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

SEMESTER LEARNING PLAN

Courses	CODE	Course Family	Credit Weight			SEMESTER	Compilation Date
Quantum Chemistry	8420402324	Compulsory Study Program Subjects	T=2	P=0	ECTS=3.18	2	January 1, 2023

AUTHORIZATION	SP Developer	Course Cluster Coordinator	Study Program Coordinator
	Dr. I Gusti Made Sanjaya, M.Si.	Prof. Dr. Suyono, M.Pd.	Prof. Dr. Utiya Azizah, M.Pd.

Learning model	**Project Based Learning**	
Program Learning Outcomes (PLO)	**PLO study program which is charged to the course**	
	PLO-6	Able to adapt to various developments in chemical science, continue to develop and learn throughout life to continue education, both formal and informal (CPL 8)
	PLO-8	Mastering the basics of scientific methods, designing and carrying out research, compiling scientific reports and communicating them both orally and in writing by utilizing information and communication technology in the field of education (CPL 6)
	PLO-10	Able to design, implement, evaluate, learn and develop chemistry learning media by utilizing Information and Communication Technology (CPL 4)
	Program Objectives (PO)	
	PO - 1	Students are able to think critically and creatively in producing appropriate solutions and visualizations of problems involving quantum chemistry
	PO - 2	Students are able to produce precise quantum chemical conclusions about structures and bonds, physical or chemical, in the analysis of various materials
	PO - 3	Students are able to master the basic concepts and principles of quantum chemistry to describe atomic structure, chemical bonds, molecular structure, molecular symmetry, spectroscopy and molecular interactions.
	PO - 4	Students are able to be given responsibility for completing quantum chemistry assignments independently and are responsible for communicating the results
	PLO-PO Matrix	

P.O	PLO-6	PLO-8	PLO-10
PO-1			
PO-2			
PO-3			
PO-4			

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																

Short Course Description	Study of the basic principles of quantum chemistry and their application to atomic structure, chemical bonds, molecular structure, molecular symmetry, spectroscopy and molecular interactions through study, practical work and simple engineering

References	**Main :**	
	1. Atkins, P., Paula, J. d., and Keeler, J. 2018. Physical Chemistry, 11th edition. UK: Oxford University Press. 2. Mortimer, R.G. 2008, Physical Chemistry, 3th edition, London: Elsevier Inc. 3. Levine, Ira N. 2014, Quantum chemistry, 7th edition, New York: Pearson Education, Inc.	
	Supporters:	
Supporting lecturer	Dr. I Gusti Made Sanjaya, M.Si. Findiyani Ernawati Asih, S.Pd., M.Pd.	

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	Mastering the quantum chemistry lecture achievement targets	Analyzing the achievements of quantum chemistry lectures	**Criteria:**	Presentations and discussions related to RPS discussions regarding lecture achievement targets, teaching materials at each meeting, and lecture evaluations. 2x150‘			0%
2	Identify the basic principles of quantum chemistry	Evaluate the difference between the time-dependent Schrodinger equation and the time-independent Schrodinger equation	**Criteria:** Participation Assessment and Assignments to work on student worksheets **Form of Assessment** : Participatory Activities, Portfolio Assessment	Presentation and discussion on quantum postulates and Schrodinger‘s equation 2x50‘		**Material:** Basics of Quantum Chemistry **Bibliography:** *Mortimer, RG 2008, Physical Chemistry, 3th edition, London: Elsevier Inc.* **Material:** Basics of Quantum Chemistry **Bibliography:** *Levine, Ira N. 2014, Quantum chemistry, 7th edition, New York: Pearson Education, Inc.* **Material:** Basics of Quantum Chemistry **References:** *Atkins, P., Paula, J. d., and Keeler, J. 2018. Physical Chemistry, 11th edition. UK: Oxford University Press.*	5%

