IPB UNIVERSITY
FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM
DEPARTEMEN KIMIA

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SYLLABUS

KIM 1331
SPECTROMETRY
3(3-0)

Pengesahan		Persetujuan		Penyusunan	
Tanggal	DD/MM/YYYY	Tanggal	DD/MM/YYYY	Tanggal	DD/MM/YYYY
Ketua Departemen (……..)		Kepala Divisi (……..)		Koordinator Mata Kuliah (……..)	

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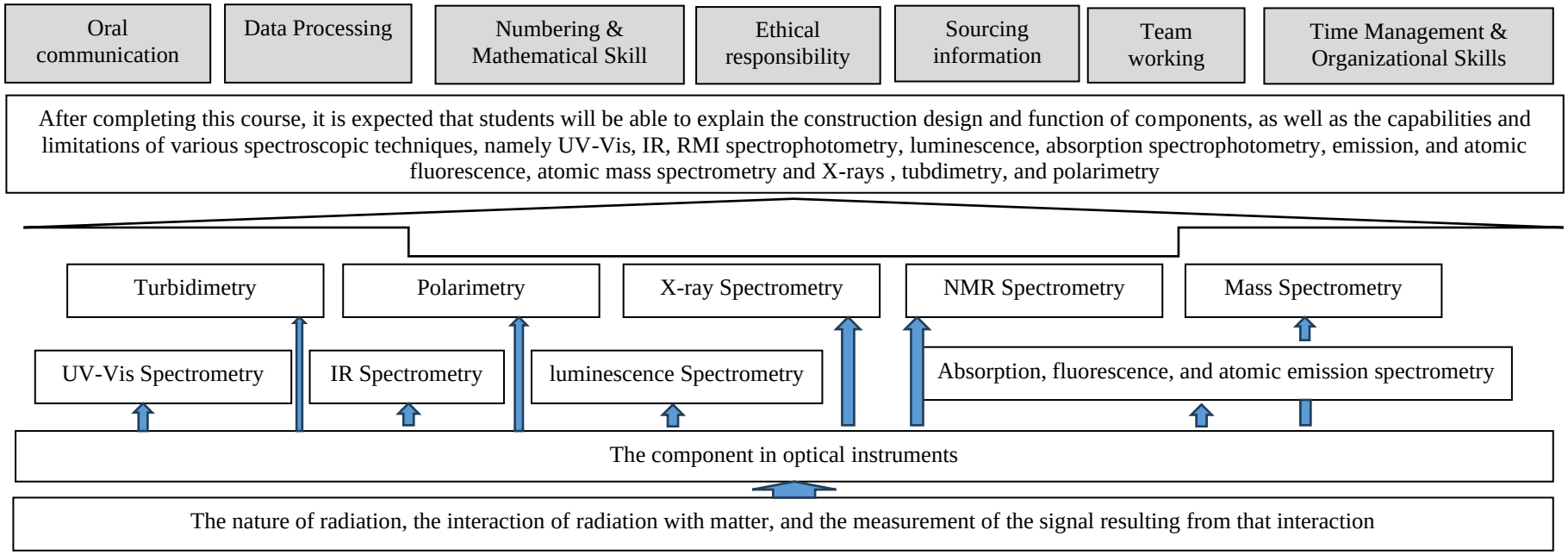
Instructional Analysis



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Course name	:	Spectrometry
Code/credit	:	KIM335 / 3(3-0)
Semester	:	5 (five)
Description	:	This lecture discusses spectrometry in chemical analysis (principles of measurement, instrumentation, and applications) including molecular and atomic spectroscopy. The studied molecular spectroscopy are ultraviolet-visible (UV-vis), infrared (IR), luminescence, mass spectrometer and nuclear magnetic resonance spectrophotometers, while for atomic spectroscopy are absorption, emission and fluorescence spectrophotometers as well as atomic mass spectrometer and X-ray. Other optical techniques such as turbidimetry and polarimetry will also be studied.
Prerequisite course	:	-
Learning outcomes	:	After completing this course, it is expected that students will be able to explain the construction design and function of components, as well as the capabilities and limitations of various spectroscopic techniques, namely UV-Vis, IR, RMI spectrophotometry, luminescence, absorption spectrophotometry, emission, and atomic fluorescence, atomic mass spectrometry and X-rays , tubdimetry, and polarimetry
Scope and curriculum map of royal society of chemistry (rsc)	:	
Division/field	:	Analytical chemistry
Lecturer	:	Dr. Eti Rohaeti Dr. Mohamad Rafi Prof. Dr. Irmanida Batubara Rudi Heryanto, SSi., MSi

