Anexa nr. 2

SYLLABUS

1. Information on the study programme

1.1 Higher education institution	West University of Timisoara
1.2 Faculty	Physics
1.3 Department	Physics
1.4 Study program field	Physics
1.5 Study cycle	Master
1.6 Study programme / Qualification	PHYSICS AND TECHNOLOGY OF ADVANCED MATERIALS/conform COR: asistent de cercetare in fizica (248102), in fizica tehnologică (211107), în fizică – chimie (248104), în metrologie (251309) ; fizician (211101); profesor in invatamantul liceal (232201 - în condiţiile legii)

2. Information on the course

2.1 Course title			X-ray characterization of materials / Cod **PTAM1201**				
2.2 Lecture instructor			Conf. Dr. Barvinschi Paul				
2.3 Laboratory instructor			Conf. Dr. Barvinschi Paul				
2.4 Study year	1	2.5 Semester	2	2.6 Examination type	E	2.7 Course type	DS

3. Estimated study time (number of hours per semester)

3.1 Attendance hours per week	4	out of which: 3.2 lecture	2	3.3 seminar/lab	2
3.4 Attendance hours per semester	56	out of which: 3.5 lecture	28	3.6 seminar/lab	28

Distribution of the allocated amount of time*		hours
Study of literature, course handbook and personal notes		28
Supplementary documentation at library or using electronic repositories		28
Preparing for laboratories, homework, reports etc.		28
Tutoring		14
Exams		8
Other activities……		

3.7 Total number of hours of individual study	106
3.8 Total number of hours per semester	162
3.9 Number of credits (ECTS)	7

4. Prerequisites (if it is the case)

4.1 curriculum	Classical Electrodynamics, Atomic Physics, Solid State Physics, Numerical Modeling and Simulation
4.2 competences	General skills: Creative application of research methods and problem solving; Elaborating studies and reports; Capacity to manage working groups and to communicate in different situations. Competente profesionale: Skills in problems solving; Skill in using laboratory equipment; Skills in using computers and software for numerical simulation of physical phenomena.

5. Requirements (if it is the case)

5.1 for the lecture	Laptop (or PC), personal notes
5.2 for the seminar / laboratory	Lab notes, PCs with data base for X-ray phases identification (PDF or Match), PowderCell, Diffrac-EVA, Octave, X-ray diffractometer and XRF equipment.

6. Course objectives

6.1 Knowledge	- To present theoretical knowledge necessary for the understanding of the processes involved in the interaction of X-rays with matter - To present the characterization techniques that use X-rays to study different physical systems - To offer the possibility to work with an X-ray diffractometer
6.2 Skills	- Computational skills (PC uses for research, data acquisition) - Bibliography investigation - To develop the skills necessary for the acquisition and analysis of experimental data, and to present the results - The capacity to transfer the acquired knowledge in practical applications - Capacity to plan and organize experimental or theoretical applications - Capacity of solving characteristic problems for real physical systems.
6.3 Responsibility and autonomy	- Adaptability to new situations by taking decisions and assuming responsabilities; - The ability to manage complex projects and to develop partnerships in economic environments; - Creativeness and initiative in solving complex problems - Capacity of critical evaluations and auto evaluation. - Capacity of communication inside a group

7. Contents

7.1 Lecture	Teaching methods	Remarks, details
Properties and nature of X-rays. Sources of X-rays.	Lecture, introductory conversation, heuristic conversation, illustration, use of analogies and algorithms, learning retention and deepening conversation. For the lectures we will use GoogleMeet software.	References (in the X-ray lab library): [1] – [3]
Interaction of X-rays with matter.		
Kinematical theory of X-ray diffraction. Laue and Bragg equations. Ewald representation.		
Scattering by a free electron. Scattering by an atom.		
Scattering from several atoms.		
Diffraction by a small crystal. The unit cell structure factor.		
Width of diffraction maxima.		
The integrating intensity from a small crystal and the Lorentz factor		
Lattice vibrations and the Debye-Waller factor		
The integrating intensity from a powder sample		
Scattering of X rays on disordered and amorphous		

materials.		
Snell's law and the Fresnel equations in the X-ray region		
Specular reflection from multilayers		
X-ray spectroscopies (XAFS, XRF, XPS).		

Recommended literature:

1. L.Als-Nielsen, D. Mc Morrow: *Elements of Modern X-ray Physics* (Wiley, New York, 2001)

2. B.D. Cullity, *Elements of X-Ray Diffraction*, 2-nd edition.(Addison-Wesley, Reading, Mass., 1978)

3. V. Pecharsky, P. Zavalij: *Fundamentals of Powder Diffraction and Structural Characterization of Materials* (Springer, Berlin, 2005)

7.2 Seminar/lab	**Teaching methods**	**Remarks, details**
Elements of crystallography	Introductory conversation, heuristic conversation, problematization, learning-retention conversation case studies, numerical modeling and numerical simulations. We will use GoogleMeet software.	-The students will be asked to answer questions meant to help them update, deepen and systematize their knowledge, then we will apply this knowledge for solving specific problems. -The students will describe physical phenomena and systems using specific theories and instruments – experimental and theoretical models, algorithms, diagrams, etc. -The students will form / practice / develop their: ---data processing abilities and the ability to interpret experimental results ---team work abilities ---organization and investigation abilities -The students will use appropriate numerical and mathematical statistical methods when analyzing and processing subject-specific data. =In order to obtain performance we aim to develop the student's ability to write a scientific report which will include the processing of experimental data and solutions regarding the application of X-ray characterization techniques.
The X-ray lab. Equipment and radiologic security		
Phase analysis and the use of PDF database: single phase		
Phase analysis and the use of PDF database: multiple phases		
Crystal structure determination: cubic structure		
Crystal structure determination: hexagonal structure		
Determination of crystallite size.		
Determination of lattice strain.		
Determination of texture.		
Determination of stress.		
Determination of the Debye-Waller factor		
Quantitative analysis.		
Rietveld refinement.		
Grazing-incidence diffraction on thin films.		

Recommended literature:

C.Suryanarayana, M.Grant Norton: *X-Ray Diffraction. A Practical Approach* (Plenum Press, New York & London , 1998)

8. Corroboration of study subjects with the expectations of the representatives of the epistemic community, the professional organizations and representative employers from fields related to the study program

The needs and expectations of the employers from related fields (academic institutions, research centers, corporate employers) were identified. The study subjects are coordinated with those of similar academic programs offered by other higher education institutions.

9. Evaluation

Activity	9.1 Assessment criteria	9.2 Assessment methods	9.3 Weight in the final mark
9.4 Lecture	The students will identify the notions and will describe / explain the subject-specific phenomena in a given context.	-Final written examination (theory + problems). -PowerPoint presentation of a subject related to the topic of the course. For the written examination and the PowerPoint presentation we will use the GoogleMeet software.	30% 20%
9.5 Seminar/lab	-The students will apply their learning to solving problems. -The students, grouped into teams, will process data using specific software packages and will correctly interpret the results. -The students, grouped into teams, will write a scientific paper / report on a given subject. The teams will present these papers and will discuss them.	Lab reports, by using the e-mail.	50%
9.6 Minimum needed performance for passing			
- To solve at least 50% of the problems at the written examination. - To obtain correct results at the labs. - To write the scientific paper / report on a given subject.			

Date of completion

20.01.2022

Lecture instructor

Conf. Dr. Paul BARVINSCHI

[redacted]

Date of approval by department head

Director of the department

[redacted]