
	B.1 (LO 2)	Show a spirit of independence, team work, leadership and entrepreneurship
	C.1 (LO 4)	Able to develop leadership attitudes, creativity and communication skills in solving a chemistry-related problem level through a research object
	C.4 (LO 7)	Able to analyze and synthesis the concept, theories and methods on the analysis and synthesis of chemical substances by consider the right intrument and the substance side effect in order to develop the chemistry
	Course Learning Outcomes (LO MK)	
	LO MK 1	Students are able to differentiate the between the electron transfer reaction, protons, and their pairs.
	LO MK 2	Students are able to determine the molecule activation mechanism
	LO MK 3	Students are able to identify the determinant factors of reactivities, thermodynamics, and radical kinetics in an organometallic compound

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1		√		√			√		

Course Description	
Study Material: Subject matter	Electron transfer reaction, transfer reaction of proton-electron pair in hydrogen and hydride, oxygen atom transfer. Activation and oxygen bond mechanisms on the centre atom transition, hydrogen molecule activation, CO2 activation, nitrogen monoxide chemical bond and redox species linkages, ligand substation in complex metals, inorganic radical reactivities in liquid solutions, thermodynamics, kinetics and mechanisms of organometallic radical reactions, metal-carbon-hydrofen bond activations.
References	**Primary:** 1. A. Bakac, "Physical Inorganic Chemistry", Wiley, 2010 **Secondary:** 2. U. Müller U, "Inorganic Structural Chemistry", edisi kedua, John Wiley and Sons, 2006 3. J.E. Huheey, "Inorganic Chemistry principles of Structure and Reactivity", edisi keempat, Harper and Row Publisher, New York, 1993.
Lecturer	Prof. Dr.rer.nat Irmina Kris Murwani, Prof. Dr. Djoko Hartanto
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assesment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assesment portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face class (5)**	**Online (6)**	**(7)**	**(8)**

1	The students should be able to differentiate between the electron transfer reaction, protons, and their pairs		**Technical:** **Criteria:**	**Lecture, discussion [TM: 1×(2×50')]**		• Electron transfer reaction	
2	The students should be able to differentiate between the electron transfer reaction, protons, and their pairs	•	**Technical:** **Criteria:**	**Lecture, discussion [TM: 1×(2×50')]**		• Electron pairs transfer reaction in hydrogen •	
3	The students should be able to differentiate between the electron transfer reaction, protons, and their pairs	•	**Technical:** **Criteria:**	**Lecture, discussion [TM: 1×(2×50')]**		• Electron pairs transfer reaction in hydride •	
4	The students should be able to differentiate between the electron transfer reaction, protons, and their pairs	•	**Technical:** **Criteria:**	**Lecture, discussion [TM: 1×(2×50')]**		• Oxygen transfer atom •	
5	The students should be able to understand the mechanism of activation molecule	• Understand the mechanism of activation molecule	**Technical:** **Assignment 1** **Criteria:**	**Lecture, discussion [TM: 1×(2×50')]**		• The mechanism of activation molecule and oxygen bond the transition center	**20**

6	The students should be able to understand the mechanism of activation molecule	•	**Technical:** **Criteria:**	**Lecture, discussion [TM: 1×(2×50')]**		• The mechanism of activation molecule and oxygen bond the transition center	
7	The students should be able to understand the mechanism of activation molecule	•	**Technical:** **Criteria:**	**Lecture, discussion [TM: 1×(2×50')]**		• Activation of hydrogen molecule	
8	**Mid Semester Evaluation**						**30**
9	The students should be able to understand the mechanism of activation molecule	•	**Technical:** **Criteria:**	**Lecture, discussion [TM: 1×(2×50')]**		• CO_2 activation	
10	The students should be able to understand the mechanism of activation molecule	•	**Technical:** **Criteria:**	**Lecture, discussion [TM: 1×(2×50')]**		• The chemistry bond of nitrogen monoxide and the redox reaction	
11	The students should be able to understand the mechanism of activation molecule	•	**Technical:** **Criteria:**	**Lecture, discussion [TM: 1×(2×50')]**		• The chemistry bond of nitrogen monoxide and the redox reaction	
12	The students should be able to understand the mechanism of activation molecule	•	**Technical:** **Criteria:**	**Lecture, discussion [TM: 1×(2×50')]**		• Ligand substitution and metal complex	

13	The students should be able to understand the determinant factor of reactivity in organometalic compound	•	**Technical:** Assignment 2 **Criteria:**	**Lecture, discussion [TM: 1×(2×50')]**		• Inorganic radical reactivity in liquid solution	**20**
14	The students should be able to understand the thermodynamic factor and radical kinetic in organometalic compound	•	**Technical:** **Criteria:**	**Lecture, discussion [TM: 1×(2×50')]**		• Thermodynamic, kinetic and radical mechanism reaction in organometalic	
15	The students should be able to understand the thermodynamic factor and radical kinetic in organometalic compound	•	**Technical:** **Criteria:**	**Lecture, discussion [TM: 1×(2×50')]**		• Bond activation of metal-carbon-hydrogen	
16	**End Semester Evaluation**						**30**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
FACULTY OF SCIENCE AND DATA ANALYTICS
CHEMISTRY DEPARTMENT

Document Code

SEMESTER LEARNING PROGRAMME

COURSE (MK)	CODE	Course Diciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
BIODEGRADATION	SK 185332	Biochemistry	3	0	III	2 March 2021

FAUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Adi Setyo Purnomo, MSc, PhD	Adi Setyo Purnomo, MSc, PhD	Prof. Dr. Didik Prasetyoko, M. Sc.

Learning Outcomes (LO)	**LO-PRODI Charged to the Courses**	
	B.2 (LO 3)	Able to solve complex problem and analyze them to be developed using logical thinking based on scientific principles
	C.4 (LO 7)	Able to analyze and synthesis the concept, theories and methods on the analysis and synthesis of chemical substances by consider the right intrument and the substance side effect in order to develop the chemistry
	D.2 (LO 9)	Able to build a chemical knowledge especially in the energy, enviromental, marine and medical in order to develop the research, industry and empolyment creation
	Course Learning Outcomes (LO MK)	
	LO MK 1	Understanding of biodegradation principles and techniques, mechanism of pollutand biodegradation, also the use of microbes in the process of biodegradation

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1			√				√		√

Course Description	This subjecy covers organic pollutant biodegradation process performed by microorganism.
Study Material: Subject matter	Biodegradation processes, types of biodegradation, biodegradation techniques, biodegradation mechanisms, biodegradation in contaminated environments.

References	**Primary:** 1. T.W.G. Solomons, "Organic Chemistry", John Wiley & Sons, New York, 2004. **Secondary:** 1. M. A. Fox and J. K. Whitesell, "Organic Chemistry", Jones and Barlett Publishers, Boston, 2001. 2. J. March, "Advanced Organic Chemistry", 4th edition, John Wiley & Sons, New York, 1992. 3. E. L. Eliel, "Stereochemistry of Organic Compounds", McGraw-Hill, Singapore, 1975. 4. H. Kagan, "La Stereochimie organique", Press Universite de France, Paris, 1973.
Lecturer	Adi Setyo Purnomo, MSc, PhD
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assesment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assesment portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face class (5)**	**Online (6)**	**(7)**	**(8)**
1,2	The students should be able to understand the principal of biodegradation	• Accuracy in explaining the principal of biodegradation	**Technical:** **Criteria:**	**Lecture** **[TM: 2x(3x50")]**		• Lecture contract • Principal of biodegradation	

3	The students should be able to understand the techniques of biodegradation	• Accuracy in explaining the techniques of biodegradation	**Technical:** **Criteria:**	**Lecture** **[TM: 1x(3x50")]**		• The techniques of biodegradation •	
4,5	The students should be able to understand the mechanism of pollutant biodegradation	• Accuracy in explaining the mechanism of DDT biodegradation	**Technical:** Quiz 1 **Criteria:**	**Lecture** **[TM: 2x(3x50")]**		• The mechanism of DDT (dichloro diphenyl trichloroethana) biodegradation •	**15**
6,7	The students should be able to understand the mechanism of pollutant biodegradation	• Accuracy in explaining the mechanism of aldrin and dieldrin biodegradation	**Technical:** **Criteria:**	**Lecture** **[TM: 2x(3x50")]**		• The mechanism of aldrin and dieldrin biodegradation	
8	**Mid Semester Evaluation**						**20**
9-11	The students should be able to understand the mechanism of pollutant biodegradation	• Accuracy in explaining the mechanism of dye biodegradation	**Technical:** Quiz 2 **Criteria:** •	**Lecture** **[TM: 3x(3x50")]**		• The mechanism of dye biodegradation •	**15**
12-15	The students should be able to understand the use of microbes in biodegradation	• Completing microproject using microorganism for biodegradation	**Technical:** Microproject **Criteria:**	**Lecture , practice** **[TM: 3x(3x50")]** **Presentation** **[TM: 1x(3x50")]**		• Micro projects •	**25**
16	**End Semester Evaluation**						**25**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
FACULTY OF SCIENCE AND DATA ANALYTICS
CHEMISTRY DEPARTMENT

Document Code

SEMESTER LEARNING PROGRAMME

COURSE (MK)	CODE	Course Diciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
FOOD CHEMISTRY	SK 185333	Biochemistry	2	0	III	2 March 2021

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Adi Setyo Purnomo, MSc, PhD; Sri Fatmawati, MSc., PhD	Adi Setyo Purnomo, MSc, PhD	Prof. Dr. Didik Prasetyoko, M. Sc.

Learning Outcomes (LO)	**LO-PRODI Charged to the Courses**	
	A.2 (LO 1)	Show moral, ethical, responsibility and good personality in completing their duties
	D.1 (LO 8)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach and inovative theoretical, -experimental or -computational approach
	D.2 (LO 9)	Able to build a chemical knowledge especially in the energy, enviromental, marine and medical in order to develop the research, industry and empolyment creation
	Course Learning Outcomes (LO MK)	
	LO MK 1	Able to understand the food fortification methods and the implementation in food fortification micro project also study case

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1	√							√	√

Course Description	This subject teaches food fortification.
Study Material: Subject matter	Protein fortification (enzymatic, texturisation), milk and its processed products, eggs and their processed products, meat and their processed products, fruits and their processed products, vegetables and their processed products, seasonings, drink products (alcohol, tea, coffee, and chocolate).
References	**Primary:**

	1. T.P. Coultate, "Food the Chemistry of Its Components", Royal Society of Chemistry, 1993. **Secondary:** 2. L.H. Mayer, "Food Chemistry", edisi keempat, Reinhold Publishing Comp, New York. 3. O.R. Fennema, "Principle of Food Science", 1978
Lecturer	Adi Setyo Purnomo, MSc, PhD; Sri Fatmawati, MSc., PhD
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assesment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assesment portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face class (5)**	**Online (6)**	**(7)**	**(8)**
1-2	The students should be able to understand the food fortification methods	• Accuracy in explaining the food fortification methods	**Technical:** **Criteria:**	**Lecture [TM: 2×(3×50')]**		• Lecture contract, protein fortification (enzymatic, tecturation)	
3	The students should be able to understand the food fortification method	• Accuracy in explaining the food fortification methods	**Technical:** **Criteria:**	**Lecture [TM: 1×(3×50')]**		• Milk and the processed product	
4,5	The students should be able to understand the food fortification method	• Accuracy in explaining the egg fortification and the processed products	**Technical:** Quiz 2 **Criteria:**	**Lecture [TM: 1×(3×50')]**		• Egg and the processed product	**15**
6	The students should be able to understand the food fortification method	• Accuracy in explaining the meat fortification	**Technical:** **Criteria:**	**Lecture [TM: 1×(3×50')]**		• Meat and the processed product	

		and the processed products					
7	The students should be able to understand the food fortification method	• Accuracy in explaining the fruits fortification and the processed products	**Technical:** **Criteria:**	**Lecture** **[TM: 1×(3×50')]**		• Fruit and the processed product	
8	**Mid Semester Evaluation**						**20**
9	The students should be able to understand the food fortification method	• Accuracy in explaining the vegetables fortification and the processed products	**Technical:** • **Criteria:**	**Lecture** **[TM: 1×(3×50')]**		• Vegetables and the processed product	
10,11	The students should be able to understand the food fortification method	• Accuracy in explaining the drink fortification and seasoning	**Technical:** **Criteria:**	**Lecture** **[TM: 2×(3×50')]**		• Seasoning, drink product (tea, coffee, chocolate, alcohol)	
12,13	The students should be able to understand the study case	• Accuracy in understanding the study case	**Technical:** **Criteria:**	**Presentation** **[TM: 2×(3×50')]**		• Study case	**15**
14,15	The students should be able to completing the food fortification micro project	• Completing the food fortification micro project	**Technical:** Micro project **Criteria:**	**Discussion, practice** **[TM: 1×(3×50')]** **Presentation** **[TM: 1×(3×50')]**		• Micro projects	**25**
16	**End Semester Evaluation**						**10**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
FACULTY OF SCIENCE AND DATA ANALYTICS
CHEMISTRY DEPARTMENT

Document Code

SEMESTER LEARNING PROGRAMME

COURSE (MK)	CODE	Course Diciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
BIOASSAY	SK 185334	Biochemistry	3	0	III	2 March 2021

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Adi Setyo Purnomo, MSc, PhD; Sri Fatmawati, MSc, PhD	Adi Setyo Purnomo, MSC, PhD.	Prof. Dr. Didik Prasetyoko, M. Sc.

Learning Outcomes (LO)	**LO-PRODI Charged to the Courses**	
	B.1 (LO 2)	Show a spirit of independence, team work, leadership and entrepreneurship
	C.4 (LO 7)	Able to analyze and synthesis the concept, theories and methods on the analysis and synthesis of chemical substances by consider the right intrument and the substance side effect in order to develop the chemistry
	D.2 (LO 9)	Able to build a chemical knowledge especially in the energy, enviromental, marine and medical in order to develop the research, industry and empolyment
	Course Learning Outcomes (LO MK)	
	LO MK 1	Able to understand the principles and types of bioassay, performing bioassay and completing the given study case

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1		√					√		√

Course Description	This subject covers the principles, types, and bioassay techniques.
Study Material: Subject matter	Bioassay principles, types of bioassay, bioassay techniques, and antimicrobial and antioxidants.

References	**Primary:** Methods in Natural Product Research and Drug Development", Springer Verlag, 1999 L. Bohlin, J.G. Bruhn (editor), "Bioassay. **Secondary:** The related article/journal
Lecturer	Adi Setyo Purnomo, MSc, PhD; Sri Fatmawati, MSc, PhD
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assesment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assesment portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face class (5)**	**Online (6)**	**(7)**	**(8)**
1-2	The students should be able to understand the principal and types of bioassay	• Accuracy in explaining the principal of bioassay	**Technical:** **Criteria:**	**Lecture [TM: 2×(3×50')]**		• Lecture contract, principal of bioassay	
3	The students should be able to understand the principal and types of bioassay	• Accuracy in explaining the types of bioassay	**Technical:** **Criteria:**	**Lecture [TM: 1×(3×50')]**		• The types of bioassay	
4,5	The students should be able to understand the principal and types of bioassay	• Accuracy in explaining the techniques of bioassay	**Technical:** Quiz 1 **Criteria:**	**Lecture [TM: 2×(3×50')]**		• The techniques of bioassay	**15**
6,7	The students should be able to understand the principal and types of bioassay	• Accuracy in explaining the microbial bioassay	**Technical:** **Criteria:**	**Lecture [TM: 2×(3×50')]**		• Antioxidant	

8	**Mid Semester Evaluation**						**20**
9-10	The students should be able to understand the principal and types of bioassay	• Accuracy in explaining the antioxidant bioassay	**Technical:** **Criteria:** •	**Lecture** **[TM: 2×(3×50')]**		• Antimicrobial	
11,12	The students should be able to understand the study case	• Accuracy in understanding the study case	**Technical:** **Criteria:**	**Presentation** **[TM: 2×(3×50')]**		• Study case	**15**
13-15	The students should be able to understand and doing the bioassay	• Completing the micro project	**Technical:** Microproject **Criteria:**	**Discussion and practice** **[TM: 2×(3×50')]** **Presentation** **[TM: 1×(3×50')]**		• Micro project	**25**
16	**End Semester Evaluation**						**25**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
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CHEMISTRY DEPARTMENT

Document Code

SEMESTER LEARNING PROGRAMME

COURSE (MK)	CODE	Course Diciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
SURFACE STRUCTURE AND ANALYSIS	SK 185341	Physical Chemistry	3	0	III	2 March 2021

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Dr. Ir. Endah Mutiara M.P., MSi; Nurul Widiastuti, PhD; Dr. Yuly Kusumawati, S.Si., M.Si	Dr. Hendro Juwono, M.Si.	Prof. Dr. Didik Prasetyoko, M. Sc.

