Programul de studii: Physics of Advanced Materials and Nanostructures

Domeniul de studii: Fizică/Physics
Ciclul de studii: Master

Discipline obligatorii:

DI.101 Quantum statistical physics
DI.102 Condensed state physics
DI.103 Group theory and application in physics
DI.104 Experimental methods in physics
DI.105 Materials characterization techniques
DI.106 Ethics and academic integrity
DI.108 Magnetism. Spintronics
DI.109 Organic semiconductors and applications
DI.110 Preparation methods for nanomaterials and nanostructures
DI.201 Nanostructures for electronics and optoelectronics
DI.210 Physics of liquid crystals and polymeric materials
DI.211 Research activity
DI.212 Finalization of master thesis
DI.213 Defense of master thesis

Discipline opţionale:

DO.107.1 Physics of mesoscopic systems
DO.107.2 Transport phenomena in disordered materials
DO.107.3 Linear response theory
DO.202.1 Nonlinear optics
DO.202.2 Physics of dielectric materials
DO.203.2 Advanced methods in statistical physics
DO.203.1 Computational methods for electronic structure of materials
DO.204.1 Special electronic and optoelectronic devices
DO.204.2 Physics and technology of thin films

Discipline facultative:

DFC.107 Volunteering
DFC.112 Phase transitions in condensed matter
DFC.113 Interaction of laser radiation with matter
DFC.114 Volunteering
DFC.205 Computational methods in condensed matter
DFC.206 Virtual instrumentation and data acquisition
DFC.207 Physics of semiconductor devices
DFC.208 Electrical and optical characterization of semiconductors
DFC.209 Volunteering
DFC.214 Volunteering

Syllabus

Academic year 2025/2026
DI.101 Quantum statistical physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Theoretical Physics, Mathematics, Optics, Plasma and Lasers
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Quantum statistical physics						
2.2. Teacher	Prof. Dr. Virgil Baran						
2.3. Tutorials/Practicals instructor(s)	Lect. Dr. Virgil V. Baran						
2.4 Year of study	1	2.5. Semester	1	2.6. Type of evaluation	examen	2.7.Classification	DA

3. Total estimated time

3.1. Hours per week	2	3.2. Lectures	1	3.3. Tutorials/Practicals/Projects	1/0/0
3.4. Total hours per semester	28	3.5. Lectures	14	3.6. Tutorials/Practicals/Projects	14/0/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	30
Research in library, study of electronic resources, field research	30
Preparation for practicals/tutorials/projects/reports/homework	15
Tutorat	0
Other activities	22
3.7. Total hours of individual study	97
3.8. Total hours per semester	125
3.9. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Quantum mechanics, Classical Statistical Mechanics, Equations of Mathematical
4.2. competences	Knowledge about: mechanics, thermodynamics, algebra, solving differential equations

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Video projector
5.2. for tutorials/practicals	

6. Learning outcomes

Knowledge	R2. The student/graduate deduces working formulas for calculations with physical quantities, correctly using fundamental principles and laws of physics. R5. The student/graduate integrates knowledge from physics, mathematics, and materials science to solve complex problems in the field.
Skills	R2. The student/graduate evaluates critically scientific communications or specialized reports of medium difficulty, analyzing the arguments and conclusions presented. R5. The student/graduate uses interdisciplinary knowledge from physics, mathematics and materials science to model and understand the observed processes.
Responsibility and autonomy	R2. The student/graduate performs independent work tasks responsibly and contributes to interdisciplinary approaches. R5. The student/graduate adequately manages experimental and computational data to support her/his decisions.

7. Contents

7.1 Lecture [chapters]	**Teaching techniques**	**Observations**

Quantum states. Microstates and macrostates of a quantum system. Statistical (density) operator: definition and properties. Time evolution.	Systematic exposition - lecture. Examples	1 Hour
Quantum entropy. Boltzmann-von Neumann formula. Physical interpretation. Principle of maximum entropy. Equilibrium distributions. Statistical operator in equilibrium. BoltzmannGibbs formula.	Systematic exposition - lecture. Examples	3 Hours
Partition functions: definition and properties. Entropy in thermodynamic equilibrium, natural variables. Equilibrium statistical ensembles. Ensemble averages. Canonical, grand-canonical and microcanonical ensembles	Systematic exposition - lecture. Examples	2 Hours
The indistinguishability of quantum particles. Occupations number representation. Pauli principle. Applications.	Systematic exposition - lecture. Examples	4 Hours
Grand-canonical partition functions for systems of independent fermions. Fermi-Dirac statistics. Applications.	Systematic exposition - lecture. Examples	2 Hours
Grand-canonical partition functions for systems of independent bosons. Bose-Einstein statistics. Applications.	Systematic exposition - lecture. Examples	2 Hours

References:

1. R. Balian, From Microphysics to Macrophysics Vol. 1, 2, Springer 2006
2. L.D. Landau, E.E. Lifsit, Fizică Statistică, Editura Tehnică
3. K. Huang, Statistical Mechanics, John Wiley and sons, 1987
4. Radu Paul Lungu, Elemente de mecanica statistica cuantica, Editura UB, 2017.

7.2 Tutorials	**Teaching techniques**	**Observations**
The statistical thermodynamics of the ideal fermionic gas. White dwarf stars. Neutron stars.	Problem solving	4 Hours
The statistical thermodynamics of the ideal bosonic gas.	Problem solving	4 Hours
Statistical mechanics of lattice vibrations. Phonons. Debye model.	Problem solving	2 Hours
Heisenberg model and applications.	Problem solving	4 Hours

References:

1. R. Balian, From Microphysics to Macrophysics Vol. 1, 2, Springer 2006
2. D. Dalvit, J. Frastai, I. Lawrie, Problems on statistical mechanics, IOP 1999.
3. Radu Paul Lungu, Elemente de mecanica statistica cuantica, Editura UB, 2017

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical competences, which are fundamental for a Master student in the field of modern physics, corresponding to national and international standards. The contents is in line with the requirement of the main employers of research institutes and universities.

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	Clarity and coherence of exposition - Correct use of the methods/ physical models - The ability to give specific examples	Written test and oral examination	60%

Tutorial	Ability to use specific problem solving methods	Homeworks	40%
Minimal requirements for passing the exam	At least 50 of exam score and of homeworks.		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Prof. Dr. Virgil Baran	Lect. Dr. Virgil V. Baran

Date of approval	Head of department name and signature
15.07.2025	Lect. dr. Rozana ZUS

Syllabus

Academic year 2025/2026
DI.102 Condensed state physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Condensed state physics
2.2. Teacher	Prof. dr. Daniela Dragoman
2.3. Tutorials/Practicals instructor(s)	Conf. dr. Sorina Iftimie

2.4 Year of study	1	2.5. Semester	1	2.6. Type of evaluation	examen	2.7.Classification	DS

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	2/0/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	28/0/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	34
Research in library, study of electronic resources, field research	30
Preparation for practicals/tutorials/projects/reports/homework	30
Tutorat	0
Other activities	0
3.7. Total hours of individual study	94
3.8. Total hours per semester	150
3.9. ECTS	6

4. Prerequisites (if necessary)

4.1. curriculum	Electricity and magnetism, Optics, Equations of Mathematical Physics, Solid State Physics
4.2. competences	Computational physics abilities

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (PC, videoprojector, internet conection)
5.2. for tutorials/practicals	

6. Learning outcomes

Knowledge	R1. The student/graduate explains and interprets concepts, theories, models and principles of physics, highlighting practical applications R5. The student/graduate integrates knowledge from physics, mathematics, and materials science to solve complex problems in the field.
Skills	R1. The student/graduate applies the principles and laws of physics in solving theoretical or practical problems, including in partially unpredictable situations. R5. The student/graduate uses interdisciplinary knowledge from physics, mathematics and materials science to model and understand the observed processes.
Responsibility and autonomy	R1. The student/graduate manages technical or professional activities or projects, making decisions including in unforeseen situations. R5. The student/graduate adequately manages experimental and computational data to support her/his decisions.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations

Introduction: kinetic Boltzmann equation; relaxation time approximation; scattering mechanisms	Systematic exposition-lecture. Examples.	2 Hours
Scattering of charge carriers on ionized and neutral impurities. Relaxation time calculation	Systematic exposition-lecture. Examples.	4 Hours
Scattering of charge carriers on phonons in nonpolar and polar crystals. Relaxation time calculation	Systematic exposition-lecture. Examples.	4 Hours
Electrical resistivity of metals, alloys and semiconductors. Dependencies on temperature and concentration of impurities/defects	Systematic exposition-lecture. Examples.	2 Hours
Fundamental transport coefficients. Thermal conductivity of conductors. Lorentz number. Thermal conductivity of insulators	Systematic exposition-lecture. Examples.	4 Hours
Thermoelectic effects. Materials' figure of merit	Systematic exposition-lecture. Examples.	2 Hours
Onsager relations. Thermo- and galvanomagnetic effects. Spin effects. Spin-orbit coupling	Systematic exposition-lecture. Examples.	4 Hours
Dielectric properties of the electron gas. Plasmons	Systematic exposition-lecture. Examples.	2 Hours
Electron-electron interactions. Fermi liquid theory. Hubbard model	Systematic exposition-lecture. Examples.	2 Hours
Polaritons. Electron-phonon interactions. Polarons	Systematic exposition-lecture. Examples.	2 Hours

References:

Yu. M. Galperin, Introduction to Modern Solid State Physics, Lecture notes https://folk.uio.no/yurig/fys448/f448pdf.pdf
C. Kittel, Introduction to Solid State Physics, 8th Ed., 2005, Wiley
N.W. Ashcroft, N.D. Mermin, Solid State Physics, Saunders College, 1976.
I. Licea, Fizica stării solide, partea I, Universitatea Bucureşti 1991
D. Dragoman, Lecture notes

7.2 Tutorials	**Teaching techniques**	**Observations**
Scattering of charge carriers on ionized impurities. Classical model. Relaxation time calculation	Exposition. Guided work	2 Hours
Solutions of the kinetic Boltzmann equation in different conditions of nonequilibrium. Moments of the kinetic Boltzmann equation	Exposition. Guided work	4 Hours
Solutions of the kinetic Boltzmann equation in different conditions of nonequilibrium. Moments of the kinetic Boltzmann equation	Exposition. Guided work	4 Hours
Solutions of the kinetic Boltzmann equation in ambipolar conductors in different conditions of nonequilibrium	Exposition. Guided work	4 Hours
Charge transport in low-dimensional conductors	Exposition. Guided work	4 Hours
Thermoelectric effect. Mott formula. Influence of dimensionality	Exposition. Guided work	4 Hours
Heat transport. Fourier versus Boltzmann equation for phonons	Exposition. Guided work	2 Hours
Spin-orbit coupling. Rashba and Dresselhaus effects	Exposition. Guided work	2 Hours
Bulk/volume plasmons and surface plasmon polaritons	Exposition. Guided work	2 Hours

References:

C. Kittel, Introduction to Solid State Physics, 8th Ed., 2005, Wiley
N.W. Ashcroft, N.D. Mermin, Solid State Physics, Saunders College, 1976.
Yu. M. Galperin, Introduction to Modern Solid State Physics, Lecture notes https://folk.uio.no/yurig/fys448/f448pdf.pdf

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

The content of this course is similar to that of other courses taught at Romanian (Univ. Babeş-Bolyai, Cluj) and foreign (Berkeley University, USA, University of Sheffield, UK, University of Oslo) universities, and is designed such that the student develops abilities of modeling the charge, heat and/or spin transport in condensed matter, and the interactions of solid materials with the electromagnetic field, domains of interest for research institutes and companies with activities in Condensed Matter Physics, especially Nanotechnologies, as well as in education

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- Clarity, coherence and concision of exposition; - Correct use of physical models and of specific mathematical methods; - Ability to exemplify	Written exam	67%
Tutorial	- Use of specific physical and mathematical methods for solving a given problem;	Written exam	33%
Minimal requirements for passing the exam	Correct solving of subjects indicated as required for obtaining mark 5.		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Prof. dr. Daniela Dragoman	Conf. dr. Sorina Iftimie

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DI.103 Group theory and application in physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Group theory and application in physics						
2.2. Teacher	Prof. dr. Lucian Ion						
2.3. Tutorials/Practicals instructor(s)	Prof. dr. Lucian Ion						
2.4 Year of study	1	2.5. Semester	1	2.6. Type of evaluation	examen	2.7.Classification	DA

3. Total estimated time

3.1. Hours per week	2	3.2. Lectures	1	3.3. Tutorials/Practicals/Projects	1/0/0
3.4. Total hours per semester	28	3.5. Lectures	14	3.6. Tutorials/Practicals/Projects	14/0/0
Distribution of estimated time for study					
Learning by using one's own course notes, manuals, lecture notes, bibliography					49
Research in library, study of electronic resources, field research					24
Preparation for practicals/tutorials/projects/reports/homework					24
Tutorat					0
Other activities					0
3.7. Total hours of individual study					97
3.8. Total hours per semester					125
3.9. ECTS					5

4. Prerequisites (if necessary)

4.1. curriculum	Linear algebra, Quantum mechanics, Solid State Physics
4.2. competences	Knowledge about: mechanics, solid state physics

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Video projector
5.2. for tutorials/practicals	

6. Learning outcomes

Knowledge	R1. The student/graduate explains and interprets concepts, theories, models and principles of physics, highlighting practical applications R2. The student/graduate deduces working formulas for calculations with physical quantities, correctly using fundamental principles and laws of physics. R5. The student/graduate integrates knowledge from physics, mathematics, and materials science to solve complex problems in the field.
Skills	R1. The student/graduate applies the principles and laws of physics in solving theoretical or practical problems, including in partially unpredictable situations. R2. The student/graduate evaluates critically scientific communications or specialized reports of medium difficulty, analyzing the arguments and conclusions presented. R5. The student/graduate uses interdisciplinary knowledge from physics, mathematics and materials science to model and understand the observed processes.

Responsibility and autonomy	R1. The student/graduate manages technical or professional activities or projects, making decisions including in unforeseen situations. R2. The student/graduate performs independent work tasks responsibly and contributes to interdisciplinary approaches. R5. The student/graduate adequately manages experimental and computational data to support her/his decisions.

7. Contents

7.1 Lecture [chapters]	**Teaching techniques**	**Observations**
Introductory notions: symmetries of a physical system, the role of group theory in physics, groups clasification.	Systematic exposition - lecture. Examples	1 Hour
Group axioms, group multiplication table, subgroups,mappings of groups, direct product of groups.	Systematic exposition - lecture. Examples	1 Hour
Conjugate elements, equivalence classes, invariant subgroups, cosets, quotient group	Systematic exposition - lecture. Examples	1 Hour
Matrix representation of a group, equivalent representations, irreducible representation. Schur lemma's.	Systematic exposition - lecture. Examples	1 Hour
Orthogonality relations for irreducible representations of a finite group, inequivalent representations for finite groups, characters and their orthogonality relations, character table. Basis functions of irreducible representations.	Systematic exposition - lecture. Examples	2 Hours
Crystallographic point groups. Symmetry coordinates. Curie-Neumann symmetry principle. Fundamental theorem of symmetry.	Systematic exposition - lecture. Examples	2 Hours
Symmetry of matter tensors. Applications	Systematic exposition - lecture. Examples	2 Hours
Space groups. Group of the wave vector. Irreducible representations of space groups.	Systematic exposition - lecture. Examples	2 Hours
Energy band models based on symmetry	Systematic exposition - lecture. Examples	2 Hours

References:
J.F. Corwell, Group theory in physics. An Introduction. Academic Press, 1997.
A. Zee, Group theory in a nutshell for physicist, Princeton University Press, 2017
M.S. Dresselhaus, G. Dresselhaus, A. Jorio, Group theory - Applications to the Physics of Condensed Matter, World Scientific, 2008
L. Ion, Lecture notes

7.2 Tutorials	**Teaching techniques**	**Observations**
Basic group theory. Applications.	Problem solving	1 Hour
Discrete groups representations.	Problem solving	2 Hours
Symmetry of material tensors. Applications	Problem solving	7 Hours
Applications to lattice vibrations	Problem solving	2 Hours
$k \cdot p$ perturbation theory. Applications.	Problem solving	2 Hours

References:
A. Zee, Group theory in a nutshell for physicist, Princeton University Press, 2017
W.K. Tung, Group theory in physics: Problems and solutions, World Scientific, 1991
M.S. Dresselhaus, G. Dresselhaus, A. Jorio, Group theory - Applications to the Physics of Condensed Matter, World Scientific, 2008

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical competences, which are fundamental for a Master student in the field of modern physics, corresponding to national and international standards. The contents is in line with the requirement of the main employers of research institutes and universities.

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- Clarity and coherence of exposition - Correct use of the methods/ physical models - The ability to analyze specific examples	Written exam/oral examination	60%
Tutorial	- Ability to use specific problem solving methods	Written exam/oral examination	40%
Minimal requirements for passing the exam	At least 50% of exam score.		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Prof. dr. Lucian Ion	Prof. dr. Lucian Ion

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DI.104 Experimental methods in physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Theoretical Physics, Mathematics, Optics, Plasma and Lasers
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Experimental methods in physics
2.2. Teacher	Conf. dr. Ovidiu TOMA Conf. dr. Adriana BALAN
2.3. Tutorials/Practicals instructor(s)	Conf. dr. Ovidiu TOMA Conf. dr. Adriana BALAN

2.4 Year of study	1	2.5. Semester	1	2.6. Type of evaluation	exam	2.7.Classification	

3. Total estimated time

3.1. Hours per week	3	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	0/1/0
3.4. Total hours per semester	42	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	0/14/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	42
Research in library, study of electronic resources, field research	21
Preparation for practicals/tutorials/projects/reports/homework	20
Tutorat	0
Other activities	0
3.7. Total hours of individual study	83
3.8. Total hours per semester	125
3.9. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	Electricity and magnetism, Optics, Solid State Physics I, Electrodynamics, Quantum mechanics
4.2. competences	Using of software tools for data analysis/processing

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (PC, videoprojector, internet conection)
5.2. for tutorials/practicals	Research infrastructure for morphological, optical, magnetic and microstructural characterizations.

6. Learning outcomes

Knowledge	R4. The student/graduate knows the principles of operation, safety and maintenance of equipment used in specialized laboratories. R6. The student/graduate knows the principles and applications of specialized software in data acquisition and analysis.
Skills	R4. tudent/graduate uses correctly specific laboratory equipments, demonstrating practical skills in calibration, maintenance and operation. R6. The student/graduate uses computer programs for simulations and computational modeling.
Responsibility and autonomy	R4. The student/graduate organizes efficiently her/his professional activity and working time in accordance with research standards R6. The student/graduate assumes responsibility for making decisions based on the interpretation of digital data.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations

Atomic force microscopy (AFM) – physical principles. Working modes (non-contact, contact). Characterization of surface morphology. Magnetic force microscopy (MFM), Scanning tunneling microscopy (STM). Applications.	Systematic exposition - lecture. Examples.	4 Hours
Photoluminescence. Light Emitting Diodes. Laser diodes.	Systematic exposition - lecture. Examples.	6 Hours
Ellipsometry. Physical principles. Optical coefficients of thin films. Spectroscopic ellipsometry. Measurement principles for (Ψ, Δ). Instrumentation, types of ellipsometers (RAE, RAEC, RCE, PME). Data analysis. Construction of optical models.	Systematic exposition - lecture. Examples.	12 Hours
NIR-VIS-UV Spectrophotometry applied in the optical investigations of semiconducting thin films.	Systematic exposition - lecture. Examples.	6 Hours

References:

M. Nastasi, J.W. Mayer, Y. Wang, Ion beam analysis – Fundamentals and applications (CRC Press, Boca Raton, USA, 2015).
M. Fox, Optical properties of solids (Oxford University Press, Oxford, UK, 2001).
R.M.A. Azzam, N.M. Bashara, Ellipsometry and polarized light, North-Holland, 1999.
H. Fujiwara, Spectroscopic ellipsometry: principles and applications, Wiley, 2007.
M. Losurdo and K. Hingerl, Ellipsometry at the Nanoscale, Springer, 2013.

