IPB UNIVERSITY
FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM
DEPARTEMEN KIMIA

DEPARTEMEN KIMIA
Gedung Kimia Wing 1 Lantai 3
Jl. Tanjung, Kampus Darmaga
Bogor 16680
Telp/Fax (0251)8624567
Email: kimia@apps.ipb.ac.id; Website: http://chem.ipb.ac.id

SYLLABUS

KIM 1223
ORGANIC CHEMISTRY PRACTICUM
2(0-2)

DEPARTEMEN KIMIA
Gedung Kimia Wing 1 Lantai 3
Jl. Tanjung, Kampus Darmaga
Bogor 16680
Telp/Fax (0251)8624567
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INSTRUCTIONAL ANALYSIS

Learning Outcomes:

1 Capable of visualizing and explaining the 3-dimensional structure of organic molecules and simple organic reactions using open-source software and molecular models;
2 Capable of constructing and using a reflux apparatus to recrystallize organic solids and perform organic reactions;
3 Capable of separating organic components from mixtures using maceration techniques, liquid-liquid extraction using a separatory funnel, and Soxhlet apparatus;
4 Capable of constructing and operating simple and fractionation distillation equipment, as well as operating a rotary evaporator to purify liquids or organic reaction products;
5 Capable of preparing and using thin layer chromatography (TLC), preparative TLC, and column chromatography to separate and identify organic components in mixtures;
6 Capable of using melting point determination instruments, an Ostwald viscometer, a refractometer, and a polarimeter to determine the identity and purity of organic compounds using melting point, viscosity, refractive index, and optical rotation data;
7 Capable of working in teams to analyze data and report experimental results;
8 Capable of performing qualitative analyses of functional groups in organic compounds, including aliphatic and aromatic hydrocarbons, alcohols and ethers, aldehydes and ketones, carboxylic acids and esters, amines and amides;
9 Capable of conducting qualitative analyses of biological compounds, such as carbohydrates, lipids, proteins, and amino acids;
10 Capable of applying various organic chemistry lab techniques learned for a specific practice work.

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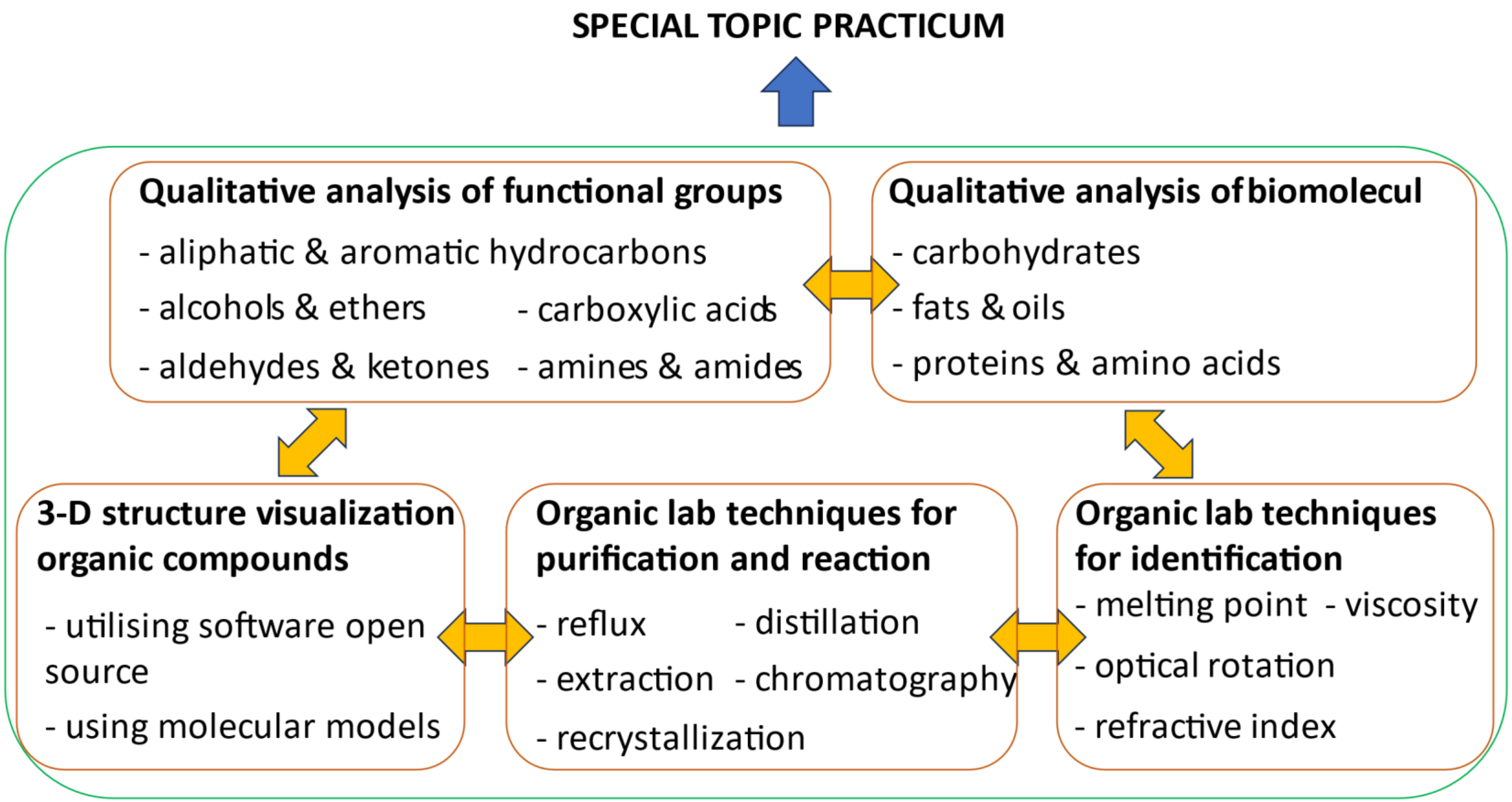

