SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	Babes-Bolyai University
1.2 Faculty	Physics
1.3 Department	Solid State Physics and Advanced Technologies
1.4 Field of study	Physics
1.5 Study cycle	Master
1.6 Study programme / Qualification	Solid State Physics

2. Information regarding the discipline

2.1 Name of the discipline				Physics of Metals and Alloys			
2.2 Course coordinator				Prof. Dr. Viorel Pop			
2.3 Seminar coordinator				Prof. Dr. Viorel Pop			
2.4. Year of study	**2**	2.5 Semester	**4**	2.6. Type of evaluation	**E**	2.7 Type of discipline	**S**

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					77
Additional documentation (in libraries, on electronic platforms, field documentation)					20
Preparation for seminars/labs, homework, papers, portfolios and essays					37
Tutorship					3
Evaluations					3
Other activities:					–

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, Quantum Physics
4.2. competencies	Valorisation of physical fundamentals, of methods and tools of solid state physics and material science for specific applications. Use and development of research laboratory equipment and industrial laboratory for conducting research experiments.

5. Conditions (if necessary)

5.1. for the course	Classroom equipped with blackboard and projector

5.2. for the seminar /lab activities	Access to the research laboratory of Babes-Bolyai University

6. Specific competencies acquired

Professional competencies	**C1.** Using of advanced knowledge of physics, mathematics and chemistry of solids for study in Sold State Physics and Materials Science. Capacity for analysis and synthesis of physical data, the ability to model complex phenomena. **C2.** Capitalization of physical fundamentals, of methods and tools of solid state physics and materials science for specific production activities, expertise and monitoring. Mindset multi-and interdisciplinary. **C3.** Planning and conducting experiments to assess the uncertainty and interpretation of the results. Use basic research laboratory equipment and industrial laboratory for conducting research experiments. Planning and implementation independently experiments or experimental investigations and evaluating the uncertainty of the results **C4.** Communicating complex scientific ideas, conclusions or results of a scientific project experiments. Ability to obtain and argue scientific results, the ability to produce scientific papers and to relate to the editorial board of scientific journals of the field.
Transversal competencies	**CT1.** Fulfil the professional tasks effectively and responsibly with respect for law and ethics under qualified assistance. Responsible execution of professional duties in terms of autonomy and decision-making based on self-assessment. **CT2.** Effective work in multidisciplinary team on different hierarchical levels. Implementation of activities and fulfilling specific teamwork roles on different hierarchical levels, showing initiative and entrepreneurial leadership based on promoting dialogue, cooperation positive attitudes, mutual respect, diversity and multiculturalism and continuous improvement of their activities. **CT3.** Effective use of information sources and communication resources and training assistance, both in Romanian and in a foreign language. Objective self-evaluation of the need for continues training to labour market insertion and the adaptation to dynamic requirements of labour market.

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

7.1 General objective of the discipline	Thorough knowledge of the theoretical and practical aspects in physics of metals and alloys and, within it, the proper use of specific language in communicating with different professional backgrounds.
7.2 Specific objective of the discipline	Valorisation of physical fundamentals, of methods and tools for study or production of metals and alloys. Use and development of research and/or industrial equipments to perform research experiments.

8. Content

8.1 Course	Teaching methods	Remarks
1. Metallic state, general aspects. Allotropy, allotropic transformations		2 h

2. Crystalline structure of the alloys: solid solutions, intermediate phases, mixing of phases.	used the video projector and the blackboard.	2 h
3. Thermodynamic equilibrium in metallic systems. Solidification of metals and alloys-nucleation.		2 h
4. Thermodynamic equilibrium in metallic systems. Solidification of metals and alloys-growth.		2 h
5. Thermodynamic equilibrium in metallic systems. Free energy of disorder alloys.		2 h
6. Thermodynamic equilibrium in metallic systems. Theory of spinodal decomposition.		2 h
7. Binary phase diagrams. Alloys with total solubility of the constituent elements.		2 h
8. Binary phase diagrams. Alloys with partial solubility of the constituent elements.		4 h
9. Ternary alloys phase diagrams.		2 h
10. Structural defects in metals and alloys. Point defects (vacancies).		2 h
11. Structural defects in metals and alloys. Line defects-dislocations. Space defects.		2 h
12. Diffusion in metals and alloys.		3 h
13. Precipitation in metallic solid solutions.		1 h

