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

SEMESTER LEARNING PLAN

Courses	CODE	Course Family	Credit Weight			SEMESTER	Compilation Date
Structure and Spectroscopy of Organic Molecules	4710203015	Compulsory Study Program Subjects	T=3	P=0	ECTS=6.72	2	January 15, 2023

AUTHORIZATION	SP Developer	Course Cluster Coordinator	Study Program Coordinator
	Dr. Ratih Dewi Saputri,S.Si., M.Si.	Prof. Dr. Suyatno, M.Si.	Prof. Dr. Nuniek Herdyastuti, M.Si.

Learning model	**Case Studies**	
Program Learning Outcomes (PLO)	**PLO study program which is charged to the course**	
	Program Objectives (PO)	
	PO - 1	Master the concepts in ultraviolet-visible spectroscopy and be able to apply them in predicting the maximum absorption wavelength of an organic compound
	PO - 2	Master the concepts in infrared spectroscopy and be able to apply them in predicting the functional groups of organic compounds
	PO - 3	Master the concepts in NMR spectroscopy and be able to apply them in predicting the types of hydrogen atoms and carbon atoms in organic compounds
	PO - 4	Master the concepts in mass spectroscopy and be able to apply them in predicting the structure of organic compounds based on their fragmentation patterns
	PO - 5	Elucidating the structure of organic compounds based on a combination of ultraviolet-visible, infrared, NMR and mass spectroscopy data

PLO-PO Matrix

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

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																

Short Course Description	This course examines ultraviolet-visible spectroscopy, infrared spectroscopy, NMR spectroscopy (1H-NMR, 13C-NMR, 2D-NMR), mass spectroscopy, as well as elucidation of the molecular structure of organic compounds based on spectroscopic data.	
References	**Main :**	

1. Silverstein, R.M., Webster, F.X. & Kiemle, D.J.2005. Spectrometric Identification of Organic Compounds. New York: John Wiley & Sons, Inc.
2. Shriner, R.L., Hermann, C.K.F., Morril, T.C., Curtin, D.Y. & Fuson, R.C..2004. The Systematic Identification of Organic Compounds. USA: John Wiley & Sons, Inc.
3. Creswell, C.J., Runquist, O.A. & Campbell, M.M. 1982. Analisis Spektrum Senyawa Organic. Bandung : ITB.
4. Suyatno.2016. Penentuan Struktur Molekul Senyawa Organik dengan Metode Spektroskopi. Surabaya: Unesa University Press.
5. Saputri, et al., 2024, Macahuilettiin A, a new isoprenylated flavanone from the leaves of Macaranga hullettii King ex Hook and their antiplasmodial activity, Vietnam J. Chem, 1-5

Supporters:

1. Suyatno dan Nurul Hidajati (2009). Karakterisasi Senyawa Aktif Antikanker dan Antioksidan dari Tumbuhan Paku Perak (Pityrogramma calomelanos). Laporan Penelitian Strategis Nasional. Universitas Negeri Surabaya
2. Breitmaier, E., 1995, Structure Elucidation by NMR in Organic Chemistry, John Willey & Sons
3. McLafferty, F.W., and Turecek, F., 1993., Interpretation of Mass Spectra, University Science Books, Sausalito, California
4. Pretsch, E., Buhlmann, P., Badertscher, M., 2009, Organic Structure Analysis, Springer-Verlag Berlin Heidelberg 2009, Zürich and Minneapolis
5. Dachriyanus, 2004, Analisis Struktur Senyawa organik Secara Spektroskopi, Universitas Andalas, Padang, Sumatra Barat
6. Saputri, R.D., Tjahjandarie, T.S., Tanjung, M. 2021. Two novel coumarins bearing an acetophenone derivative from the leaves of Melicope quercifolia. Nat. Prod. Res. 35(8): 1256-1261
7. Saputri, Ratih, et al., 2024, Xanthine Oxidase Inhibitory Activity of Xanthones from Calophyllum pseudomole P. F. Stevens, Trop. J. Nat. Prod, 8:1, 5932-5935
8. Saputri, Ratih, et al., 2023, Three novel quinolinone alkaloids from the leeves of Melicope denhamii, Natural Product Research, 37:2, 197-203