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Course Name	:	Organic Chemistry Practicum
Code/Credit	:	KIM 1223/2(0-2)
Semester	:	3
Description	:	This course covers a variety of fundamental laboratory techniques in organic chemistry, including (1) the use of open-source software and molecular models for visualizing organic structures and reactions; (3) separating organic components in mixtures or purifying organic reaction products by maceration techniques, liquid-liquid extraction by separatory funnel, Soxhlet apparatus, simple and multilevel distillation, rotary vaporizers, and thin-layer and column chromatography; (4) Measure melting point, viscosity, refractive index, and optical rotation angle to determine the identity and purity of organic compounds using melting point determination tools, Ostwald viscometer, refractometer, and polarimeter; and (5) Qualitative identification of organic compounds and biological molecules based on reactions to their functional groups.
Prerequisites course	:	–
Learning Outcomes	:	1 Capable of visualizing and explaining the 3-dimensional structure of organic molecules and simple organic reactions using open-source software and molecular models; 2 Capable of constructing and using a reflux apparatus to recrystallize organic solids and perform organic reactions; 3 Capable of separating organic components from mixtures using maceration techniques, liquid-liquid extraction using a separatory funnel, and Soxhlet apparatus; 4 Capable of constructing and operating simple and fractionation distillation equipment, as well as operating a rotary evaporator to purify liquids or organic reaction products; 5 Capable of preparing and using thin layer chromatography (TLC), preparative TLC, and column chromatography to separate and identify organic components in mixtures; 6 Capable of using melting point determination instruments, an Ostwald viscometer, a refractometer, and a polarimeter to determine the identity and purity of organic compounds using melting point, viscosity, refractive index, and optical rotation data; 7 Capable of working in teams to analyze data and report experimental results; 8 Capable of performing qualitative analyses of functional groups in organic compounds, including aliphatic and aromatic hydrocarbons, alcohols and ethers, aldehydes and ketones, carboxylic acids and esters, amines and amides; 9 Capable of conducting qualitative analyses of biological compounds, such as carbohydrates, lipids, proteins, and amino acids; 10 Capable of applying various organic chemistry lab techniques learnt for a specific practice work.
Scope and Curriculum map of the Royal Society of Chemistry (RSC) Curriculum	:	Concept strands: Bonding - Types of bonding (double/single bonds; ionic/covalent) and how bonding relates to bulk properties, including in carbon allotropes. - Aromatic compounds; structure and bonding of benzene - Shape of molecules; from VSEPR theory. - Isomers; structural, geometric, and stereoisomers, including chirality.

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		Concept strands: Organic chemistry - Functionality can be used to predict reactions: simple reactions (combustion, addition across a double bond, and oxidation of alcohols) → - Reactions and structure of alkanes, alkenes, and alkynes, reaction and structure of aromatic compounds (nucleophilic/electrophilic substitution), lithiation, *ortho*/*para*/*meta* directing), reactions and structure of carbonyl compounds (aldehydes, ketones, carboxylic acids, esters, acetals, ketals, imines, enamines, enols, enolates), reactions and structure of alcohols, thiols, ethers, sulfonate esters, amines, alkyl halides; organometallics Concept strands: Chemical analysis and preparation - Mixing and dissolving are reversible reactions → - Identification and definitions of impure (mixtures) and pure substances → - Melting points and chromatography to define if a substance is pure - Mixture may be separated by filtering, sieving, evaporation → - Impure substances can be separated by filtration, evaporation, distillation and chromatography; dissolving → - Separation techniques: filtration, crystallization, advanced chromatography, simple and fractional distillation
Division/Field	:	Organic Chemistry
Lecturers	:	1 Dr. Budi Arifin 2 Dr. Muhammad Farid 3 Dr. Auliya Imiawati 4 Dr. Gustini Syahbirin