3		Determine the wave function of particles, energy and density of particles in 1, 2 and 3 dimensional boxes and their applications in chemistry	**Criteria:** Participation Assessment and Assignments to complete student worksheets **Form of Assessment** : Participatory Activities	Presentation and discussion on the application of quantum chemistry to the translational motion of particles in boxes of dimensions 1, 2 and 3 2x50‘		**Material:** Quantum translational motion **References:** *Atkins, P., Paula, J. d., and Keeler, J. 2018. Physical Chemistry, 11th edition. UK: Oxford University Press.*	5%
4	Can apply quantum chemistry to vibrational motion	Determine the wave function of particles and the energy levels of vibrational motion	**Criteria:** Participation Assessment and assignments for working on LKM **Form of Assessment** : Participatory Activities	Presentation by providing an analogy of vibrational motion in everyday life and discussion of 2 X 50		**Matter:** Application of quantum chemistry to vibrational motion **References:** *Atkins, P., Paula, J. d., and Keeler, J. 2018. Physical Chemistry, 11th edition. UK: Oxford University Press.*	5%
5	Can apply quantum chemistry to rotational motion	Determine the particle wave function and rotational energy levels	**Criteria:** Participation Assessment and assignments for working on LKM **Form of Assessment** : Participatory Activities, Portfolio Assessment	Presentation by providing an analogy of rotational motion in daily life and discussion		**Material:** Application of quantum chemistry to rotational motion **Reference:** *Mortimer, RG 2008, Physical Chemistry, 3th edition, London: Elsevier Inc.*	5%
6	Can determine the structure and spectra of the hydrogen atom	Determine the structure, shape and energy of atomic orbitals, and hydrogen spectra	**Criteria:** Participation Assessment and assignments for working on LKM **Form of Assessment** : Participatory Activities	Presentation and discussion of solving the case of 2 X 50 hydrogen atomic spectra		**Material:** Determination of the structure and spectra of the hydrogen atom. **Reference:** *Levine, Ira N. 2014, Quantum chemistry, 7th edition, New York: Pearson Education, Inc.*	0%
7	Can determine the structure and spectra of complex atoms	Analyzing orbital and term symbol approaches	**Criteria:** Participation Assessment and assignments for working on LKM **Form of Assessment** : Participatory Activities	Presentation and discussion 2 X 50		**Material:** Determination of complex atomic structures and spectra **References:** *Levine, Ira N. 2014, Quantum chemistry, 7th edition, New York: Pearson Education, Inc.*	5%
8			**Criteria:** UTS Assessment				0%

9	Understand valence bond theory or VBT	Explain VBT for diatomic molecules and polyatomic molecules	**Criteria:** Participation Assessment and assignments for working on LKM **Form of Assessment** : Participatory Activities	Presentation and discussion of case solutions on how chemical species have a tendency to reach stability through VBT 2 X 50		**Material:** Understanding valence bond theory or VBT **References:** *Atkins, P., Paula, J. d., and Keeler, J. 2018. Physical Chemistry, 11th edition. UK: Oxford University Press.*	15%
10	Understanding MOT for diatomic molecules	Write the electronic configuration of a diatomic molecule	**Criteria:** Participation Assessment and assignments for working on LKM **Form of Assessment** : Participatory Activities	Presentation and discussion of case solving regarding the prediction of the existence of diatomic molecules and their 2 X 50 magnetic properties		**Material:** Understanding MOT for diatomic molecules **References:** *Levine, Ira N. 2014, Quantum chemistry, 7th edition, New York: Pearson Education, Inc.*	10%
11	Understanding MOT for polyatomic molecules	Describe the electronic structure of polyatomic molecules	**Criteria:** Participation Assessment and assignments for working on LKM	Presentation and discussion		**Material:** Understanding MOT for polyatomic molecules **References:** *Mortimer, RG 2008, Physical Chemistry, 3th edition, London: Elsevier Inc.*	5%
12	Understand the basic principles of molecular symmetry	Determine the elements and operations of molecular symmetry	**Criteria:** Participation Assessment and assignments for working on LKM	Presentation and discussion		**Material:** Understanding the basic principles of molecular symmetry **. References:** **Material:** Understanding the basic principles of molecular symmetry **References:** *Atkins, P., Paula, J. d., and Keeler, J. 2018. Physical Chemistry, 11th edition. UK: Oxford University Press.*	5%
13	Can apply symmetry and symmetry groups of a molecule	Analyzing the symmetry group of a molecule	**Criteria:** Participation Assessment and assignments for working on LKM	Presentation and discussion		**Material:** Application of symmetry and symmetry groups of a molecule **References:** *Atkins, P., Paula, J. d., and Keeler, J. 2018. Physical Chemistry, 11th edition. UK: Oxford University Press.*	5%

14	Understand the basic principles of molecular spectroscopy	Distinguish between translational, vibrational and rotational spectra	**Criteria:** Participation Assessment and assignments for working on LKM **Form of Assessment** : Participatory Activities	Presentation and discussion 2 X 50		**Material:** Understanding the basic principles of molecular spectroscopy **References:** *Mortimer, RG 2008, Physical Chemistry, 3th edition, London: Elsevier Inc.*	5%
15	Understand molecular interactions that can give rise to electrical properties	Analyze molecular interactions that produce electrical properties	**Criteria:** Participation Assessment and assignments for working on LKM **Form of Assessment** : Participatory Activities	Presentation and discussion of case solutions related to the contribution of the conduction band and valence band as determinants of the electricity of a 2 X 50 material			15%
16			**Criteria:** UAS assessment				0%

Evaluation Percentage Recap: Project Based Learning

No	Evaluation	Percentage
1.	Participatory Activities	65%
2.	Portfolio Assessment	5%
		70%

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.