Learning Outcomes (LO)	**LO-PRODI Charged to the Courses**	
	C.1 (LO 4)	Able to develop leadership attitudes, creativity and communication skills in solving a chemistry-related problem level through a research object
	C.4 (LO 7)	Able to analyze and synthesis the concept, theories and methods on the analysis and synthesis of chemical substances by consider the right intrument and the substance side effect in order to develop the chemistry
	D.1 (LO 8)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach and inovative theoretical, -experimental or -computational approach
	D.2 (LO 9)	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation
	Course Learning Outcomes (LO MK)	
	LO MK 1	Mastering the theoretical concepts and functions of instruments used to characterize material structures on the surface.

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1				√			√	√	√

Course Description	-
Study Material: Subject matter	Definitions, properties and their phenomenons on the surface, surface morphology and hardness, molecule interactions on the surface using electromagnetic waves, spectroscopy analysis on the surface (FTIR, LEED, RHEED, SIMS, XPS, AES), imaging analysis on the surface (SEM, TEM, AFM, STM), surface contact angle analysis.
References	**Primary:** **Secondary:** 1.
Lecturer	Dr. Ir. Endah Mutiara M.P., MSi; Nurul Widiastuti, PhD; Dr. Yuly Kusumawati, S.Si., M.Si
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assesment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assesment portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face class (5)**	**Online (6)**	**(7)**	**(8)**
1-2	The students should be able to explain the definition of surface and the difference of properties/phenomena from bulky state of materials	• Accuracy in explaining the definition of surface and the difference of properties/phenomena from bulky state of materials	**Technical:** Quiz **Criteria:**	**Lecture and discussion [TM: 4×(2×50')]**		• Definition, properties and phenomena of surface	**3**
3	The students should be able to explain and analyze the parameter that influence the morphology and the roughness of surface	• Accuracy in explaining, creativity in writing and presentation, group cohesiveness	**Technical:** **Criteria:**	**Discussion [TM: 2×(2×50')]**		the parameter that influence the morphology and the roughness of surface	**3**

4	The students should be able to explain the surface molecular interaction with the electromagnetic wave	• Accuracy in explaining surface molecular interaction with the electromagnetic wave	**Technical:** Quiz **Criteria:**	**Lecture, discussion [TM: 2×(2×50')]**		• Surface molecular interaction with the electromagnetic wave	**3**
5	The students should be able to explain the concept and analyze the result from FTIR characterization on the surface materials	• Accuracy in explaining concept and analyze the result from FTIR characterization on the surface materials	**Technical:** Quiz, assignment, presentation **Criteria:**	**Lecture, discussion [TM: 2×(2×50')]**		• Surface spectroscopy analysis : FTIR	**3**
6,7	The students should be able to explain the concept and analyze the result from surface diffraction characterization : XRD, LEED< RHEED	• Accuracy in explaining the concept and analyze the result from surface diffraction characterization : XRD, LEED< RHEED	**Technical:** Quiz, assignment, presentation **Criteria:**	**Lecture, discussion [TM: 4×(2×50')]**		• Surface spectroscopy analysis : Diffraction	**3**
8	**Mid Semester Evaluation**						**20**
9	The students should be able to explain the concept and analyze the result from characterization with XPS and AES	• Accuracy in explaining the concept and analyze the result from characterization with XPS and AES	**Technical:** Quiz, assignment, presentation **Criteria:** •	**Lecture, discussion [TM: 2×(2×50')]**		• Surface spectroscopy analysis II: XPS and Auger Electron	**3**
10	The students should be able to explain the concept and analyze the result from characterization with Secondary Ion Mass Spectroscopy	• Accuracy in explaining the concept and analyze the result from characterization with	**Technical:** Quiz, assignment, presentation **Criteria:**	**Lecture, discussion [TM: 2×(2×50')]**		• Surface spectroscopy analysis II: Secondary Ion Mass Spectroscopy	**2**

		Secondary Ion Mass Spectroscopy					
11,12	The students should be able to explain the concept and analyze the result from characterization with SEM and TEM	• Accuracy in explaining the concept and analyze the result from characterization with SEM and TEM	**Technical:** Quiz, assignment, presentation **Criteria:**	**Lecture, discussion [TM: 4×(2×50')]**		• Surface imaging analysis I : SEM and TEM	**3**
13	The students should be able to explain the concept and analyze the result from characterization with STM	• Accuracy in explaining the concept and analyze the result from characterization with STM	**Technical:** Quiz, assignment, presentation **Criteria:**	**Lecture, discussion [TM: 2×(2×50')]**		Surface imaging analysis II : STM	**2**
14	The students should be able to explain the concept and analyze the result from characterization with AFM	• Accuracy in explaining the concept and analyze the result from characterization with AFM	**Technical:** Quiz, assignment, presentation **Criteria:**	**Lecture, discussion [TM: 2×(2×50')]**		Surface imaging analysis III : AFM	**2**
15	The students should be able to explain the concept and analyze the result from contact angle with statically and dynamically to determine the change of surface mechanism phenomena	• Accuracy in explaining concept and analyze the result from contact angle with statically and dynamically to determine the change of surface mechanism phenomena	**Technical:** Quiz, assignment, presentation **Criteria:**	**Lecture, discussion [TM: 2×(2×50')]**		• Analysis of static analysis and dynamic of surface contact angle	**3**

16	**End Semester Evaluation**	**20**

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CHEMISTRY DEPARTMENT

Document Code

SEMESTER LEARNING PROGRAMME

COURSE (MK)	CODE	Course Diciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
MEMBRANE SYNTHESIS	SK 185342	Physical Chemistry	2	0	III	2 March 2021

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Nurul Widiastuti, PhD	Dr. Hendro Juwono, M.Si.	Prof. Dr. Didik Prasetyoko, M. Sc.

Learning Outcomes (LO)	**LO-PRODI Charged to the Courses**	
	C.2 (LO 5)	Able to show responsibility of their individual and team work
	C.4 (LO 7)	Able to analyze and synthesis the concept, theories and methods on the analysis and synthesis of chemical substances by consider the right intrument and the substance side effect in order to develop the chemistry
	D.1 (LO 8)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach and inovative theoretical, -experimental or -computational approach
	D.2 (LO 9)	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation
	Course Learning Outcomes (LO MK)	
	LO MK 1	Able to develop membrane synthesis methods in order to produce membrane with properties that match its applications.

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1					√		√	√	√

Course Description -

Study Material: Subject matter	Membrane materials; membrane processes such as microfiltration, ultrafiltration, reverse osmosis, pervaporation, dialysis, gas separation, as well as their applications in the field of energy, environment, health, and food; membrane synthesis methods review, by using either inorganic membranes or organic polymer membranes; study case on separation and purification problems; literature study in developing synthesis methods on membrane materials in giving an alternative solution in separation and purification; review conclusions on synthesis methods on membrane materials in giving solutions to a problem.
References	**Primary:** **Secondary:**
Lecturer	Nurul Widiastuti, PhD
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assesment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assesment portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face class (5)**	**Online (6)**	**(7)**	**(8)**
1-2	The students should be able to explain the definition of membrane materials (C2)	• Report of literature study	**Technical:** Personal assignment 1 : Literature study of one type of membrane materials **Criteria:**	**Lecture [TM: 2×(2×50')]**		• Membrane materials : polymer, inorganic, mixed matrix membrane	**5**

3-5	The students should be able to explain the correlation between the synthesis process and the properties of the membrane (C3)	• Resume	**Technical:** Personal assignment 2 : Writing resume of one membrane materials and the synthesis process from literature study **Criteria:**	**Lecture, discussion [TM: 2×(2×50')]**		• Process of membrane synthesis : ultrafiltration, reverse osmosis, pervaporation, dialysis, gas separation and its application in the sector of energy, environment, medical and food.	**5**
6,7	The students should be able to write literature review of membrane synthesis method(C4)	• Writing review paper	**Technical:** Personal assignment 3 : Writing literature review of membrane synthesis method related with assignment 2 **Criteria:**	**Lecture, discussion [TM: 2×(2×50')]**		• Review of membrane synthesis method (inorganic membrane, organic polymer membrane)	**10**
8	**Mid Semester Evaluation**						**15**
9,10	The students should be able to analysis the problem of separation and purification (C4)	• Study case analysis	**Technical:** Personal assignment 4 : Study case analysis	**Lecture, discussion [TM: 2×(2×50')]**		• Study case analysis of separation and purification	**5**

			Criteria: •				
11,12	The students should be able to arrange the idea for the development of membrane synthesis method (C5)	• Draft of scientific article	**Technical:** Personal assignment 5 : The draft of scientific article related to the idea of membrane synthesis method **Criteria:**	**Lecture, discussion** **[TM: 2×(2×50')]**		• Literature study of the material membrane synthesis method development for an alternative in separation and purification	**5**
13,14	The students should be able to recommend the membrane synthesis method from literature study (C5)	• Presentation of final project	**Technical:** Presentation, personal assignment of final project **Criteria:**	**Lecture, discussion** **[TM: 2×(2×50')]**		• Recommendation of membrane synthesis/preparation based on literature study	**20** **25**
15,16	**End Semester Evaluation**						**15**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
FACULTY OF SCIENCE AND DATA ANALYTICS
CHEMISTRY DEPARTMENT

Document Code

SEMESTER LEARNING PROGRAMME

COURSE (MK)	CODE	Course Diciplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
CARBON MATERIALS	SK 185343	Physical Chemistry	2	0	III	2 March 2021

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program
	Nurul Widiastuti, PhD; Lukman Atmaja, Ph.D.	Dr. Hendro Juwono, M.Si.	Prof. Dr. Didik Prasetyoko, M. Sc.

Learning Outcomes (LO)	LO-PRODI Charged to the Courses	
	B.2 (LO 3)	Able to solve complex problem and analyze them to be developed using logical thinking based on scientific principles
	C.4 (LO 7)	Able to analyze and synthesis the concept, theories and methods on the analysis and synthesis of chemical substances by consider the right intrument and the substance side effect in order to develop the chemistry
	D.1 (LO 8)	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach and inovative theoretical, -experimental or -computational approach
	D.2 (LO 9)	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation
	Course Learning Outcomes (LO MK)	
	LO MK 1	Students are able to design carbon structures for a variety of advanced technology applications

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
CP MK 1			√				√	√	√

Course Description -

Study Material: Subject matter	The fundamentals of carbon materials, carbon materials engineering and applications, carbon materials for advanced technologies.
References	**Primary:** 1. Michio Inagaki dan Kang Feiyu, "Carbon Materials Science and Engineering from Fundamental to Applications", 2006, Tsinghua University Press **Secondary:** 2. Timothy D. Burchell, "Carbon Materials for Advanced Technologies", 1999, Pergamon, Amsterdam
Lecturer	Nurul Widiastuti, PhD; Lukman Atmaja, Ph.D.
Pre-Requisite Courses	-

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assesment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assesment portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face class (5)**	**Online (6)**	**(7)**	**(8)**
1,2	The students should be able to explain the structure and texture of carbon materials	• Accuracy in explaining the structure and texture of carbon materials	**Technical:** Ability to explain the structure and texture of carbon materials in discussion and writing. **Criteria:**	**Lecture and discussion [TM: 2×(2×50')]**		• Fundamental of carbon materials: The bonding of carbon-carbon, group of carbon, correlation of carbon with the neighboring atom • The structure of carbon materials, nano-texture and micro-texture (agglomeration)	**Include mid-semester evaluation**

3-5	The students should be able to develop the structure and pore of carbon materials	• Accuracy in analysis (assesed in rubic system)	**Technical:** Ability to analysis : completing the assesment of development structure and pore, modify the structure of carbon materials (presentation and discussion) **Criteria:**	**Lecture and discussion [TM: 3×(2×50')]**		• Development of structure of carbon with thermal treatment (carbonization and graphitization) • Development of carbon materials nanostructure • New technique for carbonization • Development of materials carbon structure • Acceleration of graphitization • Development of carbon pore materials • Modification of carbon materials	**20**
6,7	The students should be able to manipulating the carbon structure	• Accuracy in analysis (assesed in test and writing)	**Technical:** Ability to analysis : completing the assesment of development structure and pore, modify the structure of carbon materials (presentation and discussion)	**Lecture and discussion [TM: 2×(2×50')]**		• Manipulation of carbon structure: polyglass like carbon, crystalline block graphite, high-oriented-graphite, non-graphitizing, glass-like carbon, carbon fiber, porous carbon, composite based on carbon	**Include mid-semester evaluation**

			Criteria:				
8	**Mid Semester Evaluation**						**20**
9,10	The students should be able to develop the structure and texture of carbon materials from coal, biomass and waste	•	**Technical:** **Criteria:** •	**Lecture and discussion [TM: 2×(2×50')]**		• Carbon derived from coal • Activated carbon from biomass and biomass waste	**Include final-semester evaluation**
11	The students should be able to correlate the manipulation structure and the texture of carbon materials with the application.	• Discussion • Presentation • Reviewing paper (assesment with rubic system)	**Technical:** Ability to evalute the result of literature study and find the idea to develop the research **Criteria:**	**Lecture and discussion [TM: 1×(2×50')]**		• Intercalation compund: high conductivity compound, electrochemical function, catalytic function, gas adsorption, gas storage • Carbon materials for environmental remediation	**10** **10** **20**
12-14	The students should be able to design the structure and texture of carbon materials for advanced technology	•	**Technical:** **Criteria:**	**Study case [TM: 3×(2×50')]**		• Carbon materials for otomotif application • Carbon materials for energy storage • Adsorbent for natural gas vehicle storage • Adsorption in refrigerator and heat pump	

						• Carbon for lithium battery • Carbon for fusion energy application • Carbon for fision reactor application	
15,16	**End Semester Evaluation**						**20**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
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DEPARTMENT OF CHEMISTRY

Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course Disiplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
PHOTOCHEMISTRY	SK 185344	Physical Chemistry	2	0	III	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Dr. Ir. Endah Mutiara M.P., M.Si.; Prof. Dr. Syafsir Akhlus, M.Sc.	Dr. Hendro Juwono, M.Si.	Prof. Dr. Didik Prasetyoko, M.Sc

Learning Outcomes (LO)		
	LO-PRODI Charged to The Course	
	LO 1	Show moral, ethical, responsibility and good personality in completing their duties
	LO 4	Able to develop leadership attitudes, creativity and communication skills in solving a chemistry-related problem related problem
	LO 7	Able to analyze and synthesis concepts, theories, and methods on the analysis and synthesis of chemical substances by considering the right instrument and the substance side effect in order to develop the chemistry
	LO 8	Able to identify, formulize and solved the science and technology problems related to structure and chemical change through the accurate and innovative theoretical, -experimental or -computational approach
	Course Learning Outcomes (LO MK)	
	LO MK 1	Able to understand the knowledge of photochemistry in the material research topics in informatics, environments, and other related fields
	LO MK 2	Able to gain deep knowledge about the definition, theory, and role of photochemistry in a variety of its applications

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
LO MK 1	√			√			√	√	
LO MK 2									