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Table 1. Plan for Study

Week of	Learning Outcomes	Topic	Method	Duration	Student experience	Assessment			References
						Criteria	Indicator	%	
1	Capable of visualizing and explaining the 3-dimensional structure of organic molecules and simple organic reactions using open-source software	(1) Introduction to practical work explanation (practicum agreement) (2) Use open-source software to explain - Conformation (eclipsed, staggered) in alkanes (ethane, butane) and their relative stability - Conformation (chair, boat) in cyclohexane and its relative stability - Inversion of cyclohexane chair conformation, axial, and equatorial positions - Methylcyclohexane chair conformation, the relative stability of equatorial and axial methyl - Chair conformation and *cis-trans* isomers of 1,2-, 1,3-, and 1,4-dimethylcyclohexane and their relative stability - *cis-trans* Isomers in alkenes: requirements (1- vs 2-butene), differences in physical (1,2-dichloroethene) and chemical (maleic & fumaric acids) properties - Difference between single and double bonds	- Introduction - Practical work 7–9 students/group	90 min 250 min	1 Gain insight and explanation of the use of open-source software to explain the 3-dimensional structure of organic molecules and simple organic reactions 2 Interact between students and • PIC/assistant • Other students • Teaching materials 3 Obtain conformity in argument and respect opinions for a joint decision between PIC/assistants and students	**Hard Skills:** Completeness and correctness of explanations of the use of open source software to explain the conformation of alkanes, cyclohexane and substituted cyclohexane; cis-trans isomers in substituted cyclohexane and alkenes: requirements of *cis-trans* isomers in alkenes and implications on physicochemical properties; differences in single and double bonds, aromatic compounds (benzene) from aliphatic (cyclohexane); concept of enantiomers, stereogenic centers, prochirality, and reactions of stereogenic center formation on prochiral atoms **Soft Skills:** 1 Activeness 2 Cooperation 3 Responsibility	Assessment rubrics	6	Guidebook

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Week of	Learning Outcomes	Topic	Method	Duration	Student experience	Assessment			References
						Criteria	Indicator	%	
		- Difference of benzene and cyclohexane - The concept of enantiomerism, identification of stereogenic centers - Stereogenic center formation reactions in prochiral compounds				4 Discipline 5 Process data and report experimental results			
2–4, 6–8	Capable of visualizing and explaining the 3-dimensional structure of organic molecules and simple organic reactions using molecular models	- Atomic color and bond type Use molecular models to explain - Conformation (eclipsed, gauche) in alkanes (ethane, butane) and their relative stability - Conformation (chair, boat) in cyclohexane and its relative stability - Inversion of cyclohexane chair conformation, axial and equatorial positions - Methylcyclohexane chair conformation, the relative stability of equatorial and axial methyl - Chair conformation and *cis-trans* isomers at 1,2-, 1,3-, and 1,4-dimethylcyclohexane and their relative stability - *Cis-trans* isomers in alkenes: requirements (1- vs 2-butene), differences in physical (1,2-dichloroethene) and chemical	- Introduction - Practical work 7–9 students/group	170 min	1 Gain insight and explanation of the use of molecular models to explain the 3-dimensional structure of organic molecules and simple organic reactions 2 Interact between students and • PIC/assistants • Other students • Teaching materials 3 Obtain conformity in argument and respect opinions for a joint decision between PIC/ assistants and students	**Hard Skills:** Completeness and correctness of explanations of the use of molecular models to explain the conformation of alkanes, cyclohexane, and substituted cyclohexane; cis-trans isomers in substituted cyclohexane and alkenes: requirements of *cis-trans* isomers in alkenes and implications on physicochemical properties; differences in single and double bonds, aromatic compounds (benzene) from aliphatic (cyclohexane); the concept of enantiomerism, stereogenic centers, prochirality, and stereogenic center-formation reactions on prochiral atoms	Assessment rubrics	6	Guidebook