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Table 1. Plan for Study

Week	Learning outcome	Topic	Method	Duration	Study experience	Assessment			Reference
						Criteria	Indicator	%	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	explain the nature of radiation, the interaction of radiation with matter, and the measurement of the signal resulting from that interaction.	Introduction to spectrometric analysis 1. General properties of electromagnetic radiation 2. Interaction of radiation with matter 3. Absorption of radiation 4. Emission of electromagnetic radiation	Lectures, interactive discussions including discussions in real examples	50 minutes	Describe the general properties of electromagnetic radiation, interaction of radiation with matter, absorption and emission of electromagnetic radiation.	The truth about the general properties of electromagnetic radiation, interaction of radiation with matter, absorption and emission of electromagnetic radiation.	1. Describe the general properties of electromagnetic radiation 2. Distinguish and explain the types of interactions between radiation and matter **3.** Calculating the energy/wavelength of an interaction of radiation with matter	3	1, 3, 4
2	explain the components in optical instruments	Optical instrument components Optical instrument design 1. Radiation source 2. Wavelength selector 3. Sample container	Lectures, interactive discussions	250 minutes	Describe the optical instrument component.	The truth about the optical instrument component, such as Radiation source, wavelength selector, Sample container, radiation transducer, signal processor and	1. Name and explain the various radiation sources, wavelength selectors, sample containers, radiation transducers, signal processors,	13	1, 3, 4

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		4. Radiation transducer 5. Signal processor and reader 6. Optical instrument type				reader, optical instrument type	readers and provide similarities & differences in how they work **2.** Describe the types of optical instruments		
3	explain the working principle of the tool and quantitative analysis of a molecule with a UV-Vis spectrophotometer	UV-Vis Spectrophotometry 1. Measurement of transmittance and absorbance 2. Lambert Beer's Law 3. Influence of instrument noise 4. Instrumentation 5. Absorbent species 6. Qualitative and quantitative applications	Lecture	300 minutes	Describe how to measure the transmittance and absorbance, Lambert Beer's Law, the influence of instrument noise, instrumentation, absorbent species, qualitative	The truth about how to measure the transmittance and absorbance, Lambert Beer's Law, the influence of instrument noise, instrumentation, bbsorbent species, qualitative and quantitative applications	1. Distinguish between transmittance and absorbance 2. Calculate the transmittance and absorbance values 3. Explain the Lambert-Beer law 4. Calculating the concentration/extinction coefficient/cuvette thickness, and the absorbance and concentration of mixed samples using the Lambert-Beer law	14	2-4

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					and quantitative applications		5. Explain the factors that lead to deviations from the Lambert-Beer law 6. Describe the components of a UV-Vis spectrophotometer instrument 7. Describe the diagram, mention and explain the types of UV-Vis spectrophotometer instruments 8. Describe several qualitative and quantitative applications as well as calculation of component levels using UV-Vis spectrophoto-metry		
4	explain the working principles of the tool, qualitative and quantitative analysis	IR spectrophotometry 1. IR light absorption	Lecture	150 minutes	Describe the IR light absorption, the	The truth about the IR light absorption, the vibrational and rotational energy	1. Describe the interaction that occur between	7	2-4

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	of a molecule with an IR spectrophotometer	2. The vibrational and rotational energy levels of the molecule. 3. IR instrumentation: Fourier transform, dispersive and non-dispersive 4. Qualitative and quantitative applications Near, mid and far IR spectrophotometer			vibrational and rotational energy levels of the molecule, IR instrumentation: Fourier transform, dispersive and non-dispersive, Qualitative and quantitative applications Near, mid and far IR spectrophotometer	levels of the molecule, IR instrumentation: Fourier transform, dispersive and non-dispersive, Qualitative and quantitative applications Near, mid and far IR spectro-photometer	molecule and IR radiation 2. Distinguish and explain the vibrations and rotations of molecules 3. Draw a diagram and explain the functions of the IR spectrophoto-meter components 4. Describe the qualitative and quantitative applications of using an IR spectrophoto-meter		
5	explain the working principle of the tool and quantitative analysis of an example by absorption	Absorption, fluorescence and atomic emission spectrophotometry	Lecture	300 minutes	Describe the Absorption, fluorescence and atomic emission	The truth about the diagram energy levels, width of the atomic line, effect of temperature,	1. Draw a diagram of energy levels and differentiate absorption, emission, and	14	2-4