Course Short Description	
Study Material: Subject Matter	The understanding of photochemistry, the laws in photochemistry, ray sources, the interaction of rays with molecules and materials, the kinetics of photochemistry, lasers and photodissociation, semiconductor catalyst, photosynthesis, photoinduction phenomenons, and applications of photochemistry
Reference	**Primary:** 1. D.W. Bahnemann, P.K.J. Robertson, "Environmental Photochemistry", Springer, London, 2015 2. R.C. Evans, P. Douglas, H.D. Burrows, "Applied Photochemistry", Springer, London, 2013 3. B. Wardle, "Principles and Applications of Photochemistry", John Wiley & Sons, Ltd., 2009 4. A.G. Kutateladze, "Computational Methods in Photochemistry", Taylor & Francis, London, 2005 **Secondary:**
Supporting Lecturer	Dr. Ir. Endah Mutiara M.P., M.Si.; Prof. Dr. Syafsir Akhlus, M.Sc.
Pre-Requisite Courses	

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1	Introduction of photochemistry	• The accuracy in explaining	**Technical:** **Criteria:**	**Lecture and discussion [TM: 2×50'']**		• The definition of photochemistry, laws of photochemistry, and light source	**Entered in Quiz-1**
2	Students are able to explain and understand the interactions between light with molecules and materials	• The accuracy in explaining and understanding	**Technical:** **Criteria:**	**Lecture and discussion [TM: 2×50'']**		• Electron excitation, the interaction between light and matter	**Entered in Quiz-1**

3	Students are able to understand the photochemical kinetics	• The accuracy in understanding	**Technical:** **Criteria:**	**Lecture and discussion [TM: 2×(2×50'')]**		• Reaction mechanism in photochemistry, excitation state	**Entered in Quiz-1**
4	QUIZ-1						**20**
5	Students are able to understand and connect between laser and photodissociation	• The accuracy in understanding and	**Technical:** **Criteria:**	**Lecture and discussion [TM: 2×50'']**		• Definition of laser and photodissociation • Correlation between laser and photodissociation	**Entered in Mid-Semester Evaluation**
6	Students are able to understand and apply the effect of solvent on Stokes shift computationally	• Expertise in computation applications	**Technical:** Practice **Criteria:**	**Computational practice [TM: 2×50'']**		• Various solvents on Stokes shift	**Entered in Mid-Semester Evaluation**
7	Students are able to apply laser application and photodissociation	• The accuracy in understanding and explaining in the group discussion	**Technical:** Paper assignment, Presentation, and discussion **Criteria:**	**Case studies [TM: 2×(2×50'')]**		• Laser application and photodissociation	**Entered in Mid-Semester Evaluation**
8	**Mid-Semester Evaluation**						**30**
9	Students are able to understand and know several semiconductor catalysts in photochemistry	• The accuracy in understanding	**Technical:** Assignment **Criteria:**	**Lecture and discussion [TM: 2×50'']**		• Variety of semiconductor catalysts (its advantages and disadvantages in the photochemical reaction applications)	**Entered in Quiz-1**

10	Students are able to explain and understand photosynthesis and photoinduction	• The accuracy in explaining and understanding	**Technical:** Assignment **Criteria:**	**Lecture and discussion [TM: 2×50'']**		• Photosynthesis, photoinduction, (theory and application)	**Entered in Quiz-1**
11	Students are able to understand and connect the effect of the photochemistry process on the formation of mercury oxide for the environment	• Case studies	**Technical:** Assignment: Case and solution idea analysis **Criteria:**	**Lecture and case studies [TM: 2×50'']**		• Photochemistry reactions in the formation of mercury oxide	**Entered in Quiz-2**
12	QUIZ-2						**20**
13	Students are able to understand and explain the application of photochemistry in environment preservation	• The accuracy in explaining and understanding	**Technical:** Class assignment **Criteria:**	**Lecture and case studies [TM: 2×50'']**		• Photodegradation, photooxidation, and photodecompositio n	**Entered in End-of-Semester Evaluatio n**
14	Students are able to convey their ideas in writing about the application of photochemistry in everyday life	• Presentation and discussion	**Technical:** Assignment: Conveying ideas in writing **Criteria:**	**Student presentation [TM: 2×50'']**		• Application of photochemistry in the formation of carbon nanotube, santonin reaction	**Entered in End-of-Semester Evaluatio n**
15-16	**End-of-Semester Evaluation**						**30**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
FACULTY OF SCIENCES AND ANALYTICAL DATA
DEPARTMENT OF CHEMISTRY

Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course Disiplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
INDUSTRIAL PROCESSES CHEMISTRY	SK 185345	Physical Chemistry	2	0	III	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Drs. Eko Santoso, M. Si.; Prof. Dr. Syafsir Akhlus, M.Sc.	Dr. Hendro Juwono, M.Si.	Prof. Dr. Didik Prasetyoko, M.Sc

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	LO 2	Show a spirit of independence and team work in completing their duties
	LO 7	Able to analyze and synthesis concepts, theories, and methods on the analysis and synthesis of chemical substances by considering the right instrument and the substance side effect in order to develop the chemistry
	LO 9	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation industry, and employment creation
	Course Learning Outcomes (LO MK)	
	LO MK 1	Able to understand, explain, and connect the interrelationship between chemistry, especially regarding thermodynamics, catalyst, and their applications in the industrial processes

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
LO MK 1		√					√		√

Course Short Description

Study Material: Subject Matter	Industrial non-equilibrium thermodynamics, pulp suspensions multiphase thermodynamics, thermodynamics in natural gas clathrate hydrates, ionic liquids in separation processes, micro- and nano-particles production using supercritical fluids, plastic recycling, new materials thermodynamics, adsorption thermodynamics, applied thermodynamics for petroleum fluids in the refining industry, organic reactions catalysis, deactivation and poisoning of catalysts, catalysis and surface science, innovations on chemical industries
Reference	**Primary:** 1. H.H. Trimm, W. Hunter Jr., "Industrial Chemistry New Applications, Processes and Systems", Apple Academic Press, 2011 2. W.H. Flank, M.A. Abraham, M.A. Matthews, "Innovations in Industrial and Engineering Chemistry", American Chemical Society, Washington DC, 2008 3. T.M. Letcher, "Chemical Thermodynamics for Industry", The Royal Society of Chemistry, Cambridge, 2004 4. H.K. Abdel-Aal, M.A. Aggour, M.A. Fahim, "Petroleum and Gas Field Processing", Second edition, CRC Press, New York, 2015 **Secondary:**
Supporting Lecturer	Drs. Eko Santoso, M. Si.; Prof. Dr. Syafsir Akhlus, M.Sc.
Pre-Requisite Courses	

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1	Students are able to understand and explain non-equilibrium thermodynamics for industry	• The accuracy in explaining	**Technical:** Class discussion **Criteria:**	**Lecture and discussion [TM: 2×50'']**		• Non-equilibrium thermodynamics for industry	**Entered in Quiz-1**
2	Students are able to explain the principle and material properties for industry	• The accuracy in explaining	**Technical:** Assignment: Identification of industrial material properties	**Lecture and discussion [TM: 2×50'']**		• The principle of material industrial properties	**Entered in Quiz-1**

			Criteria:				
3	Students are able to understand, explain, and link the multiphase thermodynamics theory with the suspension industry	• The accuracy in linking the multiphase thermodynamics theory with the suspension industry	**Technical:** Class discussion **Criteria:**	**Lecture and discussion [TM: 2×(2×50'')]**		• Multiphase thermodynamics	**Entered in Quiz-1**
4	QUIZ-1						**20**
5	Students are able to understand, explain, and link the thermodynamics theory with the natural gas industry	• The accuracy in linking	**Technical:** Assignment: Identification of what is included in natural gas **Criteria:**	**Lecture and discussion [TM: 2×50'']**		• Thermodynamics in the natural gas industry	**Entered in Mid-Semester Evaluation**
6,7	Students are able to understand and explain the separation theory	• Case studies	**Technical:** Assignment and discussion **Criteria:**	**Lecture and case studies [TM: 2x(2×50'')]**		• Variety of separation processes in the industry	**Entered in Mid-Semester Evaluation**
8	**Mid-Semester Evaluation**						**30**
9	Students are able to link the role of supercritical fluid with the industry	• The accuracy in linking the role of supercritical fluid with production in the industry	**Technical:** Assignment: Identify the structure and properties of the fluid and connect its roles to the industry **Criteria:**	**Lecture and discussion [TM: 2×50'']**		• Production of micro- and nano-particle using supercritical fluid	**Entered in Quiz-2**

10	Students are able to understand the recycling process in the industry	• The accuracy in understanding	**Technical:** Assignment and class discussion **Criteria:**	**Lecture and discussion [TM: 2×50'']**		• Recycling of the plastics industry	**Entered in Quiz-2**
11	Students are able to think about finding chemicals for environmentally friendly industrial processes	• Case studies	**Technical:** Assignment: Case and solution idea analysis **Criteria:**	**Lecture and case studies [TM: 2x(2×50'')]**		• Polymer materials of building, paint, plastic, foam, and glue	**Entered in Quiz-2**
12	QUIZ-2						**20**
13	Students are able to think about finding the latest process for environmentally friendly industrial processes	• Case studies	**Technical:** Assignment: Case and solution idea analysis **Criteria:**	**Lecture and case studies [TM: 2×50'']**		• Variety of industrial processes	**Entered in End-of-Semester Evaluation**
14	Students are able to link the role of a catalyst with industrial process and know the methods for the identification of toxic catalyst	• Written ideas	**Technical:** Presentation of written ides **Criteria:**	**Lecture and case studies [TM: 2×50'']**		• Variety of catalysts used in the industry (utilization and prevention so as not to become toxic)	**Entered in End-of-Semester Evaluation**
15-16	**End-of-Semester Evaluation**						**30**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
FACULTY OF SCIENCES AND ANALYTICAL DATA
DEPARTMENT OF CHEMISTRY

Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course Disiplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
FUNCTIONAL POLYMERS	SK 185346	Physical Chemistry	2	0	III	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Lukman Atmaja, Ph.D.; Dr. Hendro Juwono, M.Si.	Dr. Hendro Juwono, M.Si.	Prof. Dr. Didik Prasetyoko, M.Sc

Learning Outcomes (LO)

LO-PRODI Charged to The Course	
LO 1	Show moral, ethical, responsibility and good personality in completing their duties
LO 7	Able to analyze and synthesis concepts, theories, and methods on the analysis and synthesis of chemical substances by considering the right instrument and the substance side effect in order to develop the chemistry
LO 9	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation industry, and employment creation

Course Learning Outcomes (LO MK)	
LO MK 1	Able to master the theory of structure and properties, energetic, kinetic, analysis, micro- and macro-molecule synthesis and its applications

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
LO MK 1	√						√		√

Course Short Description

Study Material:
Subject Matter

Reference	**Primary:** **Secondary:**
Supporting Lecturer	Lukman Atmaja, Ph.D.; Dr. Hendro Juwono, M.Si.
Pre-Requisite Courses	

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1	Students are able to understand the role of molecular structures in polymers on their properties	• The accuracy level of the statement about the role of molecular structure	**Technical:** **Criteria:**	**Lecture [TM: 2×50'']**		• Correlation of structure and all physical and chemical properties of materials	**5**
2	Students are able to understand the origin of the conduction behavior of polymers and the main concept of synthesis through molecular structure modification	• The accuracy level of the conduction behavior statement	**Technical:** **Criteria:**	**Lecture [TM: 2×50'']**		• The principle of electrical and intrinsical conduction properties of polymers – 1	**5**
3	Students are able to understand the origin of the conduction behavior of polymers and the main	• The accuracy level of the conduction behavior statement	**Technical:** **Criteria:**	**Lecture [TM: 2×50'']**		• The principle of electrical and intrinsical conduction	**8**

	concept of synthesis through molecular structure modification					properties of polymers – 2	
4	Students are able to understand the conduction properties of polymers caused by ion behavior	• The accuracy level of statement about the role of ions	**Technical:** **Criteria:**	**Lecture** **[TM: 2×50'']**		• Polymers which conducts through ion mechanism – 1	**8**
5	Students are able to understand the conduction properties of polymers caused by ion behavior	• The accuracy level of statement about the role of ions	**Technical:** **Criteria:**	**Lecture** **[TM: 2×50'']**		• Polymers which conducts through ion mechanism – 2	**8**
6	Students are able to understand the basis of magnetic interaction in polymers	• The accuracy level of statement about the basis of magnetic interactions	**Technical:** **Criteria:**	**Lecture** **[TM: 2×50'']**		• Study of polymer structure with magnetic properties – 1	**8**
7	Students are able to understand the basis of magnetic interaction in polymers	• The accuracy level of statement about the basis of magnetic interactions	**Technical:** **Criteria:**	**Class discussion** **[TM: 2×50'']**		• Study of polymer structure with magnetic properties – 2	**8**
8	**Mid-Semester Evaluation**						
9	Students are able to understand the role of polymers as the reaction system controller	• The accuracy level of statement about the role of polymers as the reaction system controller	**Technical:** **Criteria:**	**Lecture** **[TM: 2×50'']**		• Polymers for drug release applications in body – 1	**10**

10	Students are able to understand the role of polymers as the reaction system controller	• The accuracy level of statement about the role of polymers as the reaction system controller	**Technical:** **Criteria:**	**Class discussion [TM: 2×50'']**		• Polymers for drug release applications in body – 2	**10**
11	Students are able to understand the unique structure of biomaterials in the contex of polymer applications	• The accuracy level of statement about the unique structure of biomaterials	**Technical:** **Criteria:**	**Lecture [TM: 2×50'']**		• Interaction between synthetic polymers and natural materials	**10**
12	Students are able to understand structure modification of polymer for membrane applications	• The accuracy level of statement about the structure modification for membrane	**Technical:** **Criteria:**	**Lecture [TM: 2×50'']**		• Modified polymer structure for all types of membrane – 1	**7**
13	Students are able to understand structure modification of polymer for membrane applications	• The accuracy level of statement about the structure modification for membrane	**Technical:** **Criteria:**	**Lecture [TM: 2×50'']**		• Modified polymer structure for all types of membrane – 2	**8**
14	Students are able to understand the general theory in the structure modification of polymer molecules	• The accuracy level of statement about the structure modification for membrane	**Technical:** **Criteria:**	**Lecture [TM: 2×50'']**		• Structure modification methods of polymers – overview	**5**
15-16	**End-of-Semester Evaluation**						**50**

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DEPARTMENT OF CHEMISTRY

Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course Disiplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
PHENOLATE CHEMISTRY	SK 185552	Organic Chemistry	2	0	III	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Prof.Dr. Taslim Ersam, MS	Prof. Mardi Santoso, Ph.D.	Prof. Dr. Didik Prasetyoko, M.Sc

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	LO 1	Show moral, ethical, responsibility and good personality in completing their duties
	LO 7	Able to analyze and synthesis concepts, theories, and methods on the analysis and synthesis of chemical substances by considering the right instrument and the substance side effect in order to develop the chemistry
	Course Learning Outcomes (LO MK)	
	LO MK 1	Able to master the properties of phenolat compounds how to synthesis those compounds and their applications

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
LO MK 1	√						√		

Course Short Description	
Study Material: Subject Matter	
Reference	**Primary:**

	Secondary:
Supporting Lecturer	Prof.Dr. Taslim Ersam, MS
Pre-Requisite Courses	

Session	Learning outcomes of each learning stage (Sub-LOMK)	Assessment		Learning Design; Learning Method; Student Assignment; [Time Estimation]		Learning Material [Reference]	Assessment Portion (%)
		Indicator	Criteria and Technical				
(1)	(2)	(3)	(4)	Face-to-face Class (5)	Online Class (6)	(7)	(8)

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DEPARTMENT OF CHEMISTRY

Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course Disiplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
PIGMENTS CHEMISTRY	SK 185554	Organic Chemistry	2	0	III	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Sri Fatmawati, M.Sc., Ph.D.; Arif Fadlan, D.Sc.	Prof. Mardi Santoso, Ph.D.	Prof. Dr. Didik Prasetyoko, M.Sc