Supporting lecturer	Prof. Dr. Suyatno, M.Si. Prof. Dr. Tukiran, M.Si. Dr. Ratih Dewi Saputri, S.Si., M.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	Able to use ultraviolet-visible spectrum data to determine chromophore groups in organic compounds	1. Explain the origins of UVVis spectroscopy 2. Explain the types of electron transitions in UV-Vis spectroscopy 3. Explain the types of chromophore groups in organic compounds 4. Distinguish between bathochromic shift, hypsochromic shift, hyperchromic effect and hypochromic effect 5. Predicting the UV-Vis absorption wavelength of diene, enone, polyene and aromatic systems using Woodward and Fieser-Kuhn's rules	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Method: Discussion, question and answer, problem solving, and assignment Model: Direct instruction and case study 3 x 50 minutes	Method: Discussion, question and answer, problem solving, and assignment Model: Direct instruction and case study 3 x 50 minutes	**Material:** 1. Origin of UV-Vis spectroscopy 2. Types of electron transitions 3. Chromophore groups 4. Bathochromic, hypsochromic shifts, hyperchromic effects and hypochromic effects **References:** *Silverstein, RM, Webster, FX & Kiemle, DJ2005. Spectrometric Identification of Organic Compounds. New York: John Wiley & Sons, Inc.*	7%

2	Able to use ultraviolet-visible spectrum data to determine chromophore groups in organic compounds	Predicting the UV-Vis absorption wavelength of diene, enone, polyene and aromatic systems using Woodward and Fieser-Kuhn's rules	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities, Tests	Method: Discussion, question and answer, problem solving, and assignment Model: Direct instruction and case study 3 x 50 minutes	Method: Discussion, question and answer, problem solving, and assignment Model: Direct instruction and case study 3 x 50 minutes	**Material:** Determination of the UV-Vis absorption wavelength of organic compounds using the Woodward and Fieser-Kuhn rules. **Reference:** *Creswell, CJ, Runquist, OA & Campbell, MM 1982. Spectrum Analysis of Organic Compounds. Bandung: ITB.*	7%
3	Able to use infrared spectrum data to determine the functional group of an organic compound	1. Explain the types of bond vibrations in organic compounds 2. Predicting bond vibration frequency values in organic compounds	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	**Material:** 1. Types of bond vibrations 2. Determination of bond vibration frequencies **References:** *Shriner, RL, Hermann, CKF, Morril, TC, Curtin, DY & Fuson, RC.2004. The Systematic Identification of Organic Compounds. USA: John Wiley & Sons, Inc.*	5%
4	Able to use infrared spectrum data to determine the functional group of an organic compound	1. Explain the main vibrations in the infrared spectrum of an organic compound 2. Determining the functional group of an organic compound based on its infrared spectrum (part-1)	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities, Tests	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	**Material:** 1. Factors that influence the vibrational frequency of bonds 4. Determination of the functional group of an organic compound based on its infrared spectrum (part-1) **Reference:** *Suyatno.2016. Determination of the Molecular Structure of Organic Compounds using Spectroscopic Methods. Surabaya: Unesa University Press.*	5%
5	Able to use infrared spectrum data to determine the functional group of an organic compound	Determining the functional group of an organic compound based on its infrared spectrum (part 2)	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	**Material:** Determination of the functional group of an organic compound based on the spectrum (part-2) **References:** *Creswell, CJ, Runquist, OA & Campbell, MM 1982. Spectrum Analysis of Organic Compounds. Bandung: ITB.*	5%

6	Able to use 1H-NMR spectrum data to determine the type of hydrogen atom in organic compound molecules	1. Explain the working principle of NMR spectroscopy 2. Explain the factors that influence chemical shifts 3. Determine the type of proton in organic compounds 4. Explains spin matchmaking and the resulting effects	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities, Tests	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	**Material:** 1. Working principles of NMR spectroscopy 2. Chemical shifts and influencing factors 3. Spin matching **References:** *Silverstein, RM, Webster, FX & Kiemle, DJ2005. Spectrometric Identification of Organic Compounds. New York: John Wiley & Sons, Inc.* **Material:** 1D NMR Spectroscopy **References:** *Breitmaier, E., 1995, Structure Elucidation by NMR in Organic Chemistry, John Willey & Sons* **Material:** 1D molecular structure analysis **References:** *Pretsch, E., Buhlmann, P., Badertscher, M., 2009, Organic Structure Analysis, Springer-Verlag Berlin Heidelberg 2009, Zürich and Minneapolis*	5%