7.3 Practicals	**Teaching techniques**	**Observations**
AFM in contact and non-contact mode. Surface morphology characterizations.	Guided practical work	4 Hours
Ellipsometrical measurements. Dispersion of optical coefficients of thin films for different material structures.	Guided practical work	6 Hours
The recording of absorption spectra using a double-beam UV-VIS-NIR spectrophotometer.	Guided practical work	4 Hours

References:

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical and practical competencies and skills corresponding to national and international standards, which are important for a master student in the field of modern Physics and technology. The contents and teaching methods were selected after a thorough analysis of the contents of similar course units in the syllabus of other universities from Romania or the European Union. The contents are in line with the requirements of the main employers of the graduates (industry, research institutes, high-school teaching).

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Minimal requirements for passing the exam	Correct solving of subjects indicated as required for obtaining mark 5.		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Conf. dr. Ovidiu TOMA Conf. dr. Adriana BALAN	Conf. dr. Ovidiu TOMA Conf. dr. Adriana BALAN

Date of approval	Head of department name and signature
15.07.2025	Lect. dr. Rozana ZUS

Syllabus

Academic year 2025/2026
DI.105 Materials characterization techniques

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Materials characterization techniques						
2.2. Teacher	Prof. dr. Lucian Ion						
2.3. Tutorials/Practicals instructor(s)	drd. Maria Iulia Zai						
2.4 Year of study	1	2.5. Semester	1	2.6. Type of evaluation	examen	2.7.Classification	DS

3. Total estimated time

3.1. Hours per week	3	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	0/1/0
3.4. Total hours per semester	42	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	0/14/0
Distribution of estimated time for study					
Learning by using one's own course notes, manuals, lecture notes, bibliography					54
Research in library, study of electronic resources, field research					27
Preparation for practicals/tutorials/projects/reports/homework					27
Tutorat					0
Other activities					0
3.7. Total hours of individual study					108
3.8. Total hours per semester					150
3.9. ECTS					6

4. Prerequisites (if necessary)

4.1. curriculum	Electrodynamics, Solid state physics
4.2. competences	knowledge of electronic and optical properties of solids

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	room with multimedia infrastructure
5.2. for tutorials/practicals	specific laboratory infrastructure

6. Learning outcomes

Knowledge	R1. The student/graduate explains and interprets concepts, theories, models and principles of physics, highlighting practical applications R2. The student/graduate deduces working formulas for calculations with physical quantities, correctly using fundamental principles and laws of physics. R3. The student/graduate identifies methods, techniques and laboratory instruments necessary for designing and carrying out experiments specific to materials physics. R4. The student/graduate knows the principles of operation, safety and maintenance of equipment used in specialized laboratories. R5. The student/graduate integrates knowledge from physics, mathematics, and materials science to solve complex problems in the field. R6. The student/graduate knows the principles and applications of specialized software in data acquisition and analysis. R9. The student/graduate knows and understands the operating principles and areas of applicability for scientific equipments associated with experimental techniques specific to materials physics.

Skills	R1. The student/graduate applies the principles and laws of physics in solving theoretical or practical problems, including in partially unpredictable situations. R2. The student/graduate evaluates critically scientific communications or specialized reports of medium difficulty, analyzing the arguments and conclusions presented. R3. The student/graduate critically evaluates the results of experiments in order to determine physical quantities of interest for materials physics. R4. tudent/graduate uses correctly specific laboratory equipments, demonstrating practical skills in calibration, maintenance and operation. R5. The student/graduate uses interdisciplinary knowledge from physics, mathematics and materials science to model and understand the observed processes. R6. The student/graduate uses computer programs for simulations and computational modeling. R9. The student/graduate collects and interprets data resulting from the application of scientific methods, integrating the results obtained into an analytical framework.
Responsibility and autonomy	R1. The student/graduate manages technical or professional activities or projects, making decisions including in unforeseen situations. R2. The student/graduate performs independent work tasks responsibly and contributes to interdisciplinary approaches. R3. The student/graduate demonstrates autonomy in the operation and maintenance of laboratory equipment, respecting safety and quality standards. R4. The student/graduate organizes efficiently her/his professional activity and working time in accordance with research standards R5. The student/graduate adequately manages experimental and computational data to support her/his decisions. R6. The student/graduate assumes responsibility for making decisions based on the interpretation of digital data. R9. The student/graduate analyzes experimental data and extracts information about the quantities of interest.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
X-ray sources. X-rays properties	Systematic exposition - lecture. Examples.	2 Hours
Crystalline structures. Symmetry properties. Point groups. Space groups.	Systematic exposition - lecture. Examples.	6 Hours
Elastic scattering of X-rays and thermal neutrons. Structure factor. Ewald's sphere. Structure of X-rays pattern.	Systematic exposition - lecture. Examples.	8 Hours
Real crystals: size effects, structural disorder and temperature effects	Systematic exposition - lecture. Examples.	4 Hours
Electrical and optical properties of semiconductors and semiconductor nanostructures.	Systematic exposition - lecture. Examples.	8 Hours

References:

1. P.Y. Yu, M. Cardona, Fundamentals of semiconductors – physics and materials properties (Springer, Berlin, Germany, 2005), 3-rd ed.
2. M. Fox, Optical properties of solids (Oxford University Press, Oxford, UK, 2001).
3. C. Giacovazzo (ed.), Fundamentals of Crystallography (Oxford University Press, Oxford, UK, 2002), 2-nd. ed..
4. Y. Waseda, E. Matsubara, K. Shinoda, X-ray Diffraction Crystallography (Springer Verlag, Berlin, Germany, 2011)
5. L. Ion, Lecture notes

7.3 Practicals	Teaching techniques	Observations
Symmetry of crystalline structures. Point group. Space group.		2 Hours
X-ray diffraction. Determination of interplanar distances and of lattice constants. Identification of crystalline phases.		2 Hours
X-ray diffraction. Quantitative analysis. Williamson Hall plot. Rietveld method.		2 Hours

Ultrathin films. Grazing incidence X-ray diffraction.		2 Hours
X-ray reflectometry. Quantitative determinations (surface rugosity, thickness).		2 Hours
Optical transitions în direct band semiconductors. Optical properties.		2 Hours
Electrical characterization of thin films		2 Hours

References:
1. L. Ion, Tehnici de investigare structurală şi morfologică bazate pe împrăştierea razelor X (îndrumător de laborator)
2. P.Y. Yu, M. Cardona, Fundamentals of semiconductors – physics and materials properties (Springer, Berlin, Germany, 2005), 3-rd ed.

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

The content of this course is similar to that of other courses taught at Romanian and foreign universities, and is designed such that the student develops abilities of investigating the crystalline structure and the interactions of solid materials with the electromagnetic field, domains of interest for research institutes and companies with activities in Condensed Matter Physics, especially Nanotehnologies, as well as in education.

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- Clarity, coherence and concision of exposition; - Correct use of physical models and of specific mathematical methods; - Ability to exemplify	Written exam	75%
Practical	- Ability to perform structural/electrical/optical investigations - Ability to analyse experimental data	Lab reports	25%
Minimal requirements for passing the exam	Requirements for mark 5 (10 points scale) Reports for all practicals. Correct solving of subjects indicated as required for obtaining mark 5. Requirements for mark 10 (10 points scale) Correct solving of subjects indicated as required for obtaining mark 10.		

Date,
13.07.2025

Teacher's
name and signature,
Prof. dr. Lucian Ion

Practicals/Tutorials/Project instructor(s),
name and signature
drd. Maria Iulia Zai

Date of approval
15.07.2025

Head of department
name and signature
Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DI.106 Ethics and academic integrity

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Ethics and academic integrity						
2.2. Teacher	lector dr.Sanda Voinea						
2.3. Tutorials/Practicals instructor(s)							
2.4 Year of study	1	2.5. Semester	1	2.6. Type of evaluation	verificare	2.7.Classification	

3. Total estimated time

3.1. Hours per week	1	3.2. Lectures	1	3.3. Tutorials/Practicals/Projects	0/0/0
3.4. Total hours per semester	14	3.5. Lectures	14	3.6. Tutorials/Practicals/Projects	0/0/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	31
Research in library, study of electronic resources, field research	15
Preparation for practicals/tutorials/projects/reports/homework	15
Tutorat	0
Other activities	0
3.7. Total hours of individual study	61
3.8. Total hours per semester	75
3.9. ECTS	3

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competences	

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	
5.2. for tutorials/practicals	

6. Learning outcomes

Knowledge	R7. The student/graduate knows the ethical norms and principles regarding both the scientific research in the field and the culture of responsibility in intellectual work. R8. The student/graduate knows the principles of communication and collaboration in multidisciplinary teams and the hierarchical structure specific to organizations.
Skills	R7. The student/graduate assimilates the explicit (texts with normative value) or implicit (customs, practices) norms that regulate academic and research conduct in the field. R8. The student/graduate applies effective communication and coordination techniques in diverse teams, managing tasks and professional relationships at different hierarchical levels.
Responsibility and autonomy	R7. The student/graduate demonstrates solidarity, reactivity and support for strengthening academic integrity. R8. The Student/Graduate participates actively and responsibly in team activities, respecting the roles and rules of the organization, and requests the necessary support to achieve common goals.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations

Moral evaluation frameworks. Fundamental concepts of ethics. Ethics and the scientific community. Criteria for moral evaluation: consequences / intentions, virtues.	Lecture. Example. Discussion.	2 Hours
Academic integrity: institutional tools. Codes and ethics commissions.	Lecture. Example. Discussion.	2 Hours
Principles of research ethics	Lecture. Example. Discussion.	2 Hours
Challenges and dilemmas in research ethics	Lecture. Example. Discussion.	2 Hours
Publication ethics: authorship and co-authorship	Lecture. Example. Discussion.	2 Hours
Access to resources (fairness and equity in academic organizations and research teams)	Lecture. Example. Discussion.	2 Hours
Deontology of teamwork in scientific research	Lecture. Example. Discussion.	2 Hours

References:

Julian Baggini, Peter S. Fosl, A Compendium of Ethical Concepts and Methods, Blackwell Publishing, 2014.

Blaxter, L, Hugh, C. Tight, L. How to research, New York, 2006

Angelo Corlett. " The Role of Philosophy in Academic Ethics", Journal of Academic Ethics, Volume 12, Issue 1, pp 1–14, 2014

Codul de etică al Universităţii din Bucureşti https://unibuc.ro/wp-content/uploads/2021/01/CODUL-DE-ETICA-SI-DEONTOLOGIE-AL-UNIVERSITATII-DIN-BUCURESTI-2020-1.pdf

Carta UNIBUC (https://unibuc.ro/wp-content/uploads/2018/12/CARTA-UB.pdf)

Joshua D. Greene, et. al. "An fMRI investigation of emotional engagement in moral judgment." Science, 2001.

Neil Hamilton. Academic Ethics, Westport: Praeger Publishers, 2002

Bruce Macfarlane. Researching with Integrity. The Ethics of Academic Enquiry, London: Routledge, 2009.

James Rachels, Introducere în Etică, traducere de Daniela Angelescu, Editura Punct, 2000.

Ebony Elizabeth Thomas and Kelly Sassi, "An Ethical Dilemma: Talking about Plagiarism and Academic Integrity in the Digital Age", English Journal 100.6, pp. 47–53, 2011

Anthony Weston, A Practical Companion to Ethics, Oxford University Press, 2011

Barrow, R., Keeney, P. (eds), Academic Ethics, New York: Routledge, 2006

Bretag, T. (ed), Handbook of Academic Integrity, Singapore: Springer, 2016

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

The course addresses the most discussed theoretical issues in the area of academic ethics, along with their practical implications for impact. Not only abstract arguments and positions are discussed and evaluated, but also issues related to the ethical infrastructure of academic organizations or moral decision-making tools that can be used by students in their academic work and future professional life

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Minimal requirements for passing the exam	Achieving the grade of ADMISSION in the essay , attending at least 50% of the courses		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	lector dr.Sanda Voinea	

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DI.108 Magnetism. Spintronics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Magnetism. Spintronics						
2.2. Teacher	Prof. dr. George Alexandru NEMNES						
2.3. Tutorials/Practicals instructor(s)	Prof. dr. George Alexandru NEMNES						
2.4 Year of study	1	2.5. Semester	2	2.6. Type of evaluation	examen	2.7.Classification	DA

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	1/1/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	14/14/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	60
Research in library, study of electronic resources, field research	40
Preparation for practicals/tutorials/projects/reports/homework	40
Tutorat	0
Other activities	4
3.7. Total hours of individual study	144
3.8. Total hours per semester	200
3.9. ECTS	8

4. Prerequisites (if necessary)

4.1. curriculum	Quantum mechanics, Solid State I, Thermodynamics and statistical physics, Physical Electronics, Equations of mathematical physics
4.2. competences	- Using of software tools for data analysis/processing

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (PC, videoprojector, internet conection)
5.2. for tutorials/practicals	

6. Learning outcomes

Knowledge	R1. The student/graduate explains and interprets concepts, theories, models and principles of physics, highlighting practical applications R2. The student/graduate deduces working formulas for calculations with physical quantities, correctly using fundamental principles and laws of physics. R3. The student/graduate identifies methods, techniques and laboratory instruments necessary for designing and carrying out experiments specific to materials physics. R7. The student/graduate knows the ethical norms and principles regarding both the scientific research in the field and the culture of responsibility in intellectual work.

Skills	R1. The student/graduate applies the principles and laws of physics in solving theoretical or practical problems, including in partially unpredictable situations. R2. The student/graduate evaluates critically scientific communications or specialized reports of medium difficulty, analyzing the arguments and conclusions presented. R3. The student/graduate critically evaluates the results of experiments in order to determine physical quantities of interest for materials physics. R7. The student/graduate assimilates the explicit (texts with normative value) or implicit (customs, practices) norms that regulate academic and research conduct in the field.
Responsibility and autonomy	R1. The student/graduate manages technical or professional activities or projects, making decisions including in unforeseen situations. R2. The student/graduate performs independent work tasks responsibly and contributes to interdisciplinary approaches. R3. The student/graduate demonstrates autonomy in the operation and maintenance of laboratory equipment, respecting safety and quality standards. R7. The student/graduate demonstrates solidarity, reactivity and support for strengthening academic integrity.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
Introduction. Magnetic materials. Magnetic suceptibility. Types of magnetism.	Systematic exposition - lecture. Examples.	2 Hours
Langevin paramagnetism. Pauli paramagnetism.	Systematic exposition - lecture. Examples.	2 Hours
Langevin diamagnetism. Landau levels. Pauli diamagnetism for free electrons.	Systematic exposition - lecture. Examples.	4 Hours
Ferromagnetism. Curie-Weiss law. Stoner criterion.	Systematic exposition - lecture. Examples.	2 Hours
Exchange integral. Super-exchange and double-exchange interaction. RKKY interaction.	Systematic exposition - lecture. Examples.	4 Hours
Spin glasses. Dynamical properties. Phase transitions.	Systematic exposition - lecture. Examples.	4 Hours
Giant magnetoresistance. Rashba and Dresselhaus spin-orbit interaction. Datta-Das field effect transistor.	Systematic exposition - lecture. Examples.	4 Hours
Spin relaxation mechanisms. Spin scattering on magnetic impurities. Spin filters	Systematic exposition - lecture. Examples.	4 Hours
Magnetic domains. FORC diagrams.	Systematic exposition - lecture. Examples.	2 Hours

References:

[1] R.M. White, Quantum Theory of Magnetism (Springer, Berlin, 1983).
[2] R.M. Martin, Electronic Structure: Basic Theory and Practical Methods (Cambridge University Press, Cambridge, UK, 2004)
[3] P. Mohn, Magnetism in the solid state (Springer, Berlin, 2002)
Teruya Shinjo, Nanomagnetism and Spintronics (Elsevier, Amsterdam, 2009)
[4] I. Munteanu, Fizica solidului (Editura Universităţii din Bucureşti, 2003)

7.2 Tutorials	Teaching techniques	Observations
Paramagnetic materials. Applications.	Exposition. Guided work.	4 Hours
Diamagnetic materials. Applications.	Exposition. Guided work.	4 Hours
Exchange interaction. Applications of Hartree-Fock approximation.	Exposition. Guided work.	2 Hours
Charge and spin transport in magnetic quantum wires. Introduction to ab initio models.	Exposition. Guided work.	4 Hours

References:
[1] R.M. Martin, Electronic Structure: Basic Theory and Practical Methods (Cambridge University Press, Cambridge, UK, 2004) [2] P. Mohn, Magnetism in the solid state (Springer, Berlin, 2002) Teruya Shinjo, Nanomagnetism and Spintronics (Elsevier, Amsterdam, 2009)

7.3 Practicals	Teaching techniques	Observations
Ising spin models. Ferromagnets, antiferromagnets and spin glasses.	Guided practical work	6 Hours
Spin scattering in graphene nanoribbons.	Guided practical work	4 Hours
FORC diagrams. Identification of magnetic domain structures.	Guided practical work	4 Hours
References:		

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical and practical competencies and skills corresponding to national and international standards, which are important for a master student in the field of modern Physics and technology. The contents and teaching methods were selected after a thorough analysis of the contents of similar course units in the syllabus of other universities from Romania or the European Union (Universite Paris-Sud, University of Cambridge, Universite Catholique Louvain-la-Neuve). The contents are in line with the requirements of the main employers of the graduates (industry, research institutes, high-school teaching).

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- Explicitness, coherence and concision of scientific statements; - Correct use of physical models and of specific mathematical methods; - Ability to analyse specific examples;	Written and oral exam	50%
Tutorial	- Use of specific physical and mathematical methods and techniques;	Homework, research projects	25%
Practical	- Knowledge and correct use of specific experimental techniques - Data processing and analysis;	Colloquium	25%
Minimal requirements for passing the exam	To obtain grade 5: - Performing all experiments, presentation of Lab reports and grade 5 at Colloquium - Correct solution for indicated subjects in homeworks and the final exam - Knowledge of basic elements: types of magnetic materials, exchange integral, Rashba and Dresselhaus spin-orbit interaction, Ising Hamiltonian, FORC diagrams. Requirements for getting mark 10 (10 points scale) - Correct solutions to the written exam, homeworks and colloquium - Demonstrated ability to analyze phenomena and processes Minimum participation: 50% lectures and 100% labs.		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Prof. dr. George Alexandru NEMNES	Prof. dr. George Alexandru NEMNES

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DI.109 Organic semiconductors and applications

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title			Organic semiconductors and applications				
2.2. Teacher			Prof. Dr. Ştefan Antohe				
2.3. Tutorials/Practicals instructor(s)			Prof. dr. Ştefan Antohe/Conf. dr. Sorina Iftimie				
2.4 Year of study	1	2.5. Semester	2	2.6. Type of evaluation	examen	2.7.Classification	DS

3. Total estimated time

3.1. Hours per week	3	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	0/1/0
3.4. Total hours per semester	42	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	0/14/0
Distribution of estimated time for study					
Learning by using one's own course notes, manuals, lecture notes, bibliography					67
Research in library, study of electronic resources, field research					33
Preparation for practicals/tutorials/projects/reports/homework					33
Tutorat					0
Other activities					0
3.7. Total hours of individual study					133
3.8. Total hours per semester					175
3.9. ECTS					7

4. Prerequisites (if necessary)

4.1. curriculum	Quantum Mechanics, Solid State Physics 1, Electricity and Magnetism, Electrodynamics
4.2. competences	Understanding peculiarities of electron states in organic semiconductors; Knowledge and understanding of peculiarities of transport and optical phenomena in organic semiconductors; Understanding underlying physical phenomena; Ability to analyze and understand relevant experimental data and to formulate

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (PC, video-projector, internet connection)
5.2. for tutorials/practicals	Experimental set-ups in Thin Films Laboratory and Nanotechnology Laboratory of Materials and Devices for Electronics and Optoelectronics R and D Center

6. Learning outcomes

Knowledge	R2. The student/graduate deduces working formulas for calculations with physical quantities, correctly using fundamental principles and laws of physics. R5. The student/graduate integrates knowledge from physics, mathematics, and materials science to solve complex problems in the field.
Skills	R2. The student/graduate evaluates critically scientific communications or specialized reports of medium difficulty, analyzing the arguments and conclusions presented. R5. The student/graduate uses interdisciplinary knowledge from physics, mathematics and materials science to model and understand the observed processes.

