

SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	Babes-Bolyai University
1.2 Faculty	of Physics
1.3 Department	Biomolecular Physics
1.4 Field of study	Physics
1.5 Study cycle	Master
1.6 Study programme / Qualification	Biophysics and medical physics, Computational Physics

2. Information regarding the discipline

2.1 Name of the discipline	Advanced Molecular Spectroscopy						
2.2 Course coordinator	Assoc Prof. dr. Monica-Olivia Foçsan, Asist Prof. dr. Mihai Vasilescu						
2.3 Seminar coordinator	Assoc Prof. dr. Monica-Olivia Foçsan, Asist Prof. dr. Mihai Vasilescu						
2.4 Laboratory coordinator							
2.5. Year of study	I	2.6 Semester	1	2.7. Type of evaluation	E	2.8 Type of discipline	DA

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	3	Of which: 3.2 course	2	3.3 seminar/laboratory	1
3.4 Total hours in the curriculum	42	Of which: 3.5 course	28	3.6 seminar/laboratory	14
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					10
Additional documentation (in libraries, on electronic platforms, field documentation)					3
Preparation for seminars/labs, homework, papers, portfolios and essays					10
Tutorship					2
Evaluations					3
Other activities:					-
3.7 Total individual study hours	28				
3.8 Total hours per semester	70				
3.9 Number of ECTS credits	3				

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competencies	To know basic notions on physics from the basic courses

5. Conditions (if necessary)

5.1. for the course	Course hall with blackboard, projector and software
5.2. for the seminar /lab activities	

6. Specific skills acquired

Professional skills	<ul style="list-style-type: none"> • Operating with physical laws and physical principles in biophysics and medical physics at all levels; • Performing experiments of medical physics and biophysics and evaluating their results based on existing theoretical models; • Use of fundamental research laboratory equipment for conducting research experiments; • Planning and performing of the experiments or investigations, independently, and evaluating the degree of uncertainty of the results; • Communication of complex scientific ideas, experimental findings or the results of a scientific project; • Use of specific experimental equipment and techniques from biophysics and medical physics in restricted or interdisciplinary fields; • Advanced planning and organization capacity
---------------------	---

Transversal skills	<ul style="list-style-type: none"> •Applying the values and ethics of the profession of researcher and responsible execution of professional tasks in terms of autonomy and decision-making based on evaluation and self-evaluation; •Carrying out teamwork activities and assuming specific roles at various hierarchical levels, demonstrating initiative, as well as leadership in promoting dialogue, cooperation, positive attitudes, mutual respect and a constant preoccupation for continuous self improvement.; • Effective use of information sources and training resources, • Objective self-evaluation of the need for continuing vocational training for the purpose of insertion into the labor market and adaptation to the dynamics of its requirements and for personal and professional development and effective use of multilingual skills and knowledge of information and communication technology;
---------------------------	--

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	Acquiring notions on the theoretical methods and experimental techniques concerning the interaction of electromagnetic radiation with matter
7.2 Specific objective of the discipline	Acquiring theoretical and practical skills in the acquisition, interpretation and use of spectroscopic information in the study of physico-chemical and structural properties of various materials.

