Subject content

1. Program information

1.1 University	West University of Timisoara
1.2 Faculty	Physics
1.3 Department	Physics
1.4 Study direction	Physics
1.5 Study cycle	Master
1.6 Study program	Advanced research methods in physics

2. Subject matter information

2.1 Subject matter				Complements of Atom and Molecule Physics			
2.2 Subject teacher				Associate Professor dr. Calin Avram			
2.3 Subject applications teacher				Associate Professor dr. Calin Avram			
2.4 Study year	1	2.5 Semester	1	2.6 Assessment type	Ex	2.7 Subject type	Ob **ARMP 1103**

3. Study time distribution

3.1 Nr. of hours/week	4	In which: 3.2 course	2	3.3 seminar/lab	2
3.4 Total hours in educational plan	56	In which: 3.5 curs	28	3.6 seminar	56
Time distribution:					**hours**
Study after lecture notes, bibliography or notes					60
Additional documentation in the library, electronic specialty platforms/ field					10
Seminar / laboratory preparations, homework, portfolio and essays					40
Tutoring					-
Exams					10
Other activities……					

3.7 Total number of personal study hour	**120**
3.8 Total number of hours in semester	**176**
3.9 Number of credits	**7**

4. Preconditions (where appropriate)

4.1 curriculum	•
4.2 skills	•

5. Conditions (where appropriate)

5.1 for course	• Mathematics; Chemistry;
5.2 for seminar/lab	• Mathematics; Chemistry;

6. Course Objectives

Cunoștințe	-to know the advanced notions in the field of Physics, which involves a critical understanding of theories and principles -to know the working formulas for calculations with physical quantities using properly the principles and laws of physics -to know the language specific to the field -to know physical phenomena and interpret them by formulating hypotheses and operationalizing key concepts and the appropriate use of laboratory equipment
Abilități	-to deduce the working formulas for calculations with physical quantities, using appropriately the principles and laws of physics -To describe physical systems using specific theories and tools (experimental and theoretical models, algorithms, schemes, etc.) -to apply the principles and laws of physics in solving theoretical or practical problems, under conditions of qualified assistance
Responsabilitate și autonomie	-participate in some concrete physics experiments -to be autonomous in the context of handling laboratory equipment, including in situations requiring an interdisciplinary approach - to autonomously use information sources and resources for communication and assisted professional training (Internet portals, specialized software applications, databases, online courses, etc.) both in Romanian and in a language of international circulation

7. Table of content

7.1 Course	Teaching methods	Observations
1. Atoms and molecules. Introduction.	Exposition, demonstration, heuristic conversation	Course support and bibliographic materials will be sent to students by e-mail
2. Atomic spectra and atomic structure. Hydrogen atom.	Exposition, demonstration, heuristic conversation	
3. The structure of Helium spectra.	Exposition, demonstration, heuristic conversation	
4. Many-electron atoms. Classification of the electronic terms.	Exposition, demonstration, heuristic conversation	

5. Atoms in external field. The normal Zeeman effect.	Exposition, demonstration, heuristic conversation	
6. The anomalous Zeeman effect.	Exposition, demonstration, heuristic conversation	
7. The Stark effect.	Exposition, demonstration, heuristic conversation	
8. The calculation of electronic structure. The Hartree-Fock self-consistent field method.	Exposition, demonstration, heuristic conversation	
9. Born-Oppenheimer approximation.	Exposition, demonstration, heuristic conversation	
10. Molecular rotation.	Exposition, demonstration, heuristic conversation	
11. Molecular vibration.	Exposition, demonstration, heuristic conversation	
12. Molecular electronic transitions.	Exposition, demonstration, heuristic conversation	
13. Symmetry of molecules.	Exposition, demonstration, heuristic conversation	
14. The electric and magnetic properties of molecules.	Exposition, demonstration, heuristic conversation	

Bibliography

1. B. H. Brandsen, C. J. Joachain, "Fizica atomului si a moleculei", Ed. Tehnica, Buc.,1998;
2.H.Haken, H.C.Wolf, The Physics of Atoms and Quanta, Springer, Berlin,Heidelberg,2000;
3.G.W.F.Drake, Atomic,Molecular&Optical Physics Handbook, AIP Press, New York 1996.
4.P.W. Atkins and R.S. Friedman, "Molecuar Quantum Mechanics", Oxford University Press, Oxford,1997.

7.2 Seminar(S) / labs(L)	**Teaching methods**	**Observations**
1. Classification of spectra (S).	Conversation, investigation, case study.	
2. Terms of many electron free atoms. Classifications(S).	Conversation, investigation, case study.	
3. Coupling scheme for momentum .Applications(S).	Conversation, investigation, case study.	
4. Born-Oppenheimer approximation for hydrogen molecule(S).	Conversation, investigation, case study.	
5. Symmetry group for molecules(S).	Conversation, investigation, case study.e	
6. Classification of the normal mode of molecules using symmetry(S).	Conversation, investigation, case study.	
7. Fine structure of energy levels for alkaline atoms (L).	Experiment, case study	

8. Bohr magneton determination using normal Zeeman effect (L).	Experiment, case study	
9. Lattice parameter determination by electron difraction (L).	Experiment, case study	
10. Geometric parameters determination for molecules (L).	Experiment, case study	
11. Experimental investigation of vibration energy levels of diatomic molecules(L).	Experiment, case study	
12. Anharmonic constants determination for CN (L).	Experiment, case study	
13. Ab initio and DFT calculations of molecules I (L).	Experiment, case study	
14. Ab initio and DFT calculations of molecules II (L).	Experiment, case study	

Bibliography

1. *I. E. Irodov*, "Problems in Atomic and Nuclear Physics", Mir Publishers, Moscow, 1983.
2. *P.W. Atkins and R. S. Friedman*, "Molecular Quantum Mechanics", Oxford University Press, Oxford, 1997..

8. Relation between subject content and the expectations of employers

Molecular and atomic physics gives work skills in domain topics and related topics in which the future graduate could work. Mainly related with physics, chemistry, material science, etc., will be useful in practice.

9. Assessment

Activity type	10.1 Assessment criteria	10.2 Assessment method	10.3 Percent in final mark
10.4 Course	The assimilation level of knowledge gained	Oral examination	60%
10.5 Seminar / labs	Capacity of solving specific problem	Written test	40%
10.6 Minimum performance standards			
-To know the basic terminology -To correct address three topics, even if they cannot develop completely; -Do not make major mistakes.			

Data completării:
16.09.2024

Titular de disciplină:
Conf. dr. Avram Călin

Data avizării în department:

Director de departament:
Conf. dr. Ștefu Nicoleta