Responsibility and autonomy	R2. The student/graduate performs independent work tasks responsibly and contributes to interdisciplinary approaches. R5. The student/graduate adequately manages experimental and computational data to support her/his decisions.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
Crystalline structure of organic semiconductors: structure of small molecular weight organic solids, structure of large molecular weight solids, point-like defects, diffusion in organic solids, diffusion mechanisms, methods to determine the diffusion coefficient, doping of organic semiconductors	Systematic exposition - lecture. Examples.	4 Hours
Electron structure of organic solids: intermolecular interactions in organic solids	Systematic exposition - lecture. Examples.	4 Hours
Le Blanc's model, Katz-Rice-Chois-Jortner mode	Systematic exposition - lecture. Examples.	4 Hours
Energy transfer in organic solids	Systematic exposition - lecture. Examples.	4 Hours
Excitons: Mott-Wannier excitons, Frenkel excitons.	Systematic exposition - lecture. Examples.	2 Hours
Exciton diffusion, exciton triplets, influence of lattice defects on exciton diffusion	Systematic exposition - lecture. Examples.	2 Hours
Polarons in molecular crystals	Systematic exposition - lecture. Examples.	2 Hours
Charge transport in organic solids: transport mechanisms in organic solids – tunnel effect, hopping mechanism	Systematic exposition - lecture. Examples.	2 Hours
Charge transport in organic solids: transport mechanisms in organic solids – band transport mechanism, activation energy, anisotropy of conductivity, influence of pressure on dark conductivity of organic solids	Systematic exposition - lecture. Examples.	4 Hours

References:

S. Antohe, Materiale şi Dispozitive Electronice Organice (Editura. Universităţii din Bucureşti, Bucureşti, 1996)
S. Antohe, Electronic and Optoelectronic Devices Based on Organic Thin Films, in Handbook of Organic Electronics and Photonics: Electronic Materials and Devices, H. Singh-Nalwa (Ed.) (American Scientific Publishers, Los Angeles, California, USA, 2006).
S. Antohe, S. Iftimie, L. Hrostea, V.A. Antohe, M. Girtan, A critical review of photovoltaic cells based on organic monomeric and polymeric thin film heterojunctions in Thin Solid Films 642, 219-231, 2017.
N.F. Mott, E.A. Davis, Electron processes in non-crystalline materials (Clarendon Press, Oxford, 1979).
W. Helfrich, Physics and Chemistry of the Organic Solid State (Wiley Interscience, New York, 1967).
Lecture notes available on http://solid.fizica.unibuc.ro

7.3 Practicals	Teaching techniques	Observations
Preparation methods for organic thin films	Guided practical work	4 Hours
Surface topography investigations of organic semiconductors by atomic force microscopy (AFM)	Guided practical work	2 Hours
Morphological analysis of organic semiconductors by scanning electron microscopy (SEM)	Guided practical work	4 Hours
Electrical behavior of organic semiconductors	Guided practical work	2 Hours
Optical characterization of organic semiconductors	Guided practical work	2 Hours

References:
S. Antohe, L. Ion, F. Stanculescu, S. Iftimie, A. Radu and V. A. Antohe, ”Fizica si tehnologia materialelor semiconductoare – Lucrari practice”, Ars Docendi, Universitatea din Bucuresti, 165 pages, 2016, ISBN: 978-973-558-940-0

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical and practical competencies and skills corresponding to national and international standards, which are important for a master student in the field of modern Physics and technology. The contents and teaching methods were selected after a thorough analysis of the contents of similar course units in the syllabus of other universities from Romania or the European Union (Universite Paris-Sud, University of Cambridge, Universite Catholique Louvain-la-Neuve). The contents are in line with the requirements of the main employers of the graduates (industry, research institutes, high-school teaching).

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- Explicitness, coherence and concision of scientific statements; - Correct use of physical models and of specific mathematical methods; - Ability to analyze specific examples;	Written exam	70%
Practical	- Knowledge and correct use of specific experimental techniques - Data processing and analysis;	Colloquium	30%
Minimal requirements for passing the exam	Requirements for mark 5 (10 points scale) Correct solving of subjects indicated as required for obtaining mark 5 Requirements for mark 10 (10 points scale) Correct solving of all subjects		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Prof. Dr. Ştefan Antohe	Prof. dr. Ştefan Antohe Conf. dr. Sorina Iftimie

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DI.110 Preparation methods for nanomaterials and nanostructures

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Preparation methods for nanomaterials and nanostructures						
2.2. Teacher	Conf. Dr. Sorina Iftimie						
2.3. Tutorials/Practicals instructor(s)	Conf. Dr. Sorina Iftimie						
2.4 Year of study	1	2.5. Semester	2	2.6. Type of evaluation	examen	2.7.Classification	DA

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	0/2/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	0/28/0
Distribution of estimated time for study					
Learning by using one's own course notes, manuals, lecture notes, bibliography					72
Research in library, study of electronic resources, field research					36
Preparation for practicals/tutorials/projects/reports/homework					36
Tutorat					0
Other activities					0
3.7. Total hours of individual study					144
3.8. Total hours per semester					200
3.9. ECTS					8

4. Prerequisites (if necessary)

4.1. curriculum	Solid State Physics, Electricity and Magnetism, Equations of Mathematical Physics, and Quantum Mechanics
4.2. competences	Ability to analyze and understand relevant experimental data and to formulate rigorous conclusions

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (video-projector)
5.2. for tutorials/practicals	Specific experimental set-up from MDEO R and D Center

6. Learning outcomes

Knowledge	R1. The student/graduate explains and interprets concepts, theories, models and principles of physics, highlighting practical applications R2. The student/graduate deduces working formulas for calculations with physical quantities, correctly using fundamental principles and laws of physics. R3. The student/graduate identifies methods, techniques and laboratory instruments necessary for designing and carrying out experiments specific to materials physics. R4. The student/graduate knows the principles of operation, safety and maintenance of equipment used in specialized laboratories. R5. The student/graduate integrates knowledge from physics, mathematics, and materials science to solve complex problems in the field.

Skills	R1. The student/graduate applies the principles and laws of physics in solving theoretical or practical problems, including in partially unpredictable situations. R2. The student/graduate evaluates critically scientific communications or specialized reports of medium difficulty, analyzing the arguments and conclusions presented. R3. The student/graduate critically evaluates the results of experiments in order to determine physical quantities of interest for materials physics. R4. tudent/graduate uses correctly specific laboratory equipments, demonstrating practical skills in calibration, maintenance and operation. R5. The student/graduate uses interdisciplinary knowledge from physics, mathematics and materials science to model and understand the observed processes.
Responsibility and autonomy	R1. The student/graduate manages technical or professional activities or projects, making decisions including in unforeseen situations. R2. The student/graduate performs independent work tasks responsibly and contributes to interdisciplinary approaches. R3. The student/graduate demonstrates autonomy in the operation and maintenance of laboratory equipment, respecting safety and quality standards. R4. The student/graduate organizes efficiently her/his professional activity and working time in accordance with research standards R5. The student/graduate adequately manages experimental and computational data to support her/his decisions.

7. Contents

7.1 Lecture [chapters]	**Teaching techniques**	**Observations**
Vacuum science and technology. Kinetic theory of gases. Gas transport and pumping.	Lecture. Examples.	2 Hours
Vacuum pumps.	Lecture. Examples.	2 Hours
Thin-film evaporation processes. The physics and chemistry of evaporation.	Lecture. Examples.	2 Hours
Evaporation of multi-element materials. Evaporation of alloys.	Lecture. Examples.	2 Hours
Film thickness uniformity and purity. Conformal coverage of steps and trenches.	Lecture. Examples.	2 Hours
Evaporation hardware.	Lecture. Examples.	2 Hours
Discharges, plasma, and ion-surface interactions.	Lecture. Examples.	2 Hours
Fundamentals of plasma physics.	Lecture. Examples.	2 Hours
Plasma and ion beam processing of thin films. DC sputtering.	Lecture. Examples.	2 Hours
RF sputtering. Reactive sputtering.	Lecture. Examples.	2 Hours
Substrate surfaces and thin-film nucleation. Electronic nature of surfaces. Surface structures.	Lecture. Examples.	2 Hours
Reconstructed silicon surfaces. Thermodynamic aspects of nucleation.	Lecture. Examples.	2 Hours
Epitaxy. Manifestations of epitaxy.	Lecture. Examples.	2 Hours
Lattice misfit and defects in eptaxial films. Epitaxy of compound semiconductors.	Lecture. Examples.	2 Hours

References:
1. T. Ohji, A. Wereszczak (Eds.), Nanostructured materials and Nanotechnology (Wiley, New York, 2009);
2. C. Dups, P. Houdy, and M. Lahmani, Nanoscience. Nanotechnologies and Nanophysics (Springer Verlag, Berlin, 2004);
3. M. Adachi, D.J. Lockwood (Eds.), Self-organized nanoscale materials (Springer Verlag, Berlin, 2006);
4. M. Kohler, W. Fritzsche, Nanotechnology. An Introduction to Nanostructuring Techniques (Wiley, New York, 2007);
5. Lecture notes available on http://solid.fizica.unibuc.ro;

7.3 Practicals	**Teaching techniques**	**Observations**
Thin film deposition by DC magnetron sputtering - part 1.	Guided practical work.	2 Hours

Thin film deposition by DC magnetron sputtering - part 2.	Guided practical work.	2 Hours
Thin film deposition by RF magnetron sputtering - part 1.	Guided practical work.	2 Hours
Thin film deposition by RF magnetron sputtering - part 2.	Guided practical work.	2 Hours
Thin film deposition by thermal evaporation - part 1.	Guided practical work.	2 Hours
Thin film deposition by thermal evaporation - part 2.	Guided practical work.	2 Hours
Thin film deposition by spin-coating - part 1.	Guided practical work.	2 Hours
Thin film deposition by spin-coating - part 2.	Guided practical work.	2 Hours
Fabrication of nanostructures by electrochemical deposition - part 1.	Guided practical work.	2 Hours
Fabrication of nanostructures by electrochemical deposition - part 2.	Guided practical work.	2 Hours
Fabrication of thin films by pulsed laser deposition - part 1.	Guided practical work.	2 Hours
Fabrication of thin films by pulsed laser deposition - part 2.	Guided practical work.	2 Hours
Optical and morphological characterization of fabricated architectures - part 1.	Guided practical work.	2 Hours
Optical and morphological characterization of fabricated architectures - part 2.	Guided practical work.	2 Hours

References:

1. T. Ohji, A. Wereszczak (Eds.), Nanostructured materials and Nanotechnology (Wiley, New York, 2009);
2. Lecture notes available on http://solid.fizica.unibuc.ro;
3. Laboratory notes;

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical and practical competencies and skills corresponding to national and international standards, which are important for a master's student in the field of modern Physics and technology. The contents and teaching methods were selected after a thorough analysis of the contents of similar course units in the syllabus of other universities from Romania or the European Union (Université Paris-Sud, University of Cambridge, Université Catholique Louvain-la-Neuve). The contents are in line with the requirements of the main employers of the graduates (industry, research institutes, and high-school teaching).

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	1. Explicitness, coherence and concision of scientific statements; 2. Correct use of physical models and of specific mathematical methods; 3. Ability to analyze specific examples;	Written exam	70%
Practical	1. Knowledge and correct use of specific experimental techniques; 2. Data processing and analysis;	Colloquium	30%
Minimal requirements for passing the exam	Fundamental knowledge for magnetron sputtering (DC, RF, and Reactive sputtering) and thin-film nucleation.		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Conf. Dr. Sorina Iftimie	Conf. Dr. Sorina Iftimie

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DI.201 Nanostructures for electronics and optoelectronics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Nanostructures for electronics and optoelectronics						
2.2. Teacher	Prof. PhD Eng. Habil. Vlad-Andrei ANTOHE						
2.3. Tutorials/Practicals instructor(s)	Prof. PhD Eng. Habil. Vlad-Andrei ANTOHE / Assoc. Prof. PhD Sorina IFTIMIE						
2.4 Year of study	2	2.5. Semester	1	2.6. Type of evaluation	examen	2.7.Classification	DA

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	0/2/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	0/28/0
Distribution of estimated time for study					
Learning by using one's own course notes, manuals, lecture notes, bibliography					40
Research in library, study of electronic resources, field research					44
Preparation for practicals/tutorials/projects/reports/homework					45
Tutorat					10
Other activities					5
3.7. Total hours of individual study					144
3.8. Total hours per semester					200
3.9. ECTS					8

4. Prerequisites (if necessary)

4.1. curriculum	Introduction to Nanotechnologies; Preparation and characterization methods at nanoscale; Solid State Physics; Materials Science; Optics; Electricity; Electronics.
4.2. competences	Skills in handling small-scale lab equipment and basic research tools to perform complex scientific experiments; Using of software tools for data analysis and processing.

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (PC, video-projector, internet connection).
5.2. for tutorials/practicals	MDEO research infrastructure and Nanotechnology lab.

6. Learning outcomes

Knowledge	R1. The student/graduate explains and interprets concepts, theories, models and principles of physics, highlighting practical applications R2. The student/graduate deduces working formulas for calculations with physical quantities, correctly using fundamental principles and laws of physics. R3. The student/graduate identifies methods, techniques and laboratory instruments necessary for designing and carrying out experiments specific to materials physics. R4. The student/graduate knows the principles of operation, safety and maintenance of equipment used in specialized laboratories. R5. The student/graduate integrates knowledge from physics, mathematics, and materials science to solve complex problems in the field. R6. The student/graduate knows the principles and applications of specialized software in data acquisition and analysis. R9. The student/graduate knows and understands the operating principles and areas of applicability for scientific equipments associated with experimental techniques specific to materials physics.

Skills	R1. The student/graduate applies the principles and laws of physics in solving theoretical or practical problems, including in partially unpredictable situations. R2. The student/graduate evaluates critically scientific communications or specialized reports of medium difficulty, analyzing the arguments and conclusions presented. R3. The student/graduate critically evaluates the results of experiments in order to determine physical quantities of interest for materials physics. R4. tudent/graduate uses correctly specific laboratory equipments, demonstrating practical skills in calibration, maintenance and operation. R5. The student/graduate uses interdisciplinary knowledge from physics, mathematics and materials science to model and understand the observed processes. R6. The student/graduate uses computer programs for simulations and computational modeling. R9. The student/graduate collects and interprets data resulting from the application of scientific methods, integrating the results obtained into an analytical framework.
Responsibility and autonomy	R1. The student/graduate manages technical or professional activities or projects, making decisions including in unforeseen situations. R2. The student/graduate performs independent work tasks responsibly and contributes to interdisciplinary approaches. R3. The student/graduate demonstrates autonomy in the operation and maintenance of laboratory equipment, respecting safety and quality standards. R4. The student/graduate organizes efficiently her/his professional activity and working time in accordance with research standards R5. The student/graduate adequately manages experimental and computational data to support her/his decisions. R6. The student/graduate assumes responsibility for making decisions based on the interpretation of digital data. R9. The student/graduate analyzes experimental data and extracts information about the quantities of interest.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
C1 and C2. Introduction in nanoscale science and technology: - Nanostructures. Types and classification; - Nanometer-scale effects; - Cleanrooms. Construction and classes.	Systematic exposition. Lecture. Examples.	4 Hours
C3 and C4. Nanoporous templates in nanotechnology: - General considerations; - Supported alumina templates; - Template-assisted electrochemical synthesis.	Systematic exposition. Lecture. Examples.	4 Hours
C5 and C6. Lithography patterning approaches: - General considerations; - Optical lithography; - Electron-beam lithography.	Systematic exposition. Lecture. Examples.	4 Hours
C7 and C8. Nanostructures growth and spatial nanolocalization: - Top down and bottom-up approaches; - Localization with single-nanowire resolution; - Types of nanostructured devices.	Systematic exposition. Lecture. Examples.	4 Hours
C9, C10 and C11. Introduction in nanostructured sensing and biosensing: - Sensors and biosensors. Generalities; - Nanostructured capacitive sensors; - Nanostructured chemiresistive sensors.	Systematic exposition. Lecture. Examples.	6 Hours

C12, C13 and C14. Introduction in Photovoltaics: - Solar cells. General considerations; - Main performance quantifiers; - Solar cells based on A2-B6 heterojunctions.	Systematic exposition. Lecture. Examples.	6 Hours

References:
1. V. A. Antohe, ”Capacitive Sensors Based on Localized Nanowire Arrays. Nanotechnology and Device Integration Routes”, Lambert Academic Publishing (LAP), 2013, ISBN: 978-3-659-38899-6;
2. M. Di Ventra, S. Evoy, J. R. Heflin Jr., Kluwer, ”Introduction to Nanoscale Science and Technology”, Academic Publishers 2004, ISBN: 1-402-07757-2;
3. B. Bhushan, ”Springer Handbook of Nanotechnology”, Springer 2007, ISBN: 3-540-29855-X;
5. V. A. Antohe, ”Introduction to Nanotechnologies” (3rd year), Lecture notes;
6. V. A. Antohe, ”Preparation and characterization techniques at nanoscale” (4th year), Lecture notes.

7.3 Practicals	**Teaching techniques**	**Observations**
L1. Anodic oxidation of thin aluminum films.	Exposition. Guided practical work.	4 Hours
L2. Electrochemical deposition within supported nanoporous alumina templates.	Exposition. Guided practical work.	4 Hours
L3. Synthesis of electro-conductive polymers for sensing and biosensing.	Exposition. Guided practical work.	3 Hours
L4. Nanowires and nanotubes. Scanning electron microscopy (SEM).	Exposition. Guided practical work.	3 Hours
L5. Electron-beam lithography (EBL).	Exposition. Guided practical work.	3 Hours
L6. Topography of thin films. Atomic force microscopy (AFM).	Exposition. Guided practical work.	4 Hours
L7. Nanolithography with an atomic force microscope (AFM).	Exposition. Guided practical work.	3 Hours
P1. Proiect: presentation of a scientific paper.	Exposition. Individual work.	4 Hours

References:
1. S. Antohe, L. Ion, F. Stanculescu, S. Iftimie, A. Radu and V. A. Antohe, ”Fizica si tehnologia materialelor semiconductoare – Lucrari practice”, Ars Docendi, Universitatea din Bucuresti, 165 pages, 2016, ISBN: 978-973-558-940-0;
2. S. Matéfi-Tempfli, M. Matéfi-Tempfli, A. Vlad, V. A. Antohe and L. Piraux, ”Nanowires and nanostructures fabrication using template methods: a step forward to real devices combining electrochemical synthesis with lithographic techniques”, J. Mater. Sci – Mat. Electron. 20(1), 249-254 (2009), doi: 10.1007/s10854-008-9568-6;
3. L. Piraux, V. A. Antohe, E. Ferain and D. Lahem, ”Self-supported three-dimensionally interconnected polypyrrole nanotubes and nanowires for highly sensitive chemiresistive gas sensing”, RSC Advances 6, 21808-21813 (2016), doi: 10.1039/C6RA03439J;
4. V. A. Antohe, A. Radu, M. Matéfi-Tempfli, A. Attout, S. Yunus, P. Bertrand, C. A. Dutu, A. Vlad, S. Melinte, S. Matéfi-Tempfli and Luc Piraux, ”Nanowire-templated microelectrodes for high-sensitivity pH detection”, Appl. Phys. Lett. 94(7), 3118 (2009), doi: 10.1063/1.3089227.

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical and practical competencies and skills corresponding to national and international standards, which are important for a master student in the field of modern Physics, as well as of nanoscale science and technology. The contents and teaching methods were selected after a thorough analysis of similar course units within universities from Romania and European Union (Hannover University – Germany and Catholique University of Louvain – Belgium). The entire content of this lecture is thoroughly in-line with the requirements of the main employers from industry, research institutes, universities or high-schools.