Learning Outcomes (LO)

LO-PRODI Charged to The Course	
LO 2	Show a spirit of independence and team work in completing their duties
LO 7	Able to analyze and synthesis concepts, theories, and methods on the analysis and synthesis of chemical substances by considering the right instrument and the substance side effect in order to develop the chemistry
LO 9	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation industry, and employment creation

Course Learning Outcomes (LO MK)	
LO MK 1	Able to master the various compounds that usually used as pigments including their structure and properties

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
LO MK 1		√					√		√

Course Short Description

Study Material: Subject Matter

Definitions, essential oil separations and analysis, compositions, uses, and chemical aspects

Reference

Primary:

	Secondary:
Supporting Lecturer	Sri Fatmawati, M.Sc., Ph.D.; Arif Fadlan, D.Sc.
Pre-Requisite Courses	

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1	Students are able to explain various types of chromophore from different classes of pigments	• The accuracy in explaining the types of chromophore from different classes of pigments	**Technical:** **Criteria:**	**Lecture and discussion [TM: 2×50'']**		• Chromophores of varoius classes of pigments	
2	Students are able to explain various classes of pigments and their applications	• The accuracy in explaining various classes of pigments and their applications	**Technical:** Assignment 1 **Criteria:**	**Lecture and discussion [TM: 2×50'']**		• Various classes of pigments and their applications	**10**
3	Students are able to explain the concepts of sulfur-containing pigments	• The accuracy in explain the concepts of sulfur-containing pigments	**Technical:** **Criteria:**	**Lecture and discussion [TM: 2×50'']**		• Types and properties of sulfur-containing pigments	
4	Students are able to explain the Bunte Salt Dyes concept	• The accuracy in explaining the Bunte Salt Dyes concept	**Technical:** **Criteria:**	**Lecture and discussion [TM: 2×50'']**		• Types and properties of the Bunte Salt Dyes	

5	Students are able to explain the condition of pigments in a dye bath and substrates	• The accuracy in explaining the condition of pigments in a dye bath and substrates	**Technical:** Assignment 2 **Criteria:**	**Lecture and discussion [TM: 2×50'']**		• Pigments in a dye bath • Pigments in substrates	**15**
6,7	Students are able to understand and explain the reaction mechanism of pigment	• The accuracy in understanding and explaining the reaction mechanism of pigment	**Technical:** **Criteria:**	**Lecture and discussion [TM: 2×50'']**		• Reaction mechanism of pigment	
8	**Mid-Semester Evaluation**						**25**
9	Students are able to explain and apply various types of pigments for different types of textile materials such as cellulose, wool, silk, etc.	• The accuracy in explaining and applying various types of pigments for different types of textile materials such as cellulose, wool, silk, etc.	**Technical:** **Criteria:**	**Lecture, demonstration, and discussion [TM: 2×50'']**		• Textile dyes	
10,11	Students are able to explain and apply various types of pigments for different types of non-textile materials such as paper, food, skin, etc.	• The accuracy in explaining and applying various types of pigments for different types of non-textile materials such as paper, food, skin, etc.	**Technical:** Assignment 3 **Criteria:**	**Lecture, demonstration, and discussion [TM: 2×50'']**		• Non-textile dyes	**10**
12,13	Students are able to explain various types of functional pigments and their applications such as imaging,	• The accuracy in explaining various types of functional pigments and their applications	**Technical:** **Criteria:**	**Lecture, presentation, and discussion [TM: 2×50'']**		• Functional pigments	

	printing, electrochromic, laser, chemiluminescence, etc.	such as imaging, printing, electrochromic, laser, chemiluminescence, etc.					
14,15	Students are able to explain optical brighteners agents, their characteristics, and their function	• The accuracy in explaining optical brighteners agents, their characteristics, and their function	**Technical:** Assignment 4 **Criteria:**	**Lecture, presentation, and discussion [TM: 2×50'']**		• Optical brighteners agents	**15**
16	**End-of-Semester Evaluation**						**25**

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SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course Disiplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
PETROLEUM CHEMISTRY	SK 185554	Organic Chemistry	2	0	III	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Prof. Dr. R.Y. Perry Burhan, M.Sc.; Dr. Yulfi Zetra, M.S.	Prof. Mardi Santoso, Ph.D.	Prof. Dr. Didik Prasetyoko, M.Sc

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	LO 3	Able to solve complex problem and analyze them to be developed using logical thinking based on scientific principles
	LO 4	Able to develop leadership attitudes, creativity and communication skills in solving a chemistry-related problem related problem
	LO 7	Able to analyze and synthesis concepts, theories, and methods on the analysis and synthesis of chemical substances by considering the right instrument and the substance side effect in order to develop the chemistry
	LO 9	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation industry, and employment creation
	Course Learning Outcomes (LO MK)	
	LO MK 1	Able to master the various compounds in petrouleum
	LO MK 2	Able to master the structure and properties of chemical compounds in petroluem
	LO MK 3	Able to master the application of petroluem chemistry

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
LO MK 1			√				√		
LO MK 2							√		
LO MK 3				√			√		√

Course Short Description	
Study Material: Subject Matter	1. Definition and importance of petroleum geochemistry 2. Strategy and assessment planning of petroleum geochemistry 3. Determination and interpretation of maturity, the quality level of source rocks, the depositional environment of source rocks, kerogen 4. Formation and migration of hydrocarbon, types of petroleum and natural gas as well their correlation with source rocks, the modeling of hydrocarbon formation
Reference	**Primary:** **Secondary:**
Supporting Lecturer	Prof. Dr. R.Y. Perry Burhan, M.Sc.; Dr. Yulfi Zetra, M.S.
Pre-Requisite Courses	

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1-3	Students are able to explain the importance of petroleum geochemistry and understand the strategy and assessment planning of geochemistry	• The accuracy in explaining the importance of petroleum geochemistry and understand the strategy and assessment planning of geochemistry	**Technical:** Assignment 1 **Criteria:**	**Lecture and discussion** **[TM: 3x(2×50'')]** **Assignment 1** **[BT+BM:(1+1)x(2x60)]**		• Definition of petroleum geochemistry • Role of petroleum geochemistry • Strategy and assessment planning of geochemistry	**10**

4,5	Students are able to determine and interpret the maturity of petroleum and the quality of source rocks	• The accuracy in determining and interpreting the maturity of petroleum and the quality of source rocks	**Technical:** **Criteria:**	**Lecture and group discussion**		• Determination and interpretation of the maturity of petroleum • Determination and interpretation of the quality level of source rocks	
6-7	Students are able to determine and interpret the depositional environment of source rocks and kerogen	• The accuracy in determining and interpreting the depositional environment of source rocks and kerogen	**Technical:** Assignment 2 **Criteria:**	**Lecture and group discussion** **[TM: 2x(2×50'')]** **Assignment 2** **[BT+BM:(1+1)x(2x60)]**		• Determination and interpretation of the depositional environment of source rocks and kerogen	**10**
8	**Mid-Semester Evaluation**						**25**
9,10	Students are able to explain the formation process of hydrocarbon and the migration process of hydrocarbon	• The accuracy in explaining the formation process of hydrocarbon and the migration process of hydrocarbon	**Technical:** **Criteria:**	**Lecture and group discussion** **[TM: 2x(2×50'')]**		• The formation process of hydrocarbon • The migration process of hydrocarbon • The formation process of kerogen	
11-13	Students are able to explain types of petroleum and natural gas as well as their correlation with source rocks	• The accuracy in explaining types of petroleum and natural gas as well as their correlation with source rocks	**Technical:** Assignment 3 **Criteria:**	**Lecture and group discussion** **[TM: 2x(2×50'')]** **Assignment 3** **[BT+BM:(1+1)x(2x60)]**		• Types of petroleum • Types of natural gas • Correlation of petroleum and natural gas with source rocks	**15**

14,15	Students are able to explain the modeling of hydrocarbon formation	• The accuracy in explaining the modeling of hydrocarbon formation	**Technical:** Assignment 4 **Criteria:**	**Lecture and group discussion [TM: 2x(2×50'')]** **Assignment 4 [BT+BM:(1+1)x(2x60)]**		• Modeling of hydrocarbon formation	**15**
16	**End-of-Semester Evaluation**						**25**

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Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course Disiplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
HETEROCYCLIC AROMATIC CHEMISTRY	SK 185555	Organic Chemistry	3	0	III	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Prof. Mardi Santoso, Ph.D.	Prof. Mardi Santoso, Ph.D.	Prof. Dr. Didik Prasetyoko, M.Sc

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	LO 7	Able to analyze and synthesis concepts, theories, and methods on the analysis and synthesis of chemical substances by considering the right instrument and the substance side effect in order to develop the chemistry
	Course Learning Outcomes (LO MK)	
	LO MK 1	Able to understand the definition, nomenclature, structure, reactivity, synthesis, role, and benefits of heterocyclic aromatic compounds

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
LO MK 1							√		

Course Short Description	
Study Material: Subject Matter	The definition, nomenclature, structure, reactivity, synthesis, role, and benefits of heterocyclic aromatic compounds
Reference	**Primary:**

	1. J.A. Joule, K. Mills, "Heterocyclic Chemistry", edisi keempat, Blackwell, Oxford, 2002 2. J.A. Joule, K. Mills, "Heterocyclic Chemistry at a Glance", edisi kedua, Wiley, 2013 3. Related journals **Secondary:**
Supporting Lecturer	Prof. Mardi Santoso, Ph.D.
Pre-Requisite Courses	

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1-3	Students are able to understand the course contract, definition, nomenclature, role, and benefits of heterocyclic aromatic compounds	• The accuracy in explaining the definition, nomenclature, role, and benefits of heterocyclic aromatic compounds	**Technical:** **Criteria:**	**Lecture and discussion [TM: 3x(2×50'')]**		• Definition, nomenclature, role, and benefits of heterocyclic aromatic compounds	
4	Quiz-1						**15**
5-14	Students are able to understand the electron-rich heterocyclic aromatic compounds	• The accuracy in explaining the structure, reactivity, synthesis, role, and benefits of pyrrole, furan, thiophene, azole, indole, benzofuran,	**Technical:** **Criteria:**	**Lecture and discussion [TM: 10x(2×50'')]**		• Structure, reactivity, synthesis, role, and benefits of pyrrole, furan, thiophene, azole, indole, benzofuran, benzothiazole, benzimidazole	

		benzothiazole, benzimidazole					
15-16	**Mid-Semester Evaluation**						**35**
17-20	Students are able to understand the electron-deficient heterocyclic aromatic compounds	• The accuracy in explaining the structure, reactivity, synthesis, role, and benefits of pyridine, quinoline, isoquinoline, pyrylium, benzopyrylium	**Technical:** **Criteria:**	**Lecture and group discussion**		• Structure, reactivity, synthesis, role, and benefits of pyridine, quinoline, isoquinoline, pyrylium, benzopyrylium	
21	Quiz-2						**20**
22-28	Students are able to understand the latest topics about heterocyclic aromatic compounds	• The accuracy in explaining the latest topics about heterocyclic aromatic compounds	**Technical:** **Criteria:**	**Lecture and group discussion**		• The latest topics about heterocyclic aromatic compounds	
16	**End-of-Semester Evaluation**						**30**

INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)
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DEPARTMENT OF CHEMISTRY

Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course Disiplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
MEDICINAL CHEMISTRY	SK 185556	Organic Chemistry	2	0	III	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Sri Fatmawati, M.Sc., Ph.D.	Prof. Mardi Santoso, Ph.D.	Prof. Dr. Didik Prasetyoko, M.Sc

Learning Outcomes (LO)		
	LO-PRODI Charged to The Course	
	LO 2	Show a spirit of independence and team work in completing their duties
	LO 5	Able to show responsibility of their individual and team work
	LO 7	Able to analyze and synthesis concepts, theories, and methods on the analysis and synthesis of chemical substances by considering the right instrument and the substance side effect in order to develop the chemistry
	LO 9	Able to build a chemical knowledge especially in the energy, environmental, marine and medical in order to develop the research, industry and employment creation industry, and employment creation
	Course Learning Outcomes (LO MK)	
	LO MK 1	Able to know drug and its activities
	LO MK 2	Able to explain the introduction and discovery of the drug
	LO MK 3	Able to explain the structure-activity relationship (SAR) and quantitative structure-activity relationship (QSAR), as well as do the computer drug design, combinatorial chemistry, pharmacokinetics, drug metabolism

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
LO MK 1					√		√		
LO MK 2							√		
LO MK 3		√					√		√

Course Short Description	
Study Material: Subject Matter	Drug and its activities, introduction and discovery of the drug, structure-activity relationship (SAR) and quantitative structure-activity relationship (QSAR), computer-aided drug design, combinatorial chemistry, pharmacokinetics, drug metabolism
Reference	**Primary:** 1. G. Thomas, "Medicinal Chemistry; an Introduction", John Wiley & Sons, New York, 2011. 2. A. Burger, "Burger's Medicinal Chemistry and Drug Discovery", Jones and Barlett Publishers, Boston, 2001. **Secondary:**
Supporting Lecturer	Sri Fatmawati, M.Sc., Ph.D.
Pre-Requisite Courses	

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1,2	Students are able to show the introduction of the drug and its activities	• The accuracy in writing how a drug was discovered, the form of medicine, drug source and lead compound, classification of the drug, pharmaceutics phase, and drug activity	**Technical:** Assignment 1: Source and classification of drug **Criteria:**	**Introduction lecture and brainstorming [TM: 2×50'']** **Lecture and discussion [TM: 2×50'']**		• Introduction of drug • Discovery of drug and its form • Drug source and lead compound • Classification of drug • Pharmaceutics phase • Introduction of drug activity	**10**

3,4	Students are able to show the introduction and discovery of drug	• The accuracy in writing the stereochemistry and solubility in drug design, drug structure, the formation of the salt in structure	**Technical:** Quiz **Criteria:**	**Lecture and group discussion [TM: 2x(2×50'')]**		• Stereochemistry and design of drug • Solubility and structure of a drug • The formation of the salt • Addition of water-soluble groups in a structure	
5-7	Students are able to explain the structure-activity relationship (SAR) and the quantitative structure-activity relationship (QSAR) as well as drug design	• The accuracy in writing the mechanism of nucleophilic substitution reaction of carboxylic acid and its derivatives as well as that of amine	**Technical:** **Criteria:**	**Lecture and group discussion [TM: 3x(2×50'')]**		• Structure-activity relationship (SAR) • Quantitative structure-activity relationship (QSAR) • Computer-aided drug design	
8	**Mid-Semester Evaluation**						**20**
9,10	Students are able to show combinatorial chemistry	• The accuracy in writing combinatorial chemistry compounds	**Technical:** Assignment **Criteria:**	**Lecture and group discussion [TM: 2x(2×50'')]**		• Examples of drug which interfere cell membrane and cell wall • Examples of drug which inhibit the cell wall synthesis	**5**
11,12	Students are able to show the action of drugs in several common drug target areas	• The accuracy in writing the action of drugs in several common drug target areas	**Technical:** **Criteria:**	**Lecture and group discussion [TM: 2x(2×50'')]**		• Transisition state inhibitor • Receptor-targeted drug • Nucleic acid-targeted drug • Antiviral drugs	

13,14	Students are able to show pharmacokinetics	• The accuracy in writing pharmacokinetics and drug design, pharmacokinetics model, intravascular administration, extravascular administration	**Technical:** Presentation **Criteria:**	**Lecture and group discussion [TM: 2x(2×50'')]**		• Modeling of hydrocarbon formation	**5**
15,16	Students are able to show the metabolism of a drug	• The accuracy in writing stereochemistry of drug metabolism, the biological and environmental factors affecting drug metabolism, human and metabolism, secondary pharmacological metabolism implications, active site, phase 1 and 2 metabolism reaction and their metabolites	**Technical:** Presentation **Criteria:**	**Lecture and group discussion [TM: 2x(2×50'')]**		• Stereochemistry of drug metabolism • Biological factors affecting metabolism • Environmental factors affecting metabolism • Human and metabolism • Secondary pharmacological metabolism implications • Active site • Phase 1 metabolism reactions (oxidation, reduction, hydration, and other reactions) • Phase 2 metabolism reactions	

						• Metabolites of pharmacokinetics • Metabolism and drug design • Prodrugs	
16	**End-of-Semester Evaluation**						**25**

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Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course Disiplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
ESSENTIAL OILS CHEMISTRY	SK 185556	Organic Chemistry	2	0	III	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Sri Fatmawati, M.Sc., Ph.D.; Arif Fadlan, D.Sc.	Prof. Mardi Santoso, Ph.D.	Prof. Dr. Didik Prasetyoko, M.Sc

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	LO 2	Show a spirit of independence and team work in completing their duties
	Course Learning Outcomes (LO MK)	
	LO MK 1	Able to understand the definition, separation, analysis, composition, utilization, and chemical aspects of essential oils

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
LO MK 1		√							

Course Short Description

Study Material: Subject Matter

The definition, separation and analysis of essential oils; composition of essential oils; utilization of essential oils; chemical aspects of essential oils

Reference

Primary:

1. K.H.C. Baser, G. Buchbauer (editor), “Handbook of Essential Oils: Science, Technology, and Applications”, Second edition, CRC Press, 2015.
2. Relevant articles.

