	Universitas Negeri Surabaya **Faculty of Mathematics and Natural Sciences** **Undergraduate Chemistry Study Program**	**Document Code**

SEMESTER LEARNING PLAN

Courses	CODE	Course Family	Credit Weight			SEMESTER	Compilation Date
Molecular Structure Determination	4720102149		T=2	P=0	ECTS=3.18	6	April 26, 2023

AUTHORIZATION	SP Developer	Course Cluster Coordinator	Study Program Coordinator
	Prof. Dr. Tukiran, M.Si	Prof. Dr. Suyatno, M.Si.	Dr. Amaria, M.Si.

Learning model	**Case Studies**	
Program Learning Outcomes (PLO)	**PLO study program that is charged to the course**	
	Program Objectives (PO)	
	PO - 1	Understand sample preparation methods from various extraction, separation, purification and sample purity testing techniques
	PO - 2	Able to use ultraviolet-visible spectrum data to determine the chromophore group in an organic compound
	PO - 3	Able to use infrared spectrum data to determine the functional group of an organic compound
	PO - 4	Able to use NMR spectroscopy data to determine the types of hydrogen atoms and carbon atoms in organic compounds
	PO - 5	Able to use mass spectroscopy data to determine the molecular mass and fragmentation pattern of an organic compound
	PO - 6	Able to predict the molecular structure of an organic compound based on a combination of ultraviolet-visible, infrared, nuclear magnetic resonance and mass spectra data

PLO-PO Matrix

P.O
PO-1
PO-2
PO-3
PO-4
PO-5
PO-6

PO Matrix at the end of each learning stage (Sub-PO)

P.O	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PO-1																
PO-2																
PO-3																
PO-4																
PO-5																
PO-6																

Short Course Description	Study of sample preparation, extraction techniques, separation, purification and purity testing of samples, ultraviolet-visible spectroscopy, infrared spectroscopy, nuclear magnetic resonance spectroscopy, mass spectroscopy, as well as elucidation of the molecular structure of an organic compound based on spectroscopic data.	
References	**Main :**	

1. Cannel,R. J. P. (1998).Natural ProductIsolation. New Jersey : Humana Press.
2. Silverstein, R. M. , Webster, F. X. & Kiemle, D. J. , (2005).SpectrometricIdentification of Organic Compounds. 7th edition. New York: JohnWiley & Sons, Inc.
3. Shriner, R. L. , Hermann, C. K. F. , Morril, T. C. , Curtin, D. Y. & Fuson, R. C. , (2004).The SystematicIdentification of Organic Compounds. 3rd edition. USA: John Wiley & Sons, Inc.
4. Creswell,C. J. , Runquist, O. A. & Campbell, M. M. (1982).Analisis Spektrum Senyawa Organic. Kosasih Padmawinata dan IwangSudiro, Penterjemah. Bandung : ITB.
5. Watson, J. T. (1985).Introduction to Mass Spectrometry. New York : Raven PressBooks.
6. Suyatno (2016).Penentuan StrukturMolekul Senyawa Organik dengan Metode Spektroskopi. Surabaya: UnesaUniversity Press

Supporters:	

Supporting lecturer	Prof. Dr. Suyatno, M.Si. Prof. Dr. Tukiran, M.Si. Dr. Ratih Dewi Saputri, S.Si., M.Si. Dr. Andika Pramudya Wardana, S.Si., M.Si. Dr. First Ambar Wati, S.Si.