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	Explicitness, coherence and concision of scientific statements.	Written test and oral exam.	25%

Practical	- Knowledge and correct use of specific experimental techniques; - Ability to use various top-down and bottom-up methods to design nanostructured devices.	Colloquium.	50%
Project	- Presentation of a scientific paper; - Quality of the presentation; - Ability to communicate the scientific results in a clear and structured manner; - Ability to address the questions and comments arising during and after the presentation.	Oral presentation with Q and A session.	25%
Minimal requirements for passing the exam	Requirements for mark 5 (10 points scale): - Mandatory attendance of all laboratory sessions; - Attending the presentations session and presenting a scientific paper, as a partial assessment; - Finalizing the work associated with the practical sessions and obtaining a mark of 5 at the colloquium; - Correctly addressing the final exam topics for a minimal mark of 5. Requirements for mark 10 (10 points scale): - Attendance of minimum 50% of the lectures and mandatory attendance of all laboratory sessions; - Deeply argued skills and knowledge; - Correct answer to all the questions.		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Prof. PhD Eng. Habil. Vlad-Andrei ANTOHE	Prof. PhD Eng. Habil. Vlad-Andrei ANTOHE Assoc. Prof. PhD Sorina IFTIMIE

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DI.210 Physics of liquid crystals and polymeric materials

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Matter Structure, Atmospheric and Earth Physics, Astrophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Physics of liquid crystals and polymeric materials						
2.2. Teacher	Prof. univ. dr. Valentin Barna						
2.3. Tutorials/Practicals instructor(s)	Prof. univ. dr. Valentin Barna						
2.4 Year of study	2	2.5. Semester	2	2.6. Type of evaluation	examen	2.7.Classification	DA

3. Total estimated time

3.1. Hours per week	3	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	0/1/0
3.4. Total hours per semester	30	3.5. Lectures	20	3.6. Tutorials/Practicals/Projects	0/10/0
Distribution of estimated time for study					
Learning by using one's own course notes, manuals, lecture notes, bibliography					48
Research in library, study of electronic resources, field research					24
Preparation for practicals/tutorials/projects/reports/homework					23
Tutorat					0
Other activities					0
3.7. Total hours of individual study					95
3.8. Total hours per semester					125
3.9. ECTS					5

4. Prerequisites (if necessary)

4.1. curriculum	Numerical methods, Molecular physics and heat, Thermodynamics and Statistical Physics
4.2. competences	1. Knowledge and understanding of physical properties of liquid crystals 2. Knowledge and understanding of physical properties of polymeric materials 3. Knowledge and understanding of the physical processes and phenomena typical for liquid crystals and polymeric materials based devices 4. Understanding underlying physical phenomena 5. Ability to analyze and understand relevant experimental data and to formulate rigorous conclusions

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (PC, video-projector, internet connection)
5.2. for tutorials/practicals	Experimental set-ups in Thin Films Laboratory and Nanotechnology Laboratory of Materials and Devices for Electronics and Optoelectronics RD Center

6. Learning outcomes

Knowledge	R1. The student/graduate explains and interprets concepts, theories, models and principles of physics, highlighting practical applications R2. The student/graduate deduces working formulas for calculations with physical quantities, correctly using fundamental principles and laws of physics. R3. The student/graduate identifies methods, techniques and laboratory instruments necessary for designing and carrying out experiments specific to materials physics. R4. The student/graduate knows the principles of operation, safety and maintenance of equipment used in specialized laboratories. R6. The student/graduate knows the principles and applications of specialized software in data acquisition and analysis. R9. The student/graduate knows and understands the operating principles and areas of applicability for scientific equipments associated with experimental techniques specific to materials physics.

Skills	R1. The student/graduate applies the principles and laws of physics in solving theoretical or practical problems, including in partially unpredictable situations. R2. The student/graduate evaluates critically scientific communications or specialized reports of medium difficulty, analyzing the arguments and conclusions presented. R3. The student/graduate critically evaluates the results of experiments in order to determine physical quantities of interest for materials physics. R4. tudent/graduate uses correctly specific laboratory equipments, demonstrating practical skills in calibration, maintenance and operation. R6. The student/graduate uses computer programs for simulations and computational modeling. R9. The student/graduate collects and interprets data resulting from the application of scientific methods, integrating the results obtained into an analytical framework.
Responsibility and autonomy	R1. The student/graduate manages technical or professional activities or projects, making decisions including in unforeseen situations. R2. The student/graduate performs independent work tasks responsibly and contributes to interdisciplinary approaches. R3. The student/graduate demonstrates autonomy in the operation and maintenance of laboratory equipment, respecting safety and quality standards. R4. The student/graduate organizes efficiently her/his professional activity and working time in accordance with research standards R6. The student/graduate assumes responsibility for making decisions based on the interpretation of digital data. R9. The student/graduate analyzes experimental data and extracts information about the quantities of interest.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
Physics of liquid crystals – classification, physical and chemical properties, aggregation states.	Systematic exposition - lecture.	2 Hours
Nematic liquid crystals: phase transitions, density functional theory, nematic liquid crystals – isotropic materials interface.	Systematic exposition - lecture.	2 Hours
Continuum theory applied to liquid crystals: Freank-Oseen free energy, physical phenomena at surface, Fredericks effect for various configurations.	Systematic exposition - lecture.	2 Hours
Liquid crystals displays: definition, classification, physical properties.	Systematic exposition - lecture.	2 Hours
Liquid crystal-impurities compounds.	Systematic exposition - lecture.	2 Hours
Polymer liquid crystals: classification, physical and chemical properties, growth methods.	Systematic exposition - lecture.	2 Hours
Structure-properties relation for polymer liquid crystals: geometric stereoisomers, optical stereoisomers, stereoisomerism to polymers.	Systematic exposition - lecture.	2 Hours
Supramolecular polymers: physical properties, chemical properties.	Systematic exposition - lecture.	2 Hours
Liquid crystals and polymer liquid crystals based devices.	Systematic exposition - lecture.	2 Hours
Resume of lectures.	Systematic exposition - lecture.	2 Hours

References: 1. L. Georgescu, V. Popa-Niţă, E. Barna, C. Berlic, Fizica cristalelor lichide, Ed. Universităţii din Bucureşti, 2002 2. P.G. de Gennes, J. Prost, The physics of liquid crystals, Oxford University Press, 1993 3. S. Chandrasekhar, Liquid crystals, Cambridge University Press, 1994 4. C. Moţoc, G. Iacobescu, Cristale lichide – proprietăţi fizice şi aplicaţii, Editura Universităţii din Craiova, 2004 5. L. Constantinescu, C. Berlic, Structura polimerilor. Metode de studiu, Editura Universităţii din Bucureşti, 2003

7.3 Practicals	**Teaching techniques**	**Observations**
Building of liquid crystal cells with various configurations and by different methods.	Guided practical work	1 Hour
Aligned nematic liquid crystal cells.	Guided practical work	1 Hour
Twisted nematic liquid crystal cells.	Guided practical work	1 Hour
Electro-optical characterization of liquid crystal cells and polymeric thin film.	Guided practical work	1 Hour
Liquid crystal cells: molecular alignment at the surface. Homeotropic alignment. Planar alignment.	Guided practical work	1 Hour
Polymerization process by cold plasmas. Atomic force microscopy analysis and optical microscopy investigations of obtained polymeric films. Evaluation of specific parameters.	Guided practical work	1 Hour
Liquid crystals displays: electro-optical characterization – pixels and optical filters	Guided practical work	1 Hour
The anisotropy of output functions. Evaluation of Stokes parameters.	Guided practical work	1 Hour
Liquid-solid nucleation methods and phase transitions.	Guided practical work	1 Hour
Hand-on lab test and quiz.	Group project	1 Hour

References: L. Georgescu, L. Constantinescu, E. Barna, C. Miron, C. Berlic, Introducere în fizica polimerilor, Editura Credis, Bucureşti, România, 2004 • Shri Singh, Liquid crystals. Fundamentals, Editura World Scientific, 2002 • L.M. Constantinescu, C. Berlic, V. Barna, Fizico-chimia polimerilor. Aplicaţii, Editura Universităţii din Bucureşti, 2006

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical and practical competencies and skills corresponding to national and international standards, which are important for a master student in the field of modern Physics and technology. The contents and teaching methods were selected after a thorough analysis of the contents of similar course units in the syllabus of other universities from Romania or the European Union. The contents are in line with the requirements of the main employers of the graduates (industry, research institutes, highschool teaching).

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- Explicitness, coherence and concision of scientific statements; - Correct use of physical models and of specific mathematical methods; - Ability to analyze specific examples.	Written exam	70%

Practical	- Knowledge and correct use of specific experimental techniques; - Data processing and analysis.	Colloquium	30%
Minimal requirements for passing the exam	Correct solving of subjects indicated as required for obtaining the final mark 5.		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Prof. univ. dr. Valentin Barna	Prof. univ. dr. Valentin Barna

Date of approval	Head of department name and signature
15.07.2025	Lect. dr. Sanda VOINEA

Syllabus

Academic year 2025/2026
DI.211 Research activity

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Research activity
2.2. Teacher	
2.3. Tutorials/Practicals instructor(s)	

2.4 Year of study	2	2.5. Semester	2	2.6. Type of evaluation	verificare	2.7.Classification	DA

3. Total estimated time

3.1. Hours per week	8	3.2. Lectures	0	3.3. Tutorials/Practicals/Projects	0/8/0
3.4. Total hours per semester	80	3.5. Lectures	0	3.6. Tutorials/Practicals/Projects	0/80/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	210
Research in library, study of electronic resources, field research	105
Preparation for practicals/tutorials/projects/reports/homework	105
Tutorat	0
Other activities	0
3.7. Total hours of individual study	420
3.8. Total hours per semester	500
3.9. ECTS	20

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competences	

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	
5.2. for tutorials/practicals	

6. Learning outcomes

Knowledge	R8. The student/graduate knows the principles of communication and collaboration in multidisciplinary teams and the hierarchical structure specific to organizations.
Skills	R8. The student/graduate applies effective communication and coordination techniques in diverse teams, managing tasks and professional relationships at different hierarchical levels.
Responsibility and autonomy	R8. The Student/Graduate participates actively and responsibly in team activities, respecting the roles and rules of the organization, and requests the necessary support to achieve common goals.

7. Contents

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Minimal requirements for passing the exam			

Date, | Teacher's name and signature, | Practicals/Tutorials/Project instructor(s), name and signature

13.07.2025

Date of approval | Head of department name and signature

15.07.2025 | Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DI.212 Finalization of master thesis

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Finalization of master thesis						
2.2. Teacher							
2.3. Tutorials/Practicals instructor(s)							
2.4 Year of study	2	2.5. Semester	2	2.6. Type of evaluation	verificare	2.7.Classification	DA

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	0	3.3. Tutorials/Practicals/Projects	0/4/0
3.4. Total hours per semester	40	3.5. Lectures	0	3.6. Tutorials/Practicals/Projects	0/40/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	43
Research in library, study of electronic resources, field research	21
Preparation for practicals/tutorials/projects/reports/homework	21
Tutorat	0
Other activities	0
3.7. Total hours of individual study	85
3.8. Total hours per semester	125
3.9. ECTS	5

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competences	

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	
5.2. for tutorials/practicals	

6. Learning outcomes

Knowledge	R8. The student/graduate knows the principles of communication and collaboration in multidisciplinary teams and the hierarchical structure specific to organizations.
Skills	R8. The student/graduate applies effective communication and coordination techniques in diverse teams, managing tasks and professional relationships at different hierarchical levels.
Responsibility and autonomy	R8. The Student/Graduate participates actively and responsibly in team activities, respecting the roles and rules of the organization, and requests the necessary support to achieve common goals.

7. Contents

7.4 Project	**Teaching techniques**	**Observations**
References:		

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities,

professional associations and employers (in the field of the study program

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Minimal requirements for passing the exam			

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025		

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DI.213 Defense of master thesis

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Defense of master thesis						
2.2. Teacher							
2.3. Tutorials/Practicals instructor(s)							
2.4 Year of study	2	2.5. Semester	2	2.6. Type of evaluation	0	2.7.Classification	

3. Total estimated time

3.1. Hours per week	0	3.2. Lectures	0	3.3. Tutorials/Practicals/Projects	0/0/0
3.4. Total hours per semester	0	3.5. Lectures	0	3.6. Tutorials/Practicals/Projects	0/0/0
Distribution of estimated time for study					
Learning by using one's own course notes, manuals, lecture notes, bibliography					125
Research in library, study of electronic resources, field research					63
Preparation for practicals/tutorials/projects/reports/homework					62
Tutorat					0
Other activities					0
3.7. Total hours of individual study					250
3.8. Total hours per semester					250
3.9. ECTS					10

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competences	

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	
5.2. for tutorials/practicals	

6. Learning outcomes

Knowledge	R8. The student/graduate knows the principles of communication and collaboration in multidisciplinary teams and the hierarchical structure specific to organizations.
Skills	R8. The student/graduate applies effective communication and coordination techniques in diverse teams, managing tasks and professional relationships at different hierarchical levels.
Responsibility and autonomy	R8. The Student/Graduate participates actively and responsibly in team activities, respecting the roles and rules of the organization, and requests the necessary support to achieve common goals.

7. Contents

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Minimal requirements for passing the exam			

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025		

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DO.107.1 Physics of mesoscopic systems

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Physics of mesoscopic systems
2.2. Teacher	Prof. dr. Lucian Ion
2.3. Tutorials/Practicals instructor(s)	drd. Amanda Preda

2.4 Year of study	1	2.5. Semester	2	2.6. Type of evaluation	examen	2.7.Classification	DS

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	2/0/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	28/0/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	60
Research in library, study of electronic resources, field research	30
Preparation for practicals/tutorials/projects/reports/homework	29
Tutorat	0
Other activities	0
3.7. Total hours of individual study	119
3.8. Total hours per semester	175
3.9. ECTS	7

4. Prerequisites (if necessary)

4.1. curriculum	Electrodynamics, Solid state physics
4.2. competences	knowledge of electronic and optical properties of solids

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	room with multimedia infrastructure
5.2. for tutorials/practicals	computer room

6. Learning outcomes

Knowledge	R1. The student/graduate explains and interprets concepts, theories, models and principles of physics, highlighting practical applications R2. The student/graduate deduces working formulas for calculations with physical quantities, correctly using fundamental principles and laws of physics. R5. The student/graduate integrates knowledge from physics, mathematics, and materials science to solve complex problems in the field. R6. The student/graduate knows the principles and applications of specialized software in data acquisition and analysis.
Skills	R1. The student/graduate applies the principles and laws of physics in solving theoretical or practical problems, including in partially unpredictable situations. R2. The student/graduate evaluates critically scientific communications or specialized reports of medium difficulty, analyzing the arguments and conclusions presented. R5. The student/graduate uses interdisciplinary knowledge from physics, mathematics and materials science to model and understand the observed processes. R6. The student/graduate uses computer programs for simulations and computational modeling.

Responsibility and autonomy	R1. The student/graduate manages technical or professional activities or projects, making decisions including in unforeseen situations. R2. The student/graduate performs independent work tasks responsibly and contributes to interdisciplinary approaches. R5. The student/graduate adequately manages experimental and computational data to support her/his decisions. R6. The student/graduate assumes responsibility for making decisions based on the interpretation of digital data.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
Introduction: description of mesoscopic systems. Growth and processing methods. Length scales.	Systematic exposition - lecture. Examples.	4 Hours
Electronic structure of mesoscopic systems. Envelope wavefunction method.	Systematic exposition - lecture. Examples.	4 Hours
Anderson localization. Scaling theory of localization. Reduced dimensionality. Case d¡=2. Case d¿2. Metal-insulator transition	Systematic exposition - lecture. Examples.	6 Hours
Quantum interference effects in charge transport. Landauer-Buttiker formalism. Applications.	Systematic exposition - lecture. Examples.	4 Hours
Charge transport în magnetic fields. Shubnikov-de Haas oscillations. Integer quantum Hall effect.	Systematic exposition - lecture. Examples.	4 Hours
Aharonov-Bohm effect. Berry phase.	Systematic exposition - lecture. Examples.	4 Hours
Coulomb blockade în semiconductor nanostructures	Systematic exposition - lecture. Examples.	2 Hours

References:
1. D.K. Ferry, S.M. Goodnick, Transport in nanostructures (Cambridge University Press, Cambridge, UK, 1997).
2. P.A. Lee, T.V. Ramakrishnan, Rev. Mod. Phys. 57, 287 (1985).
3. H. Bouchiat, Y. Gefen, S. Gueron, G. Montambaux, J. Dalibard (Eds.), Nanophysics: Coherence and Transport (Elsevier, Amsterdam, Netherland, 2005).
4. V.F. Gantmakher, Electrons and disorder în solids (Clarendon Press, Oxford, UK, 2005)
5. L. Ion, Course notes

7.2 Tutorials	Teaching techniques	Observations
Electronic states în mesoscopic systems. Envelope wavefunction method. Aplications.	Exposition. Guided work	4 Hours
Effect of disorder in 1D and 2D electronic systems.	Exposition. Guided work	4 Hours
Electronic states in 2D electron systems in magnetic fields. Disorder effects.	Exposition. Guided work	6 Hours
Charge transport in mesoscopic structures. Landauer-Buttiker formalism.	Exposition. Guided work	6 Hours
Weak localization regime.	Exposition. Guided work	4 Hours
Electron-phonon interaction în low-dimensional systems. Peierls transition.	Exposition. Guided work	4 Hours

References:
1. L. Mihaly, M.C. Martin, Solid State Physics - Problems and solutions (Wiley, New York, USA, 1996)
2. S. Datta, Electronic Transport în Mesoscopic Systems (Cambridge University Press, Cambridge, UK, 1997).
3. Y. Imry, Introduction to Mesoscopic Physics (Oxford University Press, Oxford, UK, 1997)

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical and practical competencies and skills corresponding to national and international standards, which are important for a master student in the field of modern Physics and technology. The contents and teaching methods were selected after a thorough analysis of the contents of similar course units in the syllabus of other universities from Romania or the European Union (Universite Paris-Saclay, University of Cambridge, Universite Catholique Louvain-la-Neuve). The contents are in line with the requirements of the main employers of the graduates (industry, research institutes, high-school teaching).

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- Explicitness, coherence and concision of scientific statements; - Correct use of physical models and of specific mathematical methods; - Ability to analyse specific examples;	Written and oral exam	50%
Tutorial	- Use of specific physical and mathematical methods and techniques;	Homework, research projects	50%
Minimal requirements for passing the exam	Requirements for mark 5 (10 points scale) Correct solving of subjects indicated as required for obtaining mark 5. Requirements for mark 10 (10 points scale) Correct solving of subjects indicated as required for obtaining mark 10.		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Prof. dr. Lucian Ion	drd. Amanda Preda

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DO.107.2 Transport phenomena in disordered materials

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Transport phenomena in disordered materials
2.2. Teacher	Prof. dr. Lucian Ion
2.3. Tutorials/Practicals instructor(s)	drd. Amanda Preda

2.4 Year of study	1	2.5. Semester	2	2.6. Type of evaluation	examen	2.7.Classification	DS

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	2/0/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	28/0/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	60
Research in library, study of electronic resources, field research	30
Preparation for practicals/tutorials/projects/reports/homework	29
Tutorat	0
Other activities	0
3.7. Total hours of individual study	119
3.8. Total hours per semester	175
3.9. ECTS	7

4. Prerequisites (if necessary)

4.1. curriculum	Optics, Solid state physics
4.2. competences	knowledge of electronic and optical properties of solids

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	
5.2. for tutorials/practicals	

6. Learning outcomes

Knowledge	R1. The student/graduate explains and interprets concepts, theories, models and principles of physics, highlighting practical applications R2. The student/graduate deduces working formulas for calculations with physical quantities, correctly using fundamental principles and laws of physics. R5. The student/graduate integrates knowledge from physics, mathematics, and materials science to solve complex problems in the field. R6. The student/graduate knows the principles and applications of specialized software in data acquisition and analysis.
Skills	R1. The student/graduate applies the principles and laws of physics in solving theoretical or practical problems, including in partially unpredictable situations. R2. The student/graduate evaluates critically scientific communications or specialized reports of medium difficulty, analyzing the arguments and conclusions presented. R5. The student/graduate uses interdisciplinary knowledge from physics, mathematics and materials science to model and understand the observed processes. R6. The student/graduate uses computer programs for simulations and computational modeling.

Responsibility and autonomy	R1. The student/graduate manages technical or professional activities or projects, making decisions including in unforeseen situations. R2. The student/graduate performs independent work tasks responsibly and contributes to interdisciplinary approaches. R5. The student/graduate adequately manages experimental and computational data to support her/his decisions. R6. The student/graduate assumes responsibility for making decisions based on the interpretation of digital data.