Secondary:

Supporting Lecturer	Sri Fatmawati, M.Sc., Ph.D.; Arif Fadlan, D.Sc.
Pre-Requisite Courses	

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1-3	Students are able to explain the definition and separation method of essential oils	• The accuracy in explaining the definition and separation method of essential oils	**Technical:** Assignment 1 **Criteria:**	**Lecture and discussion [TM: 3x(2×50'')]** **Assignment 1 [BT+BM: (1+1)x(2x60)]**		• Definition of essential oils • Process and strategy of essential oils separation	**15**
4,5	Students are able to analyze the types of essential oils and their properties	• The accuracy in analyzing the types of essential oils and their properties	**Technical:** **Criteria:**	**Lecture and group discussion [TM: 2x(2×50'')]**		• The analysis method of essential oils	
6,7	Students are able to determine and explain the composition of essential oils	• The accuracy in determining and explaining the composition of essential oils	**Technical:** Assignment 2 **Criteria:**	**Lecture and group discussion [TM: 2x(2×50'')]** **Assignment 2 [BT+BM: (1+1)x(2x60)]**		• Composition of essential oils	**15**
8	**Mid-Semester Evaluation**						**25**

9-11	Students are able to explain essential oil processing and utilization of essential oils	• The accuracy in explaining essential oil processing and utilization of essential oils	**Technical:** **Criteria:**	**Lecture and group discussion** **[TM: 3x(2×50'')]**		• Essential oil processing • Utilization of essential oil	
12-15	Students are able to explain the chemical aspects of essential oils and their function	• The accuracy in explaining the chemical aspects of essential oils and their function	**Technical:** Assignment 3 **Criteria:**	**Lecture and group discussion** **[TM: 4x(2×50'')]** **Assignment 3** **[BT+BM: (1+1)x(2x60)]**		• Chemical aspects of essential oils • Role and function of compounds in essential oils	**20**
16	**End-of-Semester Evaluation**						**25**

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Document Code

SEMESTER LEARNING PLAN

COURSE (MK)	CODE	Course Disiplines (RMK)	Semester Credit Units		SEMESTER	Compilation Date
REARRANGEMENT AND PERICYCLIC CHEMISTRY	SK 185558	Organic Chemistry	2	0	III	

AUTHORIZATION / LEGALIZATION	RPS Development Lecturer	RMK Coordinator	Head of Study Program (PRODI)
	Prof. Mardi Santoso, Ph.D.	Prof. Mardi Santoso, Ph.D.	Prof. Dr. Didik Prasetyoko, M.Sc

Learning Outcomes (LO)	**LO-PRODI Charged to The Course**	
	LO 4	Able to develop leadership attitudes, creativity and communication skills in solving a chemistry-related problem related problem
	Course Learning Outcomes (LO MK)	
	LO MK 1	Able to understand the definition, variety, mechanism, stereochemistry of rearrangement and pericyclic reactions

LO – LO MK Map

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9
LO MK 1				√					

Course Short Description	
Study Material: Subject Matter	The definition, variety, mechanism, stereochemistry of rearrangement and pericyclic reactions
Reference	**Primary:**

	1. F.A. Carey, R.J. Sundberg, "Advanced Organic Chemistry. Part B: Reaction and Synthesis", Springer, 2007 2. M.B. Smith, "March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure", seventh edition, Wiley, 2013 3. Related journals **Secondary:**
Supporting Lecturer	Prof. Mardi Santoso, Ph.D.
Pre-Requisite Courses	

Session	**Learning outcomes of each learning stage (Sub-LOMK)**	**Assessment**		**Learning Design; Learning Method; Student Assignment; [Time Estimation]**		**Learning Material [Reference]**	**Assessment Portion (%)**
		Indicator	**Criteria and Technical**				
(1)	**(2)**	**(3)**	**(4)**	**Face-to-face Class (5)**	**Online Class (6)**	**(7)**	**(8)**
1	Students are able to understand the course contract, definition, and variety of pericyclic reactions	• The accuracy in explaining the definition and variety of pericyclic reactions	**Technical:** **Criteria:**	**Lecture and discussion [TM: 2×50'']**		• Definition and variety of pericyclic reactions	
2,3	Students are able to understand cycloaddition and electrocyclic reactions as well as the mechanism and stereochemistry aspects	• The accuracy in explaining cycloaddition and electrocyclic reactions as well as the mechanism and stereochemistry aspects	**Technical:** **Criteria:**	**Lecture and group discussion [TM: 2x(2×50'')]**		• Cycloaddition and electrocyclic reactions as well as the mechanism and stereochemistry aspects	
4	Quiz-1						**25**

5-7	Students are able to understand sigmatropic rearrangement reactions and ene reactions as well as mechanism and stereochemistry aspects	• The accuracy in explaining sigmatropic rearrangement reactions and ene reactions as well as mechanism and stereochemistry aspects	**Technical:** **Criteria:**	**Lecture and group discussion [TM: 3x(2×50'')]**		• Sigmatropic rearrangement reactions and ene reactions as well as mechanism and stereochemistry aspects	
8	**Mid-Semester Evaluation**						**25**
9-11	Students are able to understand the rearrangement reaction of cationic, anionic, etc.	• The accuracy in explaining the rearrangement reaction of cationic, anionic, etc.	**Technical:** **Criteria:**	**Lecture and group discussion [TM: 3x(2×50'')]**		• Rearrangement reactions of cationic, anionic, etc.	
12	Quiz-2						**30**
13-15							
16	**End-of-Semester Evaluation**						**20**

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FACULTY OF SCIENCE AND DATA ANALYTICS
CHEMISTRY DEPARTMENT
Kampus ITS Sukolilo – Surabaya 60111
Telp : 031 – 5943353, Fax : 031 – 5928314, PABX : 1207 – 1208 e-mail
: kimia@its.ac.id, http://www.its.ac.id/kimia

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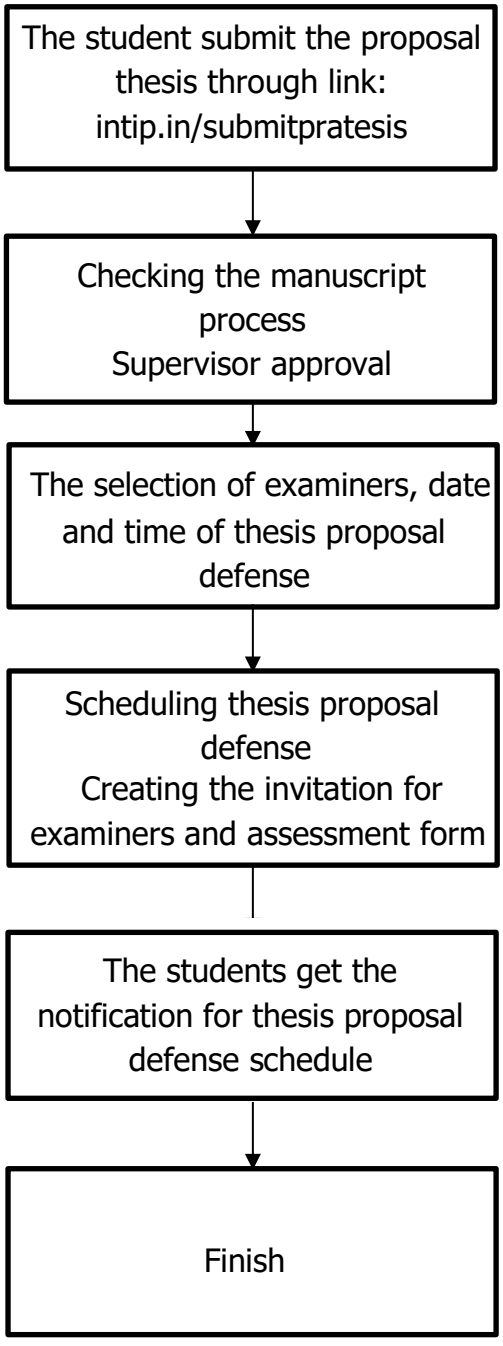

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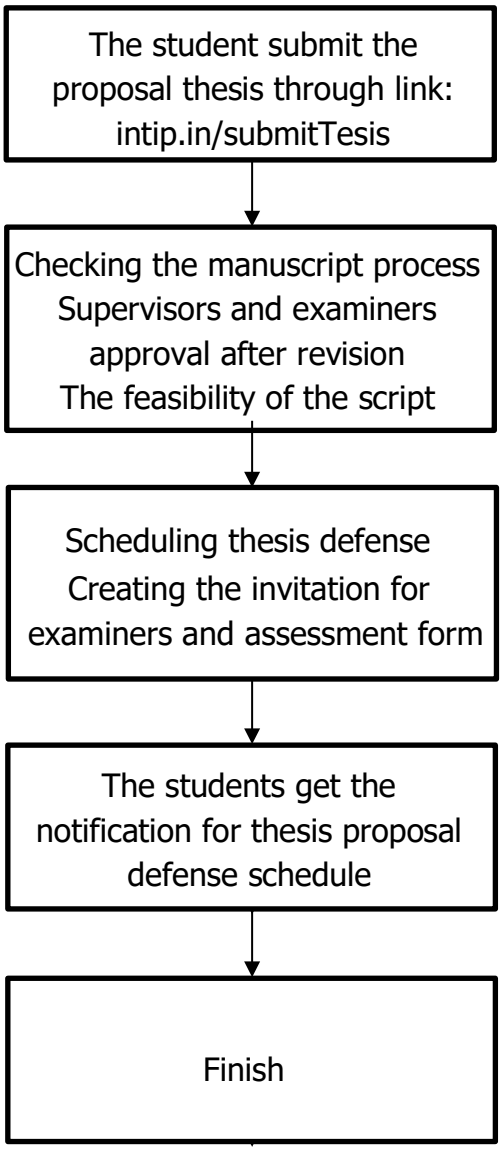

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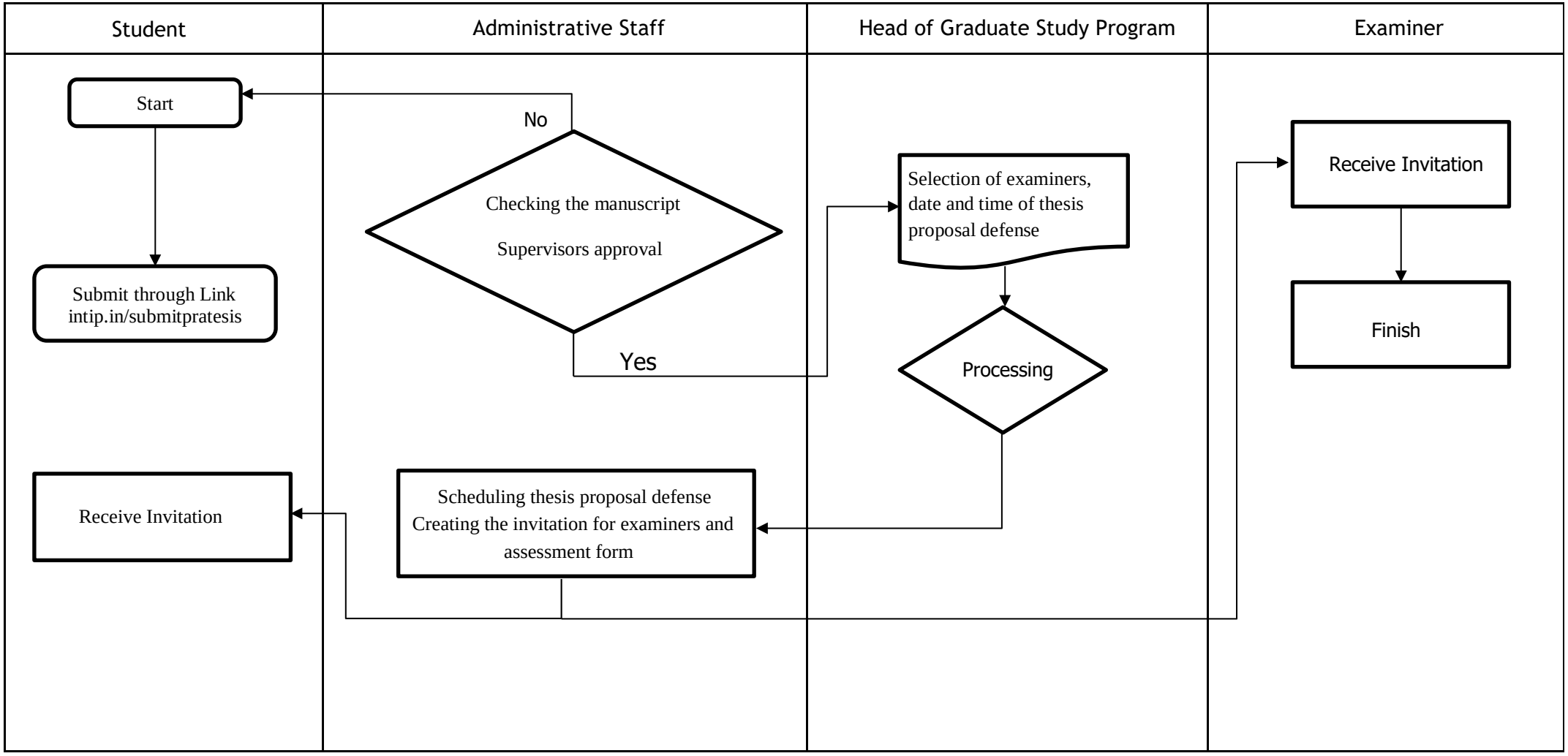