Week-	**Final abilities of each learning stage (Sub-PO)**	**Evaluation**		**Help Learning, Learning methods, Student Assignments, [Estimated time]**		**Learning materials [References]**	**Assessment Weight (%)**
		Indicator	**Criteria & Form**	**Offline (*offline*)**	**Online (*online*)**		
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
1	1. Students understand the lecture system for Determining Molecular Structure.	1. Explain the RPS, lecture system, assessment system, determination of graduation, and lecture rules for Determination of Molecular Structures2. Able to explain sample preparation methods from various extraction, separation, purification and sample purity testing techniques.	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Lectures, discussions, questions and answers, and case method 2 x 50 minutes		**Material:** 1. Extraction technique 2. Separation technique 3. Purification technique 4. Sample purity test **References:** *Cannel, RJP (1998). Natural Product Isolation. New Jersey : Humana Press.*	5%
2	1. Students understand the lecture system for Determining Molecular Structure.	1. Explain the RPS, lecture system, assessment system, determination of graduation, and lecture rules for Determination of Molecular Structures2. Able to explain sample preparation methods from various extraction, separation, purification and sample purity testing techniques.	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Lectures, discussions, questions and answers, and case method 2 x 50 minutes		**Material:** 1. Extraction technique 2. Separation technique 3. Purification technique 4. Sample purity test **References:** *Cannel, RJP (1998). Natural Product Isolation. New Jersey : Humana Press.*	5%
3	Able to use ultraviolet-visible spectrum data to determine the chromophore group in an organic compound	1. Explain the origin of the UV-Vis spectrum.	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Lectures, questions and answers, discussions, problem solving, and case methods. 2 X 50 minutes	Presentation, question and answer, discussion, problem solving, and case method	**Material:** Material: 1. Origin of UV-Vis spectroscopy 2. Types of electron transitions 3. Chromophore groups 4. Determination of the UV-Vis absorption wavelength of an organic compound **References:** *Silverstein, RM, Webster, FX & Kiemle, DJ, (2005). Spectrometric Identification of Organic Compounds. 7th edition. New York: John Wiley & Sons, Inc.*	5%

4	Able to use ultraviolet-visible spectrum data to determine the chromophore group in an organic compound	1.2. Explain the types of electron transitions in UV-Vis spectroscopy 2.3. Explain the types of chromophore groups in organic compounds.	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Presentation, question and answer, discussion, problem solving and case nethod 2 x 50 minutes		**Material:** Material: 1. Origin of UV-Vis spectroscopy 2. Types of electron transitions 3. Chromophore groups 4. Determination of the UV-Vis absorption wavelength of an organic compound **References:** *Shriner, RL , Hermann, CKF , Morril, TC , Curtin , DY & Fuson, RC , (2004). The Systematic Identification of Organic Compounds. 3rd edition. USA: John Wiley & Sons, Inc.*	5%
5	Able to use ultraviolet-visible spectrum data to determine the chromophore group in an organic compound	1. Explain the origin of the UV-Vis spectrum 2. Explain the types of electron transitions in UV-Vis spectroscopy 3. Explain the types of chromophore groups in organic compounds 4. Predict the wavelength of UV absorption in diene, enone, polyene and aromatic systems using Woodward's rule	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Presentation, question and answer, discussion, problem solving and case method 2 X 50 minutes		**Material:** Material: 1. Origin of UV-Vis spectroscopy 2. Types of electron transitions 3. Chromophore groups 4. Determination of the UV-Vis absorption wavelength of an organic compound **References:** *Suyatno (2016). Determination of the Structure of Organic Compound Molecules using Spectroscopic Methods. Surabaya: Unesa University Press*	10%
6	Able to use infrared spectrum data to determine the functional group of an organic compound	1.1. Explain the types of bond vibrations. 2.2. Predict the magnitude of the vibration frequency of a bond.	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Presentation, question and answer, discussion, problem solving and case method 2 X 50 minutes		**Material:** Material: 1. Types of bond vibrations 2. Determination of vibration frequencies 3. Factors that influence vibration frequencies **References:** *Creswell, CJ, Runquist, OA & Campbell, MM (1982). Spectrum Analysis of Organic Compounds. Kosasih Padmawinata and IwangSudiro, Translators. Bandung: ITB.*	5%
7	Able to use infrared spectrum data to determine the functional group of an organic compound	1.3. Explain the main vibrational regions in the IR spectrum 2.4. Determine the functional group based on the IR spectrum.	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Presentation, question and answer, discussion, problem solving and case method 2 X 50 minutes		**Material:** Material: 1. Types of bond vibrations 2. Determination of vibration frequency 3. Factors influencing vibration frequency **References:** *Silverstein, RM, Webster, FX & Kiemle, DJ, (2005). Spectrometric Identification of Organic Compounds. 7th edition. New York: John Wiley & Sons, Inc.*	5%

