SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	**University Babes-Bolyai**
1.2 Faculty	**Physics**
1.3 Department	**Condensed matter physics and advanced technologies**
1.4 Field of study	**Physics**
1.5 Study cycle	**Master**
1.6 Study programme / Qualification	**Physics /**

2. Information regarding the discipline

2.1 Name of the discipline	**Experimental methods in solid state physics**						
2.2 Course coordinator	**Pop Aurel**						
2.3 Seminar coordinator	**Pop Aurel**						
2.4. Year of study	**1/2**	2.5 Semester	**2/4**	2.6. Type of evaluation	**Intermediary and final**	2.7 Type of discipline	**Speciality**

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

3.1 Hours per week	4	Of which: 3.2 course	2	3.3 seminar/laboratory	2
3.4 Total hours in the curriculum	56	Of which: 3.5 course	28	3.6 seminar/laboratory	28
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					38
Additional documentation (in libraries, on electronic platforms, field documentation)					24
Preparation for seminars/labs, homework, papers, portfolios and essays					38
Tutorship					10
Evaluations					10
Other activities:					20

3.7 Total individual study hours	140
3.8 Total hours per semester	196
3.9 Number of ECTS credits	8

4. Prerequisites (if necessary)

4.1. curriculum	• Solid state physics, Thermodynamics and molecular physics
4.2. competencies	• Experimental methods

5. Conditions (if necessary)

5.1. for the course	Video-projector for courses and seminars and free internet access to the lectures.
5.2. for the seminar /lab	Research equipments from the Institute of Physics of UBB computers of

activities	Physics Department network**.**

6. Specific competencies acquired

Professional competencies	▪ Extensive understanding of solid state physics. ▪ Experimental methods for characterisation the physical properties ▪ Material synthesis (Solid State Reaction , Sol – Gel) ▪ Acquisition, processing and interpretation of experimental data.
Transversal competencies	▪ Materials of technical interest. ▪ Experimental methods of study in material science: ▪ Nanotechnology

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

7.1 General objective of the discipline	The course propose a flexible approach i.e. will present both "classical" experimental methods and more modern/special ones.
7.2 Specific objective of the discipline	Elementary sample preparation techniques, diffraction methods and microscopy for sample characterization, the classical experimental methods for electrical resistivity, magnetic susceptibility and specific heat measurements, together with XPS (X-ray photoemission Spectroscopy) , NMR (Nuclear Magnetic Resonance) and Mösbauer experimental methods

8. Content

8.1 Course	Teaching methods	Remarks
1. :Introduction. Experiment. Planning an experiment, Logbook, Tables and graphs.		Nr. hours: 2
2.Temperature, pressure,magnetic and electric fields: How to create experimental conditions, measure and control the parameters.		Nr. hours: 4
2. Elementary sample preparation techniques		Nr. hours: 2
3. Diffraction Techniques X - ray Diffraction , Neutron Diffraction (ND) , Rietveld Analysis		Nr. hours: 4
5. Microstructure analysis- Scanning Electron Microscopy (SEM), Scanning tunneling spectroscopy (SEM), Atomic Force Microscopy (AFM)		Nr. hours: 4
6. Chemical composition- EDX and XPS (description of EDX, XPS and of the other related spectroscopic methods)		Nr. hours: 2
7. Resistance and Magnetoresistance (MR) measurements – Four Probe Resistivity Measurements		Nr. hours: 2
8. Magnetic Property Measurements – AC susceptibility and Vibrating Sample Magnetometer(VSM)		Nr. hours: 2
9.MÖSSBAUER spectroscopy: Introduction, requirements, experimental set-up, information provided by the method, interpretation of Mössbauer spectra.		Nr. hours: 2

10. EPR and NMR: General view over the methods. Interactions one should take into account. What kind of information can be obtained from NMR and EPR?.		Nr. hours: 4

Literature:

[1] A.V.Pop, „Introducere in fizica sistemelor vortex”, 2004, Ed.Efes-Cluj-Napoca, Library of Condensed Matter physics Department

[2] V. Pop, I. Chicinaş, N. Jumătate, *Fizica Materialelor. Metode experimentale*, Presa Universitară Clujeană, 2001

[3] I. Pop, V. Niculescu, *Metode experimentale în studiul corpului solid*, Ed. Acad. Bucureşti, 1971

[4] Handouts

[5] C. Kittel, *Introduction to Solid State Physics*, 7th ed., Wiley, 1996.

[6] G. E. Beacon, “Neutron Diffraction”, Oxford Press (1972)

[7] R. A. Young, “The Rietveld Method”, Oxford University Press Inc (1993)

[8] L. J. Whitman, J. A. Stroscio, R. A. Dragoset, and R. J. Celotta "Manipulation of Adsorbed Atoms and Creation of New Structures on Room-Temperature Surfaces with a Scanning Tunneling Microscope", Science, 251, 1206 (1991).

Optional bibliography:

Bibliography on CD/memory stick, prepared by the course instructor

8.1. Laboratory	Teaching methods	Remarks
1. Experimental measurement of temperature and magnetic field.	Critical presentation of given subjects. Measurements shall be made on laboratory research equipment; subgroups of maximum 4 students, under the guidance of the professor, will interpret and discuss the results (laboratory).	Nr. hours: 2
2.Solid state reaction method		Nr. hours: 4
3.Stucture and phase analysis by XRD measurements		Nr. hours: 4
4.SEM and EDX measurements to characterise the morphology and chemical composition of materials		Nr. hours: 4
5.AFM measurements		Nr. hours: 4
6.STM measurements		Nr. hours: 4
7. Measurement of electrical resistivity function of temperature		Nr. hours: 4
8. AC susceptibility of superconducting materials		Nr. hours: 2

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 master’s programme aims at providing students with the appropriate tools for further doctoral studies and to become professional experts in the field of solid state physics and material science.
The master curricula will be dynamic in permanent connections with top scientific subjects and the job opportunity on the market.
To prepare the future PhD students and researchers for the research activities developed in the research institutes and laboratories of Babeş-Bolyai University or exterior to UBB.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Basics: knowledge and understanding of concepts, basic principles of experimental methods.	**Partial examination** Essay on an imposed theme, with public presentation.	30%
	Using the experimental methods in material sciences for explanation and interpretation of new concepts, situations, processes, projects etc.	Exam	50%
10.5 Seminar/lab activities	The quality of the experimental measurements. Lecture and laboratory work to strengthen experimental skills.	Supervising all activities Discussion and correction if it will be neccesary of the report	20%
10.6 Minimum performance standards			
➢ Using experimental methods to solve physics applications and interdisciplinary issues ➢ Ability to develop a specific research master project ➢ Planning and carrying out an experiment to characterise solid state properties.			

Date Signature of course coordinator Signature of seminar coordinator

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Date of approval Signature of the head of department

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