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	spectrophotometry, fluorescence, and atomic emission	1. Introduction to optical atomic spectrometry - Atomic spectrum: energy level diagrams, absorption, emission and fluorescence spectra - Atom line width - The effect of temperature on the atomic spectrum 2. Sample entry method 3. Atomic absorption spectrophotometry - Sample atomization technique - Equipment - Bully - Sample preparation			spectrophotometry	distinguish several sample atomization, Describe and differentiate the instrument diagram and the function of each component in atomic absorption spectrophotometer, atomic fluorescence spectrophotometer, and atomic emission spectrophotometer, describe plasma as a source of excitation, Describe the qualitative and quantitative applications of absorption, fluorescence and atomic emission spectrophotometers	fluorescence processes 2. Explain about the width of the atomic line and the factors that influence it 3. Explain the effect of temperature and calculate the ratio of atoms at different temperatures of an atomic spectrum 4. Distinguish several sample atomization techniques 5. Describe and differentiate the instrument diagram and the function of each component in atomic absorp-		

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		4. Atomic fluorescence spectrophotometer -Equipment -Noise 5. Atomic emission spectrometry - Plasma as a source of excitation - Equipment 6. Absorption, fluorescence and atomic emission spectrophotometer applications					tion spectrophotometer, atomic fluorescence spectrophotometer, and atomic emission spectrophotometer. 6. Describe plasma as a source of excitation **7.** Describe the qualitative & quantitative applications of absorption, fluorescence & atomic emission spectrophotometers		
MIDTERM EXAM									
6	explain the working principle of the tool and quantitative analysis of a sample by luminescence spectrophotometry	Luminescence spectrophotometry 1. The theory of fluorescence and phosphorescence	Lecture	150 minutes	Describe the theory of fluorescence and phosphores-	The truth about the theory of fluorescence and phosphores-cence; equipment for measu-ring fluores-	1. Explain & differentiate fluorescent and phosphorescent processes	7	2-4

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		2. Equipment for measuring fluorescence and phosphorescence 3. Application of photoluminescence technique			cence; equipment for measu-ring fluores-cence & phosphores-cence, application of photolu-minescence technique	cence & phosphores-cence, application of photolu-minescence technique	2. Describe the process of deactivation and some of the variables that affect fluorescence and phosphorescence 3. Draw a diagram of the instrument and explain the differences between instruments for fluorescence and phosphorescence measurements **4.** Describe several applications of the use of photoluminescen ce techniques in chemical analysis		
7	perform analysis using techniques involving the interaction of radiation with matter:	Turbidimetry 1. Diffuse of light and its relation to concentration	Lecture	150 minutes	Describe the theory of turbidimetry and polarimetry	The truth about the theory of turbidimetry and polarimetry	1. Explain the process of light scattering due to the interaction between radiation and matter	7	1,3,4

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	turbidimetry and polarimetry	2. turbidimeter equipment 3. Turbidimeter measurement method Polarimetry 1. The principle of measurement with polarimetry 2. Polarimetric apparatus **3.** Qualitative and quantitative analysis					2. Describe the turbidimeter instrument diagram and explain the function of each component 3. Explain and differentiate measurement methods in turbidimetry 4. Explain the working principle of a polarimeter 5. Draw a diagram and explain the function of each component in the polarimeter **6.** Describe the application of polarimetry in chemical analysis		
8	explain the working principle of the tool, qualitative and quantitative analysis	X-ray spectrometry 1. The theory of X-ray emission - Continuous and line X-ray spectrum	Lecture	300 minutes	Describe the theory of X-ray spectro-metry	The truth about the the process of X-ray emission, Draw a diagram of an X-ray-based	1. Explain the process of X-ray emission 2. Draw a diagram of an X-ray-based	14	2-4