8	Midterm exam	Midterm exam	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Test		Online mid-term exam 2 x 50 minutes	**Material:** material 1-7 **References:** *Silverstein, RM, Webster, FX & Kiemle, DJ, (2005). Spectrometric Identification of Organic Compounds. 7th edition. New York: John Wiley & Sons, Inc.* **Material:** material 1-7 **References:** *Shriner, RL, Hermann, CKF, Morril, TC, Curtin, DY & Fuson, RC, (2004). The Systematic Identification of Organic Compounds. 3rd edition. USA: John Wiley & Sons, Inc.*	10%
9	Understand the use of NMR spectroscopy to analyze a sample.	1.1. Explain the working principle of an NMR spectrophotometer. 2.2. Explain the factors that influence chemical shifts	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Presentation, question and answer, discussion, problem solving and case method 2 X 50 minutes		**Material:** Material: 1. Working principles of NMR spectroscopy 2. Chemical shifts and influencing factors 3. Spin coupling 4. NMR Spectrum Simplification Techniques **References:** *Silverstein, RM, Webster, FX & Kiemle, DJ, (2005). Spectrometric Identification of Organic Compounds. 7th edition. New York: John Wiley & Sons, Inc.*	5%
10	Understand the use of NMR spectroscopy to analyze a sample	1.3. Determine the types of protons in an organic compound. 2.4. Using the NMR spectrum to analyze an organic compound.	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities, Tests	Presentation, question and answer, discussion, problem solving and case method 2 X 50 minutes		**Material:** Material: 1. Working principles of NMR spectroscopy 2. Chemical shifts and influencing factors 3. Spin coupling 4. NMR Spectrum Simplification Techniques **References:** *Suyatno (2016). Determination of the Structure of Organic Compound Molecules using Spectroscopic Methods. Surabaya: Unesa University Press*	5%

11	Understand the use of NMR spectroscopy to analyze a sample	1.5. Explain spin matching and the consequences it causes. 2.6. Explain techniques for simplifying the NMR spectrum.	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Presentation, question and answer, discussion, problem solving and case method 2 X 50 minutes		**Material:** Material: 1. Working principles of NMR spectroscopy 2. Chemical shifts and influencing factors 3. Spin coupling 4. NMR Spectrum Simplification Techniques **References:** *Suyatno (2016). Determination of the Structure of Organic Compound Molecules using Spectroscopic Methods. Surabaya: Unesa University Press*	5%
12	Understand the use of mass spectroscopy to analyze a sample	1.1. Explain the basic working principles of a mass spectrometer. 2.2. Explain fragmentation patterns in a mass spectrometer.	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Presentation, question and answer, discussion, problem solving and case method 2 X 50 minutes		**Material:** Material: 1. Working principle of mass spectroscopy 2. Molecular ion fractionation process 3. Ionization mode in mass spectroscopy 4. Use of mass spectroscopy to identify organic compounds **References:** *Creswell, CJ, Runquist, OA & Campbell, MM (1982). Analysis Spectrum of Organic Compounds. Kosasih Padmawinata and IwangSudiro, Translators. Bandung: ITB.*	5%
13	Understand the use of mass spectroscopy to analyze a sample	3. Predict the structure of a compound based on its fragmentation pattern in the mass spectrum.	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities, Tests	Presentation, question and answer, discussion, problem solving and case method 2 X 50 minutes		**Material:** Material: 1. Working principle of mass spectroscopy 2. Molecular ion fractionation process 3. Ionization mode in mass spectroscopy 4. Use of mass spectroscopy to identify organic compounds **References:** *Creswell, CJ, Runquist, OA & Campbell, MM (1982). Analysis Spectrum of Organic Compounds. Kosasih Padmawinata and IwangSudiro, Translators. Bandung: ITB.*	5%

