

## FIȘA DISCIPLINEI

### 1. Data about program

1.1 Institution	Babeș-Bolyai University, Cluj-Napoca
1.2 Faculty	Chemistry and Chemical Engineering
1.3 Department	Chemistry
1.4 Studies domain	Chemistry
1.5 Studies cycle	Master
1.6 Studies Program / Qualification	ADVANCED CHEMISTRY / master degree in chemistry

### 2. Data about the discipline

2.1 Name of discipline	<b>Molecular Structure and Dynamics – CMR6532</b>						
2.2 Appointed person for lecture	Assist. Prof. dr. Gabriela Nemeș						
2.3 Appointed person for seminar	Assist. Prof. dr. Gabriela Nemeș						
2.4 Year of studies	II	2.5 Semester	3	2.6. Type of evaluation	VP	2.7 Discipline regime	SD <sup>a</sup>

<sup>a</sup>SD = specialized discipline

### 3. Total time estimated (hours per semester, didactic activities)

3.1 Hours per week	3	Of which: 3.2 lecture	2	3.3 seminar/laboratory	1
3.4 Total No. of hours in the studies plan	42	Of which: 3.5 lecture	28	3.6 seminar/laboratory	14
Distribution of time :					h
Studies upon manual, lecture support, bibliography and personal notes					20
Supplementary documentation in library or on specialized websites					20
Preparation of seminars/ themes, reports, essays					35
Tutorial activities					4
Exams					4
Other: .....					-
3.7 Total hours of individual study	83				
3.8 Total hours per semester	125				
3.9 Number of credit points	5				

### 4. Preliminary conditions (where applied)

4.1 of curricula	<ul style="list-style-type: none"> <li>no need</li> </ul>
4.2 of competencies	<ul style="list-style-type: none"> <li>no need</li> </ul>

### 5. Conditions (where applied)

5.1 For lecture	<ul style="list-style-type: none"> <li>Students will attend the lectures with their mobile phones on silent mode or turned off.</li> <li>The students will receive printouts of the Powerpoint slides of the lectures before each lecture.</li> </ul>
5.2 For seminar/ practical work	<ul style="list-style-type: none"> <li>Students will attend the seminars with their mobile phones on silent mode or turned off.</li> <li>The essays and the laboratory results will be handed out in electronic format and will condition the grading of this discipline.</li> </ul>

## 6. Specific competences acquired

Professional competences	<ul style="list-style-type: none"> <li>Structural complex characterization of inorganic, bioinorganic, organic, organometallic and supramolecular compounds</li> <li>Study of the structure-properties relation in the design, preparation and characterization of materials with selected applications</li> </ul>
Crosswise competences	<ul style="list-style-type: none"> <li>Executing, independently, complex professional duties and autonomously conducting research-design activities, using computer assisted techniques by respecting the professional ethics and moral conduct rules.</li> <li>Planning, monitoring and assuming the professional duties of a subordinate professional group. Proving the ability to coordinate the activity, analytical thinking, adaptability and flexibility, cooperation with the team members.</li> <li>Self-assessment of the own professional performances and establishing the needs of continuous training, informing and constant documentation in their field of work and related fields, as required by the current needs in the labor market.</li> </ul>

## 7. Specific objectives (pointed out from the acquired competences)

7.1 General objectives	<ul style="list-style-type: none"> <li>To become familiar with basic and advanced notions, concepts, theories and basic models in the field of molecular structure and dynamics.</li> </ul>
7.2 Specific objectives	<ul style="list-style-type: none"> <li>Acquiring knowledge to improve the performance of chemical and biochemical processes by employing computer assisted tools and sustainable development principles.</li> <li>Acquiring knowledge to develop and use mathematical models and simulations by using specific software.</li> </ul>

## 8. Content

8.1 Lecture	Teaching methods	Notes
8.1.1. Introduction to molecular modeling, definition of the field, its relation to the other chemistry branches. Molecular Orbital Theory: basic concepts, molecular orbital diagrams.	lecture, explanation, discussion	
8.1.2. Punctual groups. The symmetry of orbitals. Molecular orbital diagrams.	lecture, explanation, discussion	
8.1.3. Basis sets	lecture, explanation, discussion, description	
8.1.4-5. MO Methods (semiempiric, ab-initio, post-HF)	lecture, explanation, discussion,	
8.1.6. Density Functional Theory (DFT)	lecture, explanation, discussion, description	
8.1.7. Hybrid QM/MM methods: molecular mechanic concepts.	lecture, explanation, discussion, description	
8.1.8. Hybrid QM/MM methods: Applications	explanation, discussion, description, brainstorming	
8.1.9-10. Calculation of the molecular properties	Explanation, discussion, description, brainstorming,	

	debate	
8.1.11. Computing of excited states	lecture, explanation, discussion, description	
8.1.12. Calculation of transition states; their application to calculation of reaction mechanisms	lecture, explanation, discussion, description	
8.1.13. Molecular Dynamics. Basic concepts	lecture, explanation, discussion, description, brainstorming	
8.1.14. Applications of molecular dynamics	lecture, explanation, discussion, description, brainstorming	

