

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	Physics and technology of advanced materials PTAM1103

2. Subject matter information

2.1 Subject matter	Complements of Atomic and Molecular 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

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					30
Additional documentation in the library, electronic specialty platforms/ field					8
Seminar / laboratory preparations, homework, portfolio and essays					9
Tutoring					4
Exams					3
Other activities.....					
3.7 Total number of personal study hour	54				
3.8 Total number of hours in semester	110				
3.9 Number of credits	7				

4. Preconditions (where appropriate)

4.1 curriculum	•
4.2 skills	•

5. Conditions (where appropriate)

5.1 for course	<ul style="list-style-type: none"> Mathematics; Chemistry;
5.2 for seminar/lab	<ul style="list-style-type: none"> Mathematics; Chemistry;

6. Specific skills gained

Professional skills	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> • 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;

	<ul style="list-style-type: none"> 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;
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8. Table of content

8.1 Course	Teaching methods	Observations
1. Atoms and molecules. Introduction.	Exposition, demonstration, heuristic conversation	Google Meet online conference, course support on e-mail
2. Atomic spectra and atomic structure. Hydrogen atom.	Exposition, demonstration, heuristic conversation	Google Meet online conference, course support on e-mail
3. The structure of Helium spectra.	Exposition, demonstration, heuristic conversation	Google Meet online conference, course support on e-mail
4. Many-electron atoms. Classification of the electronic terms.	Exposition, demonstration, heuristic conversation	Google Meet online conference, course support on e-mail
5. Atoms in external field. The normal Zeeman effect.	Exposition, demonstration, heuristic conversation	Google Meet online conference, course support on e-mail
6. The anomalous Zeeman effect.	Exposition, demonstration, heuristic conversation	Google Meet online conference, course support on e-mail
7. The Stark effect.	Exposition, demonstration, heuristic conversation	Google Meet online conference, course support on e-mail
8. The calculation of electronic structure. The Hartree-Fock self-consistent field method.	Exposition, demonstration, heuristic conversation	Google Meet online conference, course support on e-mail
9. Born-Oppenheimer approximation.	Exposition, demonstration, heuristic conversation	Google Meet online conference, course support on e-mail
10. Molecular rotation.	Exposition, demonstration, heuristic conversation	Google Meet online conference, course support on e-mail
11. Molecular vibration.	Exposition, demonstration, heuristic conversation	Google Meet online conference, course support on e-mail
12. Molecular electronic transitions.	Exposition, demonstration, heuristic conversation	Google Meet online conference, course support on e-mail
13. Symmetry of molecules.	Exposition, demonstration, heuristic conversation	Google Meet online conference, course support on e-mail

14. The electric and magnetic properties of molecules.	Exposition, demonstration, heuristic conversation	Google Meet online conference, course support on e-mail
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.	Face to face
2. Terms of many electron free atoms. Classifications(S).	Conversation, investigation, case study.	Face to face
3. Coupling scheme for momentum .Applications(S).	Conversation, investigation, case study.	Face to face
4. Born-Oppenheimer approximation for hydrogen molecule(S).	Conversation, investigation, case study.	Face to face
5. Symmetry group for molecules(S).	Conversation, investigation, case study.e	Face to face
6. Classification of the normal mode of molecules using symmetry(S).	Conversation, investigation, case study.	Face to face
7. Fine structure of energy levels for alkaline atoms (L).	Experiment, case study	Face to face
8. Bohr magneton determination using normal Zeeman effect (L).	Experiment, case study	Face to face
9. Lattice parameter determination by electron diffraction (L).	Experiment, case study	Face to face
10. Geometric parameters determination for molecules (L).	Experiment, case study	Face to face
11. Experimental investigation of vibration energy levels of diatomic molecules(L).	Experiment, case study	Face to face
12. Anharmonic constants determination for CN (L).	Experiment, case study	Face to face
13. Ab initio and DFT calculations of molecules I (L).	Experiment, case study	Face to face
14. Ab initio and DFT calculations of molecules II (L).	Experiment, case study	Face to face
Bibliography 1. <i>I. E. Irodov</i> , "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:
 21.09.2020

Semnătura titularului de curs:
 Conf. dr. Călin Avram

Semnătura titularului de seminar/laborator
 Conf. dr. Călin Avram

Semnătura directorului de departament:
 Lect. dr. Nicoleta Ștefu