7. Contents

7.1 Lecture [chapters]	**Teaching techniques**	**Observations**
Localization of electronic states in solids: structure of isolated impurity states; Lifschitz model of localization; structure of impurity bands in lightly doped semiconductors; structure of impurity bands in heavily doped semiconductors.	Systematic exposition - lecture. Examples.	6 Hours
Hopping transport mechanism: experimental facts; Miller-Abrahams model; percolation models; nearest-neighbours hopping transport mechanism; dependence on impurity density; activation energy; variable-range hopping mechanism (Mott).	Systematic exposition - lecture. Examples.	12 Hours
Hopping in magnetic field: magnetoresistance, dependence on magnetic field; Hall effect	Systematic exposition - lecture. Examples.	8 Hours
Super-ohmic effects	Systematic exposition - lecture. Examples.	2 Hours

References:

1. B.I. Shklovskii, A.L.Efros, Electronic properties of doped semiconductors (Springer, Heidelberg, 1984.
2. N.F. Mott, E.A. Davis, Electron processes in non-crystalline materials (Clarendon Press, Oxford, 1979).
3. S. Antohe, Fizica semiconductorilor organici (Editura Universităţii din Bucureşti, Bucureşti, 1997).
4. V.F. Gantmakher, Electrons and disorder in solids (Clarendon Press, Oxford, UK, 2005).

7.2 Tutorials	**Teaching techniques**	**Observations**
Electronic states în disordered systems. Applications.	Exposition. Guided work	6 Hours
Metal/semiconductor contact phenomena	Exposition. Guided work	4 Hours
Coulomb gap. Shklovskii-Efros model.	Exposition. Guided work	4 Hours
Charge transport in polycrystalline semiconductor films	Exposition. Guided work	6 Hours
Hopping magnetoresistance.	Exposition. Guided work	4 Hours
Shockley-Read statistics. Thermally stimulated currents	Exposition. Guided work	4 Hours

References:

1. L. Mihaly, M.C. Martin, Solid State Physics - Problems and solutions (Wiley, New York, USA, 1996)
2. N.F. Mott, E.A. Davis, Electron processes in non-crystalline materials (Clarendon Press, Oxford, 1979).

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical and practical competencies and skills corresponding to national and international standards, which are important for a master student in the field of modern Physics and technology. The contents and teaching methods were selected after a thorough analysis of the contents of similar course units in the syllabus of other universities from Romania or the European Union. The contents are in line with the requirements of the main employers of the graduates (industry, research institutes, high-school teaching).

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- Explicitness, coherence and concision of scientific statements; - Correct use of physical models and of specific mathematical methods; - Ability to analyse specific examples;	Written and oral exam	50%

Tutorial	- Use of specific physical and mathematical methods and techniques;	Homework	50%
Minimal requirements for passing the exam	Requirements for mark 5 (10 points scale) Correct solving of subjects indicated as required for obtaining mark 5 (final exam and homeworks). Requirements for mark 10 (10 points scale) Correct solving of subjects indicated as required for obtaining mark 10 (final exam and homeworks).		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Prof. dr. Lucian Ion	drd. Amanda Preda

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DO.107.3 Linear response theory

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Linear response theory
2.2. Teacher	Prof. dr. Lucian Ion
2.3. Tutorials/Practicals instructor(s)	Prof. dr. Lucian Ion

2.4 Year of study	1	2.5. Semester	2	2.6. Type of evaluation	examen	2.7.Classification	DS

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	2/0/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	28/0/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	60
Research in library, study of electronic resources, field research	30
Preparation for practicals/tutorials/projects/reports/homework	29
Tutorat	0
Other activities	0
3.7. Total hours of individual study	119
3.8. Total hours per semester	175
3.9. ECTS	7

4. Prerequisites (if necessary)

4.1. curriculum	Quantum mechanics, Statistical physics, Solid state physics
4.2. competences	knowledge of the main approximation methods of quantum and statistical physics;

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	room with multimedia infrastructure
5.2. for tutorials/practicals	computer room

6. Learning outcomes

Knowledge	R1. The student/graduate explains and interprets concepts, theories, models and principles of physics, highlighting practical applications R2. The student/graduate deduces working formulas for calculations with physical quantities, correctly using fundamental principles and laws of physics. R5. The student/graduate integrates knowledge from physics, mathematics, and materials science to solve complex problems in the field. R6. The student/graduate knows the principles and applications of specialized software in data acquisition and analysis.
Skills	R1. The student/graduate applies the principles and laws of physics in solving theoretical or practical problems, including in partially unpredictable situations. R2. The student/graduate evaluates critically scientific communications or specialized reports of medium difficulty, analyzing the arguments and conclusions presented. R5. The student/graduate uses interdisciplinary knowledge from physics, mathematics and materials science to model and understand the observed processes. R6. The student/graduate uses computer programs for simulations and computational modeling.

Responsibility and autonomy	R1. The student/graduate manages technical or professional activities or projects, making decisions including in unforeseen situations. R2. The student/graduate performs independent work tasks responsibly and contributes to interdisciplinary approaches. R5. The student/graduate adequately manages experimental and computational data to support her/his decisions. R6. The student/graduate assumes responsibility for making decisions based on the interpretation of digital data.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
Introduction to non-equilibrium thermodynamics. Thermodynamic forces and fluxes.	Systematic exposition - lecture. Examples.	4 Hours
Linear response. Onsager's relations. Applications.	Systematic exposition - lecture. Examples.	4 Hours
Quantum theory of linear response. Response function. Correlation functions. Generalized susceptibility.	Systematic exposition - lecture. Examples.	6 Hours
Kramers-Kronig relations. Dissipation phenomena. Relaxation phenomena.	Systematic exposition - lecture. Examples.	4 Hours
Fluctuation-dissipation theorem	Systematic exposition - lecture. Examples.	4 Hours
Quantum transport. Kubo formula. Kubo-Greenwood formula.	Systematic exposition - lecture. Examples.	6 Hours

References:

1. R. Balescu, Equilibrium and nonequilibrium statistical mechanics (Wiley, New York, USA, 1975).
2. C. Jacoboni, Theory of electron transport in semiconductors (Springer, Berlin, 2010).
3. J. Rammer, Quantum transport theory (Perseus, Reading, USA, 1998).
4. L. Ion, Lecture notes

7.2 Tutorials	Teaching techniques	Observations
Electric conductivity in disordered electron systems.	Exposition. Guided work	6 Hours
Susceptibility of electron gas. Aproximations.	Exposition. Guided work	4 Hours
Dynamic structure factor	Exposition. Guided work	4 Hours
Aplications: dielectric relaxation; nuclear magnetic resonance	Exposition. Guided work	6 Hours
Aplications: light scattering on density fluctuations	Exposition. Guided work	4 Hours
Aplications: fluctuation-dissipation theorem	Exposition. Guided work	4 Hours

References:

1. R. Balescu, Equilibrium and nonequilibrium statistical mechanics (Wiley, New York, USA, 1975).
2. C. Jacoboni, Theory of electron transport in semiconductors (Springer, Berlin, 2010).
3. J. Rammer, Quantum transport theory (Perseus, Reading, USA, 1998).
4. L. Ion, Lecture notes

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical and practical competencies and skills corresponding to national and international standards, which are important for a master student in the field of modern Physics and technology. The contents and teaching methods were selected after a thorough analysis of the contents of similar course units in the syllabus of other universities from Romania or the European Union. The contents are in line with the requirements of the main employers of the graduates (industry, research institutes, high-school teaching).

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark

Lecture	- Explicitness, coherence and concision of scientific statements; - Correct use of physical models and of specific mathematical methods; - Ability to analyse specific examples;	Written and oral exam	50%
Tutorial	- Use of specific physical and mathematical methods and techniques;	Homework	50%
Minimal requirements for passing the exam	Requirements for mark 5 (10 points scale) Correct solving of subjects indicated as required for obtaining mark 5 (final exam and homeworks). Requirements for mark 10 (10 points scale) Correct solving of subjects indicated as required for obtaining mark 10 (final exam and homeworks).		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Prof. dr. Lucian Ion	Prof. dr. Lucian Ion

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DO.202.1 Nonlinear optics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Nonlinear optics
2.2. Teacher	prof.univ.dr. Daniela DRAGOMAN
2.3. Tutorials/Practicals instructor(s)	C.S. I dr. Adrian PETRIS

2.4 Year of study	2	2.5. Semester	1	2.6. Type of evaluation	exam	2.7.Classification	

3. Total estimated time

3.1. Hours per week	3	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	0/1/0
3.4. Total hours per semester	42	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	0/14/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	54
Research in library, study of electronic resources, field research	27
Preparation for practicals/tutorials/projects/reports/homework	27
Tutorat	0
Other activities	0
3.7. Total hours of individual study	108
3.8. Total hours per semester	150
3.9. ECTS	6

4. Prerequisites (if necessary)

4.1. curriculum	Electricity and magnetism, Optics, Equations of Mathematical Physics
4.2. competences	Computational physics abilities. Using of software tools for data analysis/processing

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (PC, videoprojector, internet connection)
5.2. for tutorials/practicals	Specifically equipped laboratory

6. Learning outcomes

Knowledge	R1. The student/graduate explains and interprets concepts, theories, models and principles of physics, highlighting practical applications R4. The student/graduate knows the principles of operation, safety and maintenance of equipment used in specialized laboratories. R9. The student/graduate knows and understands the operating principles and areas of applicability for scientific equipments associated with experimental techniques specific to materials physics.
Skills	R1. The student/graduate applies the principles and laws of physics in solving theoretical or practical problems, including in partially unpredictable situations. R4. tudent/graduate uses correctly specific laboratory equipments, demonstrating practical skills in calibration, maintenance and operation. R9. The student/graduate collects and interprets data resulting from the application of scientific methods, integrating the results obtained into an analytical framework.

Responsibility and autonomy	R1. The student/graduate manages technical or professional activities or projects, making decisions including in unforeseen situations. R4. The student/graduate organizes efficiently her/his professional activity and working time in accordance with research standards R9. The student/graduate analyzes experimental data and extracts information about the quantities of interest.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
Introduction: Maxwell's equations in dielectric media. Polarization mechanisms. Parametric nonlinear optical phenomena	Systematic exposition - lecture. Examples.	4 Hours
Coupled-mode formalism in three-wave mixing	Systematic exposition - lecture. Examples.	2 Hours
Birefringent crystals. The ellipsoid of refractive indices. Light propagation in anisotropic media. Phase-matching	Systematic exposition - lecture. Examples.	3 Hours
Second harmonic generation. The tensor of second order nonlinear polarization	Systematic exposition - lecture. Examples.	2 Hours
Efficiency of second harmonic generation. Design strategies to maximize the efficiency	Systematic exposition - lecture. Examples.	2 Hours
Sum- and difference frequency generation, parametric oscillations	Systematic exposition - lecture. Examples.	3 Hours
Linear and quadratic electro-optic effect. Symmetry of polarization tensor. Polarization matrices. Applications in electromagnetic field modulation	Systematic exposition - lecture. Examples.	4 Hours
Coupled-mode formalism in four-wave mixing. Third harmonic generation, phase conjugation	Systematic exposition - lecture. Examples.	3 Hours
Propagation of light pulses in nonlinear media. Propagation regimes. Optical solitons	Systematic exposition - lecture. Examples.	5 Hours

References:

1. R. Dabu, I. Gruia, A. Stratan, Noţiuni fundamentale de optică neliniară şi lucrări de laborator, Editura Univ. Bucuresti, 2005
2. B.E.A. Saleh, M.C. Teich, Fundamental of Photonics, 2nd edition, Wiley, 2007, Chapter 21: Nonlinear Optics
3. G. New, Introduction to Nonlinear Optics, Cambridge University Press, 2011
4. R. Boyd, Nonlinear Optics, 3rd edition, Academic Press, 2008
5. C. Manzoni, G. Cerullo, Design criteria for ultrafast optical parametric amplifiers, J. Opt. 18, 103501, 2016, open access
6. D. Dragoman, Optică neliniară, Editura Univ. Bucuresti, 2022
7. D. Dragoman, Lecture notes

7.3 Practicals	Teaching techniques	Observations
Laboratory presentation. Safety instructions	Guided practical work	1 Hour
1. Determination of the third-order nonlinear optical susceptibility by third-harmonic generation (bibliography 1.1 to 1.4)	Guided practical work	4 Hours
2. Measurement of third-order optical nonlinearities by the Z-scan method (bibliography 2.1 to 2.6)	Guided practical work	4 Hours
3. Investigation of third-order nonlinear optical processes by pump-probe interferometry. All-optical spatial light modulation (bibliography 3.1 to 3.4)	Guided practical work	4 Hours
Laboratory colloquium	Guided practical work	1 Hour

References:
1.1 R. Boyd, Nonlinear Optics, Third Edition, Elsevier, Academic Press (2008)
1.2 P. Butcher, D. Cotter, The Elements of Nonlinear Optics, Cambridge University Press, Cambridge (1990)
1.3 A. Petris, P. Gheorghe, T. Braniste, I. Tiginyanu, ”Ultrafast third-order nonlinear optical response excited by fs laser pulses at 1550 nm in GaN crystals”, Materials 14(12), 3194 (2021)
1.4 A. Petris, P. S. Gheorghe, V. I. Vlad, E. Rusu, V. V. Ursaki, I. M. Tiginyanu, Ultrafast third-order optical nonlinearity in SnS2 layered compound for photonic applications, Optical Materials 76, 69-74 (2018)
2.1 R. Boyd, Nonlinear Optics, Third Edition, Elsevier, Academic Press (2008)
2.2 R. L. Sutherland, Handbook of Nonlinear Optics, Second Edition, Revised and Expanded, Marcel Dekker, Inc., New York, Basel (2003)
2.3 M. Sheik-Bahae, A. A. Said, E. W. Van Stryland, ”High-sensitivity, single-beam n2 measurements”, Optics Letters 14 (17), 955 (1989)
2.4 M. Sheik-Bahae, A.A. Said, T.-H. Wei, D.J. Hagan, E.W. Van Stryland, ”Sensitive measurement of optical nonlinearities using a single beam”, IEEE Journal of Quantum Electronics 26 (4), 760 (1990)
2.5 E. W. Van Stryland, M. Sheik-Bahae, ”Z-Scan Measurements of Optical Nonlinearities”, in Characterization Techniques and Tabulations for Organic Nonlinear Materials, M. G. Kuzyk and C. W. Dirk, Eds., page 655-692, Marcel Dekker, Inc. (1998)
2.6 I. Dancus, V. I. Vlad, A. Petris, T. B. Rujoiu, I. Rau, F. Kajzar, A. Meghea, A. Tane, Z-scan and I-scan methods for characterization of DNA optical nonlinearities, Rom. Rep. Phys 65 (3), 966 (2013)
3.1 R. Boyd, Nonlinear Optics, Third Edition, Elsevier, Academic Press (2008)
3.2 A. Petris, P. Gheorghe, I. Rau, A. M. Manea-Saghin, F. Kajzar, ”All-optical spatial phase modulation in films of dye-doped DNA biopolymer”, European Polymer Journal 110, 130-137 (2019)
3.3 A. Petris, P. Gheorghe, V. I. Vlad, I. Rau, F. Kajzar, ”Interferometric method for the study of spatial phase modulation induced by light in dye-doped DNA complexes”, Rom. Rep. Phys 67 (4), 1373-1382 (2015)
3.4 I. Dancus, S. T. Popescu, A. Petris, ”Single shot interferometric method for measuring the nonlinear refractive index”, Optics Express 21(25), 31303-31308 (2013)

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

The content of this course is designed to lead to the formation of instrumental-application specific competences (such as the design of optical systems for special applications; the use of models and simulation methods, as well as generating and investigation techniques, of electromagnetic fields with relevant characteristics for certain applications), of interest for research institutes in Laser Physics and/or Physics of Materials and education. Because of the importance of the course for modern applications of high-power lasers, the content and the teaching methods have been put into correspondence with similar courses taught at other universities (Univ. Friedrich Schiller Jena, Germany, Institute of Optics, Univ. of Rochester, USA, Institut d'Optique, Palaiseau, France) as well as with the experimental facilities of the research institutes on the Măgurele platform

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- Clarity, coherence and concision of exposition; - Correct use of physical models and of specific mathematical methods for solving a given problem; - Ability to exemplify	Written exam	67%
Practical	- Use and correct application of experimental techniques; - Data interpretation	Exam/Laboratory colloquium	33%
Minimal requirements for passing the exam	Correct solving of subjects totaling the number of points required for obtaining mark 5 at the written exam. Attendance of all practicals/lab works and mark 5 at colloquium		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	prof.univ.dr. Daniela DRAGOMAN	C.S. I dr. Adrian PETRIS

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DO.202.2 Physics of dielectric materials

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Physics of dielectric materials
2.2. Teacher	Lect dr. Claudiu Locovei
2.3. Tutorials/Practicals instructor(s)	Lect dr. Claudiu Locovei

2.4 Year of study	2	2.5. Semester	1	2.6. Type of evaluation	exam	2.7.Classification	

3. Total estimated time

3.1. Hours per week	3	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	0/1/0
3.4. Total hours per semester	42	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	0/14/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	54
Research in library, study of electronic resources, field research	27
Preparation for practicals/tutorials/projects/reports/homework	27
Tutorat	0
Other activities	0
3.7. Total hours of individual study	108
3.8. Total hours per semester	150
3.9. ECTS	6

4. Prerequisites (if necessary)

4.1. curriculum	Electricity and magnetism, Optics, Equations of Mathematical Physics, Thermodynamics and statistical physics
4.2. competences	Using of software tools for data analysis/processing

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (PC, videoprojector, internet conection)
5.2. for tutorials/practicals	Specifically equipped laboratory

6. Learning outcomes

Knowledge	R3. The student/graduate identifies methods, techniques and laboratory instruments necessary for designing and carrying out experiments specific to materials physics. R4. The student/graduate knows the principles of operation, safety and maintenance of equipment used in specialized laboratories. R6. The student/graduate knows the principles and applications of specialized software in data acquisition and analysis.
Skills	R3. The student/graduate critically evaluates the results of experiments in order to determine physical quantities of interest for materials physics. R4. tudent/graduate uses correctly specific laboratory equipments, demonstrating practical skills in calibration, maintenance and operation. R6. The student/graduate uses computer programs for simulations and computational modeling.