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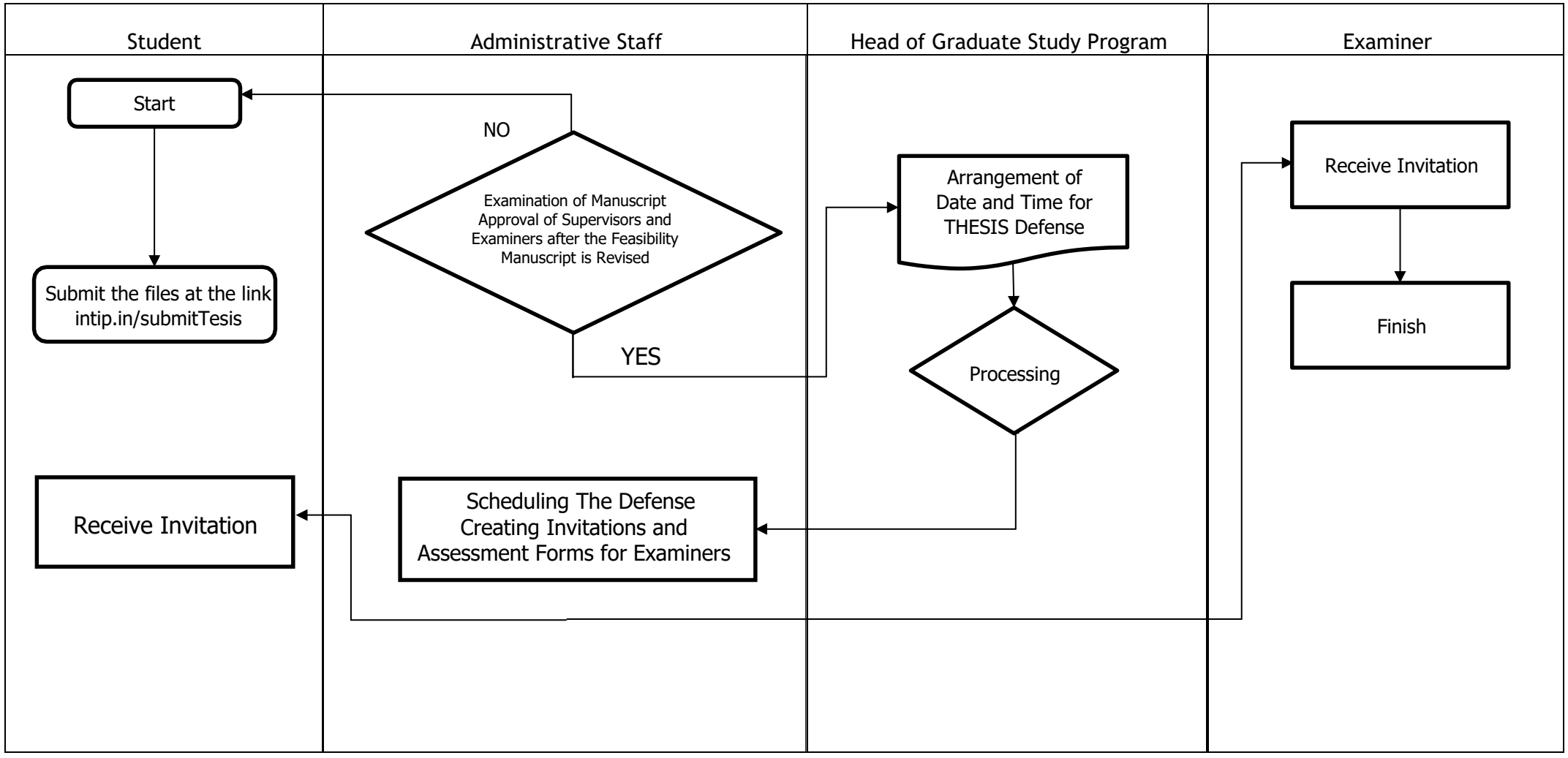
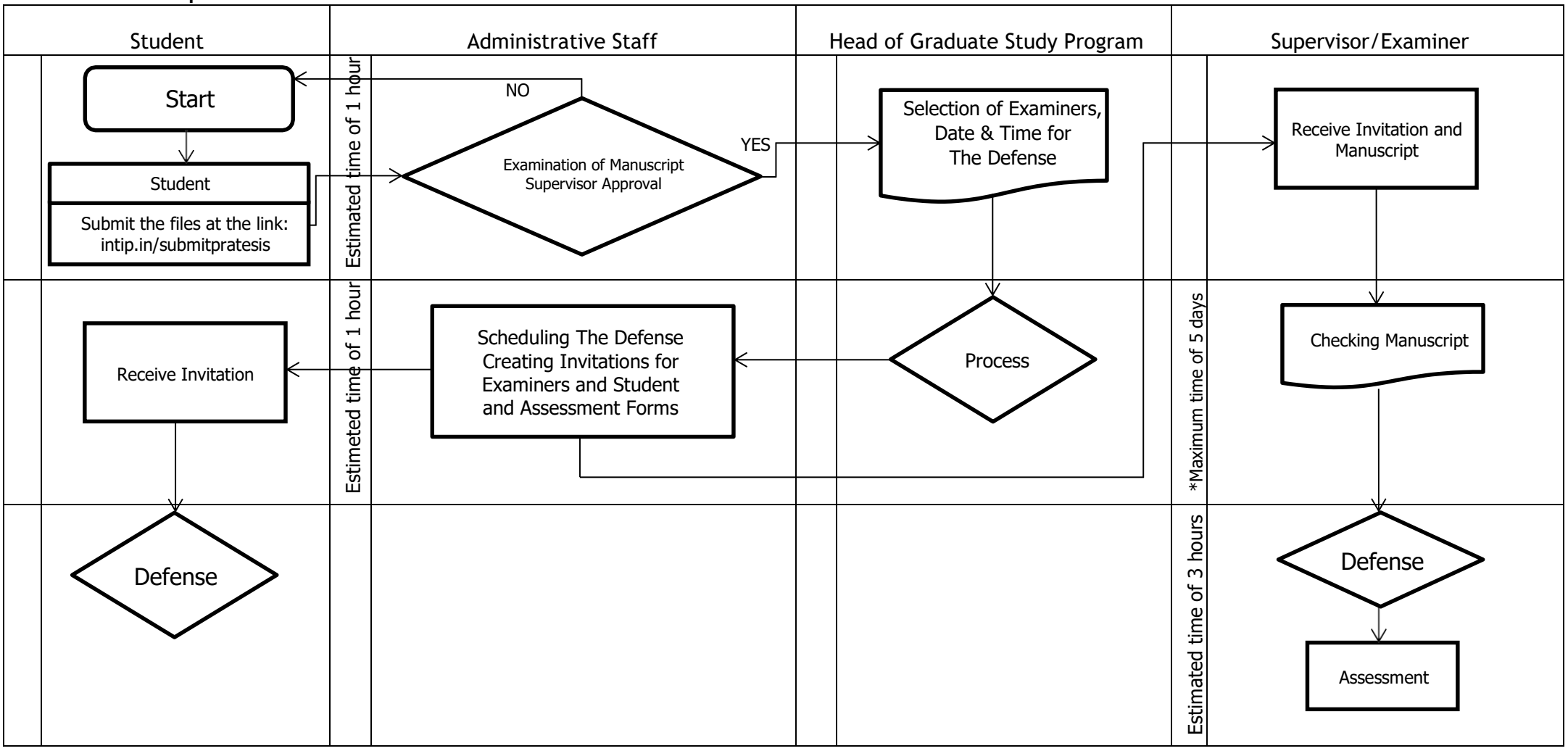
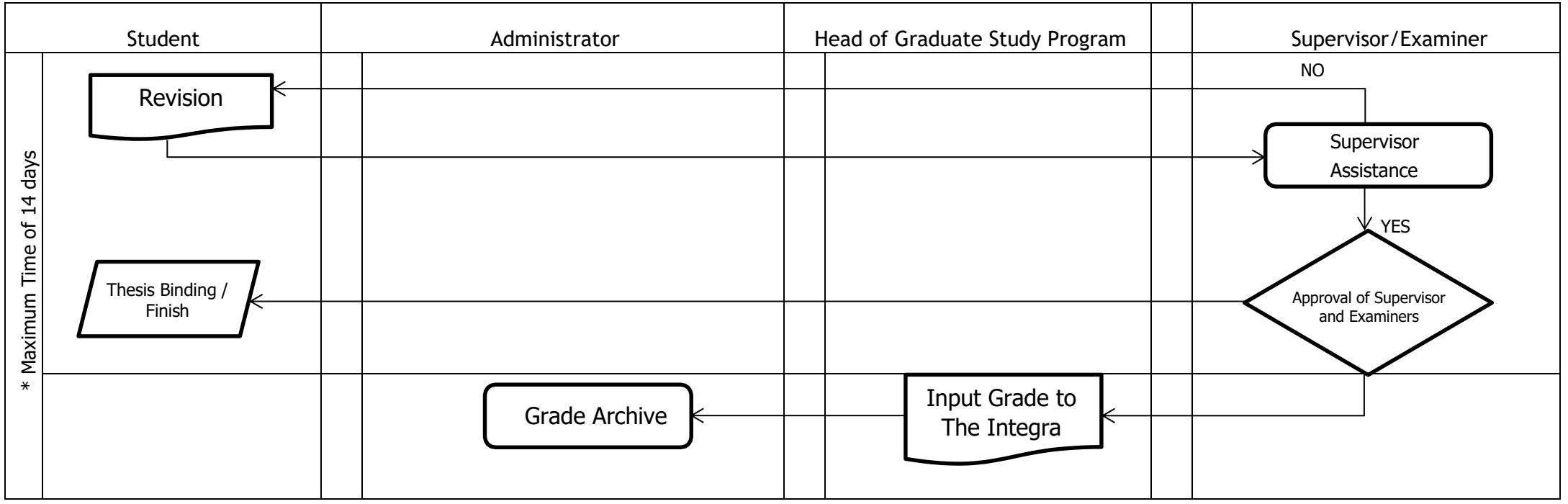