14	Predicting the molecular structure of an organic compound based on combined ultraviolet-visible, infrared, nuclear magnetic resonance and mass spectrum data	1. Determine the amount of DBE of an organic compound 2. Be able to determine the molecular structure of an organic compound based on a combination of ultraviolet-visible, infrared, NMR and mass spectrum data	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities, Tests	Presentation, question and answer, discussion, problem solving and case method 2 X 50 minutes		**Material:** Material: 1. Determining the DBE value of organic compounds 2. Predicting the molecular structure of organic compounds based on a combination of ultraviolet-visible, infrared, NMR and mass spectroscopy. **References:** *Creswell, CJ, Runquist, OA & Campbell, MM (1982). Compound Spectrum Analysis Organic. Kosasih Padmawinata and IwangSudiro, Translators. Bandung: ITB.*	5%
15	Predicting the molecular structure of an organic compound based on combined ultraviolet-visible, infrared, nuclear magnetic resonance and mass spectrum data	1. Determine the amount of DBE of an organic compound 2. Be able to determine the molecular structure of an organic compound based on a combination of ultraviolet-visible, infrared, NMR and mass spectrum data	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Presentation, question and answer, discussion, problem solving and case method 2 X 50 minutes		**Material:** Material: 1. Determining the DBE value of organic compounds 2. Predicting the molecular structure of organic compounds based on a combination of ultraviolet-visible, infrared, NMR and mass spectroscopy. **References:** *Creswell, CJ, Runquist, OA & Campbell, MM (1982). Compound Spectrum Analysis Organic. Kosasih Padmawinata and IwangSudiro, Translators. Bandung: ITB.*	5%
16	Understand concepts, attitudes, special skills and general skills in the Determination of Molecular Structure course	Understand concepts, attitudes and skills in the Determination of Molecular Structure course	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Test	Final Semester Examination (UAS) 2 X 50 minutes		**Material:** material 9-15 **References:** *Suyatno (2016). Determination of the Structure of Organic Compound Molecules using Spectroscopic Methods. Surabaya: Unesa University Press* **Material:** material 9-15 **References:** *Watson, JT (1985).Introduction to Mass Spectrometry. New York : Raven PressBooks.* **Material:** material 9-15 **References:** *Creswell, CJ, Runquist, OA & Campbell, MM (1982). Spectrum Analysis of Organic Compounds. Kosasih Padmawinata and Iwang Sudiro, Translators. Bandung: ITB.*	15%

Evaluation Percentage Recap: Case Study

No	Evaluation	Percentage
1.	Participatory Activities	67.5%
2.	Test	32.5%
		100%

Notes

1. **Learning Outcomes of Study Program Graduates (PLO - Study Program)** are the abilities possessed by each Study Program graduate which are the internalization of attitudes, mastery of knowledge and skills according to the level of their study program obtained through the learning process.
2. **The PLO imposed on courses** are several learning outcomes of study program graduates (CPL-Study Program) which are used for the formation/development of a course consisting of aspects of attitude, general skills, special skills and knowledge.
3. **Program Objectives (PO)** are abilities that are specifically described from the PLO assigned to a course, and are specific to the study material or learning materials for that course.
4. **Subject Sub-PO (Sub-PO)** is a capability that is specifically described from the PO that can be measured or observed and is the final ability that is planned at each learning stage, and is specific to the learning material of the course.
5. **Indicators for assessing** abilities in the process and student learning outcomes are specific and measurable statements that identify the abilities or performance of student learning outcomes accompanied by evidence.
6. **Assessment Criteria** are benchmarks used as a measure or measure of learning achievement in assessments based on predetermined indicators. Assessment criteria are guidelines for assessors so that assessments are consistent and unbiased. Criteria can be quantitative or qualitative.
7. **Forms of assessment:** test and non-test.
8. **Forms of learning:** Lecture, Response, Tutorial, Seminar or equivalent, Practicum, Studio Practice, Workshop Practice, Field Practice, Research, Community Service and/or other equivalent forms of learning.
9. **Learning Methods:** Small Group Discussion, Role-Play & Simulation, Discovery Learning, Self-Directed Learning, Cooperative Learning, Collaborative Learning, Contextual Learning, Project Based Learning, and other equivalent methods.
10. **Learning materials** are details or descriptions of study materials which can be presented in the form of several main points and sub-topics.
11. **The assessment weight** is the percentage of assessment of each sub-PO achievement whose size is proportional to the level of difficulty of achieving that sub-PO, and the total is 100%.
12. TM=Face to face, PT=Structured assignments, BM=Independent study.