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Week of	Learning Outcomes	Topic	Method	Duration	Student experience	Assessment			References
						Criteria	Indicator	%	
		(maleic & fumaric acids) properties. - Difference between single and double bonds. - Difference between benzene and cyclohexane - The concept of enantiomerism, identification of stereogenic centers - Stereogenic center formation reactions in prochiral compounds				**Soft Skills:** 1 Activeness 2 Cooperation 3 Responsibility 4 Discipline 5 Process data and report experimental results			
2–4, 6–8	Capable of constructing and using a reflux apparatus to recrystallize organic solids and perform organic reactions	- Choosing a solvent for recrystallization - Constructing and using reflux apparatus - Explain the steps of recrystallization and its purpose - perform recrystallization step by step from single or mixed solvents	- Introduction - Practical work 7–9 students/group	100 min	1 Gain insight and explanation of constructing and using the reflux apparatus for recrystallization and organic reactions 2 Interact between students and: • PIC/assistants • Other students • Teaching materials 3 Obtain conformity in understanding arguments and respect opinions for a joint decision between PIC/assistants and students	**Hard Skills:** Completeness and correctness of the explanation of how to choose solvents for recrystallization, assembling reflux apparatus, their use for organic reactions as well as recrystallization from single or mixed solvents **Soft Skills:** 1 Activeness 2 Cooperation 3 Responsibility 4 Discipline 5 Process data and report experimental results	Assessment rubrics	4	Guidebook

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Week of	Learning Outcomes	Topic	Method	Duration	Student experience	Assessment			References
						Criteria	Indicator	%	
2–4, 6–8	Capable of separating organic components from mixtures using maceration techniques, liquid-liquid extraction using a separatory funnel, and Soxhlet apparatus	- Extracting solid samples by maceration techniques - Using a separatory funnel for liquid-liquid extraction - Identify the extract phases and separate them - Design and work on the separation of different acidity components of a mixture, using liquid-liquid extraction with pH control - Explain how to break emulsions, types, and uses of drying agents - Drying organic coating with a drying agent - Packing sample in thimble for Soxhlet techniques - Stringing and using Soxhlet apparatus and explaining how they work	- Introduction - Practical work 7–9 students/group	240 min	1 Gain insight and explanation of component separation in mixtures by maceration extraction techniques, liquid-liquid extraction using separatory funnels and Soxhlet apparatus 2 Interact between students and • PIC/assistants • Other students • Teaching materials 3 Obtain conformity in understanding arguments and respect opinions for a joint decision between PIC/assistants, and students	**Hard Skills:** Completeness and correctness of explanations of maceration and soxhletatng techniques for extracting solid samples; the use of separatory funnels for liquid-liquid extraction; identification of the extract phase, how to break down the emulsion, the types and uses of drying agents and how to use them; and selection of extractor solvents in liquid-liquid extraction with pH control **Soft Skills:** 1 Activeness 2 Cooperation 3 Responsibility 4 Discipline 5 Process data and report experimental results	Assessment rubrics	9	Guidebook
2–4, 6–8	Capable of constructing and operating simple and fractionation distillation equipment, as well	- Assemble simple distillation apparatus and use them in the synthesis of simple esters - Assemble stratified distillation apparatus and use them to purify organic solvents	- Introduction - Practical work 7–9 students/group	240 min	1 Gain insight and explanation of the purification of organic liquids or reaction products using a simple,	**Hard Skills:** Completeness and correctness of explanations of simple, fractional, rotary evaporator distillation	Assessment rubrics	9	Guidebook

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Week of	Learning Outcomes	Topic	Method	Duration	Student experience	Assessment			References
						Criteria	Indicator	%	
	as operating a rotary evaporator to purify liquids or organic reaction products	- Describes the working principle of fractionation columns and their types - Assembling rotary evaporator and using it to remove solvents from organic reaction products			fractional distillation apparatus, and rotary evaporator 2 Interact between students and • PIC/assist • Other students • Teaching materials 3 Obtain conformity in understanding arguments and respect opinions for a joint decision between PIC/assistants and students	techniques for purifying organic solvents and ester synthesis products; The principle of work of fractionation columns and their types. **Soft Skills:** 1 Activeness 2 Cooperation 3 Responsibility 4 Discipline 5 Process data and report experimental results			
2–4, 6–8	Capable of preparing and using thin layer chromatography (TLC), preparative TLC, and column chromatography to separate and identify organic components in mixtures	- Describes examples of stationary phases common to TLC and CC - Describes the sequence of mobile phase polarities common to TLC and CC - Choosing silica gel for preparative TLC and CC - Preparing preparative TLC plates - Packing silica gel into columns - Saturating the eluents of TLC and preparative TLC - Affixing samples to TLC plates and preparative TLC	- Introduction - Practical work 7–9 students/group	240 min	1 Gain insight and explanation into the preparation and use of TLC, preparative TLC, and CC, to separate and identify organic components in mixtures 2 Interact between students and • PIC/assistants • Other students • Teaching materials	**Hard Skills:** Completeness and correctness of explanations of stationary phase and mobile phase; how to prepare plates, pack columns, saturate eluents, affix and insert samples, to elute and reveal stains; how to calculate the *Rf* value and use it for the identification of organic components in mixtures **Soft Skills:**	Assessment rubrics	9	Guidebook