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	of a sample with an X-ray spectrometer	- Moseley's Law 2. Equipment - Primary and secondary X-rays - X-ray source - Collimator - Detector - Monochromator 3. Application in chemical analysis - X-ray absorption - X-ray fluorescence - X-ray diffraction				spectrometer and explain the function of each component, Describe the qualitative and quantitative applications of X-ray spectrometry Distinguish absorption, fluorescence, and diffraction of X-rays	spectrometer and explain the function of each component 3. Describe the qualitative and quantitative applications of X-ray spectrometry **4.** Distinguish absorption, fluorescence, and diffraction of X-rays		
9	explain the working principle of the tool and qualitative analysis of a molecule with an NMR spectrometer	NMR Spectrometry 1. NMR theory 2. Fourier transform spectrum 3. NMR Instrumentation 4. NMR qualitative and quantitative applications	Lecture	150 minutes	Describe the theory of turbidimetry and polarimetry	The truth about the theory of NMR Spectrometry, including NMR theory; Fourier transform spectrum, NMR Instrumentation, NMR qualitative and quantitative applications	1. Describe the quantum description of NMR 2. Calculate the distribution of particles between magnetic quantum states 3. Describe and differentiate the types of NMR instruments **4.** Describe the application of	7	2-4

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							NMR spectrometry for qualitative and quantitative purposes		
10	explain the working principles of the tool, qualitative and quantitative analysis of a sample with a mass spectrometer	Mass spectrometry 1. General features in atomic mass spectrometry - Atomic mass - Comparison of mass and charge 2. Mass spectrometer 3. Molecular mass spectrum 4. Ion source 5. Measuring molecular mass 6. Application	Lecture	300 minutes	Describe the theory of turbidimetry and polarimetry	The truth about the theory of Mass spectrometry, including general features in atomic mass spectrometry - Atomic mass - Comparison of mass and charge; Mass spectrometer; Molecular mass spectrum; Ion source; Measuring molecular mass, and Application	1. Describe the features in the mass spectrum 2. Calculate the mass to charge ratio 3. Describe a mass spectrometer diagram and the function of each component **4.** Describe the application of mass spectrometry for qualitative and quantitative purposes	14	2-4
FINAL EXAMS									

Table 2. Plan for Assignment

Week	Topic	Objective	Description	Asesement criteria

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7	All midterm exam subject	To increase the understanding of student about the midterm subject and make it on animation or presentation.	The students in group prepare the animation and/or presentation (or in video form) about selected topic in midterm subject.	Video/animation/presentation
14	All finalterm exam subject	To increase the understanding of student about the finalterm subject and make it on animation or presentation.	The students in group prepare the animation and/or presentation (or in video form) about selected topic in finalterm subject.	Video/animation/presentation

Table 3. Plan for Assesemeent

Learning outcomes	Assignment	Exam			
		quiz	midterm	finalterm	video
explain the nature of radiation, the interaction of radiation with matter, and the measurement of the signal resulting from that interaction.	Video/animation/presentation	x	x		x
explain the components in optical instruments	Video/animation/presentation	x	x		x
explain the working principle of the tool and quantitative analysis of a molecule with a UV-Vis spectrophotometer	Video/animation/presentation	x	x		x
explain the working principles of the tool, qualitative and quantitative analysis of a molecule with an IR spectrophotometer	Video/animation/presentation	x	x		x
explain the working principle of the tool and quantitative analysis of an example by absorption spectrophotometry, fluorescence, and atomic emission	Video/animation/presentation	x	x		x
explain the working principle of the tool and quantitative analysis of a sample by luminescence spectrophotometry	Video/animation/presentation	x		x	x
perform analysis using techniques involving the interaction of radiation with matter: turbidimetry and polarimetry	Video/animation/presentation	x		x	x
explain the working principle of the tool, qualitative and quantitative analysis of a sample with an X-ray spectrometer	Video/animation/presentation	x		x	x
explain the working principle of the tool and qualitative analysis of a molecule with an NMR spectrometer	Video/animation/presentation	x		x	x

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explain the working principles of the tool, qualitative and quantitative analysis of a sample with a mass spectrometer	Video/animation/presentation	x		x	x