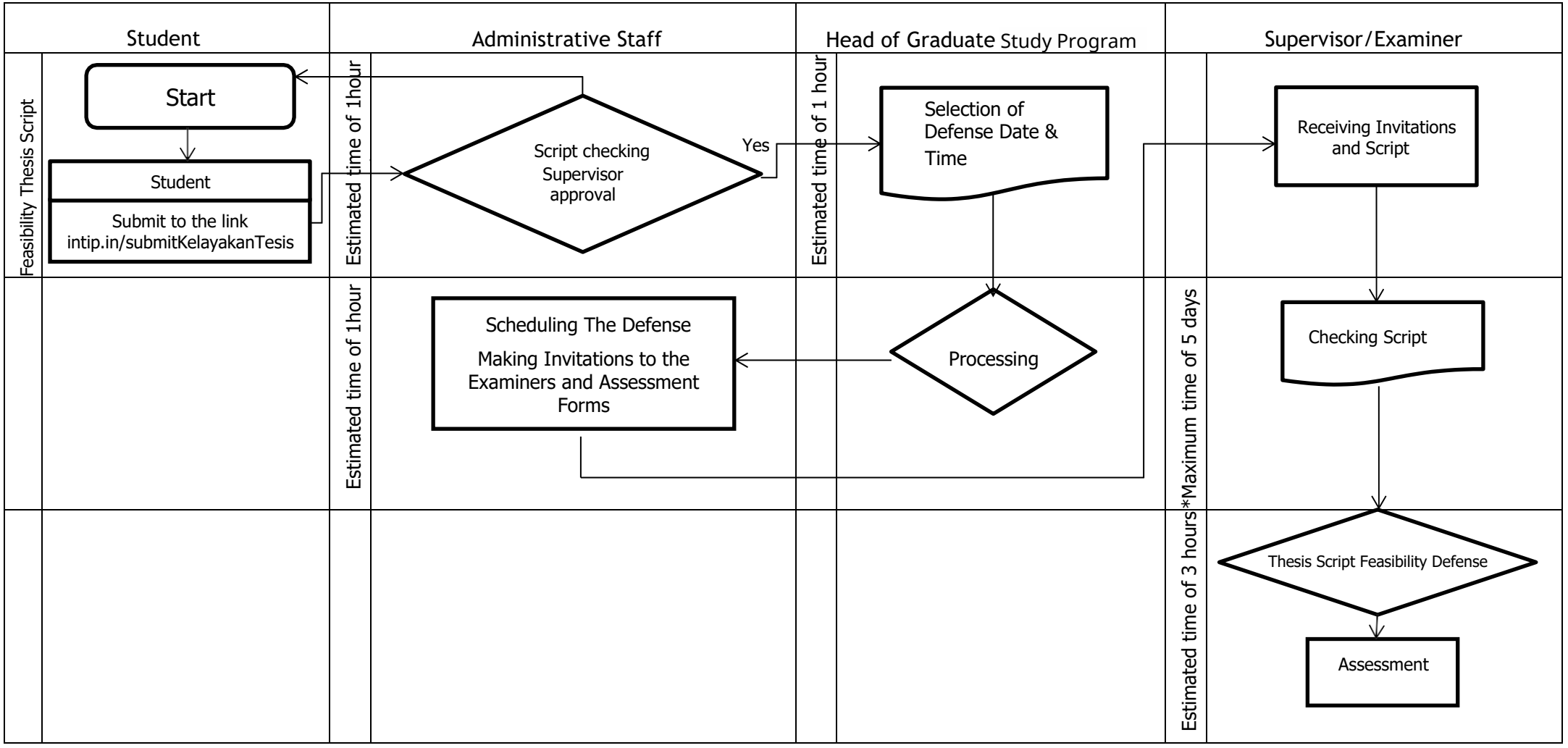
SOP for Thesis Proposal Defense

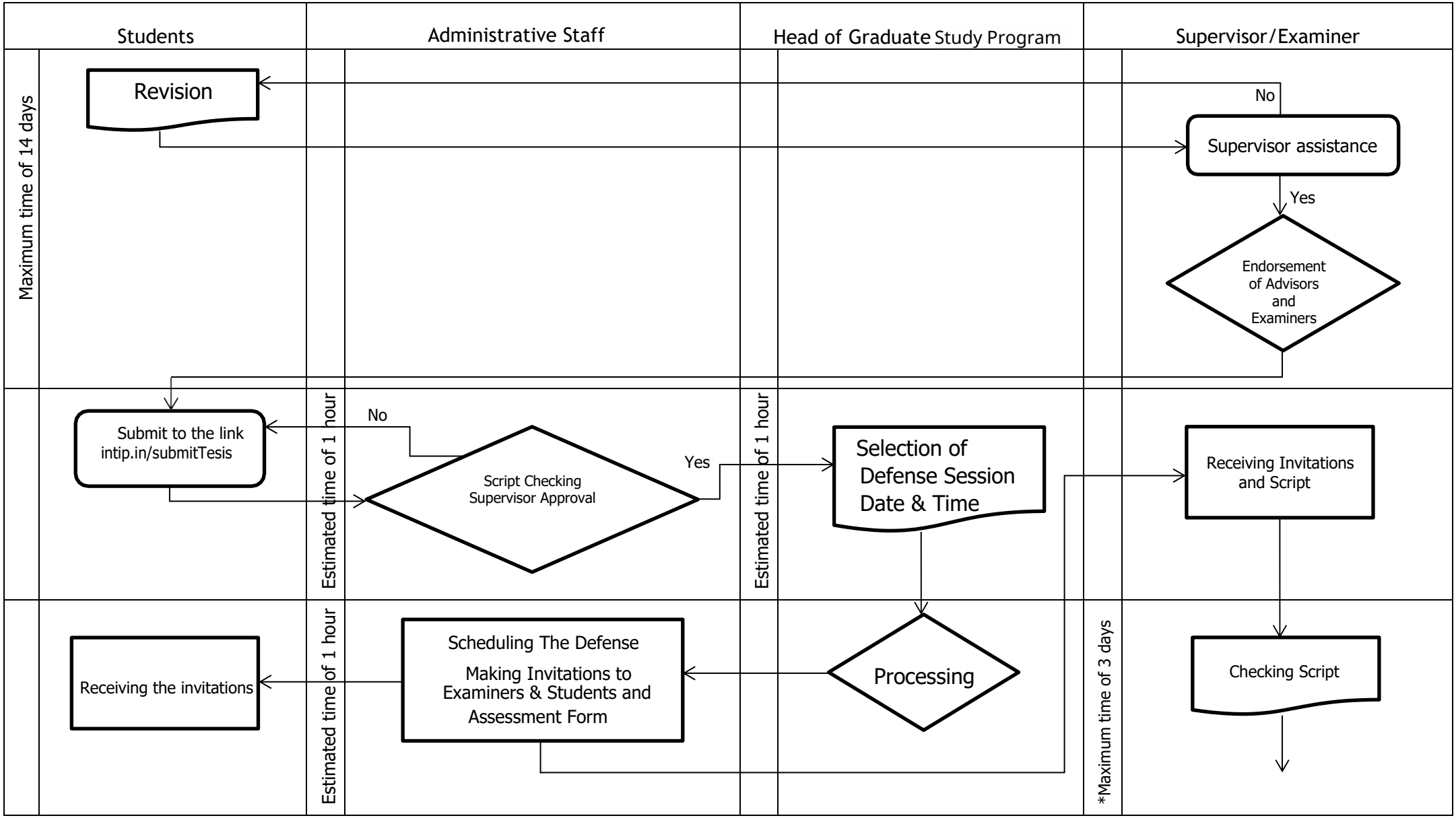


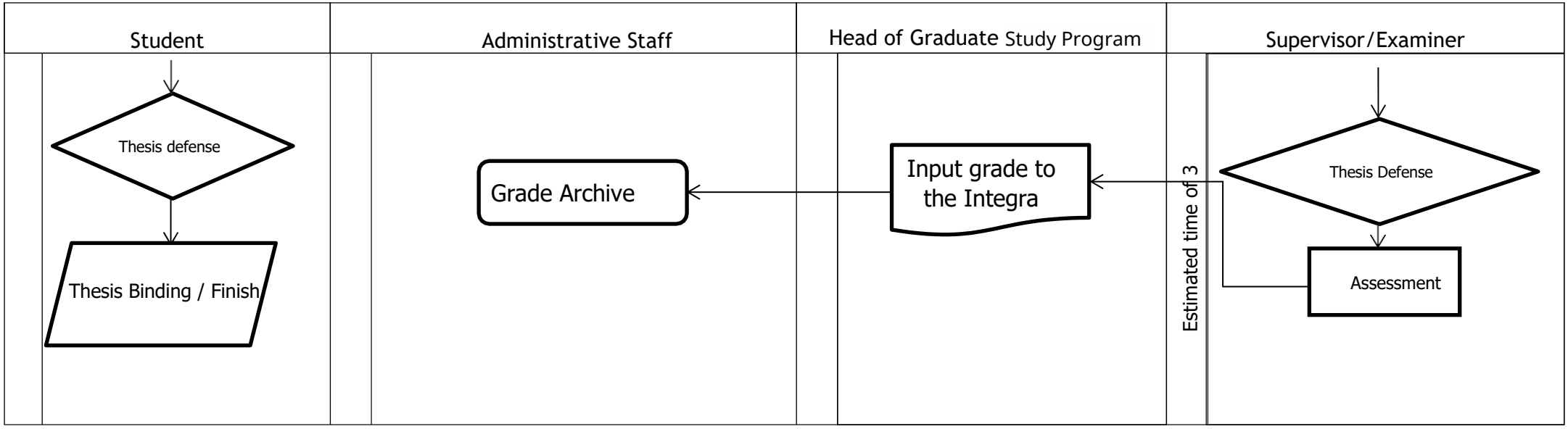


* If the process exceeds the maximum limit, the proposal trial is repeated
* During the proposal defense, revised points should be written in the defense official report
* Submission Scheme using Approval
* The total time required in this cycle is 28 days

SOP of Thesis Defense




Students
Administrative Staff
Head of Graduate Study Program
Supervisor/Examiner
Maximum time of 14 days
Revision
No
Supervisor assistance
Yes
Endorsement of Advisors and Examiners
Submit to the link intip.in/submitTesis
Estimated time of 1 hour
No
Script Checking Supervisor Approval
Yes
Estimated time of 1 hour
Selection of Defense Session Date & Time
Receiving Invitations and Script
Receiving the invitations
Estimated time of 1 hour
Scheduling The Defense
Making Invitations to Examiners & Students and Assessment Form
Processing
*Maximum time of 3 days
Checking Script



* At the time of the feasibility defense session, points to be corrected are written in the defense session minutes
* Application flow using Approval
* The topic in the thesis defense can be different from the topic in the proposal thesis defense
* The time interval between the pre-test defense and the thesis defense is at least 2 months

THIS SECTION EXPLAIN THE THESIS WRITING TEMPLATE

TESIS – SK185401

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NAMA MAHASISWA
01210000000000

DOSEN PEMBIMBING
Prof. Dr. Nama Pembimbing, S.Si., M.Sc.

PROGRAM MAGISTER
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FAKULTAS SAINS DAN ANALITIKA DATA
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SURABAYA

THESIS – SK185401

RESEARCH TITLE

NAME
01210000000000

SUPERVISOR
Prof. Dr. Nama Pembimbing, S.Si., M.Sc.

MAGISTER PROGRAM
..... CHEMISTRY
CHEMISTRY DEPARTMENT
FACULTY OF SCIENCE AND DATA ANALYTICS
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA
2020

LEMBAR PENGESAHAN TESIS

Tesis disusun untuk memenuhi salah satu syarat memperoleh gelar
Magister Sains (M.Si.)
di
Institut Teknologi Sepuluh Nopember
Oleh:
NAMA MAHASISWA
NRP: 012100000000

Tanggal Ujian: 00 Bulan 20xx
Periode Wisuda: Bulan 20xx

Disetujui oleh:
Pembimbing:

1. Prof. Nama Pembimbing, Ph.D. .....
   NIP.
2. Prof. Dr. Nama Co-Pembimbing .....
   NIP.

Penguji:

1. Dr. Ketua Penguji, M.Si. .....
   NIP.
2. Anggota Penguji 1., Ph.D. .....
   NIP.
3. Anggota Penguji 2, Ph.D. .....
   NIP.

Kepala Departemen Kimia
Fakultas Sains dan Analitika Data

Prof. Dr.rer.nat. Nama Kepala Departemen Kimia, M.Si.
NIP.

JUDUL

Nama mahasiswa	:	Nama
NRP	:	012100000000
Pembimbing	:	Prof. Dr. Nama Pembimbing

ABSTRAK

Pengembangan sintesis bahan mikropori saat ini memprioritaskan konsep kimia ramah lingkungan atau *green chemistry*. Untuk mengurangi dampak penggunaan bahan kimia, kaolin Bangka digunakan sebagai bahan baku alami alternatif yang memiliki toksisitas rendah, harga murah, dan kelimpahan tinggi. Sintesis zeolit NaA dari kaolin Bangka dimulai dengan aktivasi melalui kalsinasi pada suhu 650°C selama 2 jam. Aktivasi ini menghasilkan metakaolin dengan fasa amorf sebagaimana yang ditunjukkan oleh pola difraksi sinar-X. Hasil analisis dengan XRF menunjukkan bahwa metakaolin yang dihasilkan dari perlakuan termal sebagian besar terdiri dari Si dan Al dengan rasio Si/Al=1,38 dan komponen logam minor lainnya. Komposisi metakaolin tersebut sesuai untuk digunakan sebagai sumber untuk sintesis zeolit NaA. Sintesis zeolit NaA dilakukan dengan cara mencampurkan metakaolin dan larutan NaOH dengan perbandingan 1g/25mL, diikuti dengan kristalisasi pada suhu 100°C selama 24 jam. Sampel padatan dipisahkan melalui filtrasi. Filtrat yang dihasilkan digunakan kembali untuk sintesis zeolit NaA diikuti dengan penambahan metakaolin. Konsentrasi NaOH awal divariasikan 2, 3, 4, 5, dan 6 M dan kristalisasi dilakukan pada suhu dan waktu konstan yaitu 100°C dan 24 jam.

Kata kunci : kaolin, sintesis, zeolit NaA, filtrat, penggunaan kembali

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By	:	Name
Student Identity Number	:	012100000000
Supervisor	:	Prof. Dr. Supervisor name

ABSTRACT

The development of the micropore materials synthesis is currently prioritizing the concept of environmentally friendly chemical process or green chemistry. To reduce the impact of using chemicals, Bangka kaolin is used as an alternative natural raw material that has low toxicity, low prices, and high abundance. Synthesis of NaA zeolite from Bangka kaolin begins with activation through calcination at 600°C for 2 hours. This activation produces an amorphous metakaolin as shown by the XRD pattern. Based on the results of the XRF technique, metakaolin produced from thermal treatment consists mainly of Si and Al with a ratio of Si/Al=1.38 and other minor metal components. The metakaolin composition is suitable for use as a source for the synthesis of NaA zeolite. Synthesis of NaA zeolite was done by mixing metakaolin and NaOH solution at a ratio of 1g/25mL, followed by crystallization at 100°C for 24 hours. Solid samples are separated by filtration. The resulting filtrate was reused for the subsequent synthesis of NaA zeolite with the addition of metakaolin. The initial NaOH concentration varied 2, 3, 4, 5, and 6 M and crystallization were carried out at a constant temperature and time of 100°C and 24 hours respectively. The synthesis product was characterized by FTIR, XRD, and SEM spectroscopy. Optimal results with the highest levels of purity, crystallinity, and CBC values reaching 339.7 meq / 100g are obtained by the sample synthesized from the first stage filtrate with an initial NaOH concentration of 3 M.

Keywords: kaolin, synthesis, zeolite NaA, filtrate, reuse

KATA PENGANTAR

`DAFTAR ISI

DAFTAR GAMBAR

DAFTAR TABEL

BAB 1
PENDAHULUAN

1.1 Latar Belakang

Zeolit NaA ($Na_{12}Al_{12}Si_{12}O_{48}.27H_2O$) adalah senyawa aluminosilikat berpori dengan berbagai sifat yang sangat baik, seperti tidak beracun, porositas tinggi, stabilitas termal pada suhu tinggi, kemampuan pertukaran ion tinggi, saringan molekuler fungsional, dan ramah lingkungan (Su dkk., 2016). Berbagai keunggulan sifat tersebut menjadikan zeolit NaA digunakan secara luas dalam berbagai aplikasi industri maupun rumah tangga. Dalam industri deterjen,zeolit NaA berfungsi sebagai pelunak air, adsorben untuk mengurangi kadar air dan penukar ion (Ayele dkk., 2016). Selain itu zeolit NaA juga digunakan sebagai adsorben gas atau adsorben logam berat (Feng dkk., 2018; Wang dkk., 2018; Zayed dkk., 2017), sebagai katalis (Ng dkk., 2017) dan sebagai bahan membran (Liu dkk.,2020; Shirazian & Ashraf-zadeh, 2015).

1.2 Rumusan Masalah

Pada sintesis zeolit NaA dari kaolin, dihasilkan filtrat sebagai sisa penyaringan padatan zeolit yang dihasilkan. Umumnya filtrat sisa sintesis dibuang sebagai limbah, padahal menurut Lin dkk. (2015) yang telah melakukan sintesis zeolit NaA dari bahan baku abu layang, konsentrasi alkalin yang ada pada filtrat tidak jauh berkurang dari konsentrasi alkalin awal. Untuk mengurangi limbah yang dihasilkan dalam proses sintesis, maka filtrat digunakan kembali sebagai bahan untuk sintesis selanjutnya. Potensi penggunaan filtrat dipelajari dengan mengoptimasi konsentrasi awal NaOH yang digunakan untuk sintesis, tahap penggunaan ulang filtrat, dan rasio metakaolin yang ditambahkan terhadap filtrat. Konsentrasi awal NaOH divariasikan dari 2; 3; 4; 5; dan 6 M dan penggunaan ulang filtrat dilakukan hingga 3 kali.

1.3 Tujuan

Penelitian ini bertujuan untuk :

1. Memperoleh material zeolit NaA yang disintesis menggunakan kaolin Bangka dari filtrat hasil sintesis sebelumnya dengan variasi NaOH awal,

tahap pengulangan penggunaan (*reuse*) filtrat, waktu *aging*, dan suhu kristalisasi.

2. Menentukan karakteristik zeolit NaA yang dihasilkan meliputi struktur, kristalinitas, morfologi, serta nilai *CBC*.

1.4 Batasan Masalah

Batasan masalah pada penelitian ini adalah optimasi beberapa parameter dalam sintesis zeolit NaA dari kaolin Bangka menggunakan filtrat sisa sintesis sebelumnya terhadap karakteristik material yang dihasilkan. Variasi yang digunakan adalah konsentrasi NaOH awal, tahap pengulangan penggunaan (*reuse*) filtrat, waktu *aging*, dan suhu kristalisasi.

1.5 Manfaat Penelitian

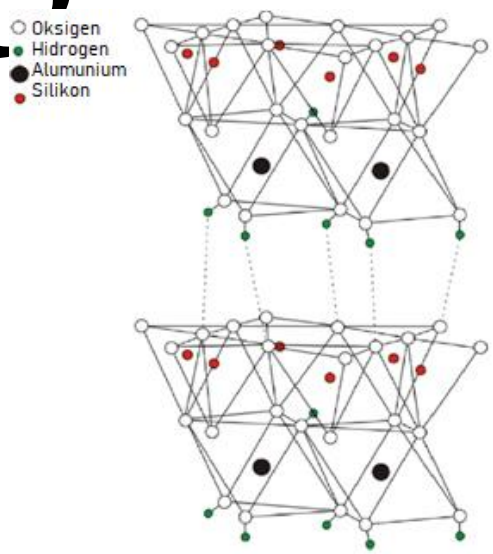
Manfaat dari penelitian ini adalah untuk memberikan informasi mengenai penggunaan kembali filtrat pada proses sintesis zeolit NaA dari kaolin Bangka, serta pengembangan ilmu pengetahuan dan teknologi tentang metode sintesis material dengan metode ramah lingkungan.

BAB 2

KAJIAN PUSTAKA

2.1 Kaolin

Komponen utama dari kaolin adalah kaolinit. Kaolin utamanya terbentuk dari dekomposisi feldspar, granit,dan alumunium silikat atau secara umum melalui proses pelapukan. Proses pembentukan kaolin disebut kaolinisasi. Kaolin dapat ditemukan dalam warna putih, abu muda, atau sedikit berwarna. Struktur kaolinit terdiri dari lapisan silika tetrahedral dan alumunium oktahedral secara berselang-seling, yang membentuk lapisan mineral lempung dengan perbandingan 1:1 (Brigatti, 2013) sebagaimana ditunjukkan pada Gambar **Error! No text of specified style in document.**.1. Lapisan yang berdekatan dihubungkan oleh gaya van der Waals dan ikatan hidrogen. Ikatan antar lapisan ini menginduksi akses terbatas ke grup alumina interlamellar (Al-OH) yang dapat digunakan untuk reaksi. (Cheng dkk., 2012).



Gambar **Error! No text of specified style in document.**.1Struktur kaolinit(Cheng dkk.,2012)

Tabel **Error! No text of specified style in document.**.1Perbandingan beberapa bahan baku alami untuk sintesis zeolit NaA

No	Bahan Baku Alami	Perlakuan	Kandungan (% berat)		Referensi
			SiO_2	Al_2O_3	
1	Chrysotile dan Abu sekam padi Brazil	Kalsinasi dan perlakuan asam	tanpa keterangan	tanpa keterangan	(Petkowicz dkk., 2008)
2	*Clinoptilolite tuffs* Iran	Pencucian	66,03	12,01	(Kazemian dkk., 2009)
3	*Halloysite* China	Alkali fusi	46,15	38,7	(Zhao dkk., 2010)
4	Kaolin Jordan	Kalsinasi	53,86	32,45	(Gougazeh and Buhl 2014)
5	Abu sekam padi	Kalsinasi	95,54	0,78	(Bohra dkk., 2014)
6	Abu daun bambu	Perlakuan asam, kalsinasi	7,09	0	(Ng dkk., 2017)
7	Abu layang	Alkali fusi	48.9	40,26	(Feng dkk., 2018)
8	*Coal gangue*	Alkali fusi	70,01	20,24	(Chen and Lu 2018)
9	*Coal fly ash*	Langsung	44,93	22,16	(Iqbal dkk., 2019)
10	Silika gel bekas dan sampah alumunium	Langsung	~100	~100	(El-Nahas dkk., 2020)

BAB 3

METODOLOGI PENELITIAN

3.1 Alat dan Bahan

3.1.1 Alat

Alat yang digunakan dalam penelitian ini antara lain peralatan gelas, *hotplate*, stirrer (pengaduk magnetik), tanur, oven, neraca analitik, termometer, instrumen X-*Ray Fluorescence*, *X-Ray Diffractometer* Phillips Expert, FTIR Shimadzu, Instrumen SEM-EDX Hitachi Flexsem 1000, dan AAS Thermofischer.