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Week of	Learning Outcomes	Topic	Method	Duration	Student experience	Assessment			References
						Criteria	Indicator	%	
		- Inserting samples into chromatographic columns - Developing preparative TLC and TLC chromatograms - Elute the CC sample - Explain the techniques for showing TLC stains - Calculate the *Rf* value and identifies the components in the TLC chromatogram by comparison with the standard *Rf* value			3. Obtain conformity in understanding arguments and respect opinions for a joint decision between PIC/assistants and students	1 Activeness 2 Cooperation 3 Responsibility 4 Discipline 5 Process data and report experimental results			
2–4, 6–8	Capable of using melting point determination instruments, an Ostwald viscometer, a refractometer, and a polarimeter to determine the identity and purity of organic compounds using melting point, viscosity, refractive index, and optical rotation data	**Melting point** - Pack in a capillary tube the sample to be measured melting point - Operating the melting point device - Explain the impact of contamination on melting point and ranges - Summing up successful recrystallization from melting point data - Determine the identity of an organic compound from its melting point and melting point of the mixture with the conjecture compound **Viscosity** - Measuring the flow time of organic compounds with an Ostwald viscometer	- Introduction - Practical work 7–9 students/group	70 min 100 min	1 Gain insights and explanations on how to determine melting point, viscosity, refractive index, and optical rotation angle using a melting point determination device, Ostwald viscometer, refractometer, and polarimeter 2 Interact between students and • PIC/assistants • Other students • Teaching materials 3 Obtain conformity in understanding arguments and	***Hard Skills*:** Completeness and correctness of explanations on how to determine melting point, viscosity, refractive index, and optical rotation angle using melting point device, Ostwald viscometer, refractometer, and polarimeter **Soft Skills:** 1 Activeness 2 Cooperation 3 Responsibility 4 Discipline 5 Process data and report experimental results	Assessment rubrics	2 3 3	Guidebook

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		- Calculate and report relative viscosity **Refractive Index** - Measuring refractive index and total dissolved solids with an Abbé refractometer - Make temperature corrections on the refractive index data obtained - Determine the identity of organic compounds by comparing refractive indices with data in the handbook **Optical Rotation** - Measuring the optical rotation of chiral organic compounds using a polarimeter - Calculate and report specific rotating angles - Determine the identity of an organic compound from a comparison of specific rotating angles with the data in the handbook		100 min 100 min	respect opinions for a joint decision between PIC/assistants and students			3	
5, 9	COMPETENCY EXAM								
2–4, 6–8, 10–11	Capable of performing qualitative analyses of functional groups in organic compounds, including aliphatic	**Saturated, Unsaturated, and Aromatic Hydrocarbons** - Use of *Handbooks* to trace the physical properties of hydrocarbons - Solubility of alkanes, alkenes, and arenes in some solvents of different polarities	- Introduction - Practical work 7–9 students/group	100 min	1 Gain insight and explanation on how to qualitatively identify and differentiate aliphatic and aromatic hydrocarbons,	**Hard Skills:** Completeness and correctness of the explanation of how to qualitatively identify and distinguish aliphatic and aromatic hydrocarbons, alcohols and ethers,	Assessment rubrics	(6 +7,5)/ 2	Guidebook

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Week of	Learning Outcomes	Topic	Method	Duration	Student experience	Assessment			References
						Criteria	Indicator	%	
	and aromatic hydrocarbons, alcohols and ethers, aldehydes and ketones, carboxylic acids and esters, amines and amides	- Properties of toluene as a solvent - Naphthalene sublimation - Reactivity of alkanes and alkenes to strong acids, strong oxidizing agents and bromine solutions - Reactivity of arenes to strong oxidizing agents, bromine solutions, sulfonation, and nitration reagents **Alcohols, Phenols, and Ethers** - The effect of R chain length, position, and amount of OH on physical properties (solubility in water, boiling point) and reactivity (substitution reactions, oxidation) of alcohols (R–OH) - Solubility of phenol in water - Chemical properties of phenol - Comparison of chemical properties of alcohols and ethers **Aldehydes and Ketones** - Reactivity of aldehydes and ketones (Tollens oxidation, addition of bisulfite, reaction with phenyl hydrazine, aldol condensation, iodoform assay) - Formaldehyde synthesis **Carboxylic Acids**		 100 min 70 min 70 min	alcohols and ethers, aldehydes and ketones, carboxylic acids, amines, and amides 2 Interact between students and • PIC/assistants • Other students • Teaching materials 3. Obtain conformity in understanding arguments and respect opinions for a joint decision between PIC/assistants and students	aldehydes and ketones, carboxylic acids, amines and amides **Soft Skills:** 1 Activeness 2 Cooperation 3 Responsibility 4 Discipline 5 Process data and report experimental results			