7	Able to use 1H-NMR and 13C-NMR spectrum data to determine the types of hydrogen atoms and carbon atoms in organic compound molecules	1. Describes techniques for simplifying 1H-NMR spectra 2. Using 1H-NMR spectra to identify the molecular structure of organic compounds	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities, Tests	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	**Material:** 1. Techniques for simplifying the 1H-NMR spectrum 5. Using the 1H-NMR spectrum to identify the molecular structure of organic compounds. **Reference:** *Suyatno.2016. Determination of the Molecular Structure of Organic Compounds using Spectroscopic Methods. Surabaya: Unesa University Press.* **Material:** 1D NMR Spectroscopy **References:** *Shriner, RL, Hermann, CKF, Morril, TC, Curtin, DY & Fuson, RC.2004. The Systematic Identification of Organic Compounds. USA: John Wiley & Sons, Inc.*	5%
8	Midterm Exam (Final Skills TM-1 to TM-7)	Assessment indicators TM-1 to TM-7	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Written test in essay form 2 x 50 minutes	Written test in essay form 2 x 50 minutes		0%

9	Able to use 13C-NMR spectrum data to determine the type of carbon atom in organic compound molecules	1. Explain the use of 13C-NMR spectrum 2. Determine the type of carbon atom in organic compounds based on the 13C-NMR spectrum 3. Explains the 13C-NMR spectrum of proton decoupling and coupling 4. Explains the spectrum of DEPT 13CNMR 5. Using 1H-NMR and 13C-NMR spectra to identify organic compounds	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	**Material:** 1. Use of 13C-NMR spectroscopy 2. Types of carbon atoms in 13C-NMR spectroscopy 3. DEPT spectrum in 13C-NMR spectroscopy 4. Application of the 13C-NMR spectrum to determine the molecular structure of organic compounds **References:** *Creswell, CJ, Runquist, OA & Campbell, MM 1982. Spectrum Analysis of Organic Compounds. Bandung: ITB.* **Material:** Structure analysis of organic compounds using NMR spectroscopy **Reference:** *Dachriyanus, 2004, Structure analysis of organic compounds using spectroscopy, Andalas University, Padang, West Sumatra* **Material:** Application of structural elucidation of natural compounds. **Reference:** *Saputri, Ratih, et al., 2023, Xanthine Oxidase Inhibitory Activity of Xanthones from Calophyllum pseudomole PF Stevens, Trop. J. Nat. Prod, 8:1, 5932-5935*	5%

10	Able to use two-dimensional NMR spectrum (2D-NMR) in determining the structure of organic compounds	1. Explain the homonuclear correlation spectrum of an organic compound 2. Explains the heteronuclear correlation spectrum of an organic compound 3. Predicting the structure of an organic compound based on its two-dimensional NMR spectrum (2D-NMR)	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities, Tests	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	**Material:** 1. Homonuclear correlation spectroscopy (1H-1H COSY or DQF COSY) 2. Heteronuclear correlation spectroscopy (HMQC, HMQC) **References:** *Suyatno and Nurul Hidajati (2009). Characterization of Active Anticancer and Antioxidant Compounds from Silver Fern (Pityrogramma calomelanos). National Strategic Research Report. Surabaya State University* **Material:** 2D Heteronuclear Correlation Spectroscopy (HMBC, HMQC) **References:** *Saputri, RD, Tjahjandarie, TS, Tanjung, M. 2021. Two novel coumarins bearing an acetophenone derivative from the leaves of Melicope quercifolia. Nat. Prod. Res. 35(8): 1256-1261* **Material:** Application for Development of 2D Heteronuclear Correlation Spectroscopy (HMBC, HMQC, COSY) **References:** *Saputri, et al., 2024, Macahuilettiin A, a new isoprenylated flavanone from the leaves of Macaranga hullettii King ex Hook and their antiplasmodial activity, Vietnam J. Chem , 1-5*	5%
11	Able to predict the molecular structure of organic compounds based on NMR spectroscopy	Elucidating the molecular structure of organic compounds based on NMR spectroscopy data	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities, Tests	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	**Material:** Structure elucidation of organic molecules based on NMR spectroscopy **References:** *Breitmaier, E., 1995, Structure Elucidation by NMR in Organic Chemistry, John Willey & Sons*	10%

						Material: Identification of organic molecular compounds using NMR spectroscopy **References:** *Silverstein, RM, Webster, FX & Kiemle, DJ2005. Spectrometric Identification of Organic Compounds. New York: John Wiley & Sons, Inc.* **Material:** Interpretation of Organic Molecular Structures **References:** *Saputri, et al., 2024, Macahuilettiin A, a new isoprenylated flavanone from the leaves of Macaranga hullettii King ex Hook and their antiplasmodial activity, Vietnam J. Chem, 1-5* **Material:** Application of structure elucidation of organic compounds in the field of natural product chemistry **References:** *Saputri, Ratih, et al., 2024, Xanthine Oxidase Inhibitory Activity of Xanthones from Calophyllum pseudomole PF Stevens, Trop. J. Nat. Prod, 8:1, 5932-5935* **Material:** Structure analysis of organic compounds using NMR spectroscopy **Reference:** *Dachriyanus, 2004, Structure analysis of organic compounds using spectroscopy, Andalas University, Padang, West Sumatra*	