Bibliography

1. Andersen J. C., Leaver K. D., Rawlings R. D., Alexander J. M., Materials Sciences, Van Nostrand Reinhold (UK) Co. Ltd, 1986.
2. Ashcroft N. W., Mermin N. D., Solid State Physics, Holt-Saunders International Editions Tokyo, 1981.
3. Bénard J., Michel A., Ohilibert J., Talbot J., Métallurgie générale, Masson Paris 1991 (in French)
4. Elliott S. R., The Physics and Chemistry of Solids, John Willey & Sons, 1998
5. Ferenc D Tamás, *Phase Equilibria: Ternary Systems*, J. Mater. Educ., Vol. 14, pp1-92, 1992
6. Kittel C. , Introduction to Solid State Physics Ed. John Wiley & Sons, New York 1996. Introducere în Fizica corpului solid, Ed. tehnică, Bucureşti 1972.
7. Licea I., Fizica Metalelor, Ed. Şt. şi Enciclopedică, Bucureti, 1986.
8. Quéré Y. Physiques des materiaux, Edition Ellipses, 1988.
9. Pop V., Chicinas I., Proprietati Fizice ale Metalelor si Aliajelor, UBB Cluj 1997.
10. Ragone D., Thermodinamics of materials, vol I şi II, John Wiley and Sons, NewYork 1995

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Chemical bounding	Critical presentation of given subjects. Will be used the video projector and the blackboard (seminar). Measurements shall	2 h
2. Binary phase diagrams.		2 h
3. Ternary phase diagrams.		2 h
4. Obtaining of polycrystalline alloys		2 h

5. Obtaining of single crystals alloys	be made on laboratory research equipment; subgroups of maximum 4 students, under the guidance of the professor, will interpret and discuss the results (laboratory).	2 h
6. Obtaining of amorphous and nanocrystalline alloys by rapid quenching and annealing.		2 h
7. Obtaining of amorphous and nanocrystalline alloys by mechanical alloying.		2 h
8. Powder metallurgy – classical sintering.		2 h
9. Powder metallurgy –microwave sintering and SPS		2 h
10. Heat treatments.		2 h
11. Differential thermal analysis (DTA), Differential scanning calorimetry (DSC) and Thermogravimetric analysis (TGA)		2 h
12. Study of crystalline structure and microstructure by X-ray diffraction.		2 h
13. Metallographic microscopy.		2 h
14. Specific physical properties (magnetic, electrical, thermal and optical) of metals and alloys.		2 h

Bibliography

1. Andersen J. C., Leaver K. D., Rawlings R. D., Alexander J. M., Materials Sciences, Van Nostrand Reinhold (UK) Co. Ltd, 1986.
2. Ashcroft N. W., Mermin N. D., Solid State Physics, Holt-Saunders International Editions Tokyo, 1981.
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6. Flin R A & Trojan P K, Engineering Materials and their Applications, John Wiley and Sons, Inc. NewYork 1995
7. Kittel C. , Introduction to Solid State Physics Ed. John Wiley & Sons, New York 1996.
8. Licea I., Fizica Metalelor, Ed. Şt. şi Enciclopedică, Bucureti, 1986.
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10. Pop V., Chicinas I., Proprietati Fizice ale Metalelor si Aliajelor, UBB Cluj 1997.
11. Pop V., Chicinas I., Fizica Materialelor. Metode experimentale, Presa Universitara Clujeana, 2001.
12. Ragone D., Thermodinamics of materials, vol I şi II, John Wiley and Sons, NewYork 1995

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

Course content is consistent with what we study in other universities from Romania or abroad being adapted to the peculiarities of research activity at Babes-Bolyai University. To adapt to the requirements of the labour market, the content of these lectures was adjusted to the specific requirements of university education, research institutes and industry.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)

10.4 Course	Depth knowledge and understanding of concepts, basic theories and methods in physics of metals and alloys. Using advance knowledge of material sciences for explanation and interpretation of new concepts, situations, processes, projects etc. associated to physics of metals and alloys.	Solving and explaining complex problems in material science more precisely in physics of metals and alloys.	75
10.5 Seminar/lab activities	Integrated use of conceptual and methodological apparatus to solve theoretical and practical problems. Nuanced and meaningful use criteria and assessment methods to make valuable judgments and promote constructive decisions.	Essay on an imposed theme, with public presentation. Lecture and laboratory work to strengthen experimental skills.	25
10.6 Minimum performance standards			
➢ Design of materials in accordance with quality management principles and elements considering environmental impact and health security. ➢ Design the management to produce a new material. ➢ Planning and carrying out an experiment to validate a theoretical model in physics of metals and alloys.			

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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