SEMESTER LEARNING ACTIVITY PLANS (SLAP)

SEMESTER EVEN 2022/2023

Physics Undergraduate Study Program

Physics Department

Atomic and Molecular Physics

MFF 2310/ 3 Credits

Lecturer Coordinator:

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UNIVERSITAS GADJAH MADA
FACULTY OF MATHEMATICS AND NATURAL SCIENCE
2022

	Universitas Gadjah Mada Faculty of Mathematics and Natural Science Physics Department / Physics Undergraduate Study Program Semester EVEN 2022/2023	**Document Number :** ……

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Code	Course Name	Credits (Credits)		Semester	Status	Prerequisite
MFF 2310	*Atomic and Molecular Physics*	*T: 3*	*P: …*	*EVEN*	*Compulsory*	*Basic Physics II (MFF1012), Quantum Physics I (MFF2034), Relativity Theory (MFF2031*), Statistical Physics (MFF2051)*

Short Description	The Atomic and Molecular Physics course (MFF 2310) is compulsory in the 2021 Curriculum for the Undergraduate Physics Study Program, Faculty of Mathematics and Natural Sciences UGM. Previously, students were required to take Courses Basic Physics II (MFF 1012), Quantum Physics I (MFF 2034), Statistical Physics (MFF 2051), and Relativity Theory (MFF 2031) as prerequisites. The topics that will be presented are pretty advanced, which involve the characteristics of atomic and molecular structures that involve standard calculations of quantum mechanics and statistical physics as the basic concepts that underlie them. To help students understand the topic of study in this lecture, the process of deepening the lecture material is also often added with visual depictions to reduce the difficulty of abstraction in understanding the lecture material. In addition, the learning process is also periodically complemented by providing assignments or homework or assignments to students to improve problem-solving skills and understanding of course material. Learning is carried out on a face-to-face schedule in class for 14 weeks, with each week consisting of 100 minutes. Four weeks during the lecture period are used for Mid-Semester Examinations and Final Semester Examinations, each of which is held on a scheduled basis for two weeks by the Academic Section of FMIPA UGM. Evaluation for students for course assessment is carried out summatively and formatively. This is manifested in the form of written exams, both the Mid-Semester Examination and the Final Semester Examination, which take a maximum of 120 minutes. The formative evaluation is manifested as independent assignments for each student. The form of independent activity is the completion of a task given to students to be discussed in groups and then completed independently at home in the form of a written report for each task. The monitoring process is carried out by looking at student activities during the lecture, such as attendance at lectures, questions and answers and discussions on the material being presented, and student performance in carrying out independent assignments in the form of homework given.	
Program Learning Outcomes (PLO) Imposed on the Course	***PLO 2***	Knowledge. Able to explain theoretical concepts and principles of classical and modern physics and able to apply basic concepts of physics and related mathematical methods in finding solutions to physical problems.
	PLO 5	Long Life Learning. Able to analyze various alternative solutions to physical problems and conclude them for appropriate decision-making, both in familiar and new problems.
Course Outcomes (CO)	**After completing this course, students are expected to be able to:**	
	CO1	Students have the ability in Physics Skills, namely how to formulate and describe (to describe) the physical phenomena being studied and reveal important information in the physics problem through various tricks or specific mathematical procedures and utilize various approaches (approximations).

