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	Astrophysics, Elementary Particles and Computational Physics

2. Subject matter information

2.1 Subject matter				Complements of Atomic and Molecular Physics **AP1103**			
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

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					28
Additional documentation in the library, electronic specialty platforms/ field					14
Seminar / laboratory preparations, homework, portfolio and essays					14
Tutoring					4
Exams					6
Other activities……					

3.7 Total number of personal study hour	**66**
3.8 Total number of hours in semester	**122**
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. Specific skills gained

Professional skils	- Capacity of understanding, analyzing and describing the structure and basic interactions in atoms and molecules. -Getting new deepening of professional skills closely related areas studies, and development capacity for scientific research in a world of knowledge. - Computational skills (model and simulation structure and parameters of systems of atoms and molecules: processing results). - Interpretation and correlations of the personal results with that of related professionals;
Transversal skills	• Skills in research ethics • Skills in research project management • Team work in a research activity. • Efficient use of informational and communication resources in English language. • Improving investigation references;

7. Course Objectives

7.1 Main Objective	• The main objective of this course is obtaining of new and deep knowledge in the field of physics of atoms and molecules.
7.2 Specific objectives	• Thorough knowledge and understanding of physical phenomena underlying the structure of atoms and molecules. • Modeling and simulation the properties of complex systems of atoms and molecules. • Developing the ability to translate into practice the knowledge acquired;

	• Use knowledge and skills acquired by graduates of this university master's program in order to access and continue their studies in the next cycle of initial training at the doctoral program;

8. Table of content

8.1 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.

8.2 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..

9. 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.

10. 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:
16.09.2022

Titular de disciplină:
Conf. dr. Avram Călin

Data avizării în department:

Director de departament:
Conf. dr. Marin Cătălin