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Week of	Learning Outcomes	Topic	Method	Duration	Student experience	Assessment			References
						Criteria	Indicator	%	
		- Solubility and qualitative test of formic acid - Oxidation of formic acid and acetic acid - Comparison of the acidity of carboxylic acids - Neutralization and reacidification of benzoic acid **Amines dan Amides** - Physical properties and basicity of ammonia, amines and amides - Amide hydrolysis reaction		70 min					
2–4, 6–8, 10–11	Capable of conducting qualitative analyses of biological compounds, such as carbohydrates, lipids, proteins, and amino acids	**Carbohydrates** - Chemical properties of mono-, di-, and polysaccharides (Molisch test, reducing sugar test, reaction with strong bases) - Starch hydrolysis and evaluation of the course of hydrolysis by iodine, Fehling, strong base tests) - Determination of carbohydrate levels by phenol-H_2SO_4 method **Fats and Oils** - Physical properties (solubility, freezing point, and liquid point) of some fats and oils - Determination of the acidity, iodine number, and peroxide of an oil sample	- Introduction - Practical work 7–9 students/group	170 min 170 min	1 Gain insight and explanation on how to qualitatively identify and differentiate aliphatic and aromatic hydrocarbons, alcohols and ethers, aldehydes and ketones, carboxylic acids, amines and amides 2 Interact between students and • PIC/assistants • Other students • Teaching materials 3. Obtain conformity in understanding	**Hard Skills:** Completeness and correctness of the explanation of how to qualitatively identify and distinguish aliphatic and aromatic hydrocarbons, alcohols and ethers, aldehydes and ketones, carboxylic acids, amines and amides **Soft Skills:** 1 Activeness 2 Cooperation 3 Responsibility 4 Discipline 5 Process data and report experimental results	Assessment rubrics	(6 +7,5)/ 2	Guidebook

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Week of	Learning Outcomes	Topic	Method	Duration	Student experience	Assessment			References
						Criteria	Indicator	%	
		- Explain the meaning of acid numbers, iodine, and peroxides numbers in oil quality **Proteins and Amino Acids** - Gelatin hydrolysis using acid catalyst - Protein solubility and the effect of denaturants (acids, bases, cations, anions, and heavy metals) on protein solubility - Chemical assays of proteins and amino acids (color reactions of biuret, xanthoprotein, and ninhydrin; buffer effects; and reactions with nitric acid) - Determination of the isoelectric point of proteins based on solubility		270 min	arguments and respect opinions for a joint decision between PIC/assistants and students				
10–13	Capable of applying various organic chemistry lab techniques learned for a specific practice work Capable of working in teams to analyze data and report experimental results	Special topics - Cyclohexanol dehydration - Acetylene, aniline - Isolation of caffeine from teabag samples - Acetanilide nitration - Isolation of cinnamaldehyde from cinnamon samples - Cannizzaro reaction on benzaldehyde	- Introduction - Practical work 7–9 students/group	540 min 540 min 540 min	1 Gain insight and explanation of the application of reflux methods, maceration extraction, liquid-liquid extraction with a separatory funnel and pH control, simple distillation, concentration with a rotary evaporator,	**Hard Skills:** Completeness and correctness of the explanation of how to use various lab techniques to isolate natural compounds and simple organic synthesis reactions that are commonly done in organic laboratories **Soft Skills:** 1 Activeness	Assessment rubrics	2,5 2,5 2,5	Guidebook

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Week of	Learning Outcomes	Topic	Method	Duration	Student experience	Assessment			References
						Criteria	Indicator	%	
					recrystallization with single solvent, vacuum-filtration, melting point determination, and KLT to do a particular topic practicum. 2 Gain insight and explanation of work that is common in research in organic labs, including isolation of natural compounds and synthesis of simple organic compounds 3 Interact between students and • PIC/assistants • Other students • Teaching materials 4. Obtain conformity in understanding arguments and respect opinions for a joint decision between PIC/assistants and students	2 Cooperation 3 Responsibility 4 Discipline 5 Process data and report experimental results			
14	FINAL EXAM (25%)								