	CO2	Students have the ability in Analytical Skills, namely how to pay attention to physics problems in detail, analyze problems and build arguments logically and carefully.		
	CO3	Students have the ability in Investigative Skills, namely how to search for physics problems from various sources and references to understand important information.		
	CO4	Students have the ability in Problem-Solving Skills, namely how to solve a problem with a structured solution (well-defined solutions), formulate a problem carefully, and try other approaches (approaches) to improve solving a challenging problem (challenging problems).		
The Correlation of CO to Learning Materials and Methods, and Time Allocation		**Learning Materials**	**Learning Methods**	**Time Allocation**
	CO 1, CO 2, CO 3, CO 4	Black Body Radiation, Photoelectric Effect	TCL-SCL mixed	***3X50 minutes***
	CO 1, CO 2, CO 3, CO 4	Franck-Hertz experiment, Thomson Atomic Model	TCL-SCL mixed	***3X50 minutes***
	CO 1, CO 2, CO 3, CO 4	Rutherford's Experiment, Bohr's Atomic Theory, and Weaknesses of the Old Quantum Theory	TCL-SCL mixed	***3X50 minutes***
	CO 1, CO 2, CO 3, CO 4	Hydrogen Atom: Schrödinger equation, quantum numbers n,l,m	TCL-SCL mixed	***3X50 minutes***
	CO 1, CO 2, CO 3, CO 4	Wavefunction interpretation, hope value, spin quantum number, coupling	TCL-SCL mixed	***3X50 minutes***
	CO 1, CO 2, CO 3, CO 4	Complex Atoms: central field approximation and Pauli exclusion, electron configuration, coupling	TCL-SCL mixed	***3X50 minutes***
	CO 1, CO 2, CO 3, CO 4	Fine structure, the sum of MJ values in one configuration, Zeeman effect, hyperfine structure	TCL-SCL mixed	***3X50 minutes***
	Midterm exam/Project Task Results/Case Analysis Results			
	CO 1, CO 2, CO 3, CO 4	Molecular Introduction: covalent bond and ionic bond	TCL-SCL mixed	***3X50 minutes***
	CO 1, CO 2, CO 3, CO 4	HOMO and LUMO	TCL-SCL mixed	***3X50 minutes***
	CO 1, CO 2, CO 3, CO 4	Symmetry and Chemical Bonds: orbital symmetries and overlap, valence-bond theory and hybrid orbitals	TCL-SCL mixed	***3X50 minutes***
	CO 1, CO 2, CO 3, CO 4	Localized and delocalized molecular orbitals, - bonding, - bonding in aromatic ring systems	TCL-SCL mixed	***3X50 minutes***
	CO 1, CO 2, CO 3, CO 4	Molecular Geometry: Stability of molecular configurations	TCL-SCL mixed	***3X50 minutes***
	CO 1, CO 2, CO 3, CO 4	Molecular Symmetry: symmetry operations and elements	TCL-SCL mixed	***3X50 minutes***

	CO 1, CO 2, CO 3, CO 4	Symmetry operation merging, point group of molecular crystal system, point group classification	TCL-SCL mixed	***3X50 minutes***
	Final exams/ Project Task Results/Case Analysis Results			

Learning Methods	**SCL (Student Centered Learning): Project-based learning (Team-based Project)/Case-based learning/PBL/other SCL methods**
Student Learning Experience	**Learn to study and examine physical systems as well as examples of problem-solving procedures**
Access to Learning Media/ LMS and Offline and Online Percentage	Offline (LCD, PPT Slide, Whiteboard, Laptop) and Online (Zoom Meeting, Google Meet, Google Classroom)

Assessment Methods and Synchronization with CO

Assessment Methods	Assessment Percentage	Criteria/ Indicators	CO1	CO2	CO3	CO4
Participatory Activity*						
Project Results/ Case Study Results/ PBL Results*						
Cognitive						
Assignment	**40**		√	√	√	√
Midterm Exam	**30**		√	√	√	√
Final Exam	**30**		√	√	√	√
Total	**100**					

*) can also be obtained from the Midterm or Final Exam as the result of participatory activities or project/ case study results. According to IKU 7, the percentage of project results/ case study/ PBL results is at least 50%.

References

Main References;

1. Krane, K., 1992, Modern Physics, John Willey and Sons..
2. Haken, H. and Wolf, H. C., 1984, Atomic and Quantum Physics, Springer-Verlag, Berlin..
3. Robert L. Carter, Molecular Symmetry and Group Theory, 1998, John Wiley & Sons, USA..
4. Svanberg, 1992, Atomic and Molecular Spectroscopy, edisi 2, Springer-Verlag, New York..
5. David J. Willock, Molecular Symmetry, 2009, John Wiley & Sons, UK..

Lecturers (*Team Teaching*)

1. Moh. Adhib Ulil Absor, S.Si., M.Sc., Ph.D
2. Dr. Yosef R. Utomo, SU.

Authorization	**Date of Drafting**	**Lecturer Coordinator**	**Head of Curriculum Committee**	**Head of Study Program**

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