SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	Babes-Bolyai University
1.2 Faculty	Physics
1.3 Department	Department of condensed matter and high technologies
1.4 Field of study	Physics
1.5 Study cycle	Master
1.6 Study programme / Qualification	Computational physics, Solid state physics

2. Information regarding the discipline

2.1 Name of the discipline	Complements in theoretical physics
2.2 Course coordinator	Ioan Grosu
2.3 Seminar coordinator	Ioan Grosu

2.4. Year of study	I	2.5 Semester	I	2.6. Type of evaluation	E	2.7 Type of discipline	DSIN

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

3.1 Hours per week	3	Of which: 3.2 course	2	3.3 seminar/laborato ry	1
3.4 Total hours in the curriculum	21	Of which: 3.5 course	14	3.6 seminar/laborat ory	7

Time allotment:	hours
Learning using manual, course support, bibliography, course notes	15
Additional documentation (in libraries, on electronic platforms, field documentation)	20
Preparation for seminars/labs, homework, papers, portfolios and essays	15
Tutorship	3
Evaluations	3
Other activities:	
3.7 Total individual study hours	56
3.8 Total hours per semester	77

3.9 Number of ECTS credits	6

4. Prerequisites (if necessary)

4.1. curriculum	• Quantum mechanics, Statistical physics
4.2. competencies	• Not necessary

5. Conditions (if necessary)

5.1. for the course	• Not necessary
5.2. for the seminar /lab activities	• Not necessary

6. Specific competencies acquired

Professional competencies	*Using in-depth knowledge of physics, mathematics, and solid-state chemistry in the study of solid state and materials science.* *Using computer systems for controlling and driving equipments, as well as software programmes for processing scientific data, including statistical and management methods.* *Making effective use of the basics of physics, as well as of the methods and instruments specific to solid-state physics and the materials science in production, inspection, and monitoring activities.* *Using the equipment of basic research or industrial laboratories to perform research experiments.* *Carrying out management and marketing actions during the research activity relating to solid-state physics in order to discover new materials.*
Transversal competencies	*Implementing the values and ethics of the scientific research profession, carrying out professional tasks in a responsible manner in autonomous conditions, as well as making decisions based on assessment and self assessment.* *Carrying out teamwork activities and assuming specific roles at various hierarchical levels, demonstrating initiative and entrepreneurial spirit, as well as leadership in promoting dialogue, cooperation, positive attitudes, mutual respect, diversity, and multiculturalism and a constant preoccupation for continuous self improvement.* *Objective self evaluation of professional and continuous training needs to enable labour market insertion and adaptability to changing market demands, as well as for personal and professional development to ensure effective use of multilingual abilities and IT & communication knowledge.*

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

7.1 General objective of the discipline	• The calculation of the response functions of the complex systems.
7.2 Specific objective of the discipline	• The definitions of the correlation and the response functions. • The recognition of the properties of the response functions (for classical and quantum systems). • The calculation of the correlation and response functions for different systems.

8. Content

8.1 Course	Teaching methods	Remarks
1. Dynamics; Correlation functions and response.	Dissertation	
2. The Kramers-Kronig relations. Harmonic oscillator (undamped, damped).	Dissertation	
3. The response function. Dissipation.	Dissertation	
4. Diffusion (Fick's law, the diffusive Green's function, the dynamical response).	Dissertation	
5. The formal properties of the response functions.	Dissertation	
6. Dissipation. The spectral representation of the response function.	Dissertation	
7. The fluctuation-disipation theorem.	Dissertation	

Bibliography

- Principles of condensed matter physics, P.M.Chaikin, T.C.Lubensky, Cambridge University Press, 1995
- Condensed matter physics: Response functions and disorder effects, I.Grosu, Presa Universitara Clujeana, 2000 (in romanian)
- Statistical Physics II, Nonequilibrium Statistical Mechanics, R.Kubo, M.Toda, N.Hashitsume, Springer, 1985
- L.P.Kadanoff, P.C. Martin, Ann.Phys.24, 419, (1963)

8.2 Seminar / Laboratory	Teaching methods	Remarks
1. Dynamics; Correlation functions and response.(problems)	Conversation	

2. The Kramers-Kronig relations. Harmonic oscillator (undamped, damped). (problems)	Conversation	
3. The response function. Dissipation. (problems)	Conversation	
4. Diffusion (Fick's law, the diffusive Green's function, the dynamical response). (problems)	Conversation	
5. The formal properties of the response functions. (problems)	Conversation	
6. Dissipation. The spectral representation of the response function. (problems)	Conversation	
7. The fluctuation-disipation theorem. (problems)	Conversation	

Bibliography

1. Principles of condensed matter physics, P.M.Chaikin, T.C.Lubensky, Cambridge University Press, 1995
2. Condensed matter physics: Response functions and disorder effects, I.Grosu, Presa Universitara Clujeana, 2000 (in romanian)
3. Statistical Physics II, Nonequilibrium Statistical Mechanics, R.Kubo, M.Toda, N.Hashitsume, Springer, 1985
4. L.P.Kadanoff, P.C. Martin, Ann.Phys.24, 419, (1963)
5. Condensed matter theory. Problems, I.Grosu, I.Tifrea, Casa cartii de stiinta, 2006 (in romanian)
6. Quantum theory of the electron liquid, G.F.Giuliani, G.Vignale, Cambridge University Press, 2005

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 master classes introducing solid state physics in other universities at home and abroad. To adapt to the requirements of the labor market, the content was adjusted to the specific requirements of master level education, research institutes and businesses media.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	The chapters learned (in 7 courses).	2 intermediate exams Written exam (final)	30% 45%
10.5 Seminar/lab activities	Solving the homework and the seminar problems.	Homework evaluation.	25%

10.6 Minimum performance standards

- The definitions of the correlation and response functions.
- The formal properties of the correlation and response functions.
- The fluctuation-dissipation theorem.

Date	Signature of course coordinator	Signature of seminar coordinator
14 Mai 2018	Prof. Ioan Grosu	Prof. Ioan Grosu

Date of approval	Signature of the head of department
.....	Prof. Romulus Tetean