8. Content

8.1 Course	Teaching methods	Remarks
Optical Spectroscopy - Light interaction with atomic and molecular systems. Rotational, roto-vibrational, vibrational and electronic transitions.	Lecture, demonstration, debate, the experiment demonstration and presentations on the computer	2 hours
The theory of molecular vibrations. Diatomic molecules, polyatomic molecules. Different approximations. Normal coordinates		2 hours
IR Spectroscopy. Dipole moment. Selection rules. Characteristic IR Spectra. Examples and applications.		2 hours
Raman spectroscopy. Molecular polarizability. Raman Effect Theory. Characteristic Raman Spectra. Examples and applications.		2 hours
Methods and equipment in IR and Raman spectroscopy		2 hours
UV-Vis Spectroscopy. Classification of electronic states and Franck-Condon principle. Electronic transitions and selection rules.		2 hours
Fluorescence emission spectroscopy. Jablonskidiagram. Type of electronic transitions. Single-triplet transitions. phosphorescent emission spectroscopy.		2 hours
Nuclear Magnetic Resonance Spectroscopy: History, Introduction, Physical Basics of NMR, Formalism, Types of Interactions		2 hours
Nuclear Magnetic Resonance Spectroscopy: Experimental Description, Fourier Transform, Spectra		2 hours
Methods and equipment in magnetic resonance spectroscopy		2 hours
Electron Paramagnetic Resonance Spectroscopy: Electron in Magnetic Field, Resonance Absorption, Gyromagnetic Factor		2 hours
Methods and Equipment in Electron Paramagnetic Resonance Spectroscopy		2 hours
Photoelectronic, Absorption and Fluorescence X-ray Spectroscopy		2 hours
Methods and Equipment in XPS		2 hours
Bibliography 1. S. Astilean, <i>Metode și tehnici moderne de spectroscopie optica</i> , Ed. Casa Cărții de Știință, Cluj-Napoca, 2002. 2. T. Iliescu, S. Cîntă Pînzaru, D. Maniu, S. Astilean, R. Grecu, <i>Aplicații ale spectroscopiei vibraționale</i> , Ed. Casa Cărții de Știință, Cluj-Napoca, 2002. 3. W. S. Struve, <i>Fundamentals of molecular spectroscopy</i> , Ed. John Wiley & Sons, 1997. 4. M. Diem, <i>Introduction to modern vibrational spectroscopy</i> , Ed. John Wiley & Sons, 1993 5. S. Ramusch, <i>Fundamentals of UV-visible spectroscopy</i> , Hewlett-Packard Group, 2003. 6. J. R. Lakowicz, <i>Principles of fluorescence spectroscopy</i> , Springer Science, 1999. 7. D. M. Grant, R.K. Harris, <i>Encyclopedia of Nuclear Magnetic Resonance</i> , John Wiley&Sons, 1996. 8. C. P. Slichter, <i>Principles of Magnetic Resonance</i> , Springer, 1996.		

9. O. Cozar, V.V. Grecu, V. Znamirovski, *Aplicatii ale rezonantei electronice de spin in fizica molecule*, Cluj-Napoca, 1995.
10. G.E. Pake, T.L. Estle, *The Physical Principles of Electron Paramagnetic Resonance*, Benjamin Cummings, Menlo Park, CA, 1970.
11. N.M. Atherton, *Principles of Electron Spin Resonance*, Ellis Horwood Ltd., Chichester, 1993.
12. D. Briggs and M.P. Seah, *Practical Surface analysis and X-ray photoelectron Spectroscopy*, Wiley, New-York, 1983.
13. A.W. Czanderna, *Methods of Surface Analysis*, Elsevier, New York, 1975.

8.2 Seminar / laboratory	Teaching methods	Remarks
Aspects of IR absorption spectroscopy	Presenting the equipment, performing measurements, making calculations, interpreting the results, discussions.	2 hours
Aspects of Raman spectroscopy		2 hours
Vibrational spectra interpretation based on the theory of characteristic group frequencies		2 hours
NMR spectroscopic analyzes of some liquid samples		2 hours
Structural investigations using RES spectroscopy		2 hours
Investigation using XPS spectroscopy		2 hours
Aspects of fluorescence spectroscopy		2 hours

Bibliography:

<https://www.chem.uci.edu/~unicorn/old/H2A/handouts/PDFs/LectureB4.pdf>

<https://sci.tanta.edu.eg/files/IR%20spectroscopy%20BSc-Lect-3.pdf>

<https://wiki.ubc.ca/images/f/f1/2009W2-C529-S013.pdf>

<https://chem.libretexts.org/@go/page/39041>

<http://www.physics.dcu.ie/~be/Ps415/Raman-04.pdf>

<https://www.internetchemistry.com/chemistry/raman-spectroscopy.php>

laboratoryreports and technical books of used instruments

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

The students acquire theoretical and practical skills in the acquisition, interpretation and use of spectroscopic information in the study of physics-chemistry and structural properties of various materials. These competencies are required after abstraction in scientific research, service or commercial activities in the field of spectral equipment, technological consultancy and didactic activities, both in the country and abroad.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Understanding of the interaction between electromagnetic radiation and matter and capacity to make connexion between the results obtained by different spectroscopic methods and physico-chemical and structural properties of various materials.	Final exam	100 %
10.5 Minimum performance standards			
<ul style="list-style-type: none"> ➤ The main differences between spectroscopic methods ➤ Understanding the principles of main techniques used in molecular spectroscopy ➤ Planning and carrying out an spectroscopic experiment. 			

Date

Signature of course coordinator

Signature of seminar coordinator

5.05.2023

Date of approval

Signature of the head of department

8.05.2023

Netean