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Table 2. Assignment Plan

Week of)	Topic	Objective	Description	Assessment Criteria
1	Open-source software for visualization of 3-dimensional structures	Can visualize and explain the 3-dimensional structure of organic molecules and simple organic reactions using open-source software	Participatory activities (Individuals)	Actively preparing software on their respective devices, watching practicum videos that have been prepared on the IPB Organic Chemistry YouTube channel, listening to assistant explanations and active discussions during practicum
2–4, 6–8	Open-source software for visualization of 3-dimensional structures	Can visualize and explain the 3-dimensional structure of organic molecules and simple organic reactions using molecular models	Competency Exam: Molecular Model, Recrystallization, and Melting Point (Individual)	The student chooses 1 practicum question (drawn) that is in accordance with the subject matter that has been taught and then answers it in 15-20 minutes. One assistant/PIC supervises and assesses 1–2 students.
	Recrystallization, use of reflux apparatus	Can recrystallize organic solids and carry out organic reactions with the help of reflux apparatus	Competency Exam: Molecular Model, Recrystallization, and Melting Point (Individual)	
	Extraction	Can separate components in mixtures via maceration extraction techniques, liquid-liquid extraction using separatory funnels, and soxhletation	Competency Exam: Ostwald Extraction and Viscometry (Individual)	
	Distillation	Can assemble simple, fractional, and rotary evaporator, and use them to purify liquids or reaction products	Competency Exam: Distillation and Refractometry (Individual)	
	Chromatography	Can prepare and use thin layer chromatography (TLC), preparative TLC, and column chromatography (CC) to separate and identify organic components in mixtures	Competency Exam: Chromatography and Polarimetry (Individual)	
	Determination of melting point, viscosity, refractive index,	Can operate melting point determination tools, Ostwald viscometer, refractometer, and polarimeter, and use melting point, viscosity, refractive index, and optical rotation data to	Competency Exam: Molecular Models, Recrystallization, and Melting Point Ostwald Extraction and Viscometry Distillation and Refractometry	

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Week of)	Topic	Objective	Description	Assessment Criteria
	and optical rotation	determine the identity and purity of organic compounds	Chromatography and Polarimetry (Individual)	
2–4, 6–8, 10–11	Qualitative analysis of functional groups	Can qualitatively analyze functional groups in organic compounds, including aliphatic and aromatic hydrocarbons, alcohols and ethers, aldehydes and ketones, carboxylic acids, amines and amides	Participatory activities (Individuals) Written exam (Individual)	Actively watch practicum videos that have been prepared on the IPB Organic Chemistry YouTube channel, listen to assistant explanations, and actively work on all practicum materials. The written exam in week 12 is in the form of multiple-choice questions and fill-in/short essays, prepared by the assistant and PIC.
	Biomolecular assays	Can conduct qualitative tests of biological molecules, including carbohydrates, lipids, as well as proteins and amino acids		
10–13	Special topics	Can use various organic chemistry lab techniques that have been learned to work on practicum with a specific purpose (named after a special topic) Can work together in groups to process data and report experimental results	Participatory activities (Individual & Group)	Actively watch practicum videos that have been prepared on the IPB Organic Chemistry YouTube channel, listen to assistant explanations, and actively work on all practicum materials Report per group of practicum results and discussions.
14	Final exam	All existing LOs	Competency exam (Group)	The students are divided into groups with 4–6 people per group. Each group gets 1 specific practicum topic to work on. This topic was prepared 10–14 pieces by PIC and was different from the specific topic that had been done in weeks 10–13. Each group gets a topic no later than the H-5 exam and then prepares a work plan. In week 14, each group is given a maximum of 3 hours to work on the specific topic, then report the results and discussion no later than 45 minutes after the exam ends. One assistant/PIC supervises and assesses 1 group. Assessment includes work plans, work, and reports.

DEPARTEMEN KIMIA
Gedung Kimia Wing 1 Lantai 3
Jl. Tanjung, Kampus Darmaga
Bogor 16680
Telp/Fax (0251)8624567
Email: kimia@apps.ipb.ac.id; Website: http://chem.ipb.ac.id

DEPARTEMEN KIMIA
Gedung Kimia Wing 1 Lantai 3
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Bogor 16680
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Table 3. Plan for Assessment