Responsibility and autonomy	R3. The student/graduate demonstrates autonomy in the operation and maintenance of laboratory equipment, respecting safety and quality standards. R4. The student/graduate organizes efficiently her/his professional activity and working time in accordance with research standards R6. The student/graduate assumes responsibility for making decisions based on the interpretation of digital data.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
Electric polarization. Electrical field in dielectrics. Linear response.	Systematic exposition - lecture. Examples	4 Hours
Mechanisms of electric polarization: electronic, ionic, orientational, polarization of space charge.	Systematic exposition - lecture. Examples	8 Hours
Dispersion of optical polarization. Optical properties of dielectrics.	Systematic exposition - lecture. Examples	4 Hours
Relations between optical constants: refraction index, dielectric permitivity, absorption coefficient, conductivity.	Systematic exposition - lecture. Examples	3 Hours
Dynamical properties of dielectrics: dielectric losses, optical conductivity.	Systematic exposition - lecture. Examples	3 Hours
Dielectric spectroscopy: complex impedance, equivalent electrical circuit, Nyquist diagrams.	Systematic exposition - lecture. Examples	6 Hours

References:

I. Bunget, M.Popescu, Physics of solid dielectrics (Elsevier, Amsterdam 1984)
A.Jonsker, Dielectric relaxation in solids, (Chelsea Dielectric Press, London, 1983).
A.Ioanid, Probleme de fizica dielectricilor, (Ed.Univ.Bucuresti, 2002)

7.3 Practicals	Teaching techniques	Observations
ests of Clausius-Mossotti and Langevin-Debye relations	Systematic exposition - Guided practical activity	2 Hours
Analysis of experimental data by Kramers-Kronig transform and by using relations between optical constants	Systematic exposition - Guided practical activity	2 Hours
Reflectance spectra	Systematic exposition - Guided practical activity	2 Hours
Impedance spectra. Analysis of complex impedance and of equivalent electric circuit	Systematic exposition - Guided practical activity	2 Hours
Optical properties of nanostructured systems	Systematic exposition - Guided practical activity	2 Hours
Cole-Cole diagrams	Systematic exposition - Guided practical activity	2 Hours
Bode and Nyquist diagrams	Systematic exposition - Guided practical activity	2 Hours

References:
J. D. Jackson, Classical electrodynamics, John Wiley and Sons, 1999 C. Joachain, A. Kylstra, R. M. Potvliege, Atoms in intense laser fields, Cambridge University Press, 2012 A. Di Piazza, C. Muller, K. Z. Hatsagortsyan, and C. H. Keitel, Extremely high-intensity laser interactions with fundamental quantum systems, Rev. Mod. Phys. 84, 1177 (2012) A. Gonoskov et al, Charged particle motion and radiation in strong electromagnetic fields, REv. Mod. Phys. 94, 045001, 2022 D. Suter, The Physics of Laser-Atom Interactions (Cambridge Studies in Modern Optics), 1997 F. V. Hartemann, High-field electrodynamics, CRC press, 2002 J. P. Torres (ed), Twisted photons: applications of light with orbital angular momentum, Wiley-VCH (2011) J. J. Sakurai, Advanced quantum mechanics, Addison-Wesley, 1967 R. H. Landau, M. J. Paez, and C. C. Bordeianu, Computational Physics: Problem Solving with Python, Wiley, 2024 A. Gezerlis, Numerical Methods in Physics with Python, Cambridge University Press, 2023 S. Spicklemire, Visualizing Quantum Mechanics with Python, CRC Press 2024

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

The content of this course is designed to lead to the formation of instrumental-application specific competences (use of models, simulation methods and investigation techniques specific to dielectrics) of interest for research institutes in Physics of Materials and education. Because of the importance of the course for modern applications, the content and the teaching methods have been put into correspondence with similar courses taught at other universities as well as with the experimental facilities of the research institutes on the Măgurele platform

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- Clarity and coherence of exposition - Correct use of the methods/physical models - The ability to give specific examples	Written test + oral examination	70%
Practical	Ability to use specific numerical methods for problem solving	Continuous evaluation, Homeworks	30%
Minimal requirements for passing the exam	Requirements for mark 5 (10 points scale): - At least 50% of exam score and of homework. Requirements for mark 10 (10 points scale): - At least 95% of exam score and of homework.		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Lect dr. Claudiu Locovei	Lect dr. Claudiu Locovei

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DO.203.2 Advanced methods in statistical physics

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Advanced methods in statistical physics								
2.2. Teacher	Lect. dr. Virgil V. Băran								
2.3. Tutorials/Practicals instructor(s)	Lect. dr. Virgil V. Băran								
2.4 Year of study	2	2.5. Semester	1	2.6. Type of evaluation	examen	2.7.Classification	DA		

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	2/0/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	28/0/0
Distribution of estimated time for study					
Learning by using one's own course notes, manuals, lecture notes, bibliography					72
Research in library, study of electronic resources, field research					36
Preparation for practicals/tutorials/projects/reports/homework					36
Tutorat					0
Other activities					0
3.7. Total hours of individual study					144
3.8. Total hours per semester					200
3.9. ECTS					8

4. Prerequisites (if necessary)

4.1. curriculum	Quantum mechanics, Quantum Statistical Physics, Electrodynamics
4.2. competences	Knowledge about: mechanics, algebra, solving differential equations

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (PC, videoprojector, internet conection)
5.2. for tutorials/practicals	

6. Learning outcomes

Knowledge	R1. The student/graduate explains and interprets concepts, theories, models and principles of physics, highlighting practical applications R2. The student/graduate deduces working formulas for calculations with physical quantities, correctly using fundamental principles and laws of physics. R5. The student/graduate integrates knowledge from physics, mathematics, and materials science to solve complex problems in the field.
Skills	R1. The student/graduate applies the principles and laws of physics in solving theoretical or practical problems, including in partially unpredictable situations. R2. The student/graduate evaluates critically scientific communications or specialized reports of medium difficulty, analyzing the arguments and conclusions presented. R5. The student/graduate uses interdisciplinary knowledge from physics, mathematics and materials science to model and understand the observed processes.

Responsibility and autonomy	R1. The student/graduate manages technical or professional activities or projects, making decisions including in unforeseen situations. R2. The student/graduate performs independent work tasks responsibly and contributes to interdisciplinary approaches. R5. The student/graduate adequately manages experimental and computational data to support her/his decisions.

7. Contents

7.1 Lecture [chapters]	**Teaching techniques**	**Observations**
The formalism of the Green functions: General properties of Green functions (symmetry, Lehman representations), physical interpretation for the retarded Green function	Systematic exposition - lecture. Examples	6 Hours
The formalism of the density functional: The theory of the density functional. Hohenberg-Kohn theorems. The Kohn-Sham equations. Approximate functionals. Introduction in the theory of the time dependent density functional	Systematic exposition - lecture. Examples	6 Hours
The dynamics of the Bose-Einstein condensate The Gross-Pitaevskii equation. Elementary excitations and collective modes. Solitons. Traps for condensates for finite temperature	Systematic exposition - lecture. Examples	6 Hours
From the integral Hall effect to the fractional Hall effect : Strong correlated systems and the quasiparticle concept. Laughlin theory. The theory of compound fermions.	Systematic exposition - lecture. Examples	6 Hours
Ginzburg–Landau theory of superconductivity. Basic equations. From type-I superconductor to type-II superconductors.	Systematic exposition - lecture. Examples	4 Hours

References:

E. Lipparini, Modern many-particle physics. Atomic gases, quantum dots and quantum fluids, World Scientific, 2003
R.G. Paar, W. Yang, Density functional theory for atoms and molecules, Oxford UP,1989
C.A. Ullrich, Time-Dependent Density Functional Theory, Oxford UP, 2012
J.K. Jain, Composite fermions, Cambridge UP, 2007
T. Chakraborty, P. Pietilainen, The quantum Hall effects, Fractional and Integral, Springer 1995
C.J. Pethick, H. Smith, Bose-Einstein Condensation in Dilute Gases, Cambridge UP, 2008
Z.F. Ezawa, Quantum Hall effects, World Scientific, 2007
Fetter A.L. , J.D. Walecka, Quantum theory of Many Particle systems (McGraw Hill, New-York)
W. Buckel, R. Kleiner, Superconductivity: Fundamentals and Applications, WILEY-VCH Verlag GmbH 2004

7.2 Tutorials	**Teaching techniques**	**Observations**
Galitskii-Migdal theorems. The relation with the observables. Differential equations. Correlation functions:definition, general properties, the similarity with the Green functions.	Problem solving	4 Hours
Applications of the Green formalism for various systems. The Thomas-Fermi approximation and its extensions	Problem solving	4 Hours
Applications of Density Functional Theory	Problem solving	4 Hours
Collective dynamics of Bose-Einstein condensates	Problem solving	4 Hours
The theory of compound fermions.	Problem solving	4 Hours
Superconductivity: surface energy and thermodynamic critical field in Ghinzburg-Landau theory. Vortex lattice. Josephson tunnelling.	Problem solving	4 Hours

A.S. Alexandrov Theory of Superconductivity .From Weak to Strong Coupling, IOP Publishing Ltd 2003	Problem solving	4 Hours

References:

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical competences, which are fundamental for a Master student in the field of modern physics, corresponding to national and international standards. The contents is in line with the requirement of the main employers of research institutes and universities.

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- Clarity and coherence of exposition - Correct use of the methods/physical models - The ability to give specific examples	Written test and oral examination	60%
Tutorial	- Ability to use specific problem solving methods	Homeworks	40%
Minimal requirements for passing the exam	Requirements for mark 5 (10 points scale) Correct solutions to indicated subjects (for mark 5) in final exam Requirements for mark 10 (10 points scale) Correct solutions to subjects in final exam		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Lect. dr. Virgil V. Băran	Lect. dr. Virgil V. Băran

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DO.203.1 Computational methods for electronic structure of materials

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Computational methods for electronic structure of materials
2.2. Teacher	Prof. dr. George Alexandru NEMNES
2.3. Tutorials/Practicals instructor(s)	Prof. dr. George Alexandru NEMNES

2.4 Year of study	2	2.5. Semester	1	2.6. Type of evaluation	examen	2.7.Classification	DA

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	2/0/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	28/0/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	30
Research in library, study of electronic resources, field research	30
Preparation for practicals/tutorials/projects/reports/homework	30
Tutorat	0
Other activities	54
3.7. Total hours of individual study	144
3.8. Total hours per semester	200
3.9. ECTS	8

4. Prerequisites (if necessary)

4.1. curriculum	Quantum mechanics, Solid State Physics I and II, Thermodynamics and statistical physics, Electrodynamics, Physical Electronics, Equations of mathematical physics
4.2. competences	Using of software tools for data analysis/processing

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (PC, videoprojector, internet conection)
5.2. for tutorials/practicals	

6. Learning outcomes

Knowledge	R1. The student/graduate explains and interprets concepts, theories, models and principles of physics, highlighting practical applications R2. The student/graduate deduces working formulas for calculations with physical quantities, correctly using fundamental principles and laws of physics. R3. The student/graduate identifies methods, techniques and laboratory instruments necessary for designing and carrying out experiments specific to materials physics. R7. The student/graduate knows the ethical norms and principles regarding both the scientific research in the field and the culture of responsibility in intellectual work.

Skills	R1. The student/graduate applies the principles and laws of physics in solving theoretical or practical problems, including in partially unpredictable situations. R2. The student/graduate evaluates critically scientific communications or specialized reports of medium difficulty, analyzing the arguments and conclusions presented. R3. The student/graduate critically evaluates the results of experiments in order to determine physical quantities of interest for materials physics. R7. The student/graduate assimilates the explicit (texts with normative value) or implicit (customs, practices) norms that regulate academic and research conduct in the field.
Responsibility and autonomy	R1. The student/graduate manages technical or professional activities or projects, making decisions including in unforeseen situations. R2. The student/graduate performs independent work tasks responsibly and contributes to interdisciplinary approaches. R3. The student/graduate demonstrates autonomy in the operation and maintenance of laboratory equipment, respecting safety and quality standards. R7. The student/graduate demonstrates solidarity, reactivity and support for strengthening academic integrity.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
Introduction. Classification of many-body approximate methods.	Systematic exposition - lecture. Examples.	2 Hours
The problem of electron correlations.	Systematic exposition - lecture. Examples.	4 Hours
The density functional theory (DFT). Hohenberg-Kohn theorems.	Systematic exposition - lecture. Examples.	2 Hours
Kohn-Sham method. Kohn-Sham equations.	Systematic exposition - lecture. Examples.	2 Hours
Functionals for the exchange and correlation terms. The local density approximation (LDA) and local spin density approximation (LSDA). The GGA approximation.	Systematic exposition - lecture. Examples.	4 Hours
Orbital dependent functionals: self-interaction correction (SIC) and LDA+U approximation. Hybrid functionals.	Systematic exposition - lecture. Examples.	4 Hours
Ab initio numerical techniques. Pseudopotentials.	Systematic exposition - lecture. Examples.	4 Hours
Semilocal pseudopotentials. Ultrasoft pseudopotentials.	Systematic exposition - lecture. Examples.	2 Hours
Extensions: time dependent density functional theory.	Systematic exposition - lecture. Examples.	2 Hours
GW approximation. Applications.	Systematic exposition - lecture. Examples.	2 Hours

References:

[1] H. Bruus, K. Flensberg, Many-Body Quantum Theory in Condensed Matter Physics: An Introduction (Oxford University Press, Oxford 2004).
[2] R.M. Martin, Electronic structure: basic theory and practical methods (Cambridge University Press, Cambridge, 2004).
[3] W. Nolting, Fundamentals of Many-body Physics (Springer Verlag, Berlin, 2009)

7.2 Tutorials	Teaching techniques	Observations
Elaboration of a numerical code to implement the Hartree-Fock method.	Exposition. Guided work.	4 Hours
SIESTA method: presentation. Advantages and disadvantages of the method.	Exposition. Guided work.	4 Hours

SIESTA method for band structure calculations in bulk semiconductors and nanostructures.	Exposition. Guided work.	4 Hours
SIESTA method for investigating defects in semiconductor systems.	Exposition. Guided work.	4 Hours
Calculation of phonon band structures.	Exposition. Guided work.	4 Hours
Calculation of optical properties.	Exposition. Guided work.	4 Hours
Ab initio techniques for magnetic materials.	Exposition. Guided work.	4 Hours
References: SIESTA Manual, https://departments.icmab.es/leem/siesta/		

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical and practical competencies and skills corresponding to national and international standards, which are important for a master student in the field of modern Physics and technology. The contents and teaching methods were selected after a thorough analysis of the contents of similar course units in the syllabus of other universities from Romania or the European Union (Universite Paris-Sud, University of Cambridge, Universite Catholique Louvain-la-Neuve). The contents are in line with the requirements of the main employers of the graduates (industry, research institutes, high-school teaching).

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- Explicitness, coherence and concision of scientific statements; - Correct use of physical models and of specific mathematical methods; - Ability to analyse specific examples;	Written and oral exam	50%
Tutorial	- Use of specific physical and mathematical methods and techniques;	Homework, research projects	50%
Minimal requirements for passing the exam	Requirements for mark 5 (10 points scale): Correct solutions to indicated subjects (for mark 5) in final exam Requirements for mark 10 (10 points scale): Correct solutions to subjects in final exam		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Prof. dr. George Alexandru NEMNES	Prof. dr. George Alexandru NEMNES

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DO.204.1 Special electronic and optoelectronic devices

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Special electronic and optoelectronic devices						
2.2. Teacher	Prof. Dr. Ştefan Antohe						
2.3. Tutorials/Practicals instructor(s)	Prof. dr. Ştefan Antohe						
2.4 Year of study	2	2.5. Semester	1	2.6. Type of evaluation	examen	2.7.Classification	DS

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	0/2/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	0/28/0
Distribution of estimated time for study					
Learning by using one's own course notes, manuals, lecture notes, bibliography					72
Research in library, study of electronic resources, field research					36
Preparation for practicals/tutorials/projects/reports/homework					36
Tutorat					0
Other activities					0
3.7. Total hours of individual study					144
3.8. Total hours per semester					200
3.9. ECTS					8

4. Prerequisites (if necessary)

4.1. curriculum	Electricity and magnetism, Physics of Semiconductors, Physics of Organic Thin Films
4.2. competences	Electrical measurements. Using of software tools for data analysis/processing

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (PC, videoprojector, internet conection)
5.2. for tutorials/practicals	Experimental setups from laboratories of MDEO Center

6. Learning outcomes

Knowledge	R3. The student/graduate identifies methods, techniques and laboratory instruments necessary for designing and carrying out experiments specific to materials physics. R4. The student/graduate knows the principles of operation, safety and maintenance of equipment used in specialized laboratories. R6. The student/graduate knows the principles and applications of specialized software in data acquisition and analysis.
Skills	R3. The student/graduate critically evaluates the results of experiments in order to determine physical quantities of interest for materials physics. R4. tudent/graduate uses correctly specific laboratory equipments, demonstrating practical skills in calibration, maintenance and operation. R6. The student/graduate uses computer programs for simulations and computational modeling.

Responsibility and autonomy	R3. The student/graduate demonstrates autonomy in the operation and maintenance of laboratory equipment, respecting safety and quality standards. R4. The student/graduate organizes efficiently her/his professional activity and working time in accordance with research standards R6. The student/graduate assumes responsibility for making decisions based on the interpretation of digital data.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
Phyisical Proccesses at Metal/Semiconductor Interface	Systematic exposition - lecture. Examples.	6 Hours
Theory of Space Charge Limited Currents (SCLC)	Systematic exposition - lecture. Examples.	8 Hours
Electrical properties of Organic/Inorganic Diodes (OI)	Systematic exposition - lecture. Examples.	8 Hours
Organic Photovoltaic Cells	Systematic exposition - lecture. Examples.	6 Hours
References: S.M. Sze, Physics of Semiconductor Devices (Wiley, New York, 1969). M.A. Lampert. Reports on Progress in Physics, 27:329, 1964. S. Antohe, Materiale şi Dispozitive Electronice Organice (Editura. Universităţii din Bucureşti, Bucureşti, 1996) S. Antohe, Electronic and Optoelectronic Devices Based on Organic Thin Films, in Handbook of Organic Electronics and Photonics: Electronic Materials and Devices, H. Singh-Nalwa (Ed.) (American Scientific Publishers, Los Angeles, California, USA, 2006), vol 1		
7.3 Practicals	**Teaching techniques**	**Observations**
Non-Ohmic effect in M1/organic semiconductor/M2 structures	Measurements and data analysis and processing	6 Hours
Determination of charge carrier transport parameters in an organic thin film	Measurements and data analysis and processing	6 Hours
Measuremets of I-V characteristics at forward and reverse vias of OI diodes: Ag/p-Si/PTCDI/In şi Ag/p-Si/CuPc/Cu with determination of depletion layer parameters	Measurements and data analysis and processing	6 Hours
Measurement of I-V characteristic in the dark of a Photovoltaic cell with determination of series resistance Rs, shunt resistance, ideality factor n and saturation current Is	Measurements and data analysis and processing	6 Hours
Measurement of I-V characteristic in forth quadrant, at illumination in A.M. 1.5 conditions of a Photovoltaic cell with determination of typical parameters as photoelement: Uoc, Isc, FF, EQE, PCE	Measurements and data analysis and processing	4 Hours
References: S. Antohe. Physica Status Solidi A, 136:401, 1993		

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical and practical competencies and skills corresponding to national and international standards, which are important for a master student in the field of modern Physics and technology. The contents and teaching methods were selected after a thorough analysis of the contents of similar course units in the syllabus of other universities from Romania or the European Union (University of Kent at canterbury, Hanover University, University of Angers. The contents are in line with the requirements of the main employers of the graduates (industry, research institutes, high-school teaching)

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark

Lecture	- Explicitness, coherence and concision of scientific statements; - Correct use of physical models and of specific methods; - Ability to analyse specific examples;	Written and oral exam	50%
Practical	- Knowledge and correct use of specific experimental techniques - Data processing and analysis;	Colloquium	50%
Minimal requirements for passing the exam	Requirements for mark 5 (10 points scale) Correct solving of subjects indicated as required for obtaining mark 5 (final exam and homeworks). Requirements for mark 10 (10 points scale) Correct solving of subjects indicated as required for obtaining mark 10 (final exam and homeworks).		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Prof. Dr. Ştefan Antohe	Prof. dr. Ştefan Antohe

Date of approval

15.07.2025

Head of department
name and signature

Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DO.204.2 Physics and technology of thin films

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Physics and technology of thin films						
2.2. Teacher	Prof. Dr. Ştefan Antohe						
2.3. Tutorials/Practicals instructor(s)	Prof. Dr. Ştefan Antohe						
2.4 Year of study	2	2.5. Semester	1	2.6. Type of evaluation	examen	2.7.Classification	DS

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	0/2/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	0/28/0
Distribution of estimated time for study					
Learning by using one's own course notes, manuals, lecture notes, bibliography					72
Research in library, study of electronic resources, field research					36
Preparation for practicals/tutorials/projects/reports/homework					36
Tutorat					0
Other activities					0
3.7. Total hours of individual study					144
3.8. Total hours per semester					200
3.9. ECTS					8

4. Prerequisites (if necessary)

4.1. curriculum	Solid State Physics I, Optics, Electronics, Electrodynamics
4.2. competences	Understanding the structural properties of thin films

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (PC, video-projector, internet connection)
5.2. for tutorials/practicals	Experimental set-ups in Thin Films Laboratory and Nanotechnology Laboratory of Materials and Devices for Electronics and Optoelectronics Center

6. Learning outcomes

Knowledge	R3. The student/graduate identifies methods, techniques and laboratory instruments necessary for designing and carrying out experiments specific to materials physics. R4. The student/graduate knows the principles of operation, safety and maintenance of equipment used in specialized laboratories. R6. The student/graduate knows the principles and applications of specialized software in data acquisition and analysis.
Skills	R3. The student/graduate critically evaluates the results of experiments in order to determine physical quantities of interest for materials physics. R4. tudent/graduate uses correctly specific laboratory equipments, demonstrating practical skills in calibration, maintenance and operation. R6. The student/graduate uses computer programs for simulations and computational modeling.