Table 4. Distribution of Asessement

Assesment criteria	Range	%	Note
Quizzes	0 - 100	10	4 times
Midterm exam	0 - 100	37.5	
Finalterm exam	0 - 100	37.5	
Video/animation/presentation		15	

Table 5. Assesment Criteria

Video Presentation Rubric

	Assesment Criteria				Percentage	Point
	Exceeded Expectations (EEX) (80-100)	**As Expected (MEX) (60-70)**	**Close to Expectations (APP) (40-50)**	**Need to Improve (NIM) (10-30)**	**(%)**	
Concept	The concept describes a clear picture of what students are trying to achieve including an adequate description of what they are trying to do and generally how each team member's work	The concept describes a relatively clear picture of what they are trying to achieve including what the team is trying to do overall but without specifics on how each team member's work will	The team has brainstormed their concept, but has no clear focus. Goals/final product are not clearly defined.	little effort has been spent on brainstorming and refining a concept. The team appears unclear on their goals and how the project objectives will be met.	**20**	

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	will contribute to the project	contribute to the project				
Script/storyboard	The storyboard illustrates the video presentation structure with thumbnail sketches of each scene. Notations of proposed transitions, special effects, sound and title tracks are included: text, color, placement, graphics, are detailed. Notes about proposed dialogue/ narration text are included	The storyboard includes thumbnail sketches of each video scene and includes text for each segment of the presentation, descriptions of background audio for each scene, and notes about proposed shots and dialogue.	T he thumbnail sketches on the storyboard are not in logical sequence and/or do not provide complete descriptions of the video scenes, audio background, or notes about the dialogue.	There is no evidence of a storyboard or script.	**15**	
Content/organization	The content includes a clear statement of purpose or theme and is creative, compelling and clearly written. A rich variety of supporting information in the video contributes to the understanding of the project's main	Information presented is a connected theme with accurate and current supporting information contributing to understanding of the project's main idea. Details are logical and persuasive information is used	The project does not present a clearly stated theme, is vague, and/or some of the supporting information does not seem to fit the main idea. Citations and facts are minimal.	Content lacks a central theme, clear point of view and/or logical sequence of information. Much of the supporting information is irrelevant to the overall message. The viewer is unsure what the message is. Information is incorrect, out of date, or incomplete. No citations included	**20**	

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	idea. Events and messages are presented in a logical order. Includes properly cited sources.	effectively. The content includes a clear point of view with a progression of ideas and supporting information. Includes properly cited sources				
Quality	The video project was completed and included most of the suggested elements. The video was well edited and moves smoothly from scene to scene with proper use of transitions. Audio was clear and understandable and other enhancements were well used	Video was completed and contained many of the suggested elements. Editing was incomplete or poorly done. Some poor shots remain. Video is still somewhat choppy. Audio and other enhancements were utilized, but not for maximum effect	Video was produced, but had very little editing. Many poor quality shots remain. Video was fragmented and choppy with little to no audio reinforcement.	There was no video, or video was unedited without transitions or audio support.	**15**	
Teamwork	Students met and had discussions regularly. All students on the team contributed to the discussion and were part of the final project. Team	Students met and had discussions regularly. Most of the students on the team contributed to the discussion and were part of the final	Minimal team meetings were held. Most of the students on the team contributed, but a majority of the work	Meetings were not held and/or not all of the team members contributed to the project. Teamwork was not evident.	**15**	

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	members showed respect to one another	project. Team members mostly showed respect toward each other	was done by one or two			
Timeline	All project deadlines were met	Most project deadlines were met. Those that were late did not have significant impact on the finished project.	Many project deadlines were not met, negatively impacting the finished project.	Deadlines were disregarded, having a significant impact on the final project	**15**	

Reference:

1. Skoog, DA, West DM, Holler FJ, Crouch SR. 2014. *Fundamental of Analitycal Chemistry*. Edisi ke-9. Brooks/Cole.
2. Skoog DA, Holler FJ, Crouch SR. 2007. *Principles of Instrumental Analysis*. Edisi ke-6. Thomson Brooks/Cole
3. Harvey D. 2009. *Modern Analytical Chemistry 2.0*. Singapore: McGraw Hill.
4. Other related publications

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