12	Able to use mass spectroscopy data to determine relative molecular masses and fragmentation patterns of organic compounds	1. Explain ionization modes in mass spectroscopy 2. Predicting the molecular structure of organic compounds based on mass spectrum data	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities, Tests	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	Method: Discussion, question and answer, problem solving, assignment Model: Direct instruction and case study 3 x 50 minutes	**Material:** 1. Ionization modes in mass spectroscopy (EIMS, SIMS, FABMS, CIMS) 2. Use of mass spectroscopy to identify organic compounds. **References:** *Creswell, CJ, Runquist, OA & Campbell, MM 1982. Spectrum Analysis of Organic Compounds. Bandung: ITB.*	10%
13	Able to predict the molecular structure of organic compounds based on a combination of visible ultraviolet, infrared, NMR and mass spectroscopy data	1. Determining the DBE value in an organic compound molecule 2. Elucidating the molecular structure of organic compounds based on ultraviolet-visible, infrared, NMR and mass spectrum data (part-1)	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Method: Discussion, question and answer, problem solving, assignment Model: case method 3 x 50 minutes	Method: Discussion, question and answer, problem solving, assignment Model: case method 3 x 50 minutes	**Material:** 1. Determination of the DBE value of an organic compound 2. Elucidation of the structure of an organic compound based on a combination of ultraviolet-visible, infrared, NMR and mass spectrum data (bgian-1) **References:** *Silverstein, RM, Webster, FX & Kiemle, DJ2005. Spectrometric Identification of Organic Compounds. New York: John Wiley & Sons, Inc.*	10%
14	Able to predict the molecular structure of organic compounds based on a combination of visible ultraviolet, infrared, NMR and mass spectroscopy data	Elucidating the molecular structure of organic compounds based on ultraviolet-visible, infrared, NMR and mass spectrum data (part-2)	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities, Tests	Method: Discussion, question and answer, problem solving, assignment Model: Project base learning 3 x 50 minutes	Method: Discussion, question and answer, problem solving, assignment Model: Project base learning 3 x 50 minutes	**Material:** Elucidation of the structure of organic compounds based on a combination of ultraviolet-visible, infrared, NMR and mass spectrum data. **References:** *Shriner, RL, Hermann, CKF, Morril, TC, Curtin, DY & Fuson, RC.2004. The Systematic Identification of Organic Compounds. USA: John Wiley & Sons, Inc.*	10%

15	Able to predict the molecular structure of organic compounds based on a combination of visible ultraviolet, infrared, NMR and mass spectroscopy data	Elucidating the molecular structure of organic compounds based on ultraviolet-visible, infrared, NMR and mass spectrum data (part 3)	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities, Tests	Method: Discussion, question and answer, problem solving, assignment Model: Project base learning 3 x 50 minutes	Method: Discussion, question and answer, problem solving, assignment Model: Project base learning 3 x 50 minutes	**Material:** Elucidation of the structure of organic compounds based on a combination of ultraviolet-visible, infrared, NMR and mass spectrum data (part-3) **References:** *Suyatno.2016. Determination of the Molecular Structure of Organic Compounds using Spectroscopic Methods. Surabaya: Unesa University Press.*	6%
16	Final semester exam (UAS) (Final skills TM-9 to TM-15)	TM-9 indicators up to TM-15 indicators	**Criteria:** Based on the assessment rubric that has been created by the teaching lecturer **Form of Assessment** : Participatory Activities	Written test in essay form 2 x 50 minutes	Written test in essay form 2 x 50 minutes	**Material:** Analysis of Organic Compounds using UV, IR, MS and NMR Spectroscopy **References:** *Dachriyanus, 2004, Analysis of the Structure of Organic Compounds Using Spectroscopy, Andalas University, Padang, West Sumatra* **Material:** Identification of organic compounds using UV, IR, NMR, MS spectroscopy. **Reference:** *Silverstein, RM, Webster, FX & Kiemle, DJ2005. Spectrometric Identification of Organic Compounds. New York: John Wiley & Sons, Inc.* **Material:** Determination of the structure of organic molecules using spectroscopic methods. **Reference:** *Suyatno.2016. Determination of the Molecular Structure of Organic Compounds using Spectroscopic Methods. Surabaya: Unesa University Press.*	5%

Evaluation Percentage Recap: Case Study

No	Evaluation	Percentage
1.	Participatory Activities	68.5%
2.	Test	31.5%
		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** ability in the process and student learning outcomes are specific and measurable statements that identify the ability 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.