Learning Outcomes	Participatory Activities (Individual: Activeness, Work, Reports)	Competency Exam (Individual)	Written Exam (Individual)	Final Exam (Group)
Can use open-source software and molecular models to visualize and explain the 3-dimensional structure of organic molecules and simple organic reactions	√	√		
Can assemble and use reflux apparatus to recrystallize organic solids and carry out organic reactions		√		√
Can separate organic components in mixtures by maceration techniques, liquid-liquid extraction using a separatory funnel, and Soxhlet apparatus		√		√
Can assemble and use simple and fractional distillation apparatus and operate rotary evaporators to purify liquids or organic reaction products		√		√
Can prepare and use thin layer chromatography (TLC), preparative TLC, and column chromatography (CC) to separate and identify organic components in mixtures		√		√
Can operate melting point device, Ostwald viscometer, refractometer, and polarimeter, and use melting point, viscosity, refractive index, and optical rotation data to determine the identity and purity of organic compounds		√		√
Can work together in groups to process data and report experimental results	√			√
Can qualitatively analyze functional groups in organic compounds, including aliphatic and aromatic hydrocarbons, alcohols and ethers, aldehydes and ketones, carboxylic acids and esters, amines and amides	√		√	
Can conduct qualitative tests of biological molecules, including carbohydrates, lipids, as well as proteins and amino acids	√		√	
Can use various organic chemistry lab techniques that have been learned to work in the practicum with a specific purpose	√			√

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DEPARTEMEN KIMIA

DEPARTEMEN KIMIA
Gedung Kimia Wing 1 Lantai 3
Jl. Tanjung, Kampus Darmaga
Bogor 16680
Telp/Fax (0251)8624567
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Table 4. Distribution of Assessment

Assessment Components	Score Range	Remark
Participative Activities - Activeness of open-source software materials - Material for work on qualitative analysis, functional groups, and biomolecule assays - Work on special topic material - Specific topic reports	6 3 × 2,5 = 7,5 3 × 1,5 = 4,5 3 × 1 = 3	Individual
Competency exam: - Molecular Models, Recrystallization, and Melting Point - Extraction and Ostwald Viscometry - Distillation and Refractometry - Chromatography and Polarimetry	12 12 12 12	Individual
Written exam, material qualitative analysis, functional groups, biological molecular assays	6	Individual
Final exam: - Work plan - Work - Report	5 15 5	Group
	100	

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Table 5. Assessment Criteria

Range	Assessment Criteria
	Participatory activities
0–6	(1) Activeness of open-source software materials:
	- Haven't installed either/both software: max score 3
	- Have watched videos and practiced modules (≤50%): min score 4
	- Have watched videos and practiced modules (>50%): min score 5
	- Activeness (ask/answer): up to max 6
(0–2,5) × 3	(2) Working score of material, qualitative analysis, functional groups &; biomolecule test
	- Have watched the relevant practicum video: prerequisites
	- Do insufficient material shared by the Assistant: max grade 2
	- Trying to do all practicum materials: min score 2
(0–1,5) × 3	(3) The score of the work on the specific topic
	- Have watched the relevant practicum video: prerequisites
	- Do insufficient material shared by the Assistant: max score 1
	- Trying to do all practicum materials: min score 1
(0–1) × 3	(4) The score of topic-specific reports
	- Write down results correctly, completely, and systematically: min score 0.5
	- Quality of discussion: up to max 1
(0–12) × 4	**Competency exam:** - The form containing the exam scoring items is available in the guidebook. - Incompetent status is given if at least 1 crucial assessment item is not done correctly or at least 3 non-crucial assessment items are not done correctly. The crucial criteria for whether the assessment items are determined by the PIC and informed to the Assistant. - Incompetent status can also be given if the student does not comply with the rules and procedures for practicum exams that have been set. - Competent status is given if the student does not meet the criteria for incompetence status. - Students who get incompetent status are given the opportunity for the second and third competency exams on weekends. - Score 12 for \`competence\` in the first exam, then 10 consecutive if only K in the second exam, 7 if only K in the third exam, and 3 if still BK until the third exam.
0–6	**Written exam:** like any other exam.
0–25	**Final exam:** The grades of the work plan, work, and report are categorized as excellent (A), good (B), sufficient (C), less (D), and very less (E) respectively equivalent to grades 5, 4, 3, 2, and 1 for work plans and reports and equivalent to grades 15, 12, 9, 6, and 3 for work. The assessment is based on the results of the Assistant's markings and verified by the PIC.

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Grade range:

A ≥ 85.0
77.5 ≤ AB < 85.0
70.0 ≤ B < 77.5
62.5 ≤ BC < 70.0
55.0 ≤ C < 62.5
D < 55.0

E if the presence is not 100%, committing serious academic violations and/or other disciplinary conduct.

References

(1) *Penuntun Praktikum Kimia Organik Berbasis Kompetensi* (2017) – Divisi Kimia Organik, Departemen Kimia, FMIPA, IPB – IPB Press.
(2) YouTube Channel of Kimia Organik IPB, Organic Chemistry Practicum playlist and several other playlists.