## References

1. C.J. Cramer, *Essentials of Computational Chemistry*, Theories and Models, Wiley, 2004.
2. E. Lewars, *Computational Chemistry, Introduction to the Theory and Applications of Molecular and Quantum Mechanics*, Kluwer Academic Publishers, 2003
3. I. Silaghi-Dumitrescu, D. Horvath, *Mecanică Moleculară*, Presa Universitară Cluj-Napoca, 1996.
4. F. Jensen, *Introduction to Computational Chemistry*, Wiley, 1999.
5. J.M.M. Haile, *Molecular Dynamics Simulation: Elementary Methods*, John Wiley&Sons, N. Y., 1997.

8.2 Seminar / laboratory	Teaching methods	Observation
8.2.1. Presentation of the practical activities, requirements, manner of preparing the reports. Introduction.	explanation, discussion, description, brainstorming, experiment	The practical work will be organized bimonthly, in 2 hour sessions.
8.2.2. Group Theory applications. Molecular orbital diagrams	Explanation, discussion, description, brainstorming,	
8.2.3. Computational chemistry software: building a chemical model; input and output.	explanation, discussion, description, brainstorming	
8.2.4. Modeling of molecular shape and energy using ab initio and semiempiric methods	Experiment, explanation, discussion, description, brainstorming,	
8.2.5. Modeling of complex molecular properties	Experiment, explanation, discussion, description, brainstorming,	
8.2.6. Modeling of chemical reactivity at molecular and supramolecular level	Experiment, explanation, discussion, description, brainstorming,	
8.2.7. Dynamic techniques. Evaluation.	Experiment, explanation, discussion, description, brainstorming,	

## References

1. W.J. Hehre, A.J. Shusterman, W.W. Huang, *A laboratory Book of Computational Organic Chemistry*, Wavefunction, Irvine, California, 1996.
2. E.Lewars, *Computational Chemistry, Introduction to the Theory and Applications of Molecular and Quantum Mechanics*, Kluwer Academic Publishers, 2003
3. Spartan '04. Tutorial and User Guide, Wavefunction, 2003..
4. Referate de laborator <https://sites.google.com/site/modelaresidesignmolecular/>

**9. Relationship between the content of the specific discipline with the requirements of the epistemic community, professional associations and potential employers.**

- By acquiring the theoretical and applied skills included in the content of the discipline „Molecular modeling and design” the students are acquiring consistent knowledge, corresponding to the partial competences required for the potential jobs included in diploma supplement and ANC.

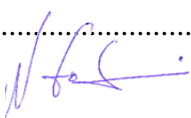
## 10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Contribution to the final mark
10.4 Lecture	Quality of the given answers – appropriate acquiring and understanding of the subjects presented during the lectures.	Written examination – the grading will be conditioned by the accomplishing the practical work. The intent to defraud will be punished by removal from the exam. The fraud will be punished by expelling, as stipulated in the ECTS rules of UBB.	70%
	Correct solving of the problems		
10.5 Seminar/laboratory	Quality of the given answers – appropriate acquiring and understanding of the subjects presented during the seminars.	Grading will be done based on the written reports and supplementary data required as annexes in case of the modeling activities.	30%
	Quality of the prepared reports		
	Activity performed in the laboratory		
10.6 Minimum standard of performance			
<ul style="list-style-type: none"><li>• Mark 5 (five).</li><li>• Knowledge of the introduction notions; use of modeling methods for a material with known chemical composition, identifying of the properties that can be foreseen and the level of precision/utility of the applied methods.</li></ul>			

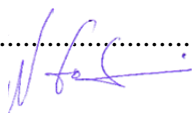
Data completării

13 aprilie 2021

Semnătura titularului de curs

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Semnătura titularului de seminar

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Data avizării în departament

13.04.2021

Semnătura directorului de departament

Acad. Cristian Sorin Silvestru