3.1.2 Bahan

Bahan-bahan yang diperlukan dalam penelitian ini adalah kaolin Bangka, NaOH p.a (Merck), NaCl p.a (Merck), $CaCl_2.2H_2O$ p.a (Ajax Chemical), kertas saring Whatman No.42 (Merck), dan air terdeionisasi (aqua DM).

3.2 Prosedur Sintesis

3.2.1 Aktivasi kaolin

Zeolit NaA disintesis dari kaolin dengan metode tanpa templat. Tahap awal dimulai dengan proses aktivasi kaolin melalui metode kalsinasi pada suhu 650°C selama 2 jam untuk membentuk fasa metakaolin yang bersifat lebih aktif. Metakaolin yang diperoleh kemudian dianalisis menggunakan XRF untuk mengetahui kandungan unsur yang terdapat di dalamnya dan menentukan rasio SiO_2/Al_2O_3 yang digunakan pada sintesis.

3.2.2 Sintesis zeolit NaA dari filtrat dengan variasi konsentrasi NaOH awal dan variasi tahap penggunaan kembali filtrat

Sintesis zeolit NaA membutuhkan larutan alkali sebagai prekursor sintesis yaitu sumber Na_2O. Sintesis dilakukan menurut metode yang digunakan oleh Gougazeh (2014). Penyiapan NaOH sebagai prekursor alkali dilakukan melalui pembuatan masing-masing sebanyak 500mL NaOH dengan konsentrasi 2 sampai 6M dengan cara melarutkan padatan NaOH menggunakan aqua DM. Selanjutnya 2 gram metakaolin ditambahkan pada 50 mL larutan NaOH masing-masing konsentrasi dengan rasio solid/liquid sebesar 1,0g/25mL sambil dilakukan pengadukan selama 15 menit pada suhu ruang. Campuran yang diperoleh kemudian dikristalisasi pada suhu 100°C selama 24 jam. Hasil sintesis disaring dengan

menggunakan penyaring Buchner dan filtrat yang diperoleh ditampung untuk digunakan sebagai prekursor alkalin dalam sintesis zeolit NaA tahap berikutnya. Padatan yang diperoleh dicuci dengan aqua DM hingga mencapai pH 8 dan dikeringkan pada suhu 100 °C selama 12 jam. Prosedur ini diulangi sampai penggunaan filtrat tahap 3. Padatan hasil sintesis dari larutan NaOH awal dinotasikan sebagai ZA, dan hasil sintesis dari filtrat dinotasikan dengan F. Variasi dilakukan dalam bentuk konsentrasi awal NaOH (x) dan tahap penggunaan ulang filtrat (y). Untuk lebih jelasnya tabel parameter sintesis ditampilkan pada Tabel **Error! No text of specified style in document.**.2.

Tabel **Error! No text of specified style in document.**.2 Kode sampel sintesis dengan variasi konsentrasi NaOH awal dan tahap penggunaan kembali filtrat

Tahap Ulang Filtrat / **Konsentrasi NaOH**	**NaOH awal**	**Filtrat ke-1**	**Filtrat ke-2**	**Filtrat ke-3**
2 M	ZA-2M	F1-2M	F2-2M	F3-2M
3 M	ZA-3M	F1-3M	F2-3M	F3-3M
4 M	ZA-4M	F1-4M	F2-4M	F3-4M
5 M	ZA-5M	F1-5M	F2-5M	F3-5M
6 M	ZA-6M	F1-6M	F2-6M	F3-6M

BAB 4
HASIL DAN PEMBAHASAN

4.1 Aktivasi Kaolin

Metakaolin yang berbentuk amorf dapat diperoleh dengan melakukan kalsinasi suhu 400-650°C. Kalsinasi di bawah 400°C hanya akan menghilangkan molekul air yang teradsorpsi pada permukaan eksternal kaolin, dan jika dilakukan pada suhu di atas 700°C akan mengakibatkan terbentuknya struktur spinnel (Cheng dkk., 2012). Proses aktivasi kaolin Bangka-Belitung dilakukan melalui kalsinasi pada suhu 650°C selama 2 jam menurut metode yang digunakan oleh Gougazeh & Buhl (2014) pada kaolin Jordania. Prosedur ini dipilih karena karakteristik kandungan kaolin Bangka mirip dengan kaolin Jordania sebagaimana dilaporkan oleh Safitri (2019).

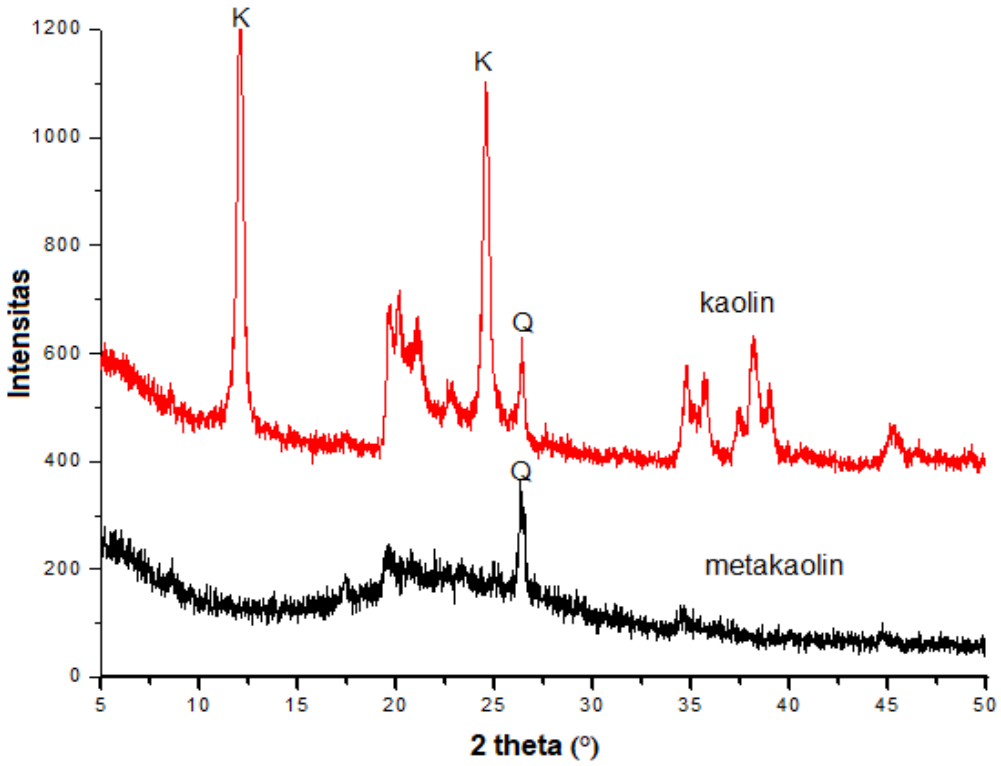
Proses kalsinasi pada suhu 400-650°C mengakibatkan terjadinya dehidroksilasi kaolin, yaitu hilangnya molekul air yang terserap pada kisi-kisi kristal dari mineral kaolin membentuk metakaolin. Kaolin yang memiliki struktur kristalin berubah menjadi silika dan alumina amorf. Adapun reaksi perubahan fasa dari kaolin menjadi metakaolin menurut Johnson dan Arshad (2014) adalah :

$$Si_2Al_2O_5(OH)_4 \rightarrow Al_2O_3.2\ SiO_2 + 2H_2O$$

kaolin metakaolin

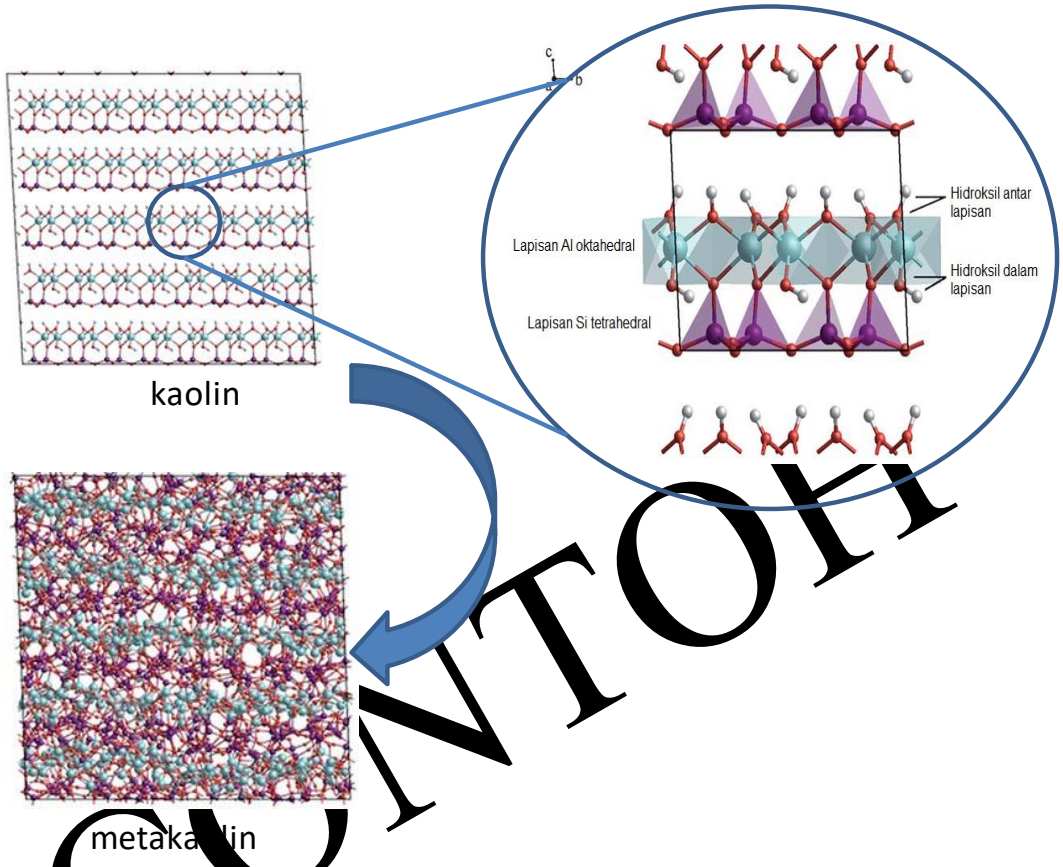
Keberhasilan proses aktivasi kaolin Bangka dapat diamati melalui karakterisasi dengan difraktometer sinar-X (XRD) yang ditampilkan pada Gambar **Error! No text of specified style in document.**.2. Perbandingan antara kedua pola XRD menunjukkan bahwa setelah kalsinasi terjadi perubahan fasa menjadi metakaolin aluminosilika amorf, ditandai dengan hilangnya puncak-puncak karakteristik kaolinit pada sudut 2θ 12,34° dan 24,64°. Hasil ini mirip dengan yang dilaporkan oleh Gougazeh & Buhl (2014), namun pada metakaolin yang dihasilkan masih terdapat puncak di sudut 2θ 26,46°. Puncak tersebut menandai terdapatnya impuritis berupa fasa kuarsa yang secara umum ditemukan pada metakaolin. Selain

kuarsa,fasa mika juga masih sering ditemukan sebagai impuritis dalam pembentukan metakaolin (Ayele dkk., 2016).



Gambar **Error! No text of specified style in document.**.2 Difraktogram sinar-X kaolin sebelum dan setelah kalsinasi 650°C selama 2 jam

Perubahan fasa menjadi bentuk amorf akan meningkatkan reaktivitas material sebagai bahan dasar sintesis zeolit. Metakaolin lebih reaktif daripada kaolin dan mineral lain dapat berubah menjadi bentuk oksidanya. Dalam struktur kaolin atom Al terkoordinasi secara oktahedral pada dua simpul oksigen dari lapisan SiO_4 tetrahedral menjadi satu gugus (OH) di satu sisi dan tiga gugus (OH) secara paralel di sisi yang lain. Sedangkan dalam metakaolin, atom Al berubah konfigurasinya menjadi koordinasi tetrahedral sebagaimana dalam struktur zeolit sehingga metakaolin lebih reaktif jika digunakan sebagai bahan sintesis zeolit (Loiola dkk., 2012). Pemodelan struktur kaolin dan metakaolin yang diperoleh setelah dehidroksilasi diilustrasikan pada Gambar **Error! No text of specified style in document.**.3.



Gambar **Error! No text of specified style in document.**.3 Perubahan struktur kaolin menjadi metakaolin (Sperinck dkk., 2011)

BAB 5

KESIMPULAN DAN SARAN

5.1 Kesimpulan

Sintesis zeolit NaA dari kaolin Bangka telah berhasil dilakukan dengan menggunakan filtrat hasil sintesis sebelumnya. Aktivasi kaolin melalui kalsinasi pada suhu 650°C selama 2 jam mampu menghasilkan metakaolin dengan fasa amorf. Teknik XRF mengungkapkan bahwa metakaolin yang diperoleh sebagian besar tersusun atas Si dan Al dengan rasio Si/Al=1,38 dan beberapa oksida logam minor lainnya. Variasi terhadap kondisi sintesis dilakukan pada konsentrasi NaOH awal dan tahap penggunaan ulang filtrat. Konsentrasi NaOH yang digunakan adalah 2, 3, 4, 5, dan 6 M, sedangkan penggunaan ulang filtrat dilakukan hingga 3 tahap.

Hasil optimasi menunjukkan alkalinitas medium yaitu konsentrasi 3 M dibutuhkan untuk memperoleh zeolit NaA dengan kristalinitas dan kemurnian.yang tinggi. Penggunaan konsentrasi NaOH yang lebih tinggi dari optimum menginisiasi terbentuknya pengotor berupa hidroksisodalit. Penggunaan *filtrat* secara berulang dengan hasil kristal NaA yang baik dapat dilakukan sampai 2 kali tahapan. Efektifitas penggunaan ulang filtrat pada tahapan yang lebih lanjut terus berkurang, yang ditunjukkan dengan tingkat kristalinitas dan kemurnian zeolit NaA yang lebih rendah. Hal ini diakibatkan oleh berkurangnya konsentrasi alkali pada larutan prekursor. Uji *Cation Binding Capacity* (CBC) juga membuktikan nilai CBC yang diperoleh sebanding dengan kemurnian dan kristalinitas zeolit NaA. Zeolit NaA dari *filtrat* tahap 1 konsentrasi 3M (F1-3M) memililiki nilai CBC tertinggi sebesar 339.7 meq/100g.

Bentuk lain dalam sintesis ramah lingkungan adalah sintesis pada suhu rendah sehingga mengurangi konsumsi energi. Sintesis pada suhu rendah dapat dilakukan dengan menambahkan tahapan *aging* pada proses sintesis. Investigasi lebih lanjut menunjukkan bahwa waktu *aging* selama 3 hari dan kristalisasi pada suhu kamar dapat menghasilkan zeolit NaA dengan kristalinitas yang tinggi dan ukuran partikel yang lebih kecil. Dengan demikian, produksi zeolit NaA dari kaolin Bangka menggunakan *filtrat* yang digunakan kembali sebagai prekursor dapat

menjadi alternatif yang baik untuk meminimalkan dampak lingkungan dan mengurangi biaya sintesis.

5.2 Saran

Dalam rangka upaya lebih lanjut dalam sintesis ramah lingkungan, perlu dikaji kembali kondisi sintesis apabila dilakukan penambahan larutan alkali pada filtrat yang akan digunakan dalam sintesis. Dengan mengetahui proses dan kondisi yang tepat diharapkan penggunaan ulang filtrat dapat melalui tahapan yang lebih panjang atau bahkan penggunaan ulang filtrat dapat berlangsung secara kontinyu.

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LAMPIRAN

BIOGRAFI PENULIS