Responsibility and autonomy	R3. The student/graduate demonstrates autonomy in the operation and maintenance of laboratory equipment, respecting safety and quality standards. R4. The student/graduate organizes efficiently her/his professional activity and working time in accordance with research standards R6. The student/graduate assumes responsibility for making decisions based on the interpretation of digital data.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
norganic materials based thin films. Introductory information. General presentation.	Systematic exposition - lecture. Examples.	2 Hours
Organic materials based thin films. Introductory information. General presentation	Systematic exposition - lecture. Examples.	2 Hours
Thermal vacuum evaporation: working principle; specific processes and phenomena for A2B6 compounds and for A3B5 compounds; adsorption processes; condensation processes; appropriateness of the method.	Systematic exposition - lecture. Examples.	4 Hours
Magnetron sputtering (RF and DC modes): working principle, specific process and phenomena, working parameters, the influence of working gas (non-reactive/reactive), appropriateness of the method.	Systematic exposition - lecture. Examples.	4 Hours
Chemical vapor deposition: working principle, diffusion phenomena, specific chemical processes involved, capacitive plasmas, appropriateness of the method.	Systematic exposition - lecture. Examples.	4 Hours
Spin-coating: working principle, kinetics of solutions; appropriateness of the method.	Systematic exposition - lecture. Examples.	4 Hours
Study of the structural properties of inorganic and organic materials based thin films.	Systematic exposition - lecture. Examples.	4 Hours
Study of morphological and optical properties of inorganic and organic materials based thin films	Systematic exposition - lecture. Examples.	2 Hours
Study of the electrical properties of inorganic and organic materials based thin films.	Systematic exposition - lecture. Examples.	2 Hours

References:

S. Antohe, Electronic and Optoelectronic Devices Based on Organic Thin Films, in Handbook of Organic Electronics and Photonics: Electronic Materials and Devices, H. Singh-Nalwa (Ed.) (American Scientific Publishers, Los Angeles, California, USA, 2006).
S. Antohe, S. Iftimie, L. Hrostea, V.A. Antohe, M. Girtan, A critical review of photovoltaic cells based on organic monomeric and polymeric thin film heterojunctions in Thin Solid Films 642, 219-231, 2017.
M. Ohring, Materials Science of Thin Films, Academic Press, London, UK, 2002.
Lecture notes available on http://solid.fizica.unibuc.ro.
J. George, Preparation of thin films, Cochin University of Science and Technology, Cochin, Kerala, India, 1992.

7.3 Practicals	Teaching techniques	Observations
Deposition of thin films by thermal vacuum evaporation	Guided practical work	4 Hours
Deposition of thin films by magnetron sputtering (RF and DC)	Guided practical work	4 Hours
Growth of thin films by chemical vapor deposition	Guided practical work	4 Hours
Growth of thin films by spin-coating	Guided practical work	4 Hours
Study of the structural properties of inorganic and organic thin films: X-ray diffraction and X-ray reflectometry	Guided practical work	4 Hours

Study of the morphological and optical properties of inorganic and organic thin films: atomic force microscopy, spectroscopic methods – absorption, transmission, reflection, ellipsometry	Guided practical work	4 Hours
Study of the electrical properties of inorganic and organic thin films: current-voltage characteristics, van der Pauw measurements, Hall effect measurements	Guided practical work	2 Hours
Hand-on lab test and quiz	Group project	2 Hours

References:

Laboratory notes
M.P. Soriaga, J. Stickney, L.A. Bottomley, Y-G. Kim, Thin Films. Preparation. Characterization. Applications., Spronger Science and Business Media, LLC, 2002.

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical and practical competencies and skills corresponding to national and international standards, which are important for a master student in the field of modern Physics and technology. The contents and teaching methods were selected after a thorough analysis of the contents of similar course units in the syllabus of other universities from Romania or the European Union (Universite Paris-Sud, University of Cambridge, Universite Catholique Louvain-la-Neuve). The contents are in line with the requirements of the main employers of the graduates (industry, research institutes, high-school teaching)

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- Explicitness, coherence and concision of scientific statements; - Correct use of physical models and of specific mathematical methods; - Ability to analyze specific examples;	Written exam	70%
Practical	- Knowledge and correct use of specific experimental techniques - Data processing and analysis;	Colloquium	30%
Minimal requirements for passing the exam	Requirements for mark 5 (10 points scale) Correct solving of subjects indicated as required for obtaining mark 5 (final exam and homeworks). Requirements for mark 10 (10 points scale) Correct solving of subjects indicated as required for obtaining mark 10 (final exam and homeworks).		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Prof. Dr. Ştefan Antohe	Prof. Dr. Ştefan Antohe

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DFC.107 Volunteering

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Volunteering						
2.2. Teacher							
2.3. Tutorials/Practicals instructor(s)							
2.4 Year of study	1	2.5. Semester	1	2.6. Type of evaluation	verificare	2.7.Classification	DC

3. Total estimated time

3.1. Hours per week	0	3.2. Lectures	0	3.3. Tutorials/Practicals/Projects	0/0/0
3.4. Total hours per semester	0	3.5. Lectures	0	3.6. Tutorials/Practicals/Projects	0/0/0
Distribution of estimated time for study					
Learning by using one's own course notes, manuals, lecture notes, bibliography					13
Research in library, study of electronic resources, field research					6
Preparation for practicals/tutorials/projects/reports/homework					6
Tutorat					0
Other activities					0
3.7. Total hours of individual study					25
3.8. Total hours per semester					25
3.9. ECTS					1

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competences	

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	
5.2. for tutorials/practicals	

6. Learning outcomes

Knowledge	R10. The student/graduate acquires civic competences.
Skills	R10. The student/graduate improves communication skills.
Responsibility and autonomy	R10. Shows spirit of initiative and entrepreneurship.

7. Contents

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark

Minimal requirements for passing the exam	

Date,

13.07.2025

Teacher's
name and signature,

Practicals/Tutorials/Project instructor(s),
name and signature

Date of approval

15.07.2025

Head of department
name and signature
Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DFC.112 Phase transitions in condensed matter

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Phase transitions in condensed matter
2.2. Teacher	Prof. dr. Lucian Ion
2.3. Tutorials/Practicals instructor(s)	drd. Amanda Preda

2.4 Year of study	1	2.5. Semester	2	2.6. Type of evaluation	examen	2.7.Classification	DA

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	2/0/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	28/0/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	22
Research in library, study of electronic resources, field research	11
Preparation for practicals/tutorials/projects/reports/homework	11
Tutorat	0
Other activities	0
3.7. Total hours of individual study	44
3.8. Total hours per semester	100
3.9. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	Quantum mechanics, Statistical physics, Solid state physics
4.2. competences	knowledge of electronic and optical properties of solids

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	room with multimedia infrastructure
5.2. for tutorials/practicals	computer room

6. Learning outcomes

Knowledge	R1. The student/graduate explains and interprets concepts, theories, models and principles of physics, highlighting practical applications R2. The student/graduate deduces working formulas for calculations with physical quantities, correctly using fundamental principles and laws of physics. R5. The student/graduate integrates knowledge from physics, mathematics, and materials science to solve complex problems in the field. R6. The student/graduate knows the principles and applications of specialized software in data acquisition and analysis.
Skills	R1. The student/graduate applies the principles and laws of physics in solving theoretical or practical problems, including in partially unpredictable situations. R2. The student/graduate evaluates critically scientific communications or specialized reports of medium difficulty, analyzing the arguments and conclusions presented. R5. The student/graduate uses interdisciplinary knowledge from physics, mathematics and materials science to model and understand the observed processes. R6. The student/graduate uses computer programs for simulations and computational modeling.

Responsibility and autonomy	R1. The student/graduate manages technical or professional activities or projects, making decisions including in unforeseen situations. R2. The student/graduate performs independent work tasks responsibly and contributes to interdisciplinary approaches. R5. The student/graduate adequately manages experimental and computational data to support her/his decisions. R6. The student/graduate assumes responsibility for making decisions based on the interpretation of digital data.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
Landau theory of phase transitions. Symmetry breaking. Order parameter. Onstein-Zernike theory – gaussian approximation. Landa-Ginzburg criterion. Introduction to critical phenomena	Systematic exposition - lecture. Examples	8 Hours
Dielectric materials – phase transitions: Permitivity and dielelctric losses. Debye theory. Frequency and temperature dependence of complex dielectric function. Applications.	Systematic exposition - lecture. Examples	6 Hours
Phase transitions în ferroelectric materials: Definition, classifications, structure, properties. Phase transitions. Spontaneous polarization and dielectric function în 1-st order phase transitions. Ferroelectric domains. Polarization and dielectric function în phase în 2-nd order phase transitions.	Systematic exposition - lecture. Examples	6 Hours
Normal-superconductor transition	Systematic exposition - lecture. Examples	8 Hours

References:

1. S. Sachdev. Quantum phase transitions (Cambridge University Press, Cambridge, UK, 2001).
2. A.S. Shumovsky V.I. Yukalov, Lectures on phase transitions (World Scientific, Singapore, 1990)
3. S.A. Kivelson, J.M. Jiang, J. Chang, Statistical mechanics of phases and phase transitions (Princeton University Press, Princeton, USA, 2024)

7.2 Tutorials	Teaching techniques	Observations
Phase transitions with order parameter. Examples	Exposition. Guided work	8 Hours
Critical phenomena. Critical exponents. Examples.	Exposition. Guided work	6 Hours
Ferroelectric and piezoelectric crystals. Structure of material tensors.	Exposition. Guided work	6 Hours
Superconductors. Landau theory. BCS theory.	Exposition. Guided work	8 Hours

References:

1. S. Sachdev. Quantum phase transitions (Cambridge University Press, Cambridge, UK, 2001).
2. A.S. Shumovsky V.I. Yukalov, Lectures on phase transitions (World Scientific, Singapore, 1990)
3. S.A. Kivelson, J.M. Jiang, J. Chang, Statistical mechanics of phases and phase transitions (Princeton University Press, Princeton, USA, 2024)

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

The contents and teaching methods were selected after an analysis of the contents of similar course units in the syllabus of other universities (LMU, KTH) . The contents are in line with the requirements/expectations of the main employers of the graduates (research, academic, secondary school teaching).

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- coherence and clarity of exposition - correct use of physical models and theories	Written test/oral examination	100%

Minimal requirements for passing the exam	Requirements for mark 5 (10 points scale) Correct solving of subjects indicated as required for obtaining mark 5 (final exam and homeworks). Requirements for mark 10 (10 points scale) Correct solving of subjects indicated as required for obtaining mark 10 (final exam and homeworks).

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Prof. dr. Lucian Ion	drd. Amanda Preda

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026

DFC.113 Interaction of laser radiation with matter

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Interaction of laser radiation with matter
2.2. Teacher	Conf. Madalina Boca
2.3. Tutorials/Practicals instructor(s)	Conf. Madalina Boca

2.4 Year of study	1	2.5. Semester	2	2.6. Type of evaluation	exam	2.7.Classification	

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	2/0/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	28/0/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	22
Research in library, study of electronic resources, field research	11
Preparation for practicals/tutorials/projects/reports/homework	11
Tutorat	0
Other activities	0
3.7. Total hours of individual study	44
3.8. Total hours per semester	100
3.9. ECTS	4

4. Prerequisites (if necessary)

4.1. curriculum	Classical electrodynamics, Quantum Mechanics, Numerical methods in Physics
4.2. competences	Knowledge of basic topics in classical electrodynamics and quantum mechanics, ability to understand basic numerical algorithms

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Room with videoprojector, acces to internet
5.2. for tutorials/practicals	Computer room with videoprojector, acces to internet

6. Learning outcomes

Knowledge	R3. The student/graduate identifies methods, techniques and laboratory instruments necessary for designing and carrying out experiments specific to materials physics. R4. The student/graduate knows the principles of operation, safety and maintenance of equipment used in specialized laboratories.
Skills	R3. The student/graduate critically evaluates the results of experiments in order to determine physical quantities of interest for materials physics. R4. tudent/graduate uses correctly specific laboratory equipments, demonstrating practical skills in calibration, maintenance and operation.
Responsibility and autonomy	R3. The student/graduate demonstrates autonomy in the operation and maintenance of laboratory equipment, respecting safety and quality standards. R4. The student/graduate organizes efficiently her/his professional activity and working time in accordance with research standards

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
1. Theoretical description of laser beams; particular solutions of the Maxwell equations: plane waves, Gaussian beams, helical beams.	Systematic exposition - lecture. Examples	6 Hours
2. Classical motion of the charged particle in the presence of a laser field; relativistic vs non relativist approach, radiation reaction effects, the Abraham-Lorentz force	Systematic exposition - lecture. Examples	8 Hours
3. Classical description of radiation scattering: linear and non-linear Thomson scattering, the energy spectrum and the angular momentum of the emitted field	Systematic exposition - lecture. Examples	8 Hours
4. Coherent non-linear Thomson scattering	Systematic exposition - lecture. Examples	6 Hours

References:

J. D. Jackson, Classical electrodynamics, John Wiley and Sons, 1999
C. Joachain, A. Kylstra, R. M. Potvliege, Atoms in intense laser fields, Cambridge University Press, 2012
A. Di Piazza, C. Muller, K. Z. Hatsagortsyan, and C. H. Keitel, Extremely high-intensity laser interactions with fundamental quantum systems, Rev. Mod. Phys. 84, 1177 (2012)
A. Gonoskov et al, Charged particle motion and radiation in strong electromagnetic fields, REv. Mod. Phys. 94, 045001, 2022
D. Suter, The Physics of Laser-Atom Interactions (Cambridge Studies in Modern Optics), 1997
F. V. Hartemann, High-field electrodynamics, CRC press, 2002
J. P. Torres (ed), Twisted photons: applications of light with orbital angular momentum, Wiley-VCH (2011)

7.2 Tutorials	Teaching techniques	Observations
Techniques for graphical representation of the electromagnetic field	Systematic exposition - Guided practical activity	6 Hours
Calculation of energy density, momentum, angular momentum of the electromagnetic field, application for some particular cases	Systematic exposition - Guided practical activity	6 Hours
Numerical solution of the classical equation of motion for charged particles in electromagnetic field in the relativistic case, study of the effects of the radiation reaction.	Systematic exposition - Guided practical activity	6 Hours
Numerical calculation of the observables of the field emitted in the non-linear Thomson scattering of radiation on electrons.	Systematic exposition - Guided practical activity	6 Hours
Radiation reaction effects in non-linear Thomson scattering	Systematic exposition - Guided practical activity	4 Hours

References:

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical competences, which are fundamental for a Master student in the field of modern physics, corresponding to national and international standards. The contents is in line with the requirement of the main employers of research institutes and universities.

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- Clarity and coherence of exposition - Correct use of the methods/physical models - The ability to give specific examples	Written test + oral examination	70%
Practical	Ability to use specific numerical methods for problem solving	Continuous evaluation, Homeworks	30%

Minimal requirements for passing the exam	Requirements for mark 5 (10 points scale): - At least 50% of exam score and of homework. Requirements for mark 10 (10 points scale): - At least 95% of exam score and of homework.

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Conf. Madalina Boca	Conf. Madalina Boca

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DFC.114 Volunteering

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Volunteering						
2.2. Teacher							
2.3. Tutorials/Practicals instructor(s)							
2.4 Year of study	1	2.5. Semester	2	2.6. Type of evaluation	verificare	2.7.Classification	DC

3. Total estimated time

3.1. Hours per week	0	3.2. Lectures	0	3.3. Tutorials/Practicals/Projects	0/0/0
3.4. Total hours per semester	0	3.5. Lectures	0	3.6. Tutorials/Practicals/Projects	0/0/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	0
Research in library, study of electronic resources, field research	0
Preparation for practicals/tutorials/projects/reports/homework	0
Tutorat	0
Other activities	0
3.7. Total hours of individual study	0
3.8. Total hours per semester	0
3.9. ECTS	1

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competences	

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	
5.2. for tutorials/practicals	

6. Learning outcomes

Knowledge	R10. The student/graduate acquires civic competences.
Skills	R10. The student/graduate improves communication skills.
Responsibility and autonomy	R10. Shows spirit of initiative and entrepreneurship.

7. Contents

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark

Minimal requirements for passing the exam	

Date,

13.07.2025

Teacher's
name and signature,

Practicals/Tutorials/Project instructor(s),
name and signature

Date of approval

15.07.2025

Head of department
name and signature
Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DFC.205 Computational methods in condensed matter

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Computational methods in condensed matter						
2.2. Teacher	Prof. dr. George Alexandru NEMNES						
2.3. Tutorials/Practicals instructor(s)	Prof. dr. George Alexandru NEMNES						
2.4 Year of study	2	2.5. Semester	1	2.6. Type of evaluation	examen	2.7.Classification	DA

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	2/0/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	28/0/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	10
Research in library, study of electronic resources, field research	5
Preparation for practicals/tutorials/projects/reports/homework	4
Tutorat	0
Other activities	0
3.7. Total hours of individual study	19
3.8. Total hours per semester	75
3.9. ECTS	3

4. Prerequisites (if necessary)

4.1. curriculum	Quantum mechanics, Solid State Physics I and II, Thermodynamics and statistical physics, Electrodynamics, Physical Electronics, Equations of mathematical physics
4.2. competences	Using of software tools for data analysis/processing

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (PC, videoprojector, internet conection)
5.2. for tutorials/practicals	

6. Learning outcomes

Knowledge	R1. The student/graduate explains and interprets concepts, theories, models and principles of physics, highlighting practical applications R2. The student/graduate deduces working formulas for calculations with physical quantities, correctly using fundamental principles and laws of physics. R5. The student/graduate integrates knowledge from physics, mathematics, and materials science to solve complex problems in the field.
Skills	R1. The student/graduate applies the principles and laws of physics in solving theoretical or practical problems, including in partially unpredictable situations. R2. The student/graduate evaluates critically scientific communications or specialized reports of medium difficulty, analyzing the arguments and conclusions presented. R5. The student/graduate uses interdisciplinary knowledge from physics, mathematics and materials science to model and understand the observed processes.

Responsibility and autonomy	R1. The student/graduate manages technical or professional activities or projects, making decisions including in unforeseen situations. R2. The student/graduate performs independent work tasks responsibly and contributes to interdisciplinary approaches. R5. The student/graduate adequately manages experimental and computational data to support her/his decisions.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
Introduction. Classification of many-body approximate methods.	Systematic exposition - lecture. Examples.	2 Hours
he problem of electron correlations.	Systematic exposition - lecture. Examples.	4 Hours
The density functional theory (DFT). Hohenberg-Kohn theorems.	Systematic exposition - lecture. Examples.	2 Hours
Kohn-Sham method. Kohn-Sham equations.	Systematic exposition - lecture. Examples.	2 Hours
Functionals for the exchange and correlation terms. The local density approximation (LDA) and local spin density approximation (LSDA). The GGA approximation.	Systematic exposition - lecture. Examples.	4 Hours
Orbital dependent functionals: self-interaction correction (SIC) and LDA+U approximation. Hybrid functionals	Systematic exposition - lecture. Examples.	4 Hours
Ab initio numerical techniques. Pseudopotentials.	Systematic exposition - lecture. Examples.	4 Hours
Semilocal pseudopotentials. Ultrasoft pseudopotentials.	Systematic exposition - lecture. Examples.	2 Hours
Extensions: time dependent density functional theory.	Systematic exposition - lecture. Examples.	2 Hours
GW approximation. Applications.	Systematic exposition - lecture. Examples.	2 Hours

References:

H. Bruus, K. Flensberg, Many-Body Quantum Theory in Condensed Matter Physics: An Introduction (Oxford University Press, Oxford 2004).
R.M. Martin, Electronic structure: basic theory and practical methods (Cambridge University Press, Cambridge, 2004).
W. Nolting, Fundamentals of Many-body Physics (Springer Verlag, Berlin, 2009).

7.2 Tutorials	Teaching techniques	Observations
Elaboration of a numerical code to implement the Hartree-Fock method.	Exposition. Guided work	4 Hours
SIESTA method: presentation. Advantages and disadvantages of the method.	Exposition. Guided work	4 Hours
SIESTA method for band structure calculations in bulk semiconductors and nanostructures.	Exposition. Guided work	4 Hours
SIESTA method for investigating defects in semiconductor systems.	Exposition. Guided work	4 Hours
Calculation of phonon band structures.	Exposition. Guided work	4 Hours
Calculation of optical properties.	Exposition. Guided work	4 Hours
Ab initio techniques for magnetic materials.	Exposition. Guided work	4 Hours

References:

SIESTA Manual, https://siesta-project.org/siesta/

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical and practical competencies and skills corresponding to national and international standards, which are important for a master student in the field of modern Physics and technology. The contents and teaching methods were selected after a thorough analysis of the contents of similar course units in the syllabus of other universities from Romania or the European Union (Universite Paris-Sud, University of Cambridge, Universite Catholique Louvain-la-Neuve). The contents are in line with the requirements of the main employers of the graduates (industry, research institutes, high-school teaching).

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- Explicitness, coherence and concision of scientific statements; - Correct use of physical models and of specific mathematical methods; - Ability to analyse specific examples;	Written exam	50%
Tutorial	- Use of specific physical and mathematical methods and techniques; - Data processing and analysis;	Homework, research projects	50%
Minimal requirements for passing the exam	To obtain grade 5: - Performing all experiments, presentation of Lab reports and grade 5 at Colloquium - Correct solution for indicated subjects in homeworks and the final exam - Knowledge of basic elements: Hohenberg-Kohn theorems, Kohn-Sham equations, Pseudopotentials, Basic usage of SIESTA code; Requirements for getting mark 10 (10 points scale) - Correct solutions to the written exam, homeworks and colloquium - Demonstrated ability to analyze phenomena and processes Minimum participation: 50% lectures and 100% labs.		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Prof. dr. George Alexandru NEMNES	Prof. dr. George Alexandru NEMNES

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DFC.206 Virtual instrumentation and data acquisition

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Virtual instrumentation and data acquisition						
2.2. Teacher	Lect. dr. Bogdan Biţă						
2.3. Tutorials/Practicals instructor(s)	Lect. dr. Bogdan Biţă						
2.4 Year of study	2	2.5. Semester	1	2.6. Type of evaluation	examen	2.7.Classification	DA

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	0/2/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	0/28/0
Distribution of estimated time for study					
Learning by using one's own course notes, manuals, lecture notes, bibliography					10
Research in library, study of electronic resources, field research					9
Preparation for practicals/tutorials/projects/reports/homework					0
Tutorat					0
Other activities					0
3.7. Total hours of individual study					19
3.8. Total hours per semester					75
3.9. ECTS					3

4. Prerequisites (if necessary)

4.1. curriculum	Programming languages, Electricity and magnetism, Electronics
4.2. competences	computer programming

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	
5.2. for tutorials/practicals	Scientific computing laboratory

6. Learning outcomes

Knowledge	R4. The student/graduate knows the principles of operation, safety and maintenance of equipment used in specialized laboratories. R6. The student/graduate knows the principles and applications of specialized software in data acquisition and analysis. R9. The student/graduate knows and understands the operating principles and areas of applicability for scientific equipments associated with experimental techniques specific to materials physics.
Skills	R4. tudent/graduate uses correctly specific laboratory equipments, demonstrating practical skills in calibration, maintenance and operation. R6. The student/graduate uses computer programs for simulations and computational modeling. R9. The student/graduate collects and interprets data resulting from the application of scientific methods, integrating the results obtained into an analytical framework.

Responsibility and autonomy	R4. The student/graduate organizes efficiently her/his professional activity and working time in accordance with research standards R6. The student/graduate assumes responsibility for making decisions based on the interpretation of digital data. R9. The student/graduate analyzes experimental data and extracts information about the quantities of interest.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
Experimental techniques in modern physics. Sensors and data acquisition.	Systematic exposition - lecture.Examples.	2 Hours
Software applications – LabVIEW programming package. Virtual instruments.	Systematic exposition - lecture.Examples.	6 Hours
G programming language: data types, structures, I/O operations.	Systematic exposition - lecture.Examples.	6 Hours
VISA architecture. GPIB and RS485 buses.	Systematic exposition - lecture.Examples.	6 Hours
Data acquisition and processing in physics experiments. Hardware configurations.	Systematic exposition - lecture.Examples.	8 Hours

References:
G Programming Reference Manual, National Instruments.
L. Ion, Course notes (slides)
R.Baican, D.S. Necsulescu, Applied Virtual Instrumentation (WIT Press, Southampton, UK, 2000)

7.3 Practicals	Teaching techniques	Observations
Introduction to graphical programming. Front panel and diagrams.	Guided practical activity	4 Hours
Virtual instruments. Design and configuration.	Guided practical activity	2 Hours
Graphics and text. I/O operations.	Guided practical activity	10 Hours
Data acquisition and processing modules	Guided practical activity	12 Hours

References:
G Programming Reference Manual, National Instruments.

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

In order to sketch the contents, to choose the teaching/learning methods, the coordinator of the course consulted the content of similar disciplines taught at Romanian universities and abroad. The content of the discipline is according to the requirements of employment in research institutes in physics and materials science, as well as in education (according to the law).

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	Clarity and coherence of exposition Correct use of the methods/physical models The ability to give specific examples	Design and implementation of a virtual instrument	70%
Practical	Ability to use specific problemsolving methods	Development of specific module	30%
Minimal requirements for passing the exam	Completion of all laboratory work and assessment with a grade of 5 at the final exam Obtaining a grade of 5 at the laboratory colloquium. Requirements for getting mark 10 (10 points scale) Correct answer to all the subjects indicated for obtaining grade 10 Skills, well-argued knowledge Demonstrated ability to analyze phenomena and processes Personal approach and interpretation.		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Lect. dr. Bogdan Biţă	Lect. dr. Bogdan Biţă

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DFC.207 Physics of semiconductor devices

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Physics of semiconductor devices								
2.2. Teacher	Associate Prof. dr. Sorina Iftimie								
2.3. Tutorials/Practicals instructor(s)	Associate Prof. dr. Sorina Iftimie								
2.4 Year of study	2	2.5. Semester	1	2.6. Type of evaluation	examen	2.7.Classification	DA		

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	0/2/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	0/28/0
Distribution of estimated time for study					
Learning by using one's own course notes, manuals, lecture notes, bibliography					10
Research in library, study of electronic resources, field research					5
Preparation for practicals/tutorials/projects/reports/homework					4
Tutorat					0
Other activities					0
3.7. Total hours of individual study					19
3.8. Total hours per semester					75
3.9. ECTS					3

4. Prerequisites (if necessary)

4.1. curriculum	Attending the lectures on: Electricity and Magnetism, Thermodynamics and Statistical physics, Electronics, Quantum Mechanics, Solid-State Physics
4.2. competences	Use of software packages for data analysis and processing

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (PC, videoprojector, internet conection)
5.2. for tutorials/practicals	Multimedia room , pc station

6. Learning outcomes

Knowledge	R3. The student/graduate identifies methods, techniques and laboratory instruments necessary for designing and carrying out experiments specific to materials physics. R4. The student/graduate knows the principles of operation, safety and maintenance of equipment used in specialized laboratories. R6. The student/graduate knows the principles and applications of specialized software in data acquisition and analysis.
Skills	R3. The student/graduate critically evaluates the results of experiments in order to determine physical quantities of interest for materials physics. R4. tudent/graduate uses correctly specific laboratory equipments, demonstrating practical skills in calibration, maintenance and operation. R6. The student/graduate uses computer programs for simulations and computational modeling.

Responsibility and autonomy	R3. The student/graduate demonstrates autonomy in the operation and maintenance of laboratory equipment, respecting safety and quality standards. R4. The student/graduate organizes efficiently her/his professional activity and working time in accordance with research standards R6. The student/graduate assumes responsibility for making decisions based on the interpretation of digital data.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
Types of semiconductor materials		2 Hours
Main technologies dedicated to semiconductor materials		2 Hours
p-n Junctions		2 Hours
Bipolar transistors		2 Hours
MOSFET structures		4 Hours
Tunnel Diodes		4 Hours
Resonant Devices		4 Hours
Photonic devices		2 Hours
Modeling of Semiconductor Devices. Processing of the results and extracting physical data of interest		6 Hours

References:
1. S. M. Sze and Kwok K. Ng, Physics of Semiconductor Devices, Wiley Interscience 2007 86
2. S. M. Sze, Semiconductor Devices, Physics and Technology, John Wiley and Sons 2002
3. M. Dragoman, D. Dragoman – Nanoelectronics: Principles and Devices, Artech House, 2nd edition, Boston, U.S.A., 2009
4. I. Munteanu, Fizica solidului, Editura Univ. Bucuresti, 1993
5. L. Ion, Solid-State Physics - Lecture Notes
6. P. Cristea, Dispozitive Electronice Speciale, Vol. 1, Editura Univ. Bucuresti, 1999

7.3 Practicals	Teaching techniques	Observations
Numerical study of the influence of doping on electrical properties	Assisted practical activity	2 Hours
Numerical study of p-n junctions and multi-junction structures. The influence of size reduction	Assisted practical activity	4 Hours
Numerical study of bipolar transistors	Assisted practical activity	8 Hours
Simulation and design of MOSFET structures	Assisted practical activity	4 Hours
Simulation and design of MODFET structures	Assisted practical activity	6 Hours
Simulation and design of resonant structures	Assisted practical activity	4 Hours

References:
S. M. Sze, Semiconductor Devices, Physics and Technology, John Wiley and Sons 2002VMD
P. Cristea, Dispozitive Electronice Speciale, Vol. 1, Editura Univ. Bucuresti, 1999
nanoHUB: https://nanohub.org/

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

To decide about the content, the teaching/learning methods, the instructor made the content compatible to similar subjects taught at universities in the country and abroad (University of Illinois, University of Cambridge, MIT). The content of the discipline complies to the requirements of employment in research institutes in physics.

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark

Lecture	- Exposure clarity, coherence and conciseness - Understand correctly the principles, models, formulas and relations of calculation - Ability to provide and make use of relevant arguments	oral examination	50%
Practical	- Ability to use software packages as WinGreen, RTD, HEMT, SelfHEMT software packages	Practical test	50%
Minimal requirements for passing the exam	Requirements for mark 5 (10 points scale) To obtain grade 5: - Performing all experiments, presentation of Lab reports and grade 5 at Colloquium - Correct solution for indicated subjects in homeworks and the final exam - Knowledge of basic elements Requirements for getting mark 10 (10 points scale) - Correct solutions to the written exam, homeworks and colloquium - Demonstrated ability to analyze phenomena and processes Minimum participation: 50% lectures and 100% labs.		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Associate Prof. dr. Sorina Iftimie	Associate Prof. dr. Sorina Iftimie

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DFC.208 Electrical and optical characterization of semiconductors

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Electrical and optical characterization of semiconductors
2.2. Teacher	Associate Prof. dr. Sorina Iftimie
2.3. Tutorials/Practicals instructor(s)	Associate Prof. dr. Sorina Iftimie

2.4 Year of study	2	2.5. Semester	1	2.6. Type of evaluation	examen	2.7.Classification	DA

3. Total estimated time

3.1. Hours per week	4	3.2. Lectures	2	3.3. Tutorials/Practicals/Projects	0/2/0
3.4. Total hours per semester	56	3.5. Lectures	28	3.6. Tutorials/Practicals/Projects	0/28/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	10
Research in library, study of electronic resources, field research	5
Preparation for practicals/tutorials/projects/reports/homework	4
Tutorat	0
Other activities	0
3.7. Total hours of individual study	19
3.8. Total hours per semester	75
3.9. ECTS	3

4. Prerequisites (if necessary)

4.1. curriculum	Electricity and magnetism, Optics, Equations of Mathematical Physics, Solid State Physics
4.2. competences	Using of software tools for data analysis/processing

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Multimedia infrastructure (PC, videoprojector, internet conection)
5.2. for tutorials/practicals	Laboratory set-ups for electrical and optical characterization of semiconductors

6. Learning outcomes

Knowledge	R3. The student/graduate identifies methods, techniques and laboratory instruments necessary for designing and carrying out experiments specific to materials physics. R4. The student/graduate knows the principles of operation, safety and maintenance of equipment used in specialized laboratories. R6. The student/graduate knows the principles and applications of specialized software in data acquisition and analysis.
Skills	R3. The student/graduate critically evaluates the results of experiments in order to determine physical quantities of interest for materials physics. R4. tudent/graduate uses correctly specific laboratory equipments, demonstrating practical skills in calibration, maintenance and operation. R6. The student/graduate uses computer programs for simulations and computational modeling.

Responsibility and autonomy	R3. The student/graduate demonstrates autonomy in the operation and maintenance of laboratory equipment, respecting safety and quality standards. R4. The student/graduate organizes efficiently her/his professional activity and working time in accordance with research standards R6. The student/graduate assumes responsibility for making decisions based on the interpretation of digital data.

7. Contents

7.1 Lecture [chapters]	Teaching techniques	Observations
Evaluation of the uncertainty of measurement;	Systematic exposition - lecture. Examples.	2 Hours
Noise in measurement systems;	Systematic exposition - lecture. Examples.	4 Hours
Resistivity measurement (direct method, two probe method, four probe method, van de Pauw method). Temperature dependence	Systematic exposition - lecture. Examples.	6 Hours
Determination of the carrier concentration, the type of conduction and the mobility of the charge carriers;	Systematic exposition - lecture. Examples.	4 Hours
Determination of the lifetime and the diffusion length of minority carriers;	Systematic exposition - lecture. Examples.	2 Hours
Characterization of the electrically active centers by the DLTS method;	Systematic exposition - lecture. Examples.	2 Hours
Interaction of electromagnetic radiation with semiconductors. Optical coefficients;	Systematic exposition - lecture. Examples.	2 Hours
Spectrophotometric methods for the characterization of semiconductors;	Systematic exposition - lecture. Examples.	2 Hours
Measurement of the impurities concentration and of the band gap energy;	Systematic exposition - lecture. Examples.	2 Hours
Ellipsometric methods for the characterization of semiconductors;	Systematic exposition - lecture. Examples.	2 Hours

References:

Alain C. Diebold "Handbook of Silicon Semiconductor Metrology", Marcel Dekker, 2001;
K Schroder, Semiconductor Material And Device Characterization, Wiley, 2006
H. Czichos, T. Sait, Leslie Smith, "Springer Handbook of Materials Measurement Methods", Springer 2006;
W.R.Runyan, T.J.Shaffner, "Semiconductor Measurements and Instrumentation", McGraw-Hill, NY,1997;
John G. Webster , "The Measurement, Instrumentation, and Sensors Handbook", CRC Press 1999;
Walt Boyes, "Instrumentation Reference Book", BUTTERWORTH HEINEMANN (Elsevier), 2003;
Annual Book of ASTM Standards, vol. 10.04 - Electronics (I) 2006
Annual Book of ASTM Standards, vol. 10.05 - Electronics (II) 2006
Semyon G. Rabinovich, "Evaluating Measurement Accuracy", Springer, 2010
Toru Yoshizawa, "Handbook of Optical Metrology", CRC Press Taylor and Francis 2009
Paolo Fornasini, "The Uncertainty in Physical Measurements", Springer, 2008
Roy M. Howard, "Principles of Random Signal Analysis and Low Noise Design", Wiley 2002
Horst Czichos, Tetsuya Saito, Leslie Smith "Springer Handbook of Metrology and Testing", Springer 2011;
Fridman, A.E., "The Quality of Measurements", Springer 2012;
Vladimir Murashov, John Howard, "Nanotechnology Standards", Springer 2011;

7.3 Practicals	Teaching techniques	Observations
Determination of semiconductor resistivity by direct method, method of two probes, method of four probes, method of van Pauw. Evaluation of the measurement uncertainty of resistivity	Guided practical work	4 Hours
Determination of the type conduction by Hall effect, by the hot / cold probe method, the rectifier contact method and the three probe method	Guided practical work	6 Hours
Determination of mobility	Guided practical work	6 Hours

Measurement of carrier concentration by CV method.	Guided practical work	4 Hours
Determination of the life time by the method of photoconduction relaxation	Guided practical work	4 Hours
Determination of some physical quantities, characteristics of semiconductors, by transmission spectrophotometry	Guided practical work	4 Hours

References:

Alain C. Diebold "Handbook of Silicon Semiconductor Metrology", Marcel Dekker, 2001;
K Schroder, Semiconductor Material And Device Characterization, Wiley, 2006
W.R.Runyan, T.J.Shaffner, "Semiconductor Measurements and Instrumentation", McGraw-Hill, NY,1997;
Annual Book of ASTM Standards, vol. 10.04 - Electronics (I) 2006
Annual Book of ASTM Standards, vol. 10.05 - Electronics (II) 2006
Semyon G. Rabinovich, "Evaluating Measurement Accuracy", Springer, 2010
Toru Yoshizawa, "Handbook of Optical Metrology", CRC Press Taylor and Francis 2009
Paolo Fornasini, "The Uncertainty in Physical Measurements", Springer, 2008

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

This course unit develops some theoretical and practical competencies and skills corresponding to national and international standards, which are important for a master student in the field of modern Physics and technology. The contents and teaching methods were selected after a thorough analysis of the contents of similar course units in the syllabus of other universities from Romania or the European Union (Universite Paris-Sud, University of Cambridge, Universite Catholique Louvain-la-Neuve). The contents are in line with the requirements of the main employers of the graduates (industry, research institutes, high-school teaching)

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark
Lecture	- Explicitness, coherence and concision of scientific statements; - Correct use of physical models and of specific mathematical methods; - Ability to analyse specific examples;	Written and oral exam	50%
Practical	- Knowledge and correct use of specific experimental techniques - Data processing and analysis;	Colloquium, Homework	50%
Minimal requirements for passing the exam	Requirements for mark 5 (10 points scale) To obtain grade 5: - Performing all experiments, presentation of Lab reports and grade 5 at Colloquium - Correct solution for indicated subjects in homeworks and the final exam - Knowledge of basic elements Requirements for getting mark 10 (10 points scale) - Correct solutions to the written exam, homeworks and colloquium - Demonstrated ability to analyze phenomena and processes Minimum participation: 50% lectures and 100% labs.		

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025	Associate Prof. dr. Sorina Iftimie	Associate Prof. dr. Sorina Iftimie

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DFC.209 Volunteering

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Volunteering						
2.2. Teacher							
2.3. Tutorials/Practicals instructor(s)							
2.4 Year of study	2	2.5. Semester	1	2.6. Type of evaluation	verificare	2.7.Classification	DC

3. Total estimated time

3.1. Hours per week	0	3.2. Lectures	0	3.3. Tutorials/Practicals/Projects	0/0/0
3.4. Total hours per semester	0	3.5. Lectures	0	3.6. Tutorials/Practicals/Projects	0/0/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	13
Research in library, study of electronic resources, field research	6
Preparation for practicals/tutorials/projects/reports/homework	6
Tutorat	0
Other activities	0
3.7. Total hours of individual study	25
3.8. Total hours per semester	25
3.9. ECTS	1

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competences	

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	
5.2. for tutorials/practicals	

6. Learning outcomes

Knowledge	R10. The student/graduate acquires civic competences.
Skills	R10. The student/graduate improves communication skills.
Responsibility and autonomy	R10. Shows spirit of initiative and entrepreneurship.

7. Contents

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark

Minimal requirements for passing the exam	

Date,

13.07.2025

Teacher's
name and signature,

Practicals/Tutorials/Project instructor(s),
name and signature

Date of approval

15.07.2025

Head of department
name and signature
Assoc. prof. Adrian RADU

Syllabus

Academic year 2025/2026
DFC.214 Volunteering

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Electricity, Solid State and Biophysics
1.4. Field of study	Fizică/Physics
1.5. Course of study	Master
1.6. Study program	Physics of Advanced Materials and Nanostructures

2. Course unit

2.1. Course unit title	Volunteering						
2.2. Teacher							
2.3. Tutorials/Practicals instructor(s)							
2.4 Year of study	2	2.5. Semester	2	2.6. Type of evaluation	verificare	2.7.Classification	DC

3. Total estimated time

3.1. Hours per week	0	3.2. Lectures	0	3.3. Tutorials/Practicals/Projects	0/0/0
3.4. Total hours per semester	0	3.5. Lectures	0	3.6. Tutorials/Practicals/Projects	0/0/0

Distribution of estimated time for study	
Learning by using one's own course notes, manuals, lecture notes, bibliography	0
Research in library, study of electronic resources, field research	0
Preparation for practicals/tutorials/projects/reports/homework	0
Tutorat	0
Other activities	0
3.7. Total hours of individual study	0
3.8. Total hours per semester	0
3.9. ECTS	1

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competences	

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	
5.2. for tutorials/practicals	

6. Learning outcomes

Knowledge	R10. The student/graduate acquires civic competences.
Skills	R10. The student/graduate improves communication skills.
Responsibility and autonomy	R10. Shows spirit of initiative and entrepreneurship.

7. Contents

8. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program

9. Assessment

Activity type	Assessment criteria	Assessment methods	Weight în final mark

Minimal requirements for passing the exam	

Date,	Teacher's name and signature,	Practicals/Tutorials/Project instructor(s), name and signature
13.07.2025		

Date of approval	Head of department name and signature
15.07.2025	Assoc